How Direct Air Capture Succeeds

A Framework for Effective DAC Hubs

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The Regional Direct Air Capture (DAC) Hubs program is a historic opportunity for the US to deploy carbon removal in a way that is just, equitable, and science-driven.

The launch of this program requires mobilizing the resources of different stakeholders, including civil society, Congress and the administration, academia, project developers, the media, and state and local governments, for years to come — but it remains unclear what successful implementation of the program looks like.

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This is the second white paper in a series on the DAC Hubs program. Read part one, *Setting DAC on Track*.

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Traditionally, DAC has been graded on cost, efficiency, scalability, and durability of storage — and while important, these technical metrics don't provide a complete or dynamic view of a project's success. For one, communities that will host DAC hubs have distinct histories, cultures, politics, natural resources, and economies, and such complexity demands a definition of success beyond the technical. For DAC hubs to have long-term viability and remove millions of tons of CO_2 year over year, we need to understand the full range of non-technical factors underpinning their success and drive the policies that support them.[1]

In December 2022, the Department of Energy (DOE) issued the program's funding opportunity announcement (FOA), officially opening applications. In the spring of 2023, the agency will begin reviewing proposals to move forward. As the first US demonstration of large-scale DAC and associated infrastructure, we must develop clear, field-wide standards for evaluating the program's success. Early alignment on this criteria is critical to deploying hubs in a way that creates economic opportunities, supports innovation, and is just and equitable. Stakeholders will need to carefully gauge the program's outcomes and in turn influence the national and local perspectives of DAC as a climate technology.

In our last paper, *Setting DAC on Track*, we articulated recommendations for DOE's implementation of hubs. Now, this follow-up paper explores what success really means and offers an original framework for evaluation. Our findings are far from exhaustive or final — rather, we see this white paper as a first step, a foundation for empowering others to consider and contribute to the field's definition of success.

1. Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy, 165*. https://doi.org/10.1016/j.enpol.2022.112922

SECTION 1:

How Should We Evaluate Success?

To identify what success looks like for DAC hubs, we must acknowledge and explore what affects our understanding of success. Success is dynamic across time and perspectives. As civil society and policymakers evaluate the DAC Hubs program, it will be important to consider not just *what* to evaluate but also *when* to evaluate it, *who* is evaluating it, and *how* a project responds to and evolves from challenges.

Temporality

The definition of success can and will change over time as the program evolves and public perception shifts. The evolutionary process of technology is not linear — and as such, the frameworks for evaluation we use today may change in the long term.[2,3] For example, the net-removal rate for a hub will likely look very different in 2030 than in 2035 as technologies improve, energy systems decarbonize, and learnings from initial deployments are integrated.

Perspective

The way success is perceived will depend on different actors' histories with geography, industry, and technology. Opinions about hubs' goals — and how we meet them — will also vary by role and experience. Civil society organizations, project developers, and local and national public entities will inherently have different interests that shape their perspectives on hubs. For example, what a project developer determines to be successful engagement may not align with the engaged community's own views. A healthy amount of differences are likely to arise, and it's imperative to hold space to reach alignment and explore alternative approaches.

2. Ayres, R. U. (1994). Toward a non-linear dynamics of technological progress. *Journal of Economic Behavior & Organization*, *24*(1), 35-69. https://doi.org/10.1016/0167-2681(94)90053-1

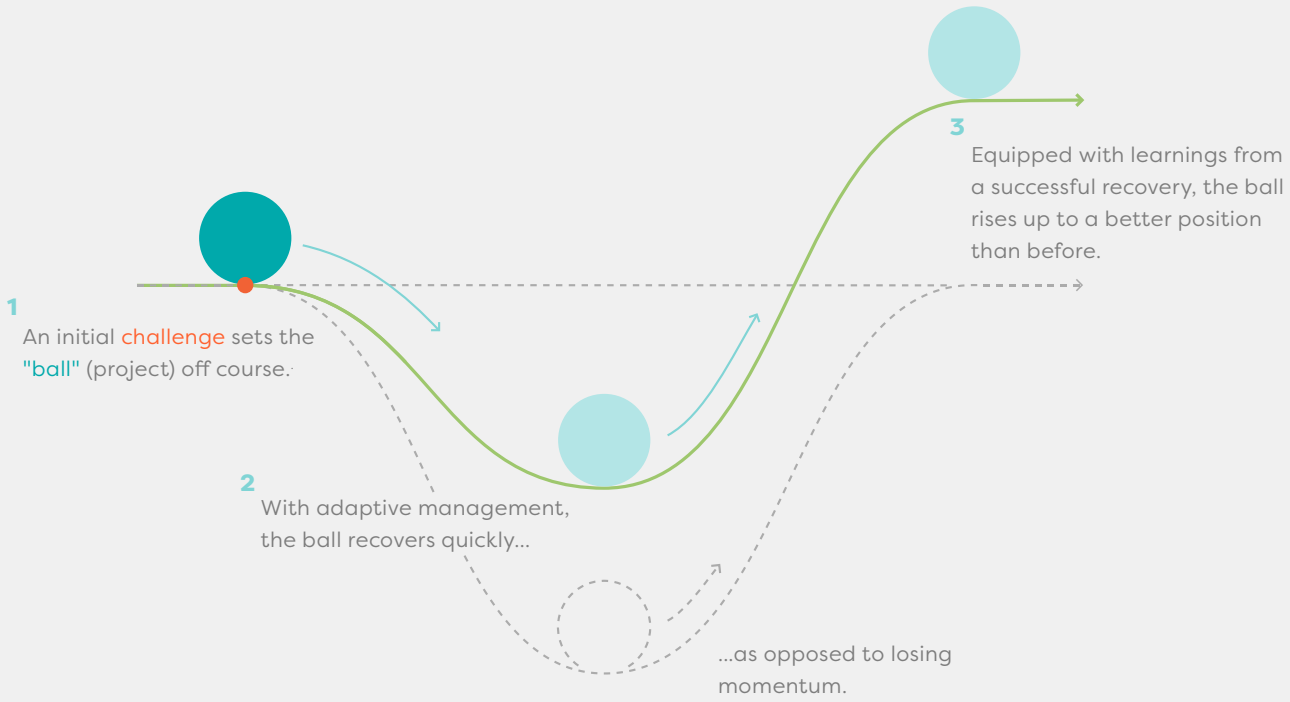
3. Minor, P. (2021, November 16). The future of DAC is knocking. *Carbon180*. https://carbon180.medium.com/the-future-of-dac-is-knocking-168326270d33

Resilience

Inevitably, challenges will arise during implementation, and how the DAC Hubs program responds will be crucial to its success. Hubs will be under many pressures — a small margin of error for scaling DAC, the tension between short- and long-term goals, and a changing political atmosphere, to name a few — while trying to sustain a program aimed at providing climate and community benefits. Stakeholders' resilience to and speed in addressing these obstacles, including learning from past models of technology development, will contribute to the program's success.

The Resilience Function for DAC Hubs

A resilient DAC Hubs program will successfully adapt to and recover from challenges, sustaining climate and non-climate benefits through changing political environments. Targeted investments, flexibility, and responsiveness to internal and external demands can put the ball back on track and potentially lead to growth from the baseline. The program may be more or less resilient depending on stakeholders' capacity, preparation, and reactions to a given challenge.



SOURCE:
Adapted from Ratcliff, N. J., Nair, D. T., Goldstein, J.R. (September 2019). The Area of Resilience to Stress Event (ARSE): A New Method for Quantifying the Process of Resilience. *The Quantitative Methods for Psychology, 15*(2), 148-173. 10.20982/tqmp.15.2.p148

CASE STUDY: THE DYNAMIC NATURE OF SUCCESS

In the 1990s, NASA set out to search for galaxies, observe star formation, and measure the properties of planetary systems.[4] To achieve this mission, they needed to build an orbiting observatory, which resulted in the James Webb Space Telescope (JWST) launching on December 25, 2021.[5] Since then, JWST has discovered the earliest confirmed galaxies to date, but not without a host of obstacles along the way.[6] In total, JWST overcame hundreds of single-point failures in deployment and post-deployment, enduring 20 years of delays from technical challenges, budgetary issues, and a shifting political environment.[7]

The project experienced several delays, and costs rose to $9.8 billion from an original estimate of $3.5 billion. JWST fell short of many key benchmarks used to measure government-funded programs and was nearly canceled.[8,9] Still, the project was buoyed by scientists and advocates who rallied to save it, even through near destruction from Hurricane Harvey.[10] JWST's precarious survival underscores the importance of building sustainable and resilient programs that can overcome various challenges.

It would have been easy to consider JWST unsuccessful at many points over the last 15 years.[11] However, JWST went on to achieve technical and political success, creating a first-of-its-kind telescope that has already collected scientifically significant findings. The popular perception of JWST today is drastically different from the past, as the scientific community, government, and civil society now view the program as a success.[12] JWST is just one example of how the definition and evaluation of success can vary with perspective, time, and resilience.

4. Space Telescope Science Institute. (n.d.). *Webb Project History*. https://webbtelescope.org/news/webb-science-writers-guide/webb-project-history
5. US National Aeronautics and Space Administration. (n.d.). *About Webb Launch*. https://webb.nasa.gov/content/about/launch.html
6. O'Callaghan, J. (2022, September 14). JWST's First Glimpses of Early Galaxies Could Break Cosmology. *Scientific American*. https://www.scientificamerican.com/article/jwsts-first-glimpses-of-early-galaxies-could-break-cosmology/
7. US Government Accountability Office. (2020, January 28). *James Webb Space Telescope: Technical Challenges Have Caused Schedule Strain and May Increase Costs*. https://www.gao.gov/products/gao-20-224
8. Leone, D. (2011, July 8). House Proposal To Kill Webb Telescope Sets Stage for Showdown with Senate. *SpaceNews*. https://spacenews.com/house-proposal-kill-webb-telescope-sets-stage-showdown-senate/
9. Overbye, D. (2018, June 27). NASA Again Delays Launch of Troubled Webb Telescope; Cost Estimate Rises to $9.7 Billion. *The New York Times*. https://www.nytimes.com/2018/06/27/science/webb-telescope-nasa.html
10. Koren, M. (2017, August 28). NASA's New Space Telescope Is in Harvey's Path. *The Atlantic*. https://www.theatlantic.com/science/archive/2017/08/james-webb-houston-harvey/538212/
11. US Government Accountability Office. (2021, May 13). *James Webb Space Telescope: Project Nearing Completion, but Work to Resolve Challenges Continues*. https://www.gao.gov/products/gao-21-406
12. US National Aeronautics and Space Administration. (2022, July 11). *President Biden Reveals First Image From NASA's Webb Telescope*. https://www.jpl.nasa.gov/news/president-biden-reveals-first-image-from-nasas-webb-telescope

GLOSSARY

Single-point failure
An event in which part of a system fails and prevents the entire system from working.

SECTION 2:

Early Conversations on Program Success

With these considerations in mind, we assembled a workshop for carbon removal experts to voice what was important to them in gauging hubs' success. This group included academics, funders, and a range of NGOs. The resulting discourse gave insight into where consensus exists, where differences must be reconciled, and how establishing a framework for success could benefit stakeholders. While we tapped a diversity of opinions, this was just one of many conversations that must be held to build a strong foundation for the program moving forward.

Together, workshop participants identified the below priorities for measuring the success of hub deployment.

- **COLLABORATION BETWEEN CARBON REMOVAL, ZERO-CARBON ENERGY, AND TRANSMISSION FIELDS:** Workshop attendees expressed that coordination between program administrators in carbon removal, zero-carbon energy, and transmission fields would yield the most effective use of federal resources and taxpayer dollars. Attendees felt that policymakers must work alongside developers in key sectors to leverage DAC-adjacent programs in the Infrastructure Investment and Jobs Act (IIJA) and maximize social, economic, and environmental impact. Coordination between DOE and the network of developers for DAC, geologic storage, and renewable energy can unite efforts across varying components of DAC hubs and the energy transition.
- **COMMUNITY EDUCATION, ENGAGEMENT, AND WORKFORCE DEVELOPMENT:** Participants discussed the importance of DOE and project developers sharing information about DAC technologies with potential host communities. Workshop attendees conveyed that it's important for project developers to build honest relationships with community-based organizations (CBOs) throughout the conceptualization, construction, and full operation of awarded projects. For example, some communities will place value on the source of project funding, accepting funders who share their fundamental values and rejecting those who contribute to other injustices faced by their communities. To ensure that employment opportunities and economic benefits stay within local communities, DOE should provide education and skills development opportunities.

GLOSSARY

Community-based organizations (CBOs) Nonprofit groups that represent a community, or a significant segment of a community, and provide educational or other services to its individuals. These organizations can include faith-based organizations, environmental justice organizations, and advocacy groups. (Source: Legal Information Institute)

While there is agreement on the need for strong community engagement practices, there remains uncertainty across participants about how to do it well — and how to balance the time required to build trust with communities with the urgency of scaling carbon removal solutions. For more recommendations on labor and economic opportunities and community outreach and engagement, see DOE's latest community benefits plan guidance and our *Removing Forward* report.[13,14]

- **EFFICIENT PLANNING AND RESOURCE MANAGEMENT PRACTICES:** Projects awarded through the DAC Hubs program will likely need technical and financial support from other DOE programs related to storage, utilization, energy, and carbon management. DOE should ensure that awarded projects are appropriately positioned to receive all the funding they need to operate and succeed. Efficient infrastructure design, development, and funding can help create shared benefits across relevant programs.
- **ROBUST STANDARDS FOR MONITORING, REPORTING, AND VERIFICATION (MRV):** The discussion uncovered that reliable, quantitative data on carbon removal, durable storage, and associated ecosystem impacts will be important in communicating the credibility of DAC as a climate solution. High-quality and accessible reporting allows civil society and policymakers to make informed decisions about projects, fosters accountability for all stakeholders, and ensures that projects deliver on the proposed outcomes. Project data must be collected, reported, and verified using open-source MRV protocols that reduce fraud and maximize public benefit.

However, we also found a lack of consensus on a number of topics.

- **THE ROLE OF ENHANCED OIL RECOVERY (EOR) IN THE DAC INDUSTRY:** Some participants believe that DAC coupled with EOR can yield fuels with lower emissions intensity, jumpstart industry markets in places with a CO_2 storage workforce and market,[15] and efficiently use existing infrastructure. But for some participants, EOR signals that DAC and other carbon removal solutions could reinforce existing environmental injustices experienced by underserved communities as a result of the oil and gas industries.

13. US Department of Energy. (2022). *Community Benefits Plan Frequently Asked Questions.* https://www.energy.gov/bil/community-benefits-plan-frequently-asked-questions-faqs
14. Kosar, U. & Suarez, V. (2021). *Removing Forward: Centering Equity and Justice in a Carbon-Removing Future.* Carbon180. https://carbon180.org/s/Carbon180-RemovingForward.pdf
15. Meckling, J., Biber, E. (2021). A policy roadmap for negative emissions using direct air capture. *Nature Communications, 12.* https://doi.org/10.1038/s41467-021-22347-1

- **IF AND HOW TO PROPEL FRONTIER TECHNOLOGIES ALONGSIDE SCALE-READY TECHNOLOGIES:** Some participants favored funding incubator programs or collaborative innovation centers — supporting DAC of various maturities — for their ability to diversify engineering risks and increase the pace of scale-up by a portfolio approach. Others expressed that DOE should reserve hubs for deployment-ready technologies, citing the National Energy Technology Laboratory (NETL) DAC Test Center and its pre-commercial and commercial prizes as existent launchpads for emerging technologies.[16]
- **BEST PRACTICES FOR INFORMATION SHARING AND TRANSPARENCY IN DEPLOYMENT:** Participants agreed on a need for increased clarity around information-sharing agreements between DOE, project developers, and civil society. These actors will need to develop best practices to coordinate on project status, updates, and lessons throughout hub deployment. Such protocols will be crucial for ensuring a program that regularly evaluates and reports on new information. However, in our workshop, it was unclear what the best practices for information-sharing should be, and some participants had specific concerns about protecting intellectual property for developing technologies.

16. H.R.133 - 116th Congress (2020-2021): Consolidated Appropriations Act of 2021. (2021, December 27). https://www.congress.gov/116/plaws/publ260/PLAW-116publ260.pdf

SECTION 3:

Our Framework for Evaluating Success

The workshop showed us where there is shared understanding of hub implementation and where consensus is still developing across the field. Guided by our workshop, organizational values, and policy and technical knowledge, we created an original framework to measure program success. This framework, while comprehensive, is of course not the final word for defining success. Crafted with the recognition that these hubs will evolve through technical and social challenges, the framework is a tool to help the field evaluate the program's outcomes over time. These shared attributes for impact and accountability can help us execute a DAC Hubs program that rapidly and equitably removes carbon.

The following themes guided the development of our framework.

Climate and environmental justice must be centered in the implementation of the DAC Hubs program.

DAC is a climate tool that can serve the public good; it should be used to remove legacy carbon emissions in ways that do not enable fossil fuel extraction and infrastructure. Successful DAC hubs will uphold a commitment to climate and environmental justice while laying the groundwork for high-quality DAC untethered to the extraction of fossil fuels. Carbon removal advocates — including the federal government and project developers — bear the burden of proof in demonstrating tangible community benefits aligned with justice priorities. Government-funded projects should not spend public dollars to continue the very activities that have caused environmental harm and disproportionate impacts on Black, Indigenous, and people of color (BIPOC) and low-income communities.[17]

DAC hubs should empower communities.

Projects that incorporate community voices and values heighten their chances of success by building an equitable decision-making process. Meaningful public engagement is key, and communities should be supported with dedicated funding, time, and capacity building.[18] These steps help ensure that benefits from DAC hubs — including power, wealth, and resources — flow back to communities.

17. Kosar, U. & Suarez, V. (2021). *Removing Forward: Centering Equity and Justice in a Carbon-Removing Future.* Carbon180. https://carbon180.org/s/Carbon180-RemovingForward.pdf

18. Fraser, C. (2022, July 6). *Community Benefits Agreements Offer Meaningful Opportunities to Include Voters' Voices in Development.* Data For Progress. https://www.dataforprogress.org/blog/2022/7/5/community-benefits-agreements-offer-meaningful-opportunities-to-include-voters-voices-in-development

A portfolio approach is key.

Today's technology will not necessarily be the most efficient or cost-effective in the long term. Innovation will play a significant role in scaling annual DAC capacity from 10,000 metric tons to 1 million metric tons, driving down the cost of technologies and creating continued benefits. This program should invest in a portfolio of DAC technologies and enable the incubation of less-established approaches, which will benefit from proximity to other developers, ancillary infrastructure, and pre-permitted sites.

Transparency and information sharing will enable more efficient innovation and public oversight on program progress.

DAC hubs provide an opportunity to create a system where public and private sectors can share project information without compromising intellectual property. To that end, open data is critical to building trust with communities and setting up potential technology transfers with other climate-vulnerable nations.

The original framework below charts the ideal outcomes for hubs across four categories: technology, politics, justice, and economics. We've determined certain attributes within these four categories that are the strongest markers of long-term success.

A framework to assess the DAC Hubs program's success

CATEGORY	ATTRIBUTE	DESCRIPTION
Technology	Encourages a diversity of design and technology	DAC hubs should employ a diverse portfolio of DAC technologies, durable storage opportunities, zero-carbon energy resources, and conversion opportunities. The technologies ready for demonstration today will not necessarily be the most efficient or cost effective. Supporting less-established technologies within regional clusters will avoid technological lock-in and enable innovation, optimizing the long-term climate impact of DAC within and beyond the four initial hubs.
	Champions technological learning, sharing, and improvement	DAC hubs should champion open and transparent practices for sharing information and learning as different technologies advance through project phases (e.g., site selection, front-end engineering and design, construction, demonstration, and commercial operation). DOE should track the progress of projects as they advance through readiness levels and remain flexible in responding to potential engineering and operational hurdles. Accessible reporting on project progress, challenges, and operations can help maximize deployment efforts, avoid recurring challenges, and foster community trust. Critically, robust standards around MRV and subsequent data management can help advance these goals.

A framework to assess the DAC Hubs program's success *(Continued)*

CATEGORY	ATTRIBUTE	DESCRIPTION
Politics and government	Strengthens political feasibility	To establish DAC's technological legitimacy, future scalability, climate impacts, and potential community benefits, DAC hubs should be geographically diverse facilities capable of removing 1 million metric tons of CO_2 per year and achieve wide political support. Policymaker and public education regarding DAC hubs' technical, political, justice, and economic opportunities and limitations will be important to building widespread trust in the government's ability to shepherd these technologies to maturity.
	Evaluates permitting and regulatory considerations and processes	Agencies (e.g., Environmental Protection Agency, Council on Environmental Quality, etc.) should be equipped to expediently and safely permit and regulate infrastructure.[19,20] In addition, DOE, the Department of Interior, and other relevant agencies should work closely with DAC developers to contextualize and interpret environmental laws to meet the novel technical considerations of DAC siting. DOE should be prepared to provide technical assistance to regulatory agencies to adapt and apply frameworks initially created for emitting facilities or carbon management technologies.

19. EPA, CEQ, and other federal departments and agencies are members of the Federal Permitting Improvement Steering Council (FPISC), created by FAST-41 and tasked with improving federal infrastructure permitting.

20. US Government. (2019, August 28). *Federal Permitting Improvement Steering Council (FPISC) Agencies.* Federal Infrastructure Projects Permitting Dashboard. https://www.permits.performance.gov/about/federal-permitting-improvement-steering-council-fpisc-agencies

A framework to assess the DAC Hubs program's success *(Continued)*

CATEGORY	ATTRIBUTE	DESCRIPTION
Justice	Builds meaningful community engagement for decision making, including siting	The DAC Hubs program should provide diverse, equitable, and inclusive opportunities for public participation and empower communities to make decisions about implementation (e.g., siting hubs in communities that welcome them). DAC is a climate technology that should be collaboratively designed with the expertise and input of various groups, including NGOs, universities, CBOs, labor organizations, and technology developers, as well as local, state, and federal agencies. To that end, DOE should require project developers to provide educational workshops and other resources about their technology to interested communities.
	Ensures good labor practices	Hubs will define the workforce, skills, and supply chains needed to build commercial-scale DAC in the US. DOE should provide skills and workforce development opportunities to communities open to hosting a hub. DAC hub projects should prioritize sourcing from local businesses and contractors, pay at or above the prevailing wage, and commit to codifying long-term project labor agreements and community benefits agreements (CBAs). Hub facilities must also uphold health and safety in the workplace. Additionally, hubs should provide transition assistance for fossil fuels workers and dedicated support to underserved groups to ensure all communities have fair access to job opportunities.

GLOSSARY

Community benefits agreements (CBAs)
Legal, enforceable agreements co-created by community groups and project developers that require a developer to provide specific amenities and/or mitigations to the local community.

A framework to assess the DAC Hubs program's success *(Continued)*

CATEGORY	ATTRIBUTE	DESCRIPTION
Economics	Supports economic development	Initial hubs should incite job creation and investment beyond the hubs and their associated infrastructure. Hubs can spur manufacturing, engineering, and service opportunities across sectors and regions. If curated effectively, hubs will establish clear demand for materials and skill sets across sectors, providing both local and national economic opportunities.
	Fosters field-wide innovation and growth	DAC hubs should provide opportunities for developers of early-stage technologies to be included and immersed in the learning environment created by hubs. In addition, hubs should support future deployments of DAC by developing shared infrastructure and finding ways to de-risk the market for carbon removal.

These attributes should be evaluated carefully by civil society and policymakers over time, and standards will shift accordingly as program implementation progresses. As a field, we're only beginning to shape this program, but this set of attributes can serve as the foundation for a shared framework of success for a diversity of stakeholders.

SECTION 4:

How Stakeholders Can Advance Success

With DAC hubs, DOE is aiming to do a lot — help the US meet climate goals, fulfill the needs and values of communities, and scale a still-nascent industry the right way. And while the agency will lead implementation, they won't be making decisions or acting alone. To attain the outcomes in our framework, multiple sectors and federal agencies must be involved, with responsibilities shifting over time.

As hubs unfold, it's also important for a diverse ecosystem of external groups to hold DOE and project developers accountable for the program's ambitions. External stakeholders, especially civil society organizations, can measure hubs' outcomes against the ideal outcomes we explore in our framework to gauge the program's success, particularly in a changing political climate. The criteria can be adapted for use across program stages and technological breakthroughs.

While these actors each have their own interests for hub implementation and outcomes, their roles will be deeply interconnected, and communication between them will help shape success.

To start, DOE should facilitate clear and honest communication between developers and community members about project details. However, developers can't and shouldn't be the sole resource on DAC projects; media and civil society organizations should serve as translators for the public, who will count on them to provide timely, factual, and unbiased information. At the same time, the federal government has the responsibility to share clear, accessible, and timely updates about projects they oversee and correct any miscommunication. Together, stakeholders can check and balance each other to minimize uncertainty and prevent misinformation.

The following table identifies and describes a cross-section of stakeholders who will be central to creating just, sustainable, and innovative outcomes.

Stakeholders involved in achieving a successful DAC Hubs program

CATEGORY	SUBCATEGORY	ROLES AND RESPONSIBILITIES

Federal Executive Branch	DOE	• Evaluate applications for DAC hubs funding using the Carbon Negative Shot framework as a guiding tool:
		  • Require and support meaningful public engagement processes to ensure community priorities are addressed and to foster trust, including the facilitation of transparent communication between project developers and community members
		  • Mandate funding milestones that include community consent deadlines and third-party oversight
		  • Provide open, clear, and transparent information on decisions for technology and project selection
		• In coordination with the Department of Labor (DOL), oversee and audit contracting to ensure high-road labor practices
		• Coordinate the design and implementation of other programs from IIJA with DAC hubs to maximize efficiency and effective use of public funds
		• Develop robust MRV protocols across CDR approaches in coordination with the private sector and other agencies
		• Provide public, accessible, and timely information about projects that are underway

	EPA	• Increase capacity and expertise to conduct efficient and safe permitting assessments for necessary infrastructure (e.g., Class VI wells) • Provide regulatory oversight for demonstrations, both during construction and operation
	White House	• Align on political goals across relevant White House offices (including the Office of Science and Technology Policy, CEQ, the Climate Policy Office, and FPISC) • Coordinate across DOE, DOL, EPA, and other relevant agencies to ensure responsible and efficient implementation

Stakeholders involved in achieving a successful DAC Hubs program *(Continued)*

CATEGORY	SUBCATEGORY	ROLES AND RESPONSIBILITIES
State & Local Government	State environmental agencies and city governments	• In coordination with federal requirements, conduct efficient and safe permitting assessments for necessary infrastructure • Ensure local governments and communities are empowered to make decisions in the engagement process
Civil Society	Labor unions	• Inform and impact labor practices around DAC hubs' capture, storage, and utilization (e.g., prevailing wages, Made in America commitments, and registered apprenticeship commitments)
	NGOs	• Inform and impact supporting hub policies • Influence and comment on labor and public engagement practices • Externally assess carbon accounting practices and outcomes • Serve as oversight-oriented third parties for MRV of DAC hubs projects to ensure accountability • When possible, participate in DOE's independent assessment panels to ensure merit-based and fair outcomes in DAC hub project selection
	CBOs	• Assess and evaluate labor and public engagement practices • Provide feedback on community-centered activity • If the opportunity arises, participate in independent assessment panels for DOE to ensure merit-based and fair outcomes in DAC hub project selection
Project Developers		• Conduct public engagement processes in coordination with DOE and CBOs to ensure community priorities are addressed and to build public trust • Provide open, clear, and transparent information on decisions for technology and project selection • Provide transparent progress updates on engineering and construction • Conduct robust carbon accounting in effort to attain negative emissions • Comply with government-led MRV standards

Stakeholders involved in achieving a successful DAC Hubs program *(Continued)*

CATEGORY	SUBCATEGORY	ROLES AND RESPONSIBILITIES
Congress		• Hold DOE accountable to congressional language and selection criteria • Write and pass supportive and enabling legislation to unlock the full potential of DAC and other CDR approaches to address challenges within and beyond DAC hubs
Media		• Provide the public with information and updates on the progress of specific projects and the overall program, including success or challenges • Disseminate engagement opportunities to the public
Academia		• Continue to pursue early-stage research and development as well as social science analysis of hub implementation • Function as community advocates, educators, and trusted third-party researchers

Conclusion

As the first US effort to coordinate regional DAC infrastructure, the hubs program will define this nascent industry for decades to come. The margin for error is small, and success must be achieved across a number of dimensions, to ensure we are on a just and sustainable path towards removing legacy emissions. We know that the DAC Hubs program will face significant hurdles, but aligning on a shared, resilient framework for success will support the program in achieving its mission.

Our framework for hub success can shape the burgeoning DAC industry to align with the interests of a broad set of stakeholders. The framework captures a diverse set of priorities, and each attribute describes an important piece of a successful program.

During implementation, policymakers must work together to create strong supporting policies that ensure DAC hubs can measure up to the attributes of success explored in this paper. We hope to see advocates and skeptics alike voice their priorities and concerns for this program moving forward, and DOE should be nimble in assessing this stakeholder input in implementation. As the vision for successful DAC hubs expands and represents an increasingly inclusive set of stakeholders, so does our potential to scale this critical climate solution.

Acknowledgements

We would like to extend our thanks to the below organizations for participating in our workshop on the successful implementation of the Regional DAC Hubs program. Their perspectives informed our understanding of the roles federal and local actors will play in determining the program's success and our overall vision for the program, which anchors our original framework for hub success. Their participation is not an endorsement of this document.

To learn more about any of the information in this report, email policy@carbon180.org.