



Decarbonization in Action: Showcasing US Carbon and Hydrogen Hubs Potential

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Great Plains Institute

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Carbon Management Project Review Meeting

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Background on GPI

Overview and Mission

- Independent nongovernmental organization focused on energy policy and technology.
- Goal is to transform the energy system to benefit the economy and the environment.

Objectives

- Increase energy efficiency and productivity.
- Decarbonize electricity production.
- Electrify the economy and adopt zero and low-carbon fuels.
- Capture carbon for beneficial use and permanent storage.



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Carbon Management Program

Our goal is to expand and accelerate economywide commercial deployment of the entire suite of carbon management and industrial solutions by 2030, so that projects and infrastructure can then be scaled to meet midcentury climate goals.



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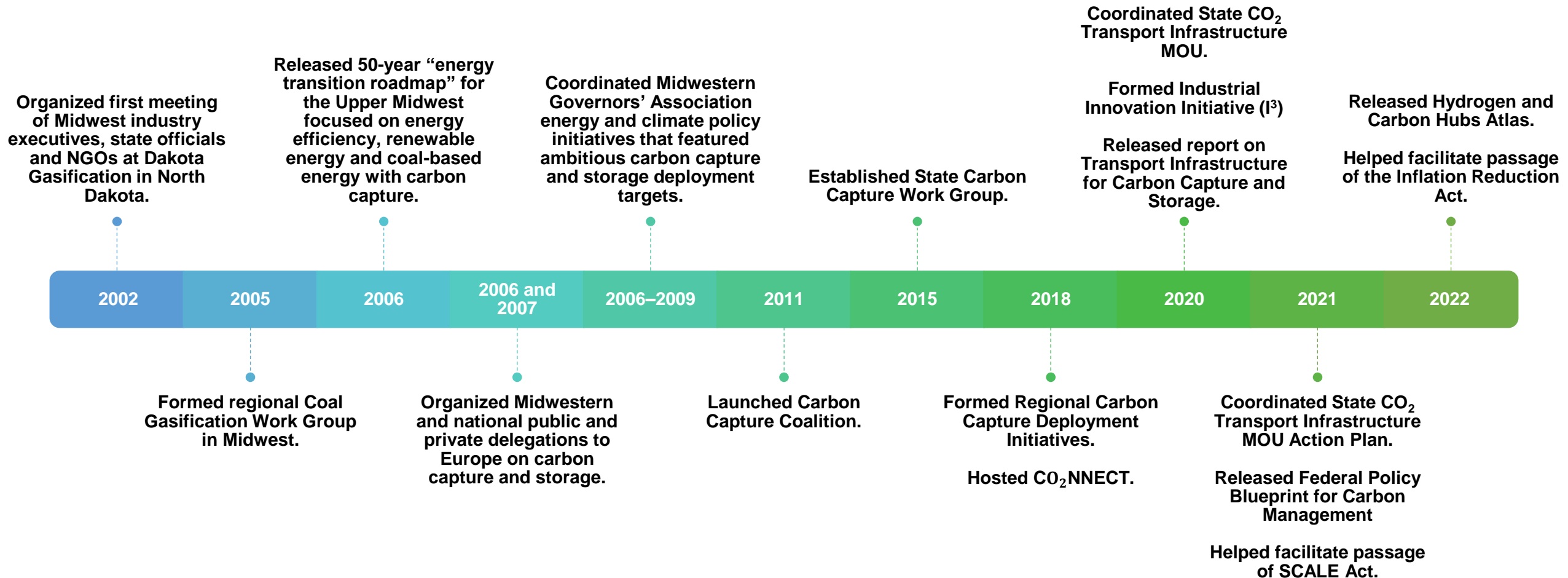
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A photograph of an industrial facility, likely a refinery or chemical plant, at night. The facility is illuminated by numerous bright lights, and its complex structure of pipes, tanks, and towers is reflected in the calm water in the foreground. The sky is dark with some clouds.

Key GPI Carbon Management Objectives

- Build on broad industry, labor, NGO and state consensus to implement a midcentury a comprehensive carbon management and industrial decarbonization blueprint.
- Enact and implement a comprehensive suite of federal carbon management and industrial decarbonization policies and incentives to support near-term deployment and commercialization across key economic sectors and regions of the country (capture, removal, transport, utilization and storage).
- Support the expedient and responsible implementation of the bipartisan infrastructure law.
- Leverage our several hundred strong state/regional network of state policymakers and stakeholders in support of federal and state advocacy on carbon capture and industrial decarbonization
- Increase attention and engagement around environmental justice to broaden the equity conversation to include jobs and to foster empirical and solutions-oriented policies and actions to ensure that benefits from project development flows to workers and communities.
- Support the development of carbon and hydrogen hubs as a crucial strategy for achieving economies of scale in the deployment of decarbonization technologies and associated infrastructure.

Great Plains Institute: Nearly Two Decades Working on Carbon Management Policy

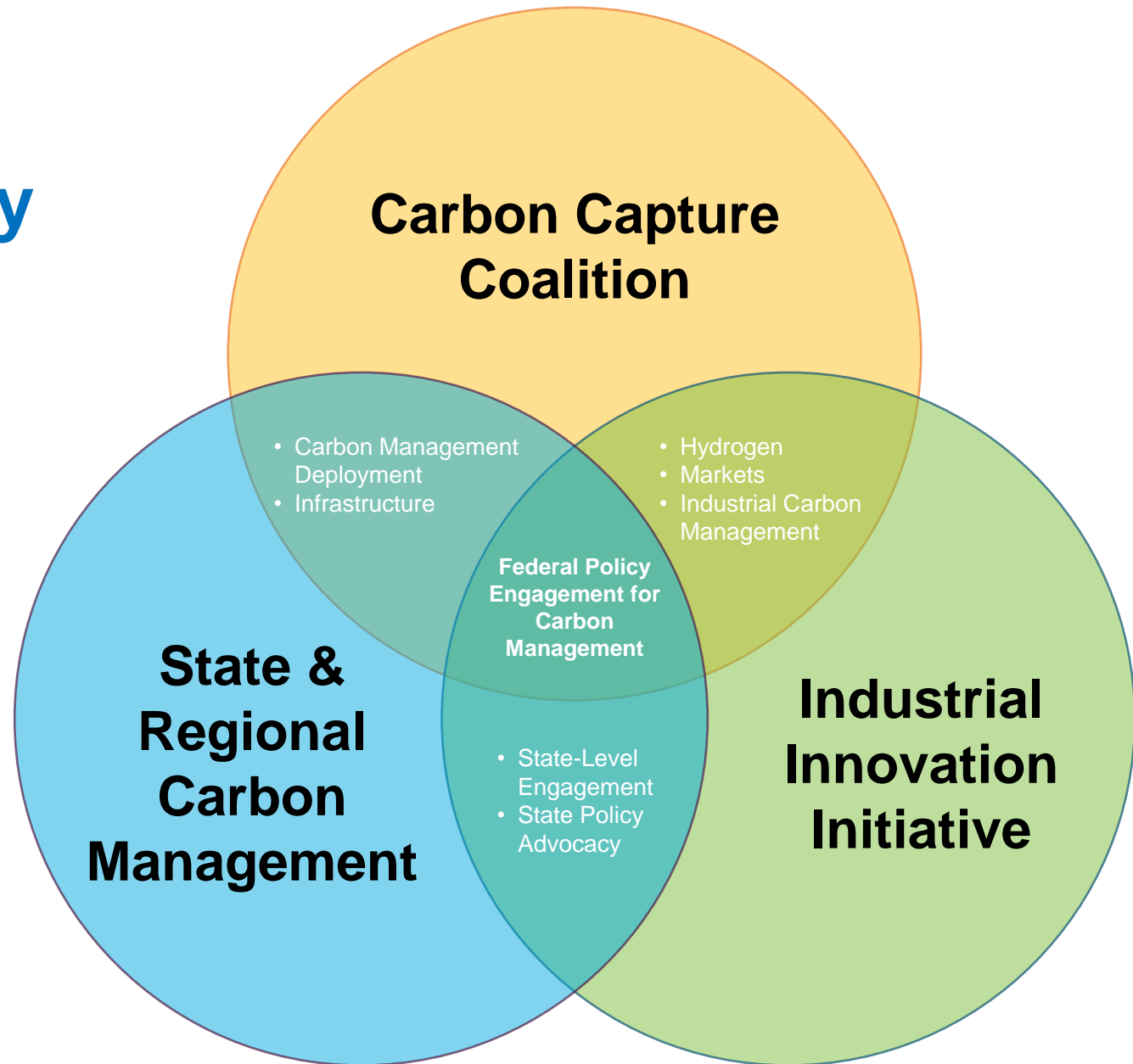


Overview of Initiatives



Building a National Infrastructure for Policy Development and Advocacy:

Strengthening the Interconnections in Federal and State/Regional Carbon Management Initiatives



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CARBON CAPTURE COALITION

Unprecedented National Coalition in U.S. Energy & Climate Policy

Goal: Economywide deployment of the full suite of carbon management options—carbon capture, removal, transport, utilization and storage—to reduce emissions, foster domestic energy and industrial production, and support high-wage jobs.

Climate, jobs and energy/industrial benefits **unite diverse interests**
in a common purpose

Over 100 members, including companies, unions and environmental
NGOs



To learn more and view our
complete membership list, visit
www.carboncapturecoalition.org



**Industrial
Innovation
Initiative**

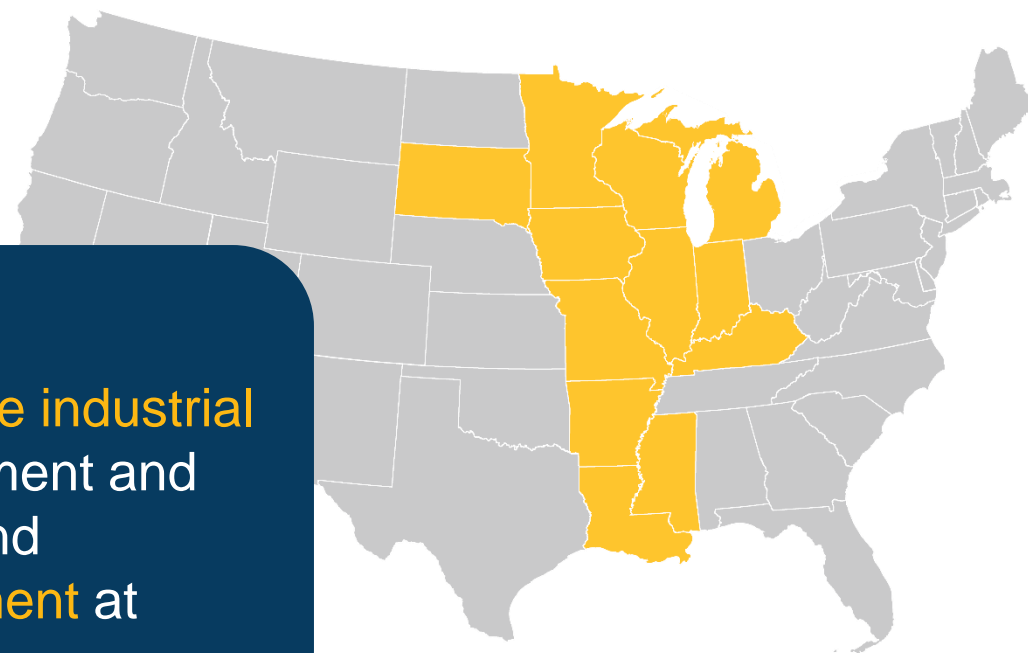
a partnership between Great Plains Institute and
World Resources Institute

Industrial Innovation Initiative (I³)

I³ convenes key industry, environmental, labor, and other stakeholders, together with state officials, to advance cross-cutting industrial decarbonization strategies.

Mission:

To advance solutions key to **decarbonizing the industrial sector** by midcentury through **policy** development and implementation; **technology** demonstration and adoption; and demand-side **market development** at state, regional, and federal levels.



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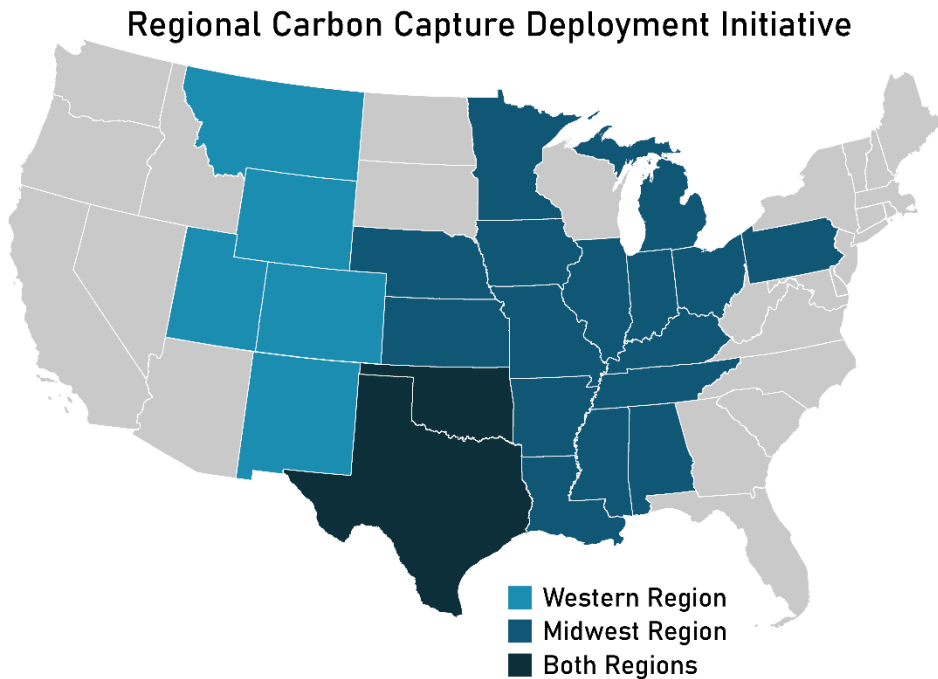
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www.industrialinnovation.org

Regional Carbon Capture Deployment Initiative / State Advocacy



- Over 800 state officials, companies, NGOs, and unions from two dozen states interested in supporting state and federal policy development.
- 24 states and growing.
- Coordinate state policymaker and stakeholder engagement, development of policy recommendations, and regional deployment modeling and jobs analysis.



State MOU for CO₂ Transport Infrastructure

- **Includes** KS, LA, MD, MT, ND, OK, PA and WY as signatories, other states considering joining
- **Recognizes** that development of CO₂ transport networks, together with financial incentives for carbon capture, can:
 - ✓ support long-term production and use of **domestic natural resources**;
 - ✓ create and preserve **high-paying jobs** in energy-producing, agricultural and industrial states; and
 - ✓ significantly **reduce net carbon emissions**
- **Provides** a collaborative mechanism to jointly develop and implement an action plan for building out regional CO₂ transport infrastructure to enable large-scale carbon management
- **Seeks** to accelerate, through state leadership and coordination, the deployment of common regional CO₂ transport infrastructure networks and carbon hubs to help industries take advantage of economies of scale



Regional Carbon Dioxide (CO₂) Transport Infrastructure Action Plan

- Provides various state and regional policy recommendations to facilitate carbon management project deployment.
- Includes policy efforts needed to incorporate CO₂ transport infrastructure and geologic storage into federal infrastructure legislation and measures for federal financing.
- Suggests supportive state policies for CO₂ transport infrastructure buildout and provide options for future collaborative carbon management work between states.

Regional Carbon Dioxide (CO₂) Transport Infrastructure Action Plan

Executive Summary

Experts agree that climate change mitigation requires the deployment of a multi-disciplinary portfolio of policies and technical approaches that will work together to reduce and eventually eliminate carbon emissions to the atmosphere. As such, carbon capture utilization and storage (CCUS) is an integral component for achieving decarbonization by the mid-21st century. Full-scale CCUS projects have been safely and successfully deployed, both domestically and abroad, and offer a proven means to store CO₂ permanently. CCUS will be necessary for meeting emission reductions in power, industry, and other sectors, because of the relatively large storage volumes afforded by many subsurface geologic units. CCUS also provides industrial and thermal sources a pathway to eliminate CO₂ emissions when decarbonization cannot be achieved solely by fuel-switching.

Infrastructure is needed on a significant scale to decarbonize the industrial and power sectors, even when accounting for aggressive low-carbon and renewable energy adoption. In addition to the economy-wide retrofit of carbon capture equipment at industrial and thermal facilities, delivering captured CO₂ to sites of utilization and long-term storage will require regional-scale transport infrastructure.

To facilitate this large-scale buildout, the State Carbon Capture Work Group launched the Regional Carbon Capture Deployment Initiative in 2018. On October 1, 2020, several states executed a [CO₂ Transport Infrastructure MOU](#) to establish a collaborative mechanism to develop and implement an action plan for the buildout of regional CO₂ transport infrastructure to enable large-scale carbon management. The current signatory states are Kansas, Louisiana, Maryland, Montana, North Dakota, Oklahoma, Pennsylvania, and Wyoming.

This Action Plan is the culmination of a year-long process engaging states and stakeholders aimed at supporting the expeditious buildout of CO₂ transport infrastructure for CCUS projects across the country. The Action Plan describes a range of potential strategies to incentivize CCUS project deployment, including federal and state financial incentives and investments, public-private partnerships with companies, partnerships with local and federal governments, and the identification of funding sources to support dedicated state resources and other appropriate mechanisms for the individual states.

Introduction and Purpose

The development of regional and national CO₂ transport networks and associated geologic storage along with proposed tax credits and other financial incentives for

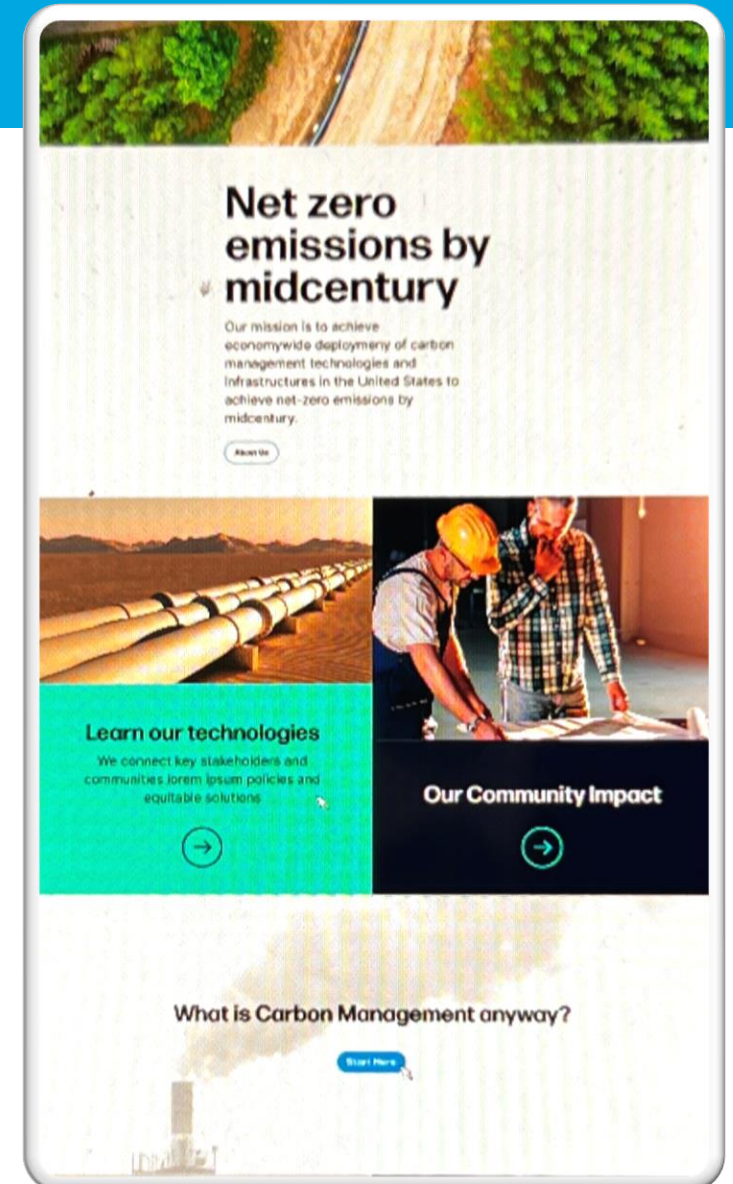




Carbon Management Action Network

Launching October 2022

- National network of stakeholders working to equitably deploy the carbon management projects and infrastructure needed to meet midcentury climate goals.
- Will bring together stakeholders across industries, political parties, and state lines to advocate for the responsible deployment of carbon management technologies.
- Website will include resources and information geared at multiple audiences including individuals, communities, governments, businesses and investors.



Carbon and Hydrogen Hubs Atlas



Carbon and hydrogen hubs can establish a low carbon industrial ecology

- Given the scale of rapid commercialization necessary, new feedstock supply chains and logistics must be established
- Regional hubs can focus investment, collaboration, and supportive policy
- Hubs can connect supply and demand, act as target markets, and utilize established supply routes or infrastructure

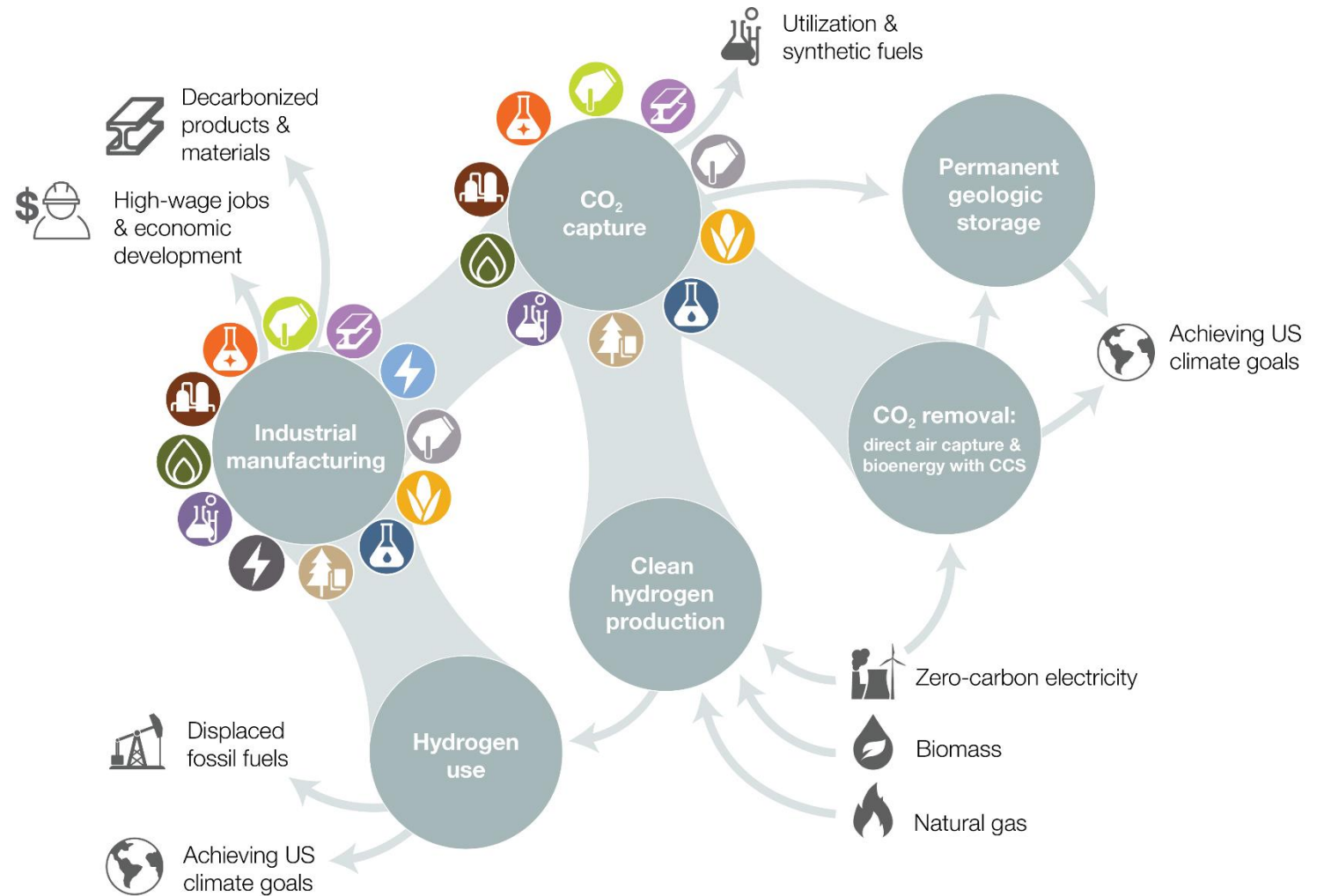


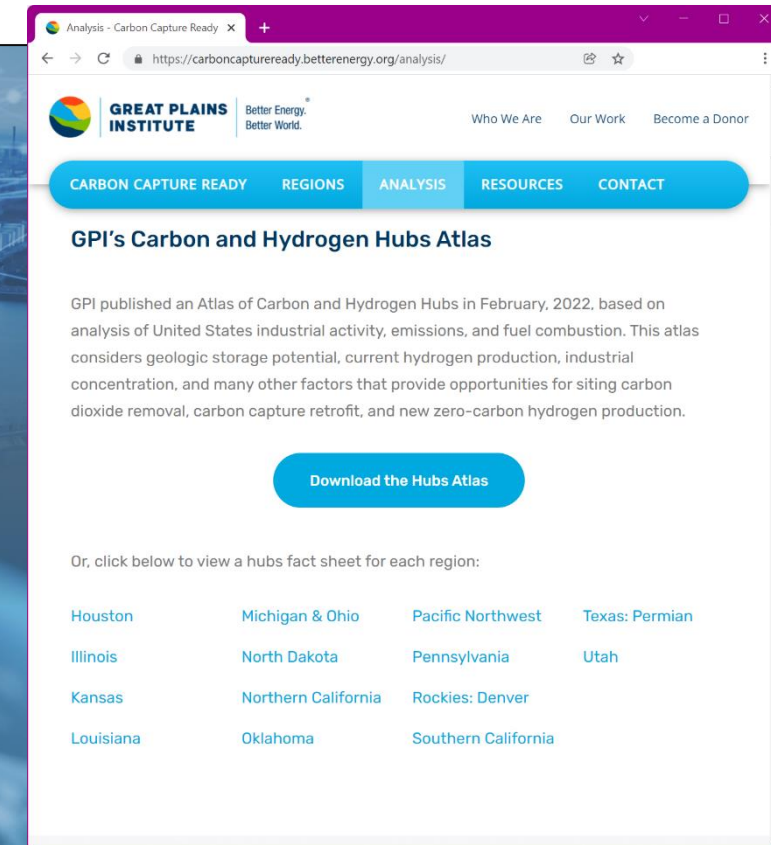
Figure authored by Elizabeth Abramson, GPI, 2021

An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization

February 2022



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Download the atlas at:
carboncaptureready.org

Potential US Carbon and Hydrogen Hubs

Guiding Criteria

- High concentration of large industrial emitters
- High quantities of fossil fuel use for on-site industrial energy production
- Presence of 45Q tax credit qualifying facilities for carbon capture retrofit, as well as identified near- and medium-term capture opportunities
- Current reported production of hydrogen and ammonia (optional)
- Large geologic saline and fossil formations for permanent CO₂ storage
- Existing multi-modal commodity distribution infrastructure such as freight railroads, barge waterways and ports, and freight truck interstate highway routes
- Existing conventional fossil fuel distribution infrastructure for hydrogen blending and established right-of-way that minimizes impact of CO₂ transport infrastructure

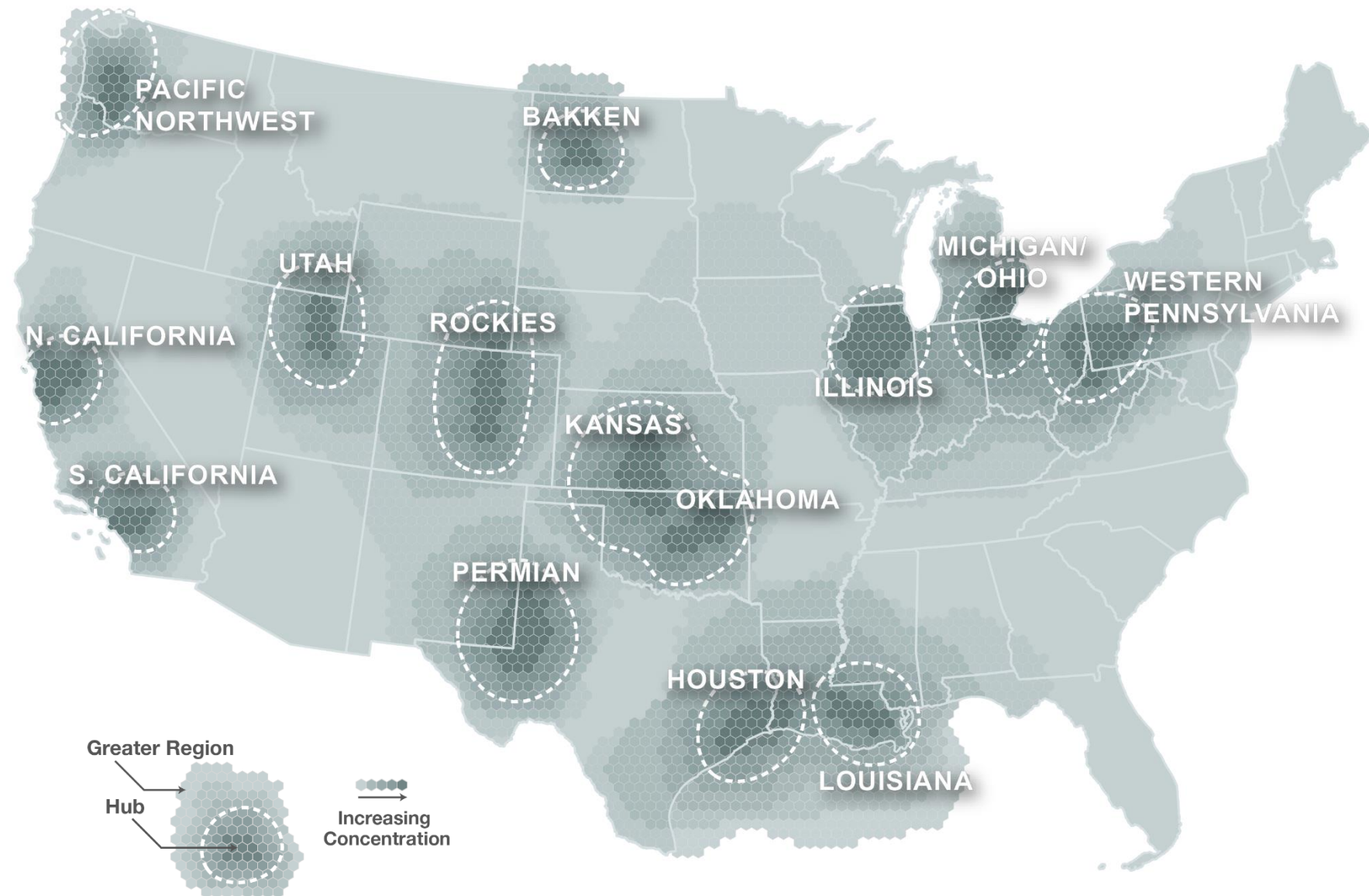


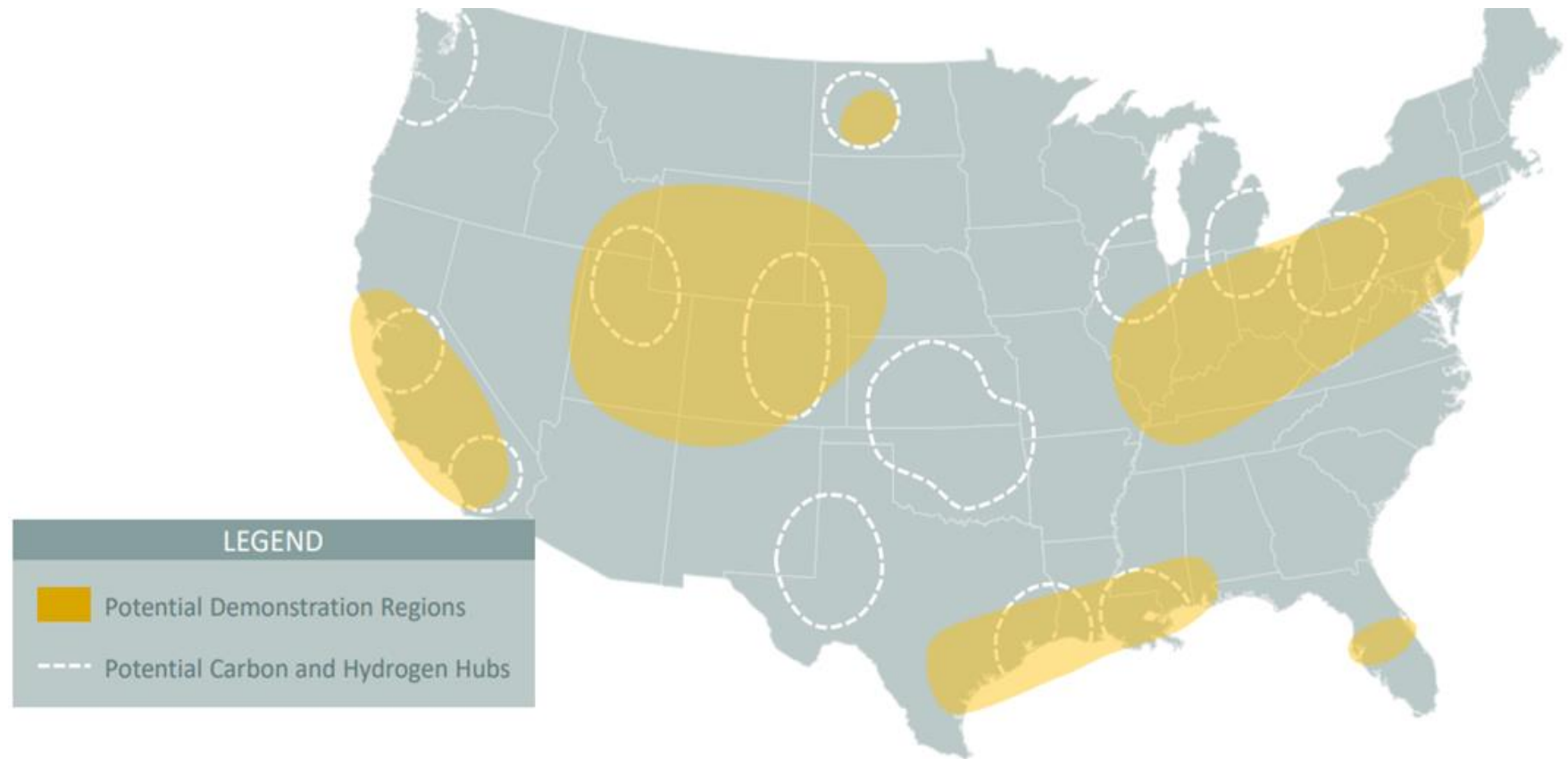
Figure authored by Elizabeth Abramson, GPI, 2021
Source: Carbon and Hydrogen Hubs Atlas, GPI 2022



Potential DOE Demonstration Host Site Regions with Great Plains Institute Identified Potential Carbon and Hydrogen Hubs

A presentation by DOE FECM in [April 2022](#) identified 5 areas of overlap between GPI's carbon and hydrogen hubs with current thinking on carbon capture and storage demonstration regions based on High Level RFI Results from DE-FOA-0002660 Deployment and Demonstration Opportunities for Carbon Reduction and Removal Technologies Technical Area #1 Responses.

Based on this map, (1) the Rockies region of Wyoming, Utah, and Colorado, (2) the Gulf Coast of Louisiana and Texas, (3) the Ohio River Valley / Appalachia region of Pennsylvania, West Virginia, Kentucky, Ohio, and Indiana, and (4) the state of California stand out as four key areas for study.



Federal Investments for Hubs



Bipartisan Infrastructure Investment and Jobs Act

- **Signed into law November 15, 2021**
- **Includes core carbon management priorities:**
 - Full text of the SCALE Act
 - Funding for 2020 Energy Act authorizations to support commercial-scale demonstrations and FEED studies for carbon capture
 - Regional direct air capture hubs and hydrogen hubs
 - Direct Air Capture technology prize
 - Carbon capture demonstration projects
 - Grants for the commercialization of products and technologies utilizing CO₂



Inflation Reduction Act of 2022

Enhancements to 45Q

Multiyear Extension of the Commence Construction Window:

- Moving forward, any carbon capture, DAC, or carbon utilization projects that commence construction **before** January 1, 2033, will qualify for 45Q.

Direct Pay:

- Domestic manufacturing projects will receive direct pay for the first 5 years **after the carbon capture equipment is placed in service** (no direct pay for final 7 years of the credit).
- Nonprofit organizations and co-ops can receive direct pay for all 12 years of the credit.

Expanded Transferability:

- Allows the owner of the carbon capture equipment to transfer the credit to any other taxpaying entity. Under this option, the capture owner could receive a cash payment to transfer those credits and the cash payment would not be included in the capture owner's taxable income.

Inflation Reduction Act of 2022

Enhancements to 45Q (continued)

Dramatically Lower Capture Thresholds:

- Direct Air Capture: 1,000 metric tons/taxable year
- Electric Generating Facility: 18,750 metric tons/taxable year **and** paired with design capacity requirement below
- Any other facility: 12,500/taxable year

Enhanced Credit Values for Industry, Power and Direct Air Capture:

- **Industrial & power facilities:** \$85 per metric ton for industrial and power facilities that store captured CO₂ in saline geologic formations, \$60 for utilization of captured CO₂ and its precursor carbon monoxide to produce low and zero-carbon fuels, chemicals, building materials and other products, and \$60 for EOR.
- **Direct air capture facilities:** \$180 per metric ton for direct air capture projects that store captured CO₂ in geologic formations, \$130 for CO/CO₂ used to produce products and \$130 for EOR.

Design Capacity Requirement:

- Point-source capture projects on electric generating units will be required to design capture equipment to capture at least 75% of unit CO₂ production, subject to a review if facility emissions increase in future years.

Inflation Reduction Act of 2022

Clean Hydrogen Production Tax Credit

- **Hydrogen Production Tax Credit** equivalent to kilograms of “clean” hydrogen produced multiplied by the applicable amount (\$0.60) multiplied by the applicable percentage (*rate below*)

Applicable percentage is determined by lifecycle GHG rates:

Between 4kg and 2.5kg CO₂e / kg H₂ = 20%

Between 2.5kg and 1.5kg CO₂e / kg H₂ = 25%

Between 1.5kg and 0.45kg CO₂e / kg H₂ = 33.4%

Less than 0.45kg CO₂e / kg H₂ = 100%

State Carbon Management Policy Trends



State policies to enable hubs development

State policy will play a complementary role to federal policy by:

- ✓ Increasing project feasibility
- ✓ Bridging remaining project gaps
- ✓ Enabling shared infrastructure systems a
- ✓ Creating economies of scale

States should consider:

- ✓ Regulatory policies and planning
- ✓ Financial incentives
- ✓ Market development policies



Carbon Management 2022 Policy Trends

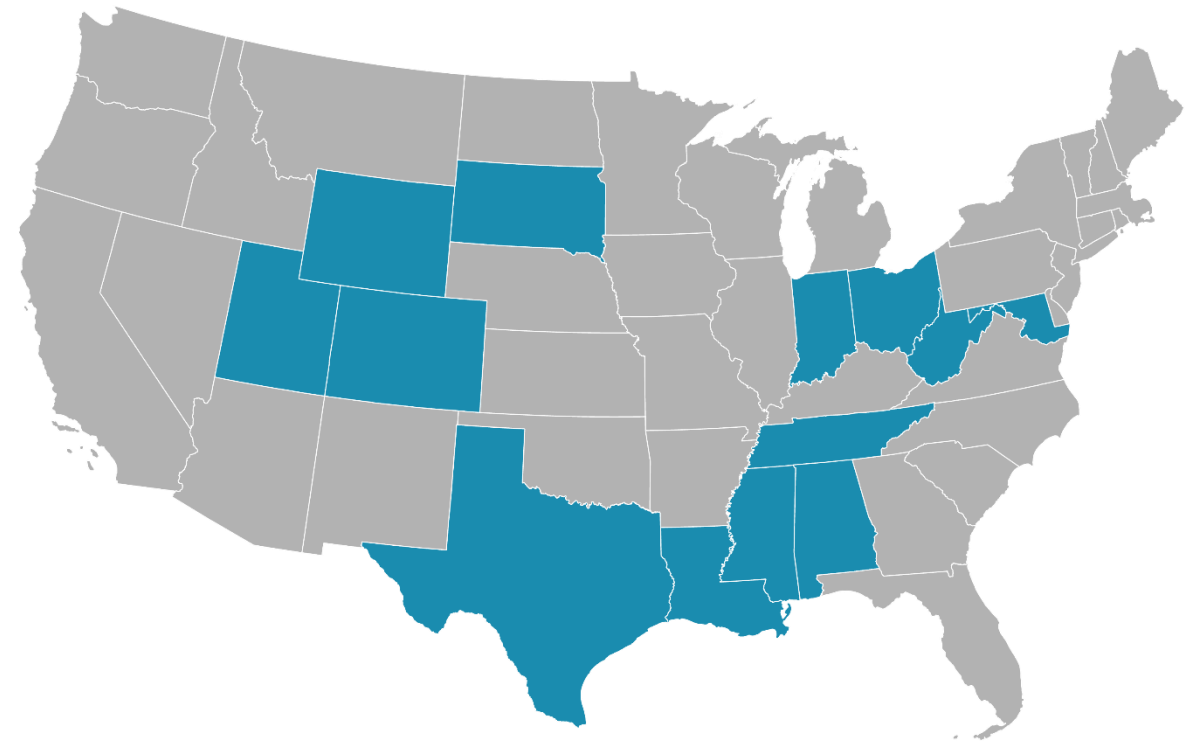
60+ bills were introduced in **26 state houses** in 2022 relating to carbon management

Topics include:

- Industrial Grant programs
- Task Force Development
- Underground Storage
- Class VI

At the state level, legislators enacted bills related to:

- Regulatory Policies and Planning.
- Financial Incentives.



States with **signed** legislation relating to **carbon management** in 2022.

Additional Carbon Management Updates

Class VI

- **EPA:** intends to publish NOI for grant money in early 2023
- **LA:** application processing
- **WV, TX:** in pre-application
- **OK:** plans to apply
- **MS, UT:** directed by statute to pursue Class VI
- **ND, WY:** have primacy

BLM Announces Intent to Develop Geologic Carbon Storage Policy

- [National policy for the right-of-way authorizations necessary for site characterization, capture, transportation, injection, and permanent geologic storage of CO₂](#)

PHMSA Announces Safety Measures

- [PHMSA Safety Measures Announcement](#)



Hydrogen 2022 Policy Trends

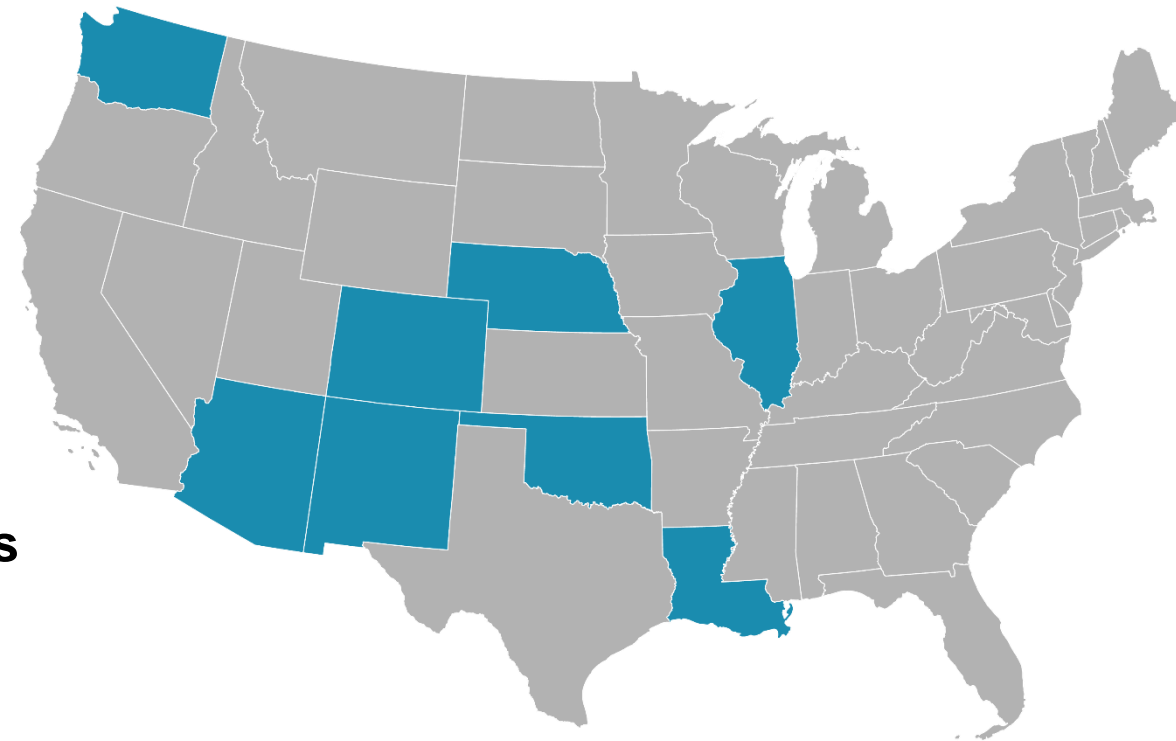
30+ bills were introduced in **14** statehouses in 2022 relating to hydrogen

Topics include:

- Hydrogen Hubs (under IIJA)
- Task Force Development
- Study Committees
- Underground Storage

At the state level, legislators enacted bills:

- Including hydrogen in **state sustainability plans and legislation.**
- Offering **financial incentives** for low- and zero-carbon hydrogen production and use.
- Federal cross-cut: hydrogen hubs.

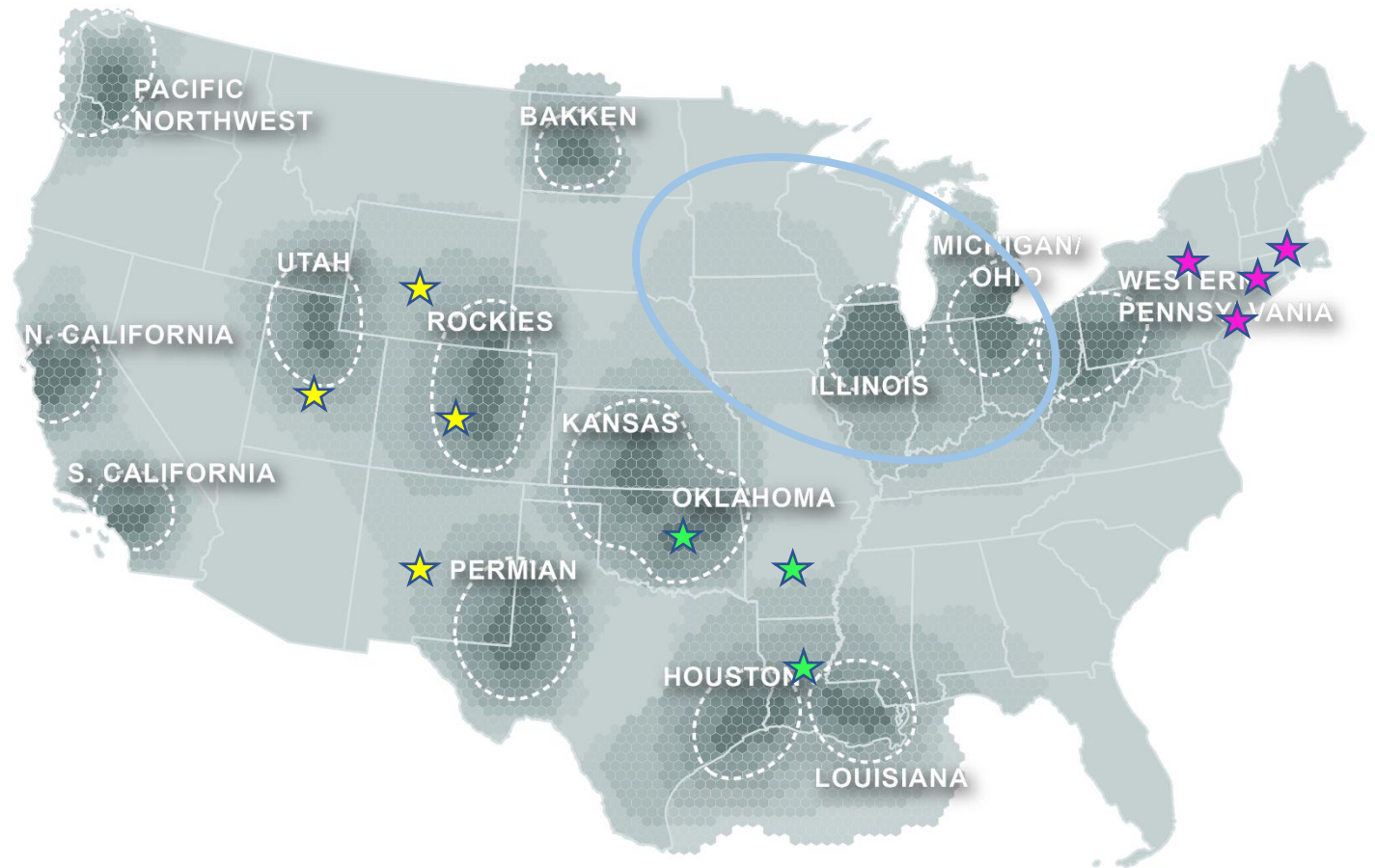


*States with **signed** legislation relating to **hydrogen** in 2022.*

Current Proposed H2 Hubs

Multi-State Collaboratives

- HALO Hydrogen Hub:
Louisiana/Oklahoma/Arkansas
- Western Inter-State Hydrogen Hub (WISHH): Colorado, New Mexico, Utah, Wyoming
- Connecticut, New York, New Jersey, Massachusetts
- Upper Midwest Hydrogen Hub
(not announced)

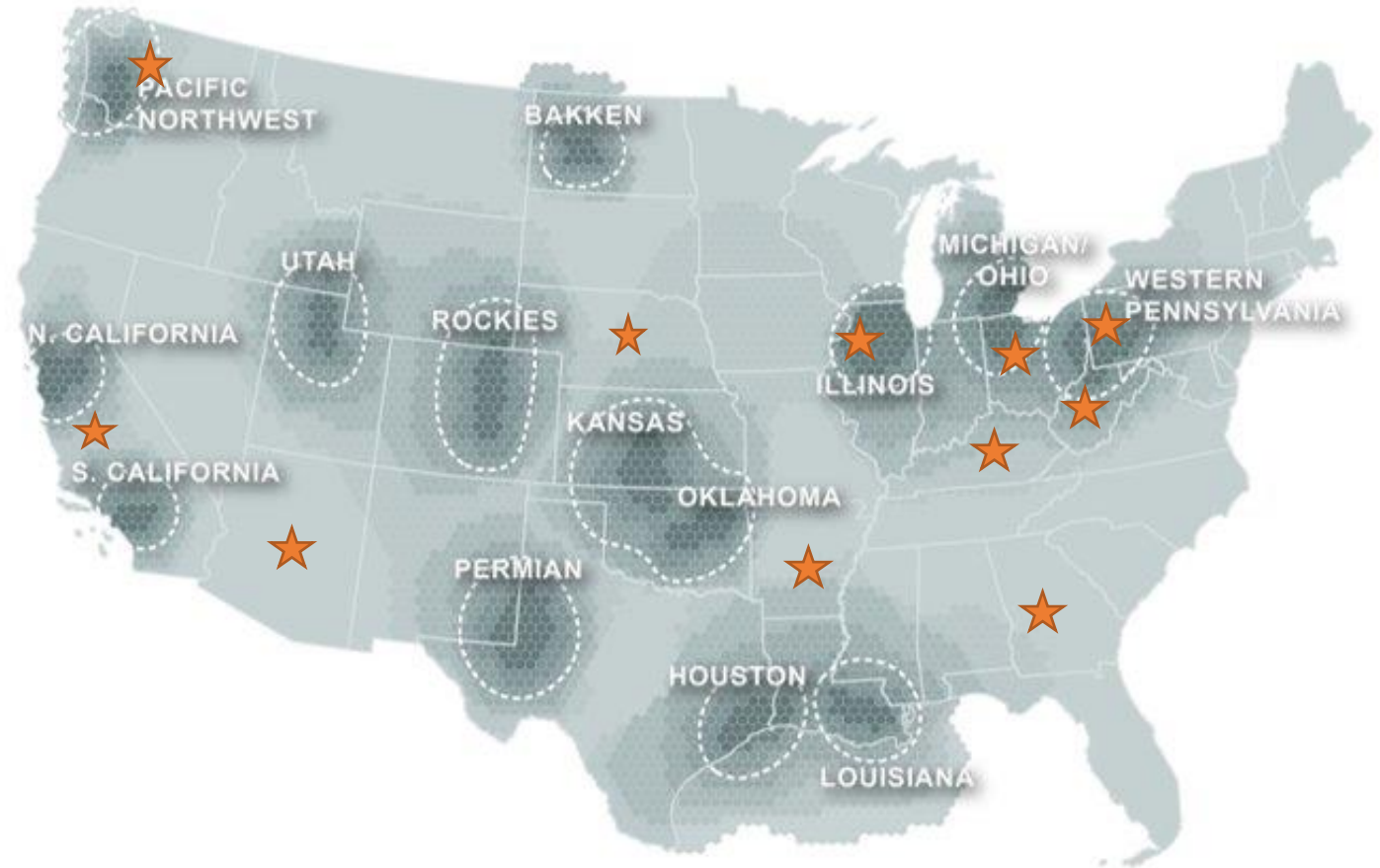


States Considering Hubs or Enabling H2 Legislation

Single State Hub Proposals & H2 Enabling Legislation

- California
- Washington
- Arizona
- Kentucky
- Nebraska
- Illinois
- Pennsylvania
- West Virginia
- Ohio
- Georgia
- Missouri

} Private Companies for a Northern Appalachian Hub (including EQT Corporation, Equinor, GE Gas Power, Marathon Petroleum, Mitsubishi Power, Shell Polymers, and US Steel)



Future Research



DAC Atlas: Study Components

Timeline: Estimated completion Q4 2022

1

Identify areas for potential development of Direct Air Capture Hubs

2

Incorporate various heating and electric sources for both low temp and high temp DAC technologies

3

Consider opportunities for DAC Hubs sited to be incorporated into CO₂ transport infrastructure



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Future Research

Maximizing the Decarbonization Potential of Clean Energy Hubs

Building upon the foundation of the Carbon and Hydrogen Hubs Atlas released in February 2022, this study will quantify the impacts of H2 development. Particularly considering the climate and community impacts of switching to hydrogen from preexisting fossil fuels.

Timeline: Report Anticipated Q1 2023

Partners:



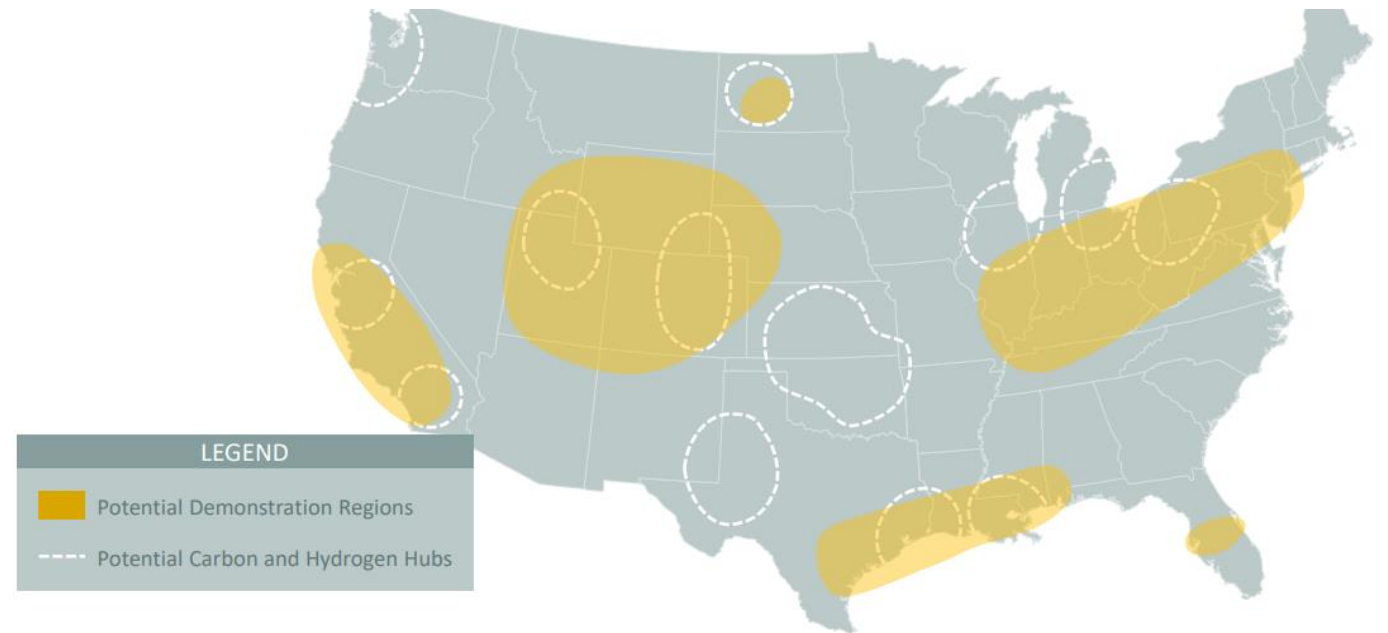
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Carbon Solutions LLC

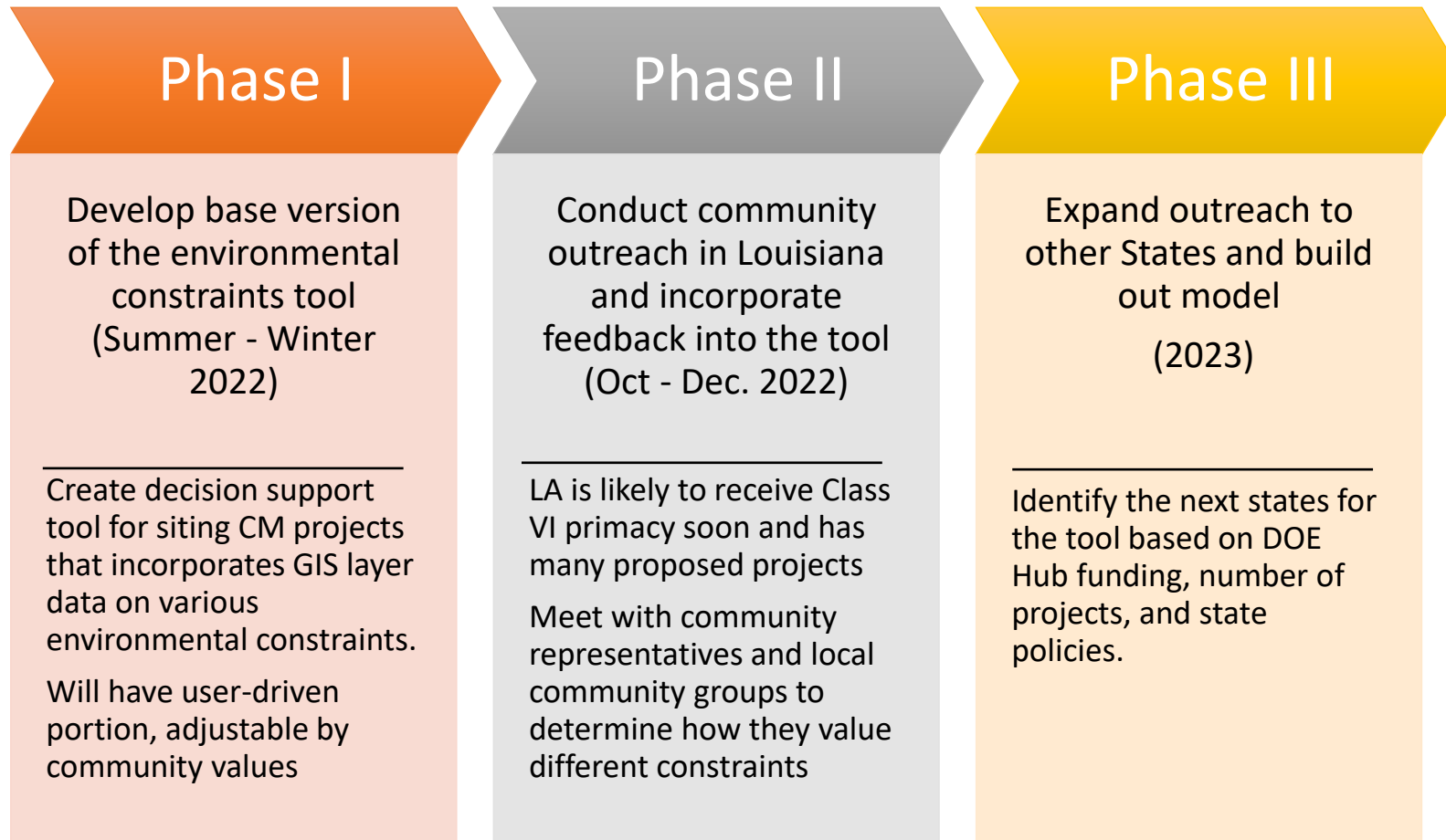
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Environmental Constraints Tool: Where We are in the Process



Research and Analysis: 2023

Identify near-term opportunities for CO₂ capture retrofit within the context of an updated 45Q tax credit

Expand modeling of optimized CO₂ transport infrastructure to describe capture and storage opportunities

Jobs and Economic Impact Analysis: Carbon, Hydrogen & DAC Hubs

Jobs and Economic Impact Analysis: Injecting captured CO₂ underground and permanent storage



Thank you!



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