BetterHubs

Decarbonizing industry across the global economy will be an enormous challenge. To tackle it, billions of dollars are being invested globally in new industrial "Hubs" designed to cluster clean energy infrastructure and enhance outcomes for the climate and economies. These efforts present an opportunity to create a new paradigm for environmentally conscious and community-centered industrial planning and design. To protect both people and the planet, we can and must do it better than ever before.

ABOUT

BetterHubs aims to help governments, companies, investors, and local communities design and engage with decarbonization Hub projects in a way that sets a higher bar to ensure that industrial innovation drives positive outcomes for the climate and local communities.

Billions of dollars are being invested in Hub energy projects around the world.

Implemented wisely, these projects have great potential to significantly reduce emissions, jumpstart clean strategies across economic sectors, and address the legacy of inequity that has permeated industrial development for generations.

Implemented poorly, the Hubs will fail to meet their climate aspirations, and repeat or potentially compound equity failures of the past.

BetterHubs aims to help all Hubs stakeholders have an informed and actionable dialog about what "better" can look like.

The resources that will be made available here are designed to help regulators, developers, investors, and community stakeholders understand the opportunities and challenges, advance project objectives, and lay the groundwork for meaningful engagement and effective outcomes. Importantly, EDF hopes to see this effort enhance collaboration among partners and public stakeholders as the ideas here are built on over time.

BetterHubs is an Environmental Defense Fund initiative.

Please reach out to betterhubs@edf.org with your ideas, insights, or questions on these topics.

Learn more about our work and vision.

ABOUT U.S. HUBS

Historic legislation, including the U.S. Infrastructure Investment and Jobs Act and the Inflation Reduction Act, will inject tens of billions of dollars into decarbonization projects across the country including the development of Clean Hydrogen and Direct Air Capture Hubs. The Department of Energy will award and distribute this investment via a process through which regions, companies and other entities can join forces to propose game-changing demonstration and commercialization projects. Critically, this process requires a community engagement plan and evaluation.

You can learn more about DOE's approach to the Hub projects, timelines, and other materials here:

Infrastructure Investment and Jobs Act

Regional Clean Hydrogen Hubs and Funding Opportunity Announcement

Regional Clean Direct Air Capture Hubs and Funding Opportunity Announcement

CORE OBJECTIVES

Monitor and Mitigate Climate Pollutant Emissions

Track, Minimize, and Mitigate Local and International Environmental Impacts

Responsibly, Equitably, and Efficiently Site and Resource Hub Operations

Demonstrate Safe and Effective Carbon Management from Capture to Sequestration if Applicable

Deploy Rigorous Community Engagement and Partnership

Foster Diverse Local Economic Development Opportunities

Comply with Advanced Protective Regulatory Frameworks

Demonstrate Added Value and Necessity as a Clean Energy Solution

Maximize Transparency and Foster Information Sharing

Safely Transport and Store Materials and Products

Hubs comprehensively monitor and have a mitigation plan for climate pollutant emissions across the Hub value chain.

WHAT IT MEANS IN PRACTICE

Hub developers demonstrate knowledge of the implications of climate pollutant (e.g., CO2, CH4, H2) emission risks across the value chain they are part of and incorporate appropriate strategies to minimize, monitor, and mitigate emissions (leakage or venting) of any climate impacting pollutant through feasibility analysis, development plans, and outreach materials.

Infrastructure (esp. relating to hydrogen, natural gas, carbon management (see Carbon Management Objective)) includes robust leak prevention design; measurement, reporting, and verification; and mitigation plans for leakage of all climate pollutants, direct and indirect.

**While companies should pursue common sense practices for H2 containment learned from experiences with methane and other pollutants, EDF notes that monitoring equipment is not yet commercially available to measure hydrogen concentrations at the parts-per-billion level necessary to accurately measure emissions from large portions of the value chain and assess climate impacts — current tools to detect leakage for safety monitoring alone are not precise enough for this objective. EDF expects advancement in this area in the short-term.*

TARGETED OUTCOMES

Emissions are limited such that, where applicable based on the Hub type:

- Hubs are prepared to meet a <1% hydrogen emissions goal for the value chain including production, storage, transport, and end use.
- Hubs support and participate in research and development of sensor equipment capable of detecting hydrogen emissions with sufficient precision to be confident they are minimal.
- Hydrogen end-uses have defined plans to mitigate hydrogen emissions and control related pollutants (e.g., NOx).
- Total methane emissions from upstream natural gas production are well below 0.2% (see OGCI and OGMP) with decreasing rate over time as technology improves.
- Carbon dioxide emissions are captured and minimized and safely managed through permanent storage (see Carbon Management Objective).

RESOURCES

9 recommendations for getting US hydrogen hubs right from the start

STUDY: Emissions of Hydrogen Could Undermine Its Climate Benefits; Warming Effects Are Two to Six Times Higher Than Previously Thought

Climate consequences of hydrogen emissions

Assessment of methane emissions from the U.S. oil and gas supply chain

What policy options are available to address methane emissions from the oil and gas sector?

Methane: A crucial opportunity for climate fight

EDF Blog: What DOE should consider as it makes decisions on Carbon Capture and Storage Demonstration Projects

Hubs commit to tracking, minimizing, and mitigating associated local and international environmental impacts of Hub build out.

WHAT IT MEANS IN PRACTICE

Hubs include plans to minimize environmental impacts and demonstrate that to be the case by assessing, monitoring, managing, and remediating impacts beyond GHG emissions tied to both their direct operations and, wherever possible, end use applications.

This includes understanding and working to address factors including material sourcing impacts, non-GHG air pollution, waste management, freshwater consumption, and land disturbance with the intention of preventing impacts and, whenever possible, improving local environmental conditions.

TARGETED OUTCOMES

- In addition to Hub developers, communities, regulators, investors, lenders, and the general public have an improved understanding of the potential for cumulative impacts that results in more collaborative dialogue and planning regarding how to monitor, prevent, and mitigate those impacts.
- Hubs prioritize the need for international environmental stewardship, such as incorporating policies and practices for responsible sourcing of materials like critical minerals.
- Hubs have a well-developed plan to monitor and control related air quality pollutants (e.g., NOx, PM, VOC, PFAS) and other environmental impacts (e.g., water use; waste management; traffic, noise, light, dust, and other nuisances; land disturbance; biodiversity and wildlife impacts) and work toward improvement of associated local conditions.

RESOURCES

9 recommendations for getting US hydrogen hubs right from the start

New Tool Shows Air Pollution's Path

Sustainable energy 101: understand the landscape

Advancing Groundwater Sustainability in Texas

We have to think about water in a new way. Climate change demands it

Hub siting and operational decisions responsibly and equitably optimize the use of local infrastructure, natural resources, and geology while proactively working to reduce existing cumulative pollution and other community burdens.

WHAT IT MEANS IN PRACTICE

Hub siting and operational decisions are both efficient and equitable and informed by an analysis of local natural resources and an analysis of local cumulative pollution and community burden. For example, analyses are done to show that Hub projects have access to adequate natural resources (e.g., water, land, power, fuel, pore space) for project completion without negatively impacting quality, access, use, or cost of those resources for local community, existing users, or otherwise harming protected environments.

Hub project locations are responsibly sited. This means siting decisions take a clear-eyed approach that recognize the cumulative impacts within communities, historical disparities in pollution burden, and related vulnerabilities. Environmentally responsible siting should also aim to minimize new land use impacts, leakage risks, and other infrastructure burdens (e.g., new pipelines) through co-location or proximity to end-use applications. Working diligently alongside communities to thoughtfully address potential tensions between these aims should be an early priority.

Hubs have thoroughly evaluated the potential impact zone from accidents or explosions, such as from pipelines (see Transportation Objective), and have a plan in place for prevention, response, and remediation.

Hubs showcase efficient resource use, such as waste heat utilization and materials recycling/reuse.

TARGETED OUTCOMES

Siting and planning processes include an assessment of local resources and local cumulative pollution and other community burdens and vulnerabilities.

Siting and operational decisions are made in consultation and in partnership with local communities to ensure that cumulative impacts and other disproportionate burdens are thoughtfully and substantively addressed to the extent feasible.

Local resources are used efficiently and responsibly and achieving this is a substantive factor in siting and planning, including:

- Use of only high-quality geologic formations for hydrogen storage and/or carbon sequestration (see Carbon Management Objective).
- Existing industrial facilities/brownfields are thoughtfully repurposed in a manner that reduces local impact.
- Repurposed infrastructure meets safety, operational, and leak prevention specifications.
- Use of clean power resources, such as renewables, does not undercut meeting local needs.

RESOURCES

International land use scientists urge policymakers to adopt new approaches to addressing climate change, biodiversity and climate justice

Where carbon capture or removal is a Hub component, Hubs have demonstrated plans and capabilities for safe and effective carbon management, transportation, and sequestration (or utilization).

WHAT IT MEANS IN PRACTICE

Hubs employing the capture and/or removal of carbon dioxide include comprehensive data, analysis, and project plans to effectively account for the safety, efficiency, and expected long-term sequestration outcomes of those components (see also Climate Pollutant Objective).

All Hubs incorporating carbon management activities must have environmental integrity (be technically sound and environmentally protective in design and operation and subject to rigorous legal regulatory oversight), be economically justified (as compared to available decarbonization alternatives), and meaningfully address community considerations (including consultation, collaboration, and proactive mitigation efforts).

TARGETED OUTCOMES

Hubs with carbon management components are set up to track and demonstrate that:

- Hubs meaningfully address carbon-management related community considerations (see Community Engagement Objective).
- Carbon dioxide capture equipment is designed to efficiently capture at or above 95% of emissions.
- Geologic storage projects demonstrate an expected leakage rate of no more than 1% over 1,000 years.
- Geologic storage projects are designed and regulated to achieve environmental integrity — no groundwater contamination, no leakage, no significant earthquake risk.
- Geologic storage is limited to sedimentary formations until comprehensive research and science support alternatives, including basalt.
- Capture-associated air quality co-benefits and increased risks are understood, monitored, and managed such that projects do not reduce local air quality and when possible, improve it.
- Carbon storage operations do not occur in states with liability exemptions that reduce or remove the consequences of negative outcomes for storage operators (i.e., increase "moral hazard") or are inconsistent with federal policy (see Protective Regulatory Frameworks Objective).
- CO2 pipelines are sited, designed, and operated to create minimal local environmental or public health impacts (see Transportation Objective).
- Hubs that claim to "utilize" captured carbon dioxide as a means of sequestration have appropriate and transparent monitoring, reporting, and verification procedures to comprehensively demonstrate the long-term security of the sequestration or utilization mechanism in addition to appropriate regulatory programs and permits to ensure safety and desired outcomes.

RESOURCES

EDF Blog: States should not weaken liability laws for CCS projects

Congressional Testimony: The Opportunities and Risks of Offshore Carbon Storage in the Gulf of Mexico

EDF comment: Council on Environmental Quality CCUS Guidance

Understanding the differences between carbon removal and carbon capture

Carbon management in net-zero energy systems

Getting to net zero: New policy insights on the role of carbon management strategies

EDF Blog: What DOE should consider as it makes decisions on Carbon Capture and Storage Demonstration Projects

Hub proponents and partners develop and deploy rigorous plans for community engagement and partnership including commitments to take action to address local needs and concerns.

WHAT IT MEANS IN PRACTICE

All Hub developers, including all associated partners and projects, commit to meaningful and actionable dialogue and proactive partnership and consultation with all potentially impacted communities, public health officials, and environmental justice leaders.

Dialogue and consultation leads to demonstrated actions to address needs and concerns raised and by so doing provide a cumulative benefit to potentially impacted communities (see Environmental Impact Objective; Economic Development Objective; Added Value Objective).

Existing facilities and operators with histories of negative environmental and community impacts, limited community engagement, and continuing permit violations are not included in Hubs without an explicit successful effort to address existing issues collaboratively with communities.

TARGETED OUTCOMES

- Hubs demonstrate genuine, diligent community engagement and partnership toward mutual benefit and support.
- Government funding programs and other investors take into consideration community concern and opposition in a manner that incentivizes more genuine, collaborative approaches, including serious consideration of modifications to alternative siting of Hub components of concern as a requisite of financial support.
- Funding is set aside for substantive community engagement on the part of Hub proponents and made available (or identified) for community groups to have the resources, support, and technical capacity necessary to participate substantively in the Hub planning and development process.

RESOURCES

Equity and Environmental Justice at EDF

DOE Office of Clean Energy Demonstration: Community Benefits Plan Frequently Asked Questions (FAQ)'s

Guidance for Creating a Community Benefits Plan for the Regional Clean Energy Hubs (Office of Clean Energy Demonstrations)

Hubs foster local economic development opportunities, supporting local employment, skill building, subcontractors, research institutions, and other partnerships toward equitable distribution of work and opportunities.

WHAT IT MEANS IN PRACTICE

Hubs comprehensively support local economies and equitably distribute work in a manner that supports local communities, local and minority-lead research institutions, and local businesses.

Hubs seek academic and research partnerships with local HBCU and other minority serving institutions.

TARGETED OUTCOMES

- Hubs not only economically benefit Hub partners, but also local economies and communities in a manner that equitably distributes opportunities and benefits through jobs, training, and other partnerships.
- Outcomes might include advanced labor force protections; small and minority-owned business prioritization; apprenticeship opportunities; research grants and partnerships with minority serving institutions/HBCU's; community benefit agreements; enhanced supply chain transparency and disclosure, and more.

Hubs are developed in areas with advanced, protective regulatory frameworks across all relevant government levels that are implemented and enforced by adequately staffed agencies with a proven record of thoughtful oversight.

WHAT IT MEANS IN PRACTICE

Hub development teams do not seek out jurisdictions with the weakest regulations or enforcement records or bring on partners with a history of non-compliance. Instead, they work together with their partners, government officials, and other stakeholders to meet or exceed best practices and push for strong standards (e.g., methane regulations; air quality monitoring; water management programs). Both the Hub and partners, and any associated regulatory programs, clearly demonstrate a commitment to adequate staffing and training alongside transparent compliance and enforcement.

Where core regulatory programs or protections are absent or lagging what best practices would require, Hubs transparently identify gaps and any related impacts on their operational plans or timelines and support efforts to raise regulatory standards appropriately.

See also: Community Engagement Objective

TARGETED OUTCOMES

- Hubs operate and are sited predominantly in regions that have legal and regulatory mechanisms in place to effectively minimize risks and encourage best practice operations.
- Potential Hub participants or jurisdictions with a history of non-compliance or lax enforcement are selectively avoided in order to reduce risks and prioritize more reliable actors for investment incentive benefits.
- Hubs with overlapping jurisdictions create publicly available agreements to clarify roles and ensure consistency and transparency in regulatory oversight and enforcement expectations.
- Hubs that are sited in jurisdictions with weaker regulations commit voluntarily to go above and beyond existing regulatory requirements to reflect “best in class” practices and design.

RESOURCES

Fact Sheet: Summary of State Methane Regulations

EDF Blog: States should not weaken liability laws for CCS projects

Hubs clearly demonstrate added value and necessity, providing potential clean energy solutions that are efficient, relevant, and cost-effective.

WHAT IT MEANS IN PRACTICE

Hubs demonstrate added value and necessity for national and regional industrial decarbonization objectives through unique and novel solutions. Projects proposed are efficient, relevant, knowledge-building, and have the potential to present cost-effective and impactful solutions for the identified need/end-use, justifying significant public investment of funds. Value and necessity should be broadly defined, including added value in the short- and long-term to local communities.

Hubs outline a clear plan for tracking and demonstrating over the life of the project that they meet emission and climate commitments and other environmental and social expectations (see Climate Pollution Objective; Environmental Impact Objective; Community Engagement Objective; Economic Development Objective).

TARGETED OUTCOMES

- Hubs focus on hard-to-abate applications and end-uses in the specified sector (e.g., industrial, heavy transportation).
- Hubs have the potential for future scalability and/or integration into existing and future clean energy infrastructure networks.
- Hubs have clear off-taker arrangements or demonstrated end-uses — not only demonstrating value in production but also end-use.
- Hubs mitigate vulnerabilities to future supply chain impacts or adverse environmental impacts (see also Environmental Impact Objective).
- Hubs have a neutral or positive impact on broader economy-wide decarbonization plans.
- Resources utilized for the project (e.g., land, energy, water, materials) have low emissions- intensities and minimal environmental impacts, and they are additional to those needed for the deployment of higher priority clean energy technologies.
- Hubs expedite a transition away from polluting industries that are unlikely to play a significant role in a net-zero economy.

RESOURCES

9 recommendations for getting US hydrogen hubs right from the start

EDF blog: The latest IPCC report unpacks the role of innovation. Here are five key takeaways

Rule #1 of deploying hydrogen: Electrify first

Hub projects and partners commit to robust transparency and foster information sharing, technology transfer, and other learnings.

WHAT IT MEANS IN PRACTICE

Hubs aim to share and disclose relevant plans, findings, data, and learnings across all stages of the project from proposal through operation and closure, particularly those projects that are government funded or demonstration focused.

Enhanced transparency demonstrates a commitment to advancement of society-wide net-zero economies; enables genuine and meaningful stakeholder engagement and awareness of Hub operations; and maximizes sharing of lessons-learned across a variety of areas, ranging from technological improvements to community impacts.

High levels of transparency can be achieved even while confidential business information is protected.

TARGETED OUTCOMES

- Initial Hub investments accelerate innovation through the transparent publication, sharing, and transfer of insights, ideas, and other advanced knowledge generated by the demonstration and deployment of emerging technologies.
- The collection and transparent publication of project data improves policy design and regulatory implementation. This transparency helps agencies to identify policy needs and update programs over time including enhanced cross-agency coordination on key energy technologies.
- Hubs bolster the innovation pipeline by offering both startups and incumbent companies opportunities to participate in industrial decarbonization advancements, including hydrogen and carbon management markets.
- Hubs demonstrate a more robust, inclusive, and informed innovation process by inviting and fostering input from a variety of stakeholders on project performance, insights, and ideas.

RESOURCES

EDF-commissioned report: Aldy, J. E. (Working Paper). Learning How to Build Back Better through Clean Energy Program Evaluation. HKS Faculty Research Working Paper Series

Data access paves the way for cleaner air

Setting the bar

Promoting government transparency

Hubs demonstrate plans and capabilities for safe and effective transportation and storage of all associated materials and products.

WHAT IT MEANS IN PRACTICE

Hubs ensure that transportation and storage of all associated products and materials (from hydrogen and carbon to raw materials and wastes) is done in a safe and efficient manner.

Hubs associated with ports, shipping, or other transportation networks complement existing efforts to decarbonize and electrify transportation-related equipment and operations.

TARGETED OUTCOMES

Hubs that deploy safe and effective transportation and storage plans:

- Minimize transportation and movement of products like hydrogen or captured carbon to curtail leakage, risk, and unnecessary infrastructure buildout (see also Climate Pollution Objective; Efficient Use of Resources Objective; Carbon Management Objective).
- Design pipelines and other movement infrastructure, including trucks and ships, specifically for the product in order to minimize leakage, maximize safety, and minimize community impacts — including where necessary going above-and-beyond existing regulatory requirements until such requirements are appropriately updated to reflect best practices and design standards so as to ensure proper safety, leak detection, and repair (see Protective Regulatory Framework Objective);
- Thoughtfully select transportation methods and design transportation routes to minimize traffic, air emission, and other nuisances or local harms.
- Minimize or avoid hydrogen blending into gas distribution systems, unless and until there is clear safety, cost, and climate justification.
- Understand and mitigate risks associated with above-ground and below-ground hydrogen storage, particularly those that may made hydrogen storage uniquely challenging as compared to natural gas or carbon storage. For more on permanent carbon storage see Carbon Management Objective.

RESOURCES

Business and Transportation

Maritime Makeover: The Role for Investors in Decarbonizing Global Shipping

How ports can use the Bipartisan Infrastructure Law to protect public health and act on climate

As Feds advance pipeline emission rules, report finds widespread availability and adoption of technologies to cut methane

Research shows gathering pipelines in the Permian Basin leaking 14 times more methane than officials estimate

Act now or pay later: the costs of climate inaction for ports and shipping

Pipeline Safety Trust Report: CO2 Pipeline Safety Trust Report: H2