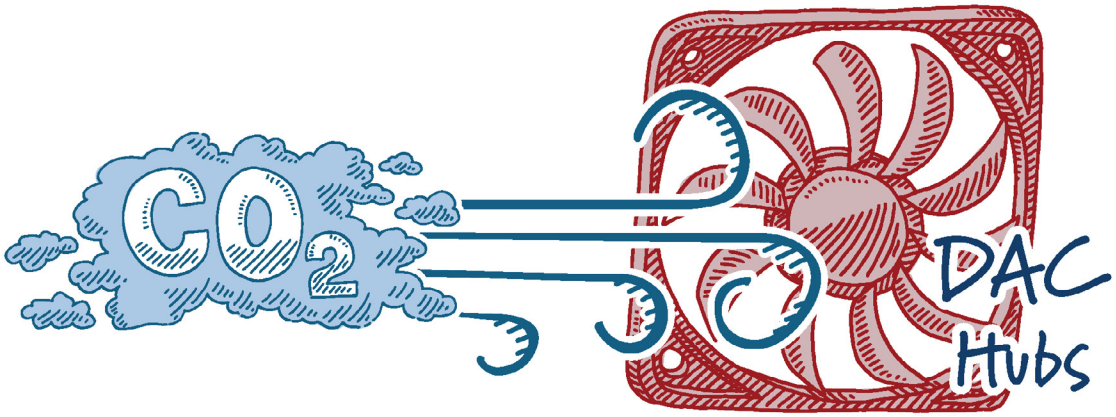


# Clearpath Direct Air Capture Hubs Implementation Recommendations

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# Purpose

This memo provides recommendations for the successful deployment of carbon removal solutions and implementation of direct air capture (DAC) hubs by the Department of Energy (DOE), as authorized and appropriated under Section 40308 of the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58).

# Background

Nearly all climate and energy models, including models done by the Intergovernmental Panel on Climate Change (IPCC) and International Energy Agency (IEA), indicate the need for a near-term focus on carbon dioxide removal (CDR) development and deployment to achieve carbon neutrality by 2050. In tandem with other sector-specific decarbonization strategies, carbon removal solutions are required to tackle emissions that have already been released into the atmosphere. Private organizations are already recognizing this reality as many have started to establish voluntary net-zero targets. The need for carbon removal has also been heightened because while some companies have begun to decarbonize their operations, an array of difficult to decarbonize sectors such as steel, cement, and chemicals will necessitate carbon removal to reach net-zero emissions.

While Congress does not have a robust history of work on cross-cutting carbon removal technologies, progress has been made over the last several years. First, the Energy Act of 2020, signed into law by President Trump which contained bipartisan carbon removal legislation. Second, as outlined below, the IIJA made historic investments in the deployment of direct air capture. Most recently, the Department of Energy announced its carbon removal Earthshot which is expected to provide significant resources for this technology.

### *Infrastructure Investment and Jobs Act (IIJA) of 2021*

The IIJA authorizes and appropriates funding for two key provisions for DAC carbon removal technologies. It provides $3.5 billion between 2022 to 2026 for four regional DAC hubs each with the capacity to capture 1 million metric tons (MMt) of $CO_2$ annually.[1]

### *Required Legislative Criteria*

The IIJA included a set of criteria that the DAC hubs will need to follow in order to be eligible for federal funding and support:

- **Carbon intensity of local industry:** Projects are to be located in a region with either existing or retired (in the last 10 years) carbon-intensive fuel production or industrial capacity. Geographic diversity: DAC hubs should be located in different regions of the U.S.
- **Carbon potential:** Projects should be located in regions with high potential for carbon sequestration or utilization.
- **Hubs in fossil-producing regions:** Two regional DAC hubs should be located in economically distressed communities within the U.S. with high levels of coal, oil, or natural gas resources. This could include communities in states like Tennessee, Kentucky, South Carolina, New Mexico, Alabama, Arkansas, Louisiana, West Virginia, Texas, Alaska, and Mississippi.[2]

- **Scalability:** Prioritize projects with larger initial capacity, greater potential for expansion, and lower levelized cost per metric ton of $CO_2$ removed from the atmosphere.
- **Employment:** Prioritize projects that are likely to create opportunities for skilled training and long-term employment to the greatest number of residents of the region.
  Timelines:
    - ***Proposal solicitation:*** No later than 180 days after enactment of IIJA
    - ***Additional solicitations:*** Applications for funding may occur on a recurring basis after the first round of applications is received until all amounts appropriated are spent.
    - ***Project Selection:*** No later than three years after the date of the deadline for the submission of proposals.
    - ***Appropriated funding:*** $3,500,000,000 for fiscal years 2022 through 2026, to remain available until spent.

# Recommendations

The purpose of this memo is to provide recommendations for the successful deployment of carbon removal solutions and implementation of direct air capture (DAC) hubs by the Department of Energy (DOE), as authorized and appropriated under Section 40308 of the Infrastructure Investment and Jobs Act (IIJA).

## *Co-location*

In selecting a hub location, it is recommended that the following factors are prioritized:

- Leveraging existing infrastructure and/or other DOE projects
    - Locating DAC hubs close to hydrogen hubs and carbon capture, utilization, and storage (CCUS) demonstration sites can leverage pipeline infrastructure.

- Proximity to geologic storage sites, pipelines, or transportation infrastructure
    - Ensuring that a DAC hub will have easy access to a storage site, such as one identified through DOE's Carbon Storage Assurance Facility Enterprise (SAFE) program, or at the very least transportation infrastructure, such as pipelines, would ensure that captured carbon would be efficiently stored or utilized. Additionally, the closer hubs are to storage sites the lower the cost will be to transport and store the carbon.

- Regions with high wind velocity and/or proximity to high clean power production and clean heat sources such as Alaska, Wyoming, Montana, Nebraska, South Dakota, Oklahoma, Wisconsin, and Texas.[3,4]
    - DAC units function in a similar fashion to air filters, they require significant airflow to be able to strip out large quantities of $CO_2$ from the atmosphere. This is why placing a hub in regions with high winds would allow hubs to optimally function and remove $CO_2$. If this is not possible, the alternative would be to locate a hub in regions with high clean power production to ensure that, if more power is required to increase airflow and $CO_2$ scrubbing, hubs are utilizing low emission power sources.

- Location will also need to factor in the energy source required to run the specific DAC technology. The energy used to capture the $CO_2$ will determine, from an emissions standpoint, how net-negative the system is on a life-cycle basis and can also play a part in determining the cost per metric ton of $CO_2$ captured. The IEA notes that both solid and liquid capture technologies can be fueled by clean energy sources, while recovered low-grade waste heat from clean heat sources, such as geothermal or nuclear cooling towers, could power a solid DAC system.[5]

## *Guidance for DAC Hub Applicants*

The authorization text allows flexibility for DOE to decide how to select and deploy projects, particularly regarding which entities are eligible to apply. As DOE begins issuing Funding Opportunity Announcements (FOAs) to select projects, DOE should provide additional clarity on the following items:

- Eligible entities
  - The FOA should provide guidance on who would be eligible to apply for funding and in instances in which multiple entities apply in one bid, applications should require a detailed and agreed-upon distribution of federal funds.
  - To avoid impeding otherwise promising projects, individual projects that do not meet the 1 $MMtCO_2$ capacity should be eligible to receive funding on the condition that they construct common carrier transportation and storage infrastructure to facilitate supplemental capture capacity allowing the site to achieve 1 $MMtCO_2$ cumulatively.

- Definition of a "hub"
  - The statutory text provides a very broad definition of what constitutes a "hub," and clarification should be provided on whether that is a singular entity or a structured consortium of entities.
  - Flexibility to allow multiple projects to collectively meet the capture threshold requirement, as no singular project on a megaton level has ever been built historically.
  - Flexibility should be provided to allow multiple projects to collectively meet the capture threshold requirement, as no singular project on a megaton level has been built historically. Clarification should be provided on if it is an individual project, whether each project needs to feed into the same transportation network, and if there can be multiple transportation networks for storage and/or utilization.
  - Flexibility should be provided on how much time is given to each project to meet their $CO_2$ capture capacity. Meeting the annual capture capacity will likely take years to achieve as facilities are built out, tested, and become operational.

- Carbon-intensive fuel production
  - Clarification should be provided on what is meant by a carbon-intensive fuel production region. Having said this, though a definition is important this should not be the sole criteria as it will be important to understand performance in various geographic settings and climates as this will allow developers to analyze and optimize their technology as needed to perform efficiently in various settings.

- What to include in each FOA application
    - Project $CO_2$ capture capacity, technology specifics, funding allocations, prior DAC project experience (if relevant), estimated cost, timeline to completion, etc.

- Integrate flexibility into the application and review process
    - Though it is important to provide clear guidance for the DAC hubs, there may be instances where ambiguity and flexibility are best. For example, it might be beneficial to specify that a minimum of two DAC technologies must be used but not specify which technologies to encourage diverse and sophisticated solutions.

### *Timelines*

Coordinating construction and operation across multiple systems and projects concurrently to reach the same timeline will be challenging, therefore it is preferable to establish a network of multiple DAC projects with a collective capture capacity of 1MMt$CO_2$ or greater at the time of completion. Accordingly, the Regional DAC hubs provisions should set a deadline of 2030 for which eligible hubs will achieve and maintain a collective capacity of at least 1MMt$CO_2$ per year to accommodate multiple construction timelines and unforeseeable barriers.

Furthermore, projects should demonstrate they have secured or are working to secure an offtake agreement for the captured $CO_2$ at the time of application. If an offtake agreement is not secured at the time of application, then a reasonable deadline such as before construction commences should be provided to ensure that a project is able to store or utilize the captured $CO_2$ once the system is operational.

Finally, permitting processes can also delay timelines and result in increased project costs. Siting of these projects must take into account local and state ordinances; therefore, these projects should be sited in locations where the existing regulatory regime facilitates timely deployment.

### *Technological Diversity*

Current DAC technologies include but are not limited to sorbent, solvent, membrane, amine, or a combination of materials to capture $CO_2$ from the atmosphere. DAC technology should be diverse among the four hubs; having two or more types of DAC technologies to track and analyze the efficiency of each material in various geographical locations. Additionally, DAC system sizes range from small modular systems to larger systems, therefore having various sized solutions will allow providers and the DOE to track the success of each system operating within any given hub.

### *Coordination With Other DOE Programs*

Outside of carbon removal specific provisions, the IIJA also provides significant funding for carbon capture, carbon storage, and $CO_2$ pipeline and transport infrastructure and mandates coordination with the carbon capture technology program established under section 962(b)(1), the carbon storage validation and testing program established under section 963(b)(1), and the carbon dioxide transportation infrastructure finance and innovation (CIFIA) program established under section 999B(a). Additionally, offices such as the

Advanced Research Projects Agency–Energy (ARPA-E), Loan Programs Office (LPO), and Office of Fossil Energy and Carbon Management (FECM) should be coordinated with in order to pilot technologies already in their pipeline and leverage technical assistance. Finally, DOE should determine how to leverage other opportunities across programs to efficiently utilize funding and ensure maximum project delivery.

### *Life-Cycle Analysis & Techno-Economic Analysis*

Understanding the full costs and benefits (both economic and environmental) is crucial to properly scale up DAC technologies. Each hub should conduct life-cycle and techno-economic analyses on each system on-site per DOE's methodology. A life-cycle analysis will help understand how many emissions are produced per metric ton of $CO_2$ that's removed and determine if this varies between technologies, geographic location, climate, system size, etc. A techno-economic analysis will also help inform the economics of scaling a DAC system and if there are cost-point areas to be wary of depending on the type of system.

## Conclusion

The carbon removal investments in the IIJA provide a never-before opportunity to advance DAC technology. Successful implementation of the DAC Hubs and prioritizing technological diversity of DAC materials will ensure the success of this program and deployment of this integral climate solution. IIJA requires that bids for the program be solicited within 180 days of enactment, which would be May 14, 2022. These recommendations can help achieve that deadline and advance the development of successful DAC hubs.

## Sources

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