



Prepared for the  
Pennsylvania DEP  
Citizens Advisory Council

May 9, 2023



# Hydrogen Hub Development



## WHY ARE WE TALKING ABOUT HYDROGEN HUBS?

Department of Energy

# DOE Launches Bipartisan Infrastructure Law's \$8 Billion Program for Clean Hydrogen Hubs Across U.S.

JUNE 6, 2022

- Under the US Infrastructure Investment and Jobs Act, Congress allocated \$8 billion for the creation of multiple hubs, dubbed “H2Hubs,” to support clean hydrogen in the United States.
- The US Department of Energy (DOE) defines an H2Hub as a “network of clean hydrogen producers, potential clean hydrogen consumers, and connective infrastructure located in close proximity.”
- The development of H2Hubs across the United States is intended to be the first step toward the creation of a national network of clean hydrogen producers and customers that could facilitate the emergence of a clean hydrogen economy.

# WHY ARE WE TALKING ABOUT HYDROGEN HUBS?

## DOE's Regional Clean Hydrogen Hub Program

- Provides up to \$7B to support the development of 6-10 hubs in the U.S., including at least two hubs in gas-producing regions and at least one hub powered by fossil fuels (blue hydrogen)
- Remaining \$1B - \$2B reserved for future launches or other supporting activities
- Minimum 50% cost share
- Executed over 8-12 years (or faster)
- Min of 50-100 metric ton per day H2 production to ensure regional impact & scale

## National Clean Hydrogen Strategy and Roadmap

- The hubs are part DOE's national hydrogen strategy, which sets a goal of 50 million metric tons of "clean" hydrogen by 2050
- Currently, approx. 10 million metric tons of hydrogen are produced in the US with 95% "grey" hydrogen

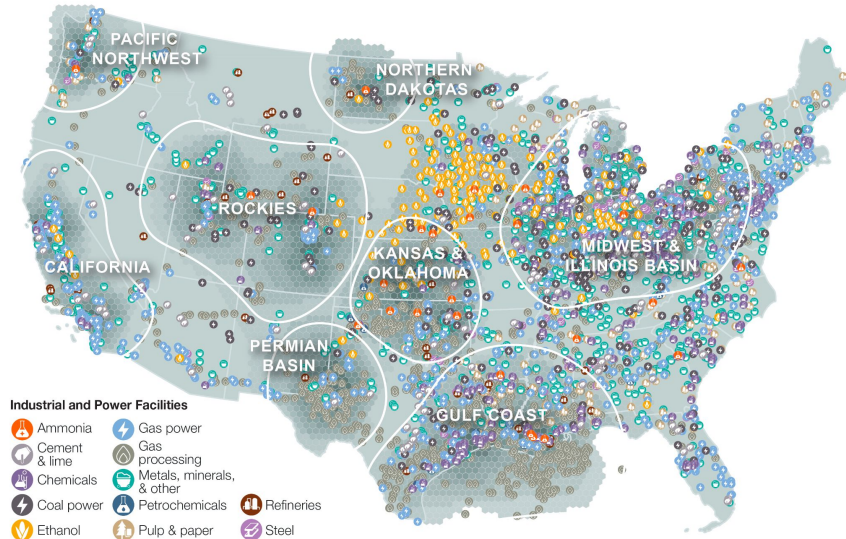


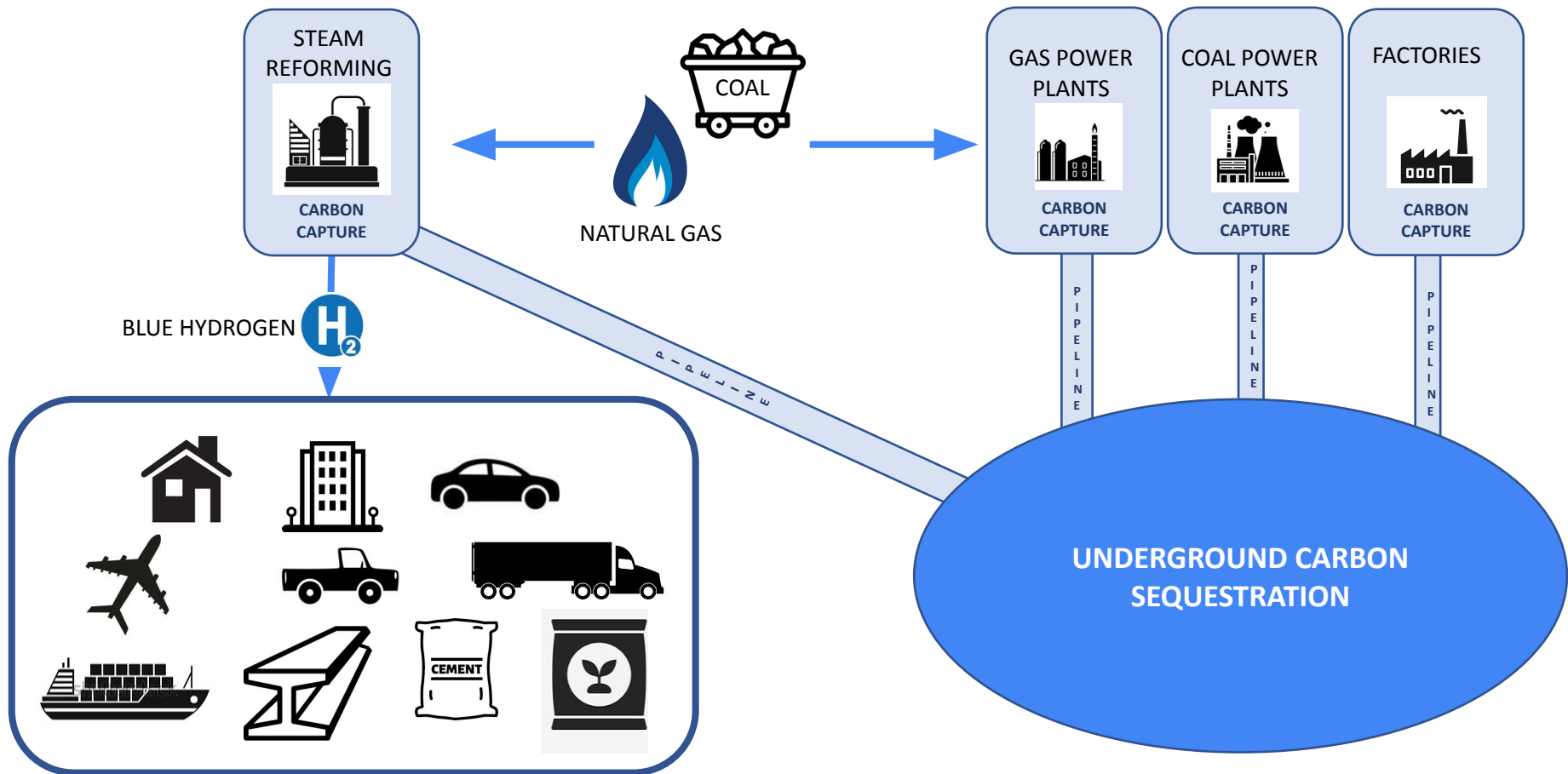
Image Source: Great Plains Institute  
<https://betterenergy.org/blog/hydrogen-hubs-the-state-of-play/>

## TIMELINE FOR DOE DECISIONS ON HYDROGEN HUBS

Milestone	Date
DOE announces Request for Information (RFI) for H2Hub implementation	February 15th, 2022
RFI responses due	March 21st, 2022
Funding Opportunity issued	September 9th, 2022
Concept papers due	November 7th, 2022
Encourage/Discourage notifications*	December 2022
Full applications due	April 7th, 2023
Deadline for Replies to Reviewer Comments	May 31st, 2023
Pre-Selection Interviews	Summer 2023
DOE Selection Notifications	Fall 2023
Award Negotiations	Winter 2023-2024

*Note: An applicant who receives a “discouraged” notification may still submit a full application. Applicants may also decide to consolidate proposals ahead of application submission.*

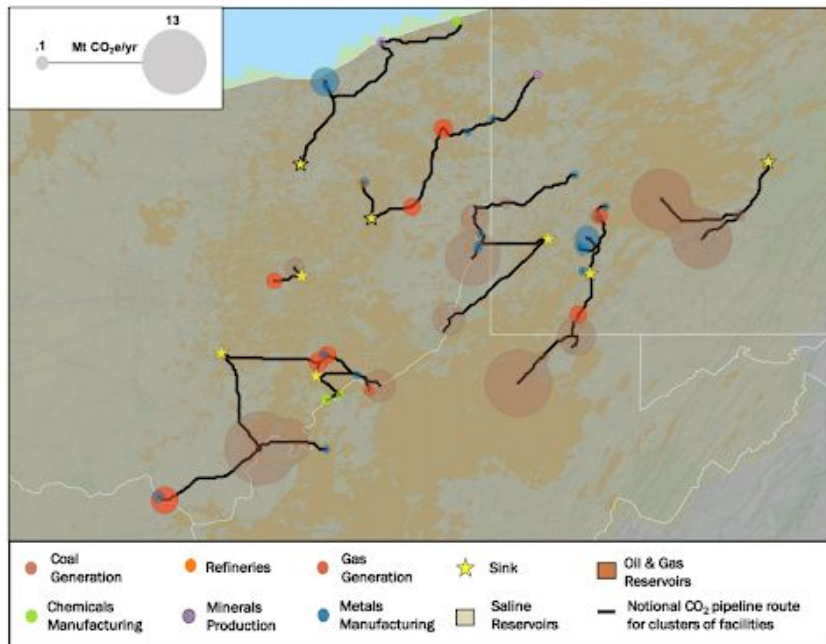
# WHAT IS A HYDROGEN HUB, ANYWAY?



# A PROPOSED OHIO RIVER VALLEY BLUE H<sub>2</sub>/CO<sub>2</sub> HUB FOOTPRINT

**FIGURE 12**

**The Ohio River Valley CCUS Project Development Possibilities**



*This figure is a compilation of major emitting facilities and notional CO<sub>2</sub> pipeline routes and sinks in the Ohio River Valley, modeled using SimCCS. The black lines show notional pipelines that run in seven separate locations on the map.*

This “notional” layout for carbon capture and sequestration in the Ohio Valley was suggested by the Labor Energy Partnership (The AFL-CIO and the Energy Futures Initiative) in its [“Building to Net-Zero: A U.S. Policy Blueprint for Gigaton-Scale CO<sub>2</sub> Transport & Storage Infrastructure”](#).

But this is just one of many possible layouts, which vary depending on the number and locations of the power plants and factories from which you expect to capture and sequester CO<sub>2</sub>. Projections range from 56 plants and factories to over 150.

This image represents the low end of that range.

Note: no carbon capture and sequestration (CCS) system has so far achieved a consistent 95 percent annual average carbon capture rate on a commercial scale over the long-term.

# HYDROGEN HUB PROPOSALS IN THE REGION

## Decarbonization Network of Appalachia (DNA H2Hub) in Pennsylvania

- End use: industrial applications (Shell Polymers), gas-fired power plants likely
- Key partners: Team Pennsylvania, Pennsylvania, Shell
- (Equinor pulled out of the project prior to application submission)



# THE TEAM PENNSYLVANIA CARBON CAPTURE & HYDROGEN HUB ROADMAP

Team Pennsylvania, a public/private partnership, has given us the most completely sketched out vision of what a Pennsylvania hub might look like.

It features 1,400 miles of pipelines that would capture and transport 62 million tons of CO<sub>2</sub> annually, about 2/3s of industrial emissions.

89% of the captured CO<sub>2</sub> would come from coal and gas-fired power plants.

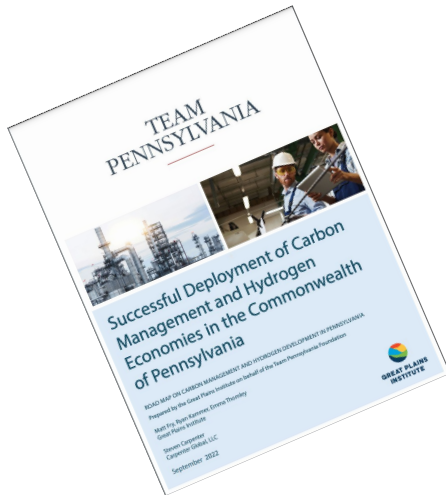


Figure 3. Midcentury carbon capture opportunities infrastructure scenario



Source: Figure authored by Elizabeth Abramson, 2022. Based on results of the SimCCS model and data from EPA GHGRP, 2020; NATCARB, 2015; SCOT, 2020.

#### Optimized transport network for midcentury CO<sub>2</sub> capture and storage

- Regional CO<sub>2</sub> infrastructure (modeled)
- ▲ Potential CO<sub>2</sub> storage area

#### Geologic storage opportunity

- Assessed low-cost saline storage
- Saline CO<sub>2</sub> storage formation

#### Capture sources

- 🏭 Cement & lime
- ⚡ Coal power
- 🍷 Ethanol
- ⚡ Gas power
- 🏭 Metals, minerals & other
- 📄 Pulp & paper
- 🏭 Refineries
- 🏭 Steel
- ♻️ Waste

Carbon captured from H<sub>2</sub> would probably amount to less than 15% of the amount captured and sequestered.

Table 1. Pennsylvania industrial and power sector emissions

Sector	Number of facilities	CO <sub>2</sub> emissions MMTPA CO <sub>2</sub>
Cement	8	3.7
Chemicals	15	0.6
Coal power plants	15	24.5
Ethanol	1	0.2
Gas power plants	48	47.3
Gas processing	44	2.0
Metals, minerals & other	50	2.9
Other power plants	2	0.04
Petrochemicals	2	0.2
Pulp & paper	10	3.1
Refineries	6	2.1
Steel	27	5.9
Waste	51	2.8
<b>Total</b>	<b>279</b>	<b>95.3</b>

Source: EPA GHGRP 2020.

Table 2. 45Q-eligible facilities in Pennsylvania

Sector	Number of facilities	CO <sub>2</sub> emissions MMTPA CO <sub>2</sub>	Potential capture quantity MMTPA CO <sub>2</sub>
Cement	8	3.9	3.3
Coal power plants	9	24.4	20.8
Ethanol	1	0.2	0.4
Gas power plants	23	44.4	34.7
Metals, minerals & other	1	0.9	0.1
Pulp & paper	4	2.7	1.0
Refineries	2	1.8	0.4
Steel	1	3.5	1.0
Waste	1	0.9	0.8
<b>Total</b>	<b>50</b>	<b>81.8</b>	<b>62.4</b>

Source: EPA GHGRP 2020.



## DOCUMENTED CONCERNS WITH CO2 PIPELINES

Figure 3. Midcentury carbon capture opportunities infrastructure scenario



Source: Figure authored by Elizabeth Abramson, 2022. Based on results of the SimCCS model and data from EPA GHGRP, 2020; NATCARB, 2015; SCO<sub>2</sub>T, 2020.

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- The well documented issues regarding carbon dioxide pipelines include a susceptibility to **ductile fractures**, **corrosion** from impurities in the carbon stream, and **accidental releases**.
- There is **very little experience** with carbon dioxide pipelines as there are currently **only about 5,000 miles of lines** and **insufficient exposure studies** to properly assess health issues.
- PHMSA regulations only apply to carbon dioxide transported by pipeline as a supercritical fluid and does not apply to all CO<sub>2</sub> pipelines that may be developed for CCS projects.
- Carbon dioxide is odorless and colorless and PHMSA does not require the addition of an odorant to any transported carbon dioxide.

## HYDROGEN HUB PROPOSALS IN THE REGION

### Appalachian Regional Clean Hydrogen Hub (ARCH2)

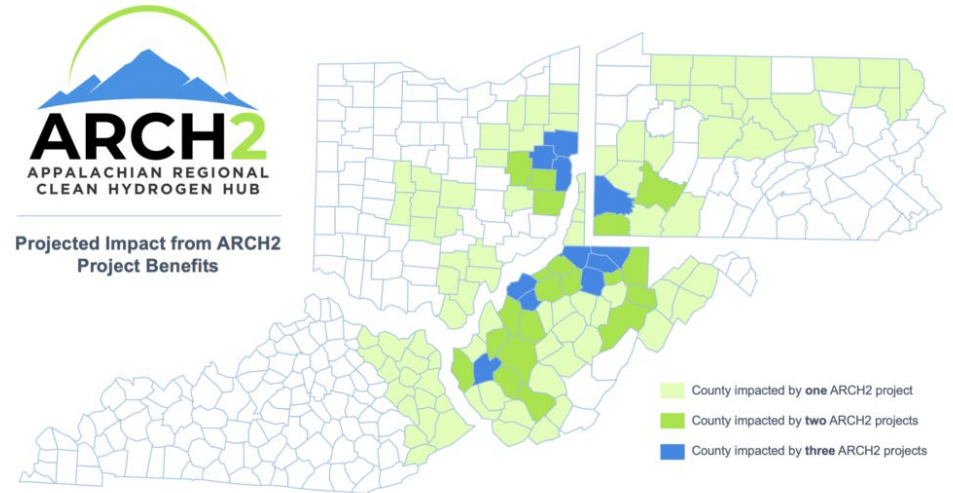


- Proposed end uses: power generation, industrial, commercial, residential, and transportation
- Project footprint spanning 118 counties in KY, OH, PA, and WV
- Evenly distributed across region but with largest and heaviest footprint in **West Virginia**, with three proposed projects each in:
  - North-Central: Wetzel, Monongalia, Marion, Harrison
  - Mid-Ohio Valley: Wood, Wirt
  - Southern: Lincoln
- **Ohio:**
  - Three projects in Columbiana, Carroll, and Jefferson counties
  - Two in Tuscarawas, Harrison, and Belmont counties
- **Pennsylvania:**
  - Three projects in Washington county
  - Two projects in Westmoreland and Greene counties

# HYDROGEN HUB PROPOSALS IN THE REGION

## ARCH2 Announced Projects:

- [Adams Fork Energy blue ammonia facility](#)
  - Gilbert Creek, Mingo County, WV
- [Empire Diversified Energy "waste-to-fuel" project](#)
  - Follansbee, Brooke County, WV, outside of Weirton
- [Chemours and TC Energy electrolysis projects](#)
  - Washington in Wood County, WV outside of Parkersburg
  - Belle in Kanawha County, WV south of Charleston



## HYDROGEN HUB PROPOSALS IN THE REGION

**Great Lakes Clean Hydrogen Coalition to  
apply it for funding**



### Great Lakes Clean Hydrogen Hub (GLCH)

- Ohio and Michigan, with parts of Pennsylvania and Indiana
- Nuclear-power hydrogen production (pink hydrogen)
- Linde serving as prime applicant, and includes Energy Harbor, Cleveland-Cliffs, GE Aerospace, the University of Toledo, and the Glass Manufacturing Industry Council

### Mid-Atlantic Clean Hydrogen Hub (MACH2)

- Philadelphia, Delaware, New Jersey
- Blue hydrogen in early stages, transition to green and pink hydrogen
- Heavy industry, transportation

## IEEFA: OVERVIEW OF NATIONAL H2HUB PROPOSAL TRENDS



Institute for Energy Economics  
and Financial Analysis  
IEEFA.org

**This preliminary information suggests a substantial amount of the regional clean hydrogen hub funding may go to bolster the extraction, transport, and use of fossil fuels, primarily natural gas.**

- Less than a quarter of 22 confirmed pre-applicants plan to produce hydrogen solely using renewable energy and water, with half utilizing renewable energy alongside fossil fuel or nuclear energy.
- Eight proposals rely either entirely or partly on nuclear power and water.
- Nine proposals either entirely or partly fossil fuel-based hydrogen production.



## PLUS, THE COST OF A BLUE H<sub>2</sub>/CCS HUB IS EXTREMELY HIGH - EVEN WITH FEDERAL TAX CREDITS

[https://energyfuturesinitiative.org/wp-content/uploads/sites/2/2023/02/20230212-CCS-Final\\_Full-copy.pdf](https://energyfuturesinitiative.org/wp-content/uploads/sites/2/2023/02/20230212-CCS-Final_Full-copy.pdf)

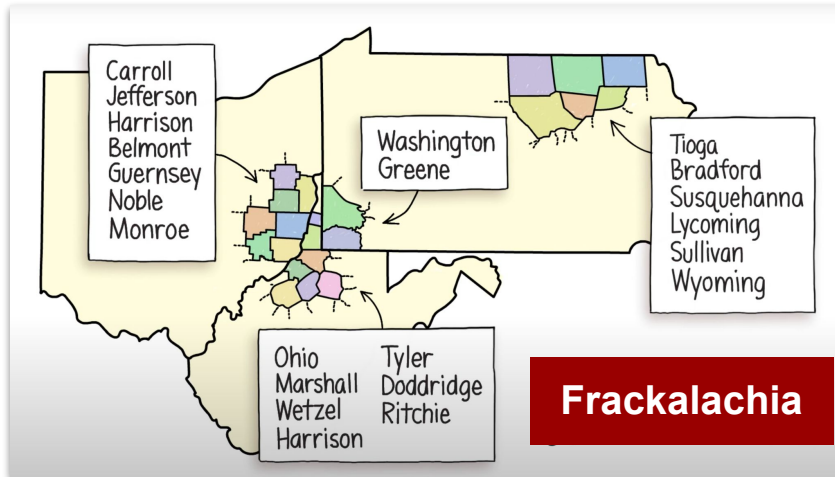
“On a risk-adjusted basis, even in the presence of greater financial support mechanisms, **CCS remains challenged relative to most other kinds of development when it comes to attracting investment capital.** Given such conditions, now is a critical time to develop a coordinated, comprehensive, long-term set of incentives as well as improved market, permitting, and regulatory policies. All these are needed to attract billions of dollars of private sector financial capital and widen the application of CCS to key industries. **Without private capital to leverage public investment, CCS will not scale up and a key solution will remain lacking, and by such postponement, driving up the overall cost of decarbonization.**” (Page ES-4)

“While the bold steps offered by the BIL and IRA to support CCS are significant, **further policy action is needed to materially deploy CCS** to help decarbonize the U.S. stock of electricity and industrial facilities.” (Page ES-5)

“Specifically, CCS deployed for steel, pulp mill wood byproduct boilers, natural gas and coal-based generation and hydrogen production using steam methane reformers **are all currently out-of-the-money (i.e., more expensive than the value of the credit)** for FOAK and in some cases mature Nth-of-a-kind (NOAK) installations. Crucially, these out-of-the money CCS applications make up the bulk of CO<sub>2</sub> emissions from the U.S. electricity and industrial sectors (ES-1a and ES-1b, next page).” (Page ES-5)

## THE COST ISN'T JUST ECONOMIC OR ENVIRONMENTAL - OUR LIVES ARE AT STAKE

- 7.5% of US counties have a cancer risk of greater than 1 in 1 million
- 100% of major natural gas counties in OH, PA, and WV counties have a cancer risk of greater than 1 in 1 million
- In Ohio, only Frackalachian counties have a greater than 1 in a million risk and all Frackalachian counties have a greater than 1 in a million risk.





# COST IS NOT THE ONLY POTENTIAL RISK - ENVIRONMENTAL JUSTICE OBJECTIONS ARE SIGNIFICANT

WHEJAC Final Report Executive Order 14008

## EXAMPLES OF THE TYPES OF PROJECTS THAT WILL NOT BENEFIT A COMMUNITY

1. Fossil fuel procurement, development, infrastructure repair that would in any way extend lifespan or production capacity, transmission system investments to facilitate fossil-fired generation or any related subsidy.
2. Carbon capture and storage (CCS) or carbon capture, utilization, and storage (CCUS)
3. Direct air capture
4. The procurement of nuclear power
5. Research and development
6. The establishment or advancement of carbon markets, including cap and trade
7. Geoengineering and techno fixes
8. Highway expansion
9. Road improvements or automobile infra-structure, other than electric vehicle charging stations
10. Industrial scale bioenergy
11. Incentives for investor-owned utilities
12. Projects that promote gentrification without any housing policy crafted by a community to prevent displacement
13. Incineration, waste-to-energy or biomass incineration, and landfilling ([Anishinabek Nation and Iroquois Caucus Transport and Abandonment of Radioactive Waste](#))
14. Pipeline creation, expansion, or maintenance
15. [Memo to the Biden administration: What not to do on climate](#)
16. [The Conversation: Climate Scientists: Concept of Net Zero Is A Dangerous Trap](#)
17. [NAACP Environmental and Climate Justice Program: Fossil Fueled Foolery](#)

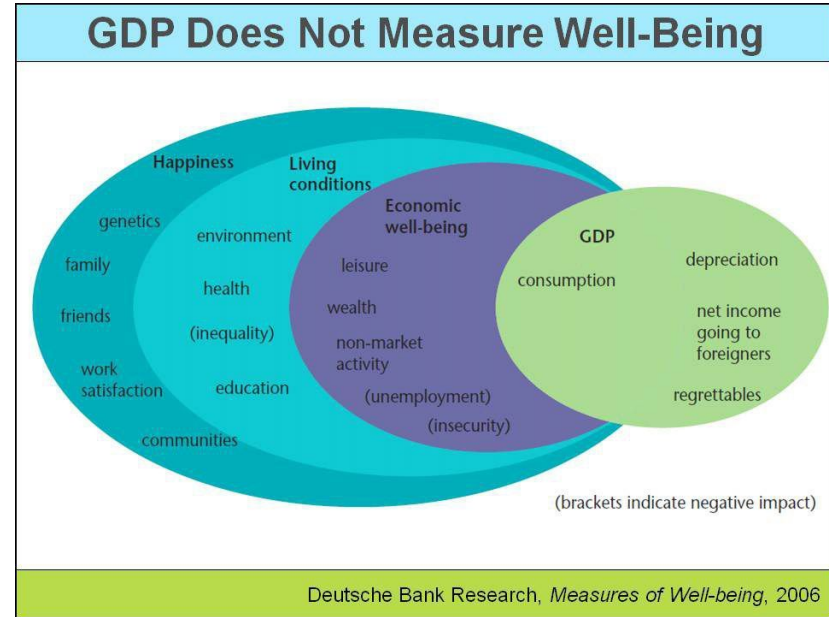
The push for hydrogen hub proposals based on blue hydrogen (shale gas+ccs) is in tension with the articulated Justice40 goals, which call for a reduction in energy burden and environmental exposure to disadvantaged communities and asserts the importance of energy democracy and energy resiliency.

## COST IS NOT THE ONLY POTENTIAL RISK - ENVIRONMENTAL JUSTICE ≠ GDP

Hub applicants have used GDP as a proxy for community benefit, though research shows that GDP generated by these industries does not lead to local wealth creation.

From the [DNA H2Hub Project Summary](#):

**Environmental Justice:** The nearly 3 million residents living in the 30 counties directly surrounding the broader DNA H2Hub network are among the most vulnerable to energy transition-related job losses and live in some of the most polluted counties in the country. **These communities stand to see billions in GDP growth**, increased small business development, reduced environmental burden, and increased clean energy access.



## LEGAL LANDSCAPE AND REGULATORY CONSIDERATIONS

### Council on Environmental Quality Report to Congress on Carbon Capture, Utilization, and Sequestration

Delivered to the Committee on Environment and Public Works of the Senate and the Committee on Energy and Commerce, the Committee on Natural Resources, and the Committee on Transportation and Infrastructure of the House of Representatives, as directed in Section 102 of Division 5 of the Consolidated Appropriations Act, 2021



7.6 State & Regional Policies: Combined with Federal incentives such as the Section 45Q tax credit, state policies can help enable responsible CCUS deployment.

Tax incentives include: tax credits, exemption or reduction of property tax, severance tax, gross receipt tax, and sales tax, among others.

Non-tax incentives: low carbon fuel standards, declaring CO2 storage to be in the public interest, clarifying CO2 ownership laws, transfer of long-term liability to the state, various forms of financial assistance, off-take agreements (providing a guaranteed buyer for the electricity or output from a CCUS project), and eligibility of CCUS in Electricity Generation Portfolio Standards or Voluntary Goals (earning saleable compliance credits by generating electricity using CCUS).

## LEGAL LANDSCAPE AND REGULATORY CONSIDERATIONS - REGIONAL EXAMPLES

### Pennsylvania:

- Act 108 of 2022 - Regional Clean Hydrogen Hub Tax Credit Program [Subarticle D]: An entity that purchases natural gas and hydrogen for use in a project facility within a federally approved regional clean hydrogen hub can earn tax credit via purchase of natural gas and hydrogen: **\$0.81 per kilogram of clean hydrogen purchased** from a clean hydrogen hub in Pennsylvania; **\$0.47 per unit of natural gas purchased and used at the qualified taxpayer's facility**. Total credits available **per fiscal year: \$50 million**. The credit program runs from **1/1/2024 to 12/31/2043**.

### West Virginia:

- Revised rules to incorporate Class VI injection wells and is currently in the “Pre-Application” phase for Primacy, i.e. engaging EPA officials and preparing primacy application
- Shifts long term liability of geologic storage wells to the state upon receipt of a completion certification, which can be issued after ten years
- Passed legislation allowing DNR to lease state-owned pore spaces for carbon storage beneath DNR-owned lands, excluding state parks, and allowing DNR to award leases without an open bidding process.

### Ohio:

- Passed legislation directing the state to pursue Class VI primacy
- Legislation went into effect in the fall of 2022
- Ohio will soon be in the “Pre-Application” phase for Primacy

Note: only [2 Class VI wells](#) have been permitted anywhere in the US to date



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