

EXPLORING COMMUNITY CO-BENEFITS, BARRIERS, AND FUTURE RESEARCH GAPS FOR INDUSTRIAL DECARBONIZATION IN THE UNITED STATES

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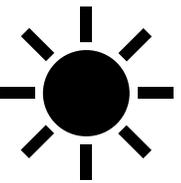
OUR RESEARCH AREAS:



Planetary & Environmental Health



Energy Systems of the Future



Climate Governance & Sustainability Transitions

SAMPLE PROJECTS:



U.S. DEPARTMENT OF
ENERGY



Alfred P. Sloan
FOUNDATION



National Institutes
of Health

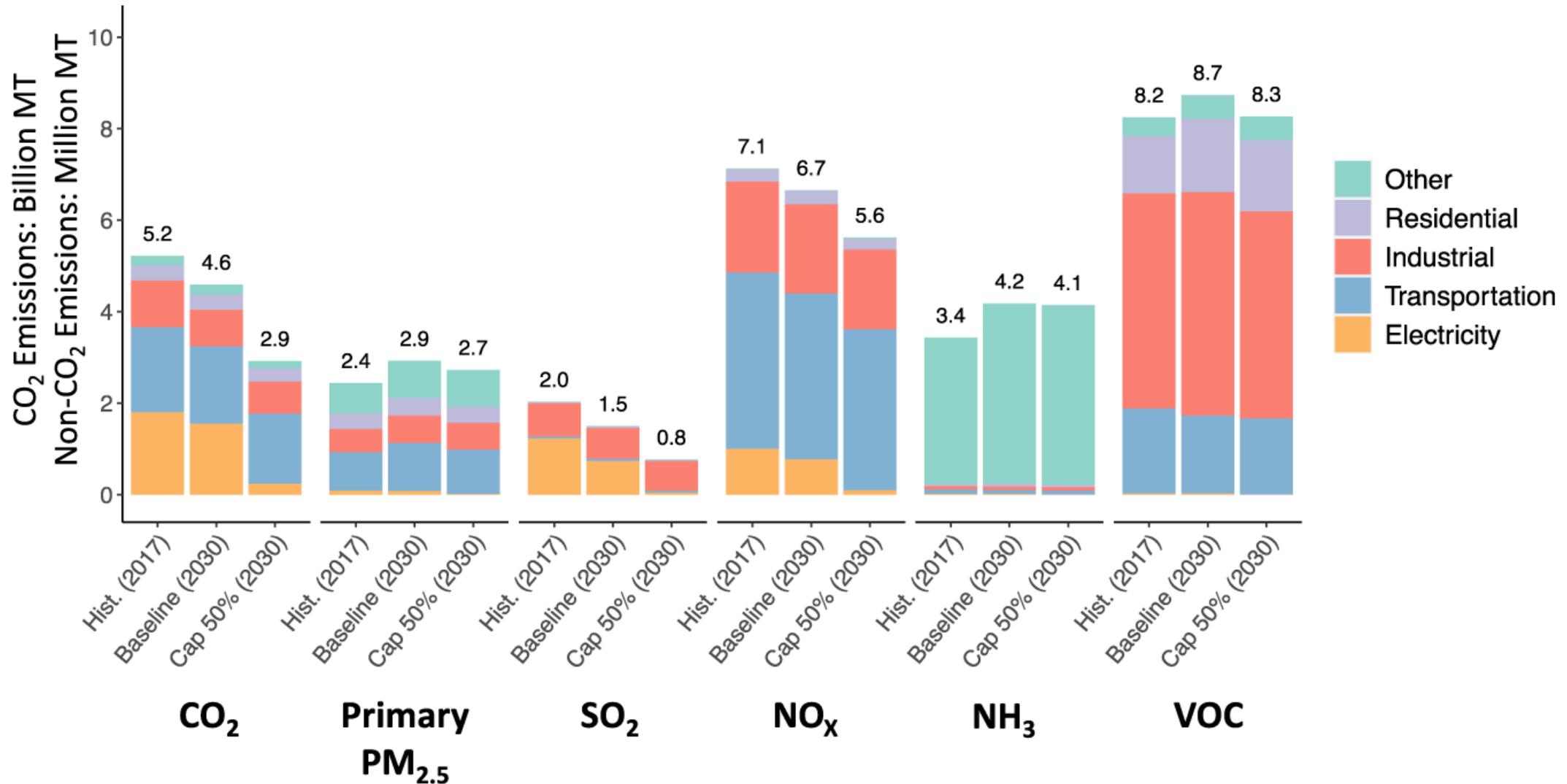
OUR APPROACH:

Equity & Justice

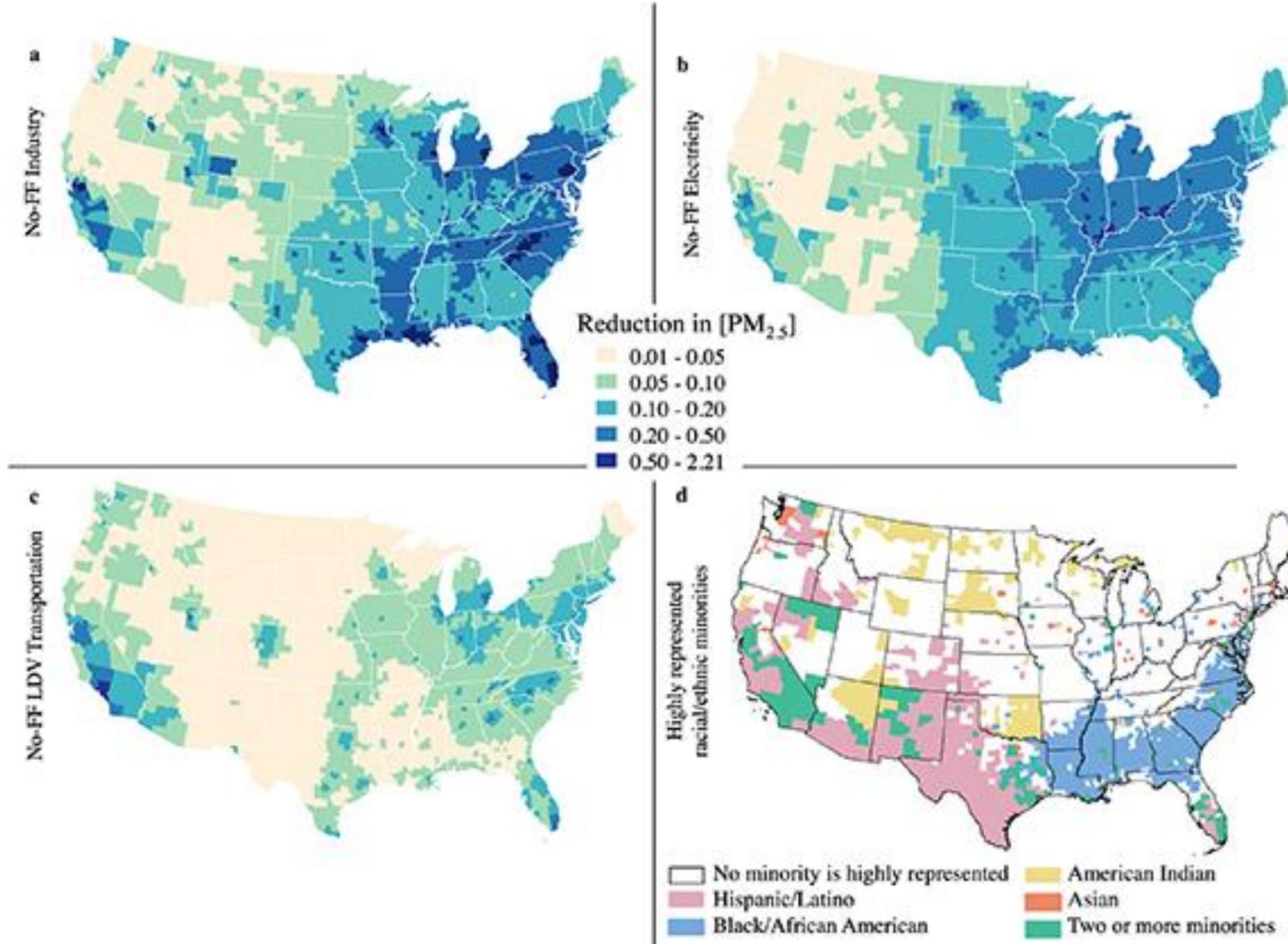
Robust Data Analysis

Real-World Impact

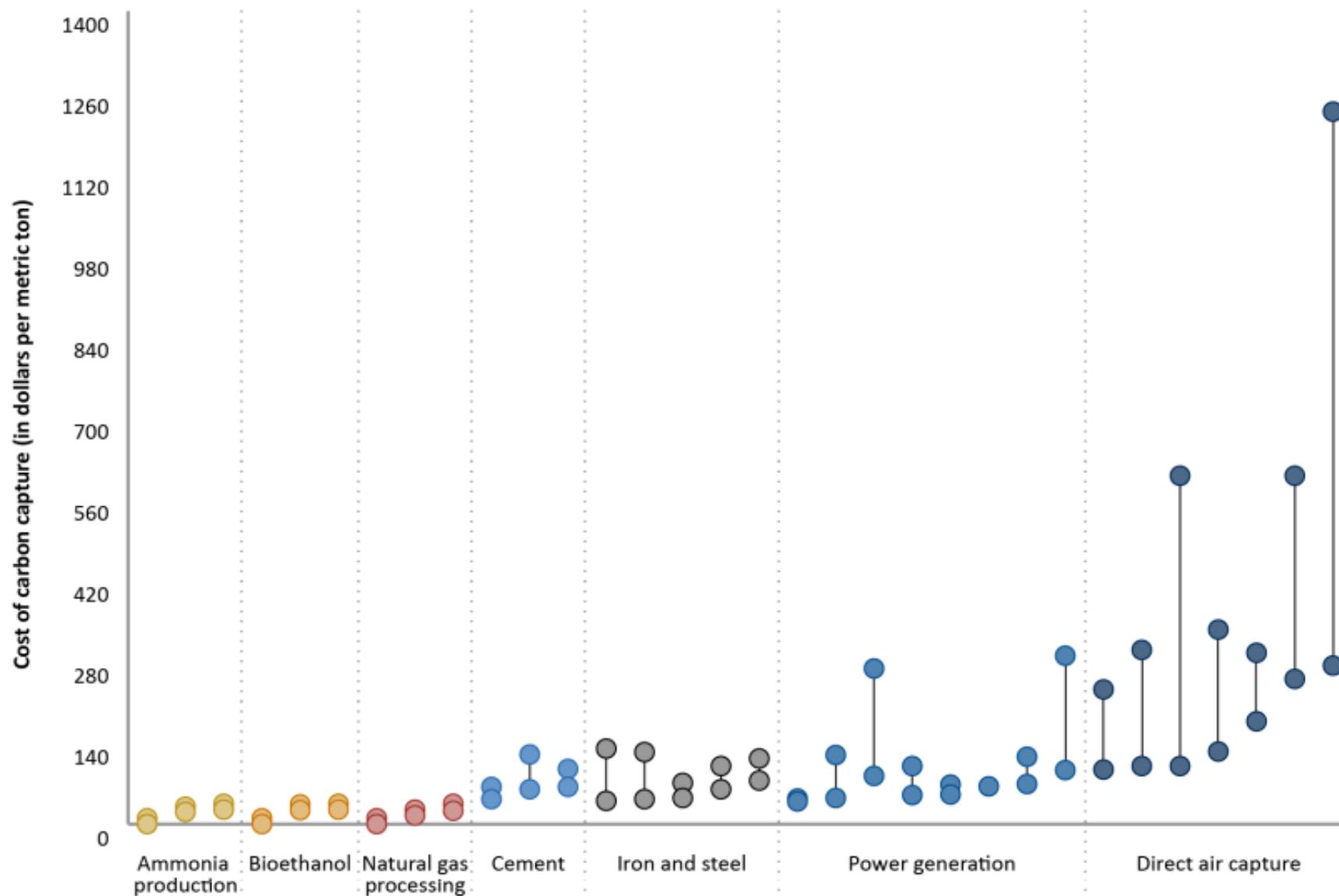
The air quality benefits of industrial decarbonization in the United States (compared to other sectors of decarbonization such as transport or homes)



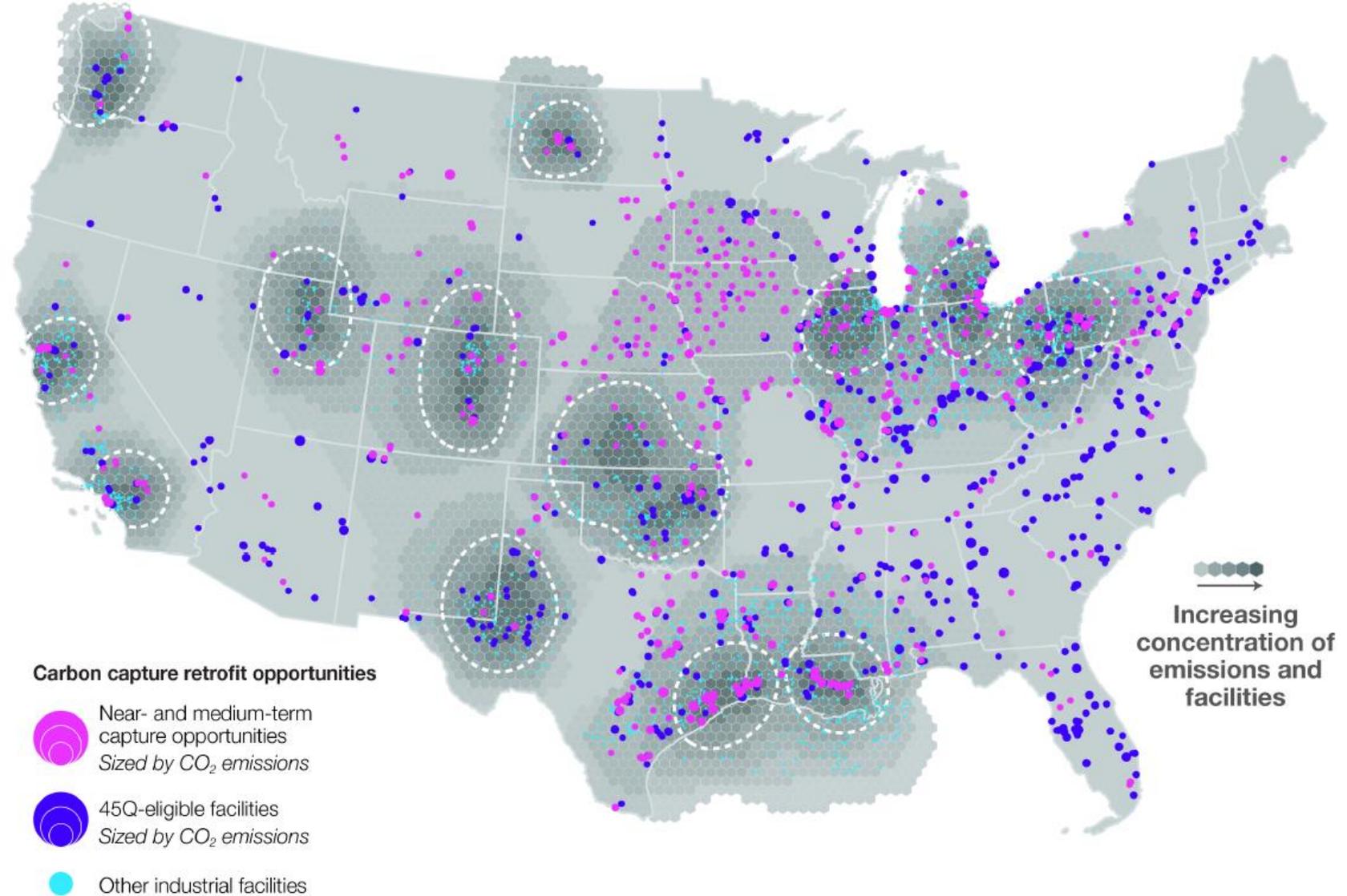
Changes in ambient particulate matter pollution for industrial decarbonization (panel a) compared to electricity (panel b) and transport (panel c), with racial diversity patterns shown in panel d.



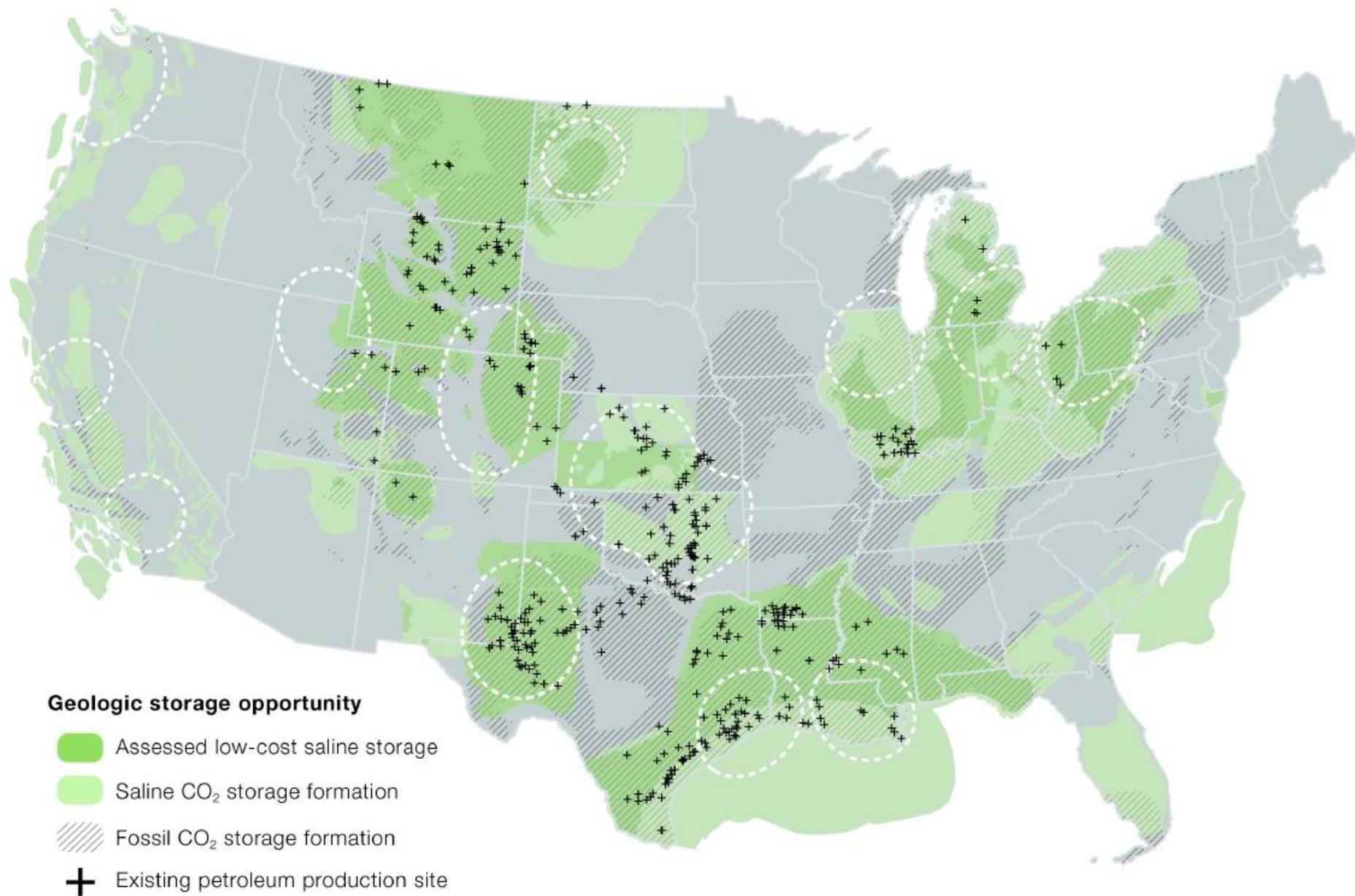
Estimated costs to capture one ton of carbon dioxide in the United States across different industrial sectors



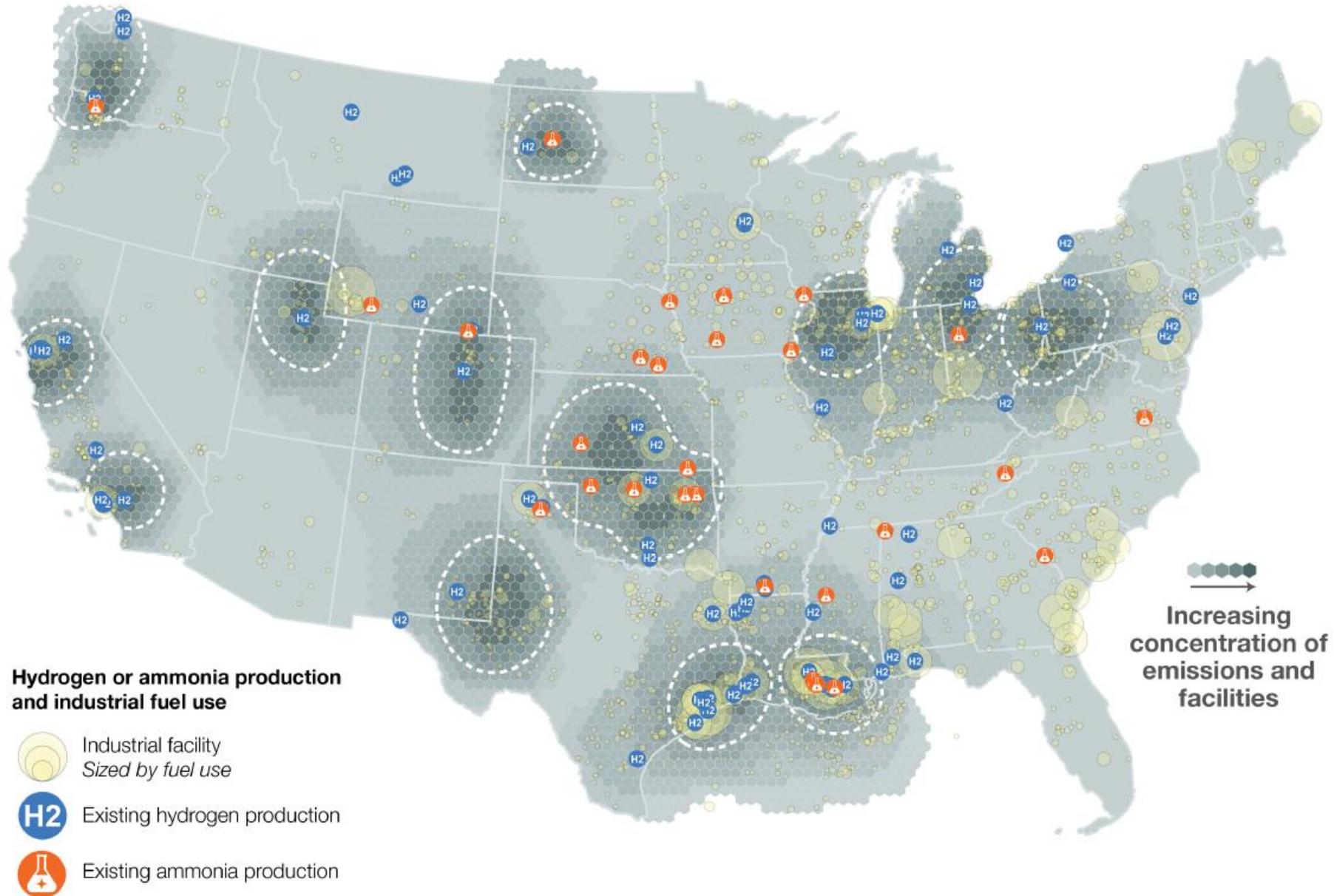
Carbon capture retrofit opportunities among 14 regional hubs in the United States



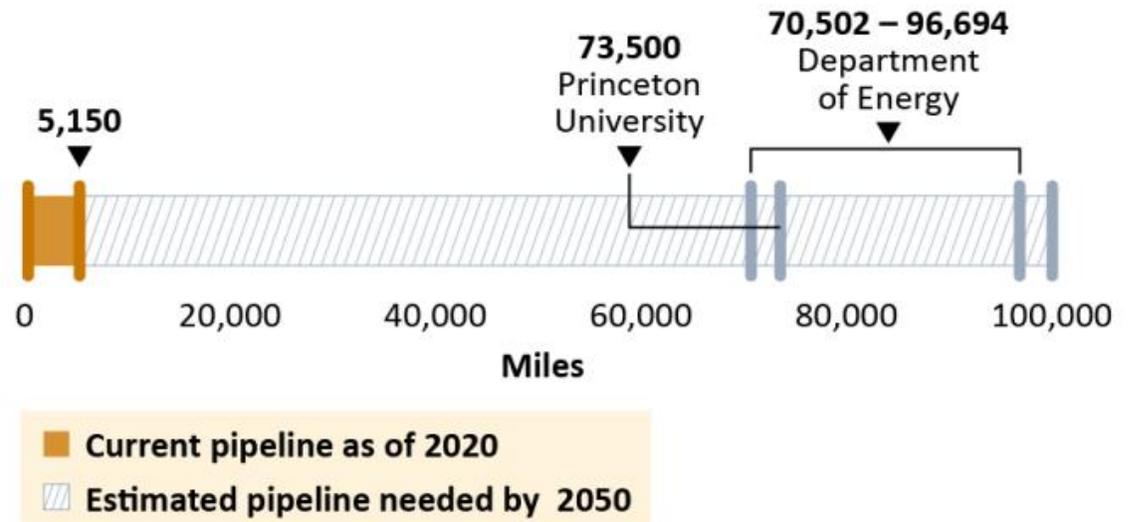
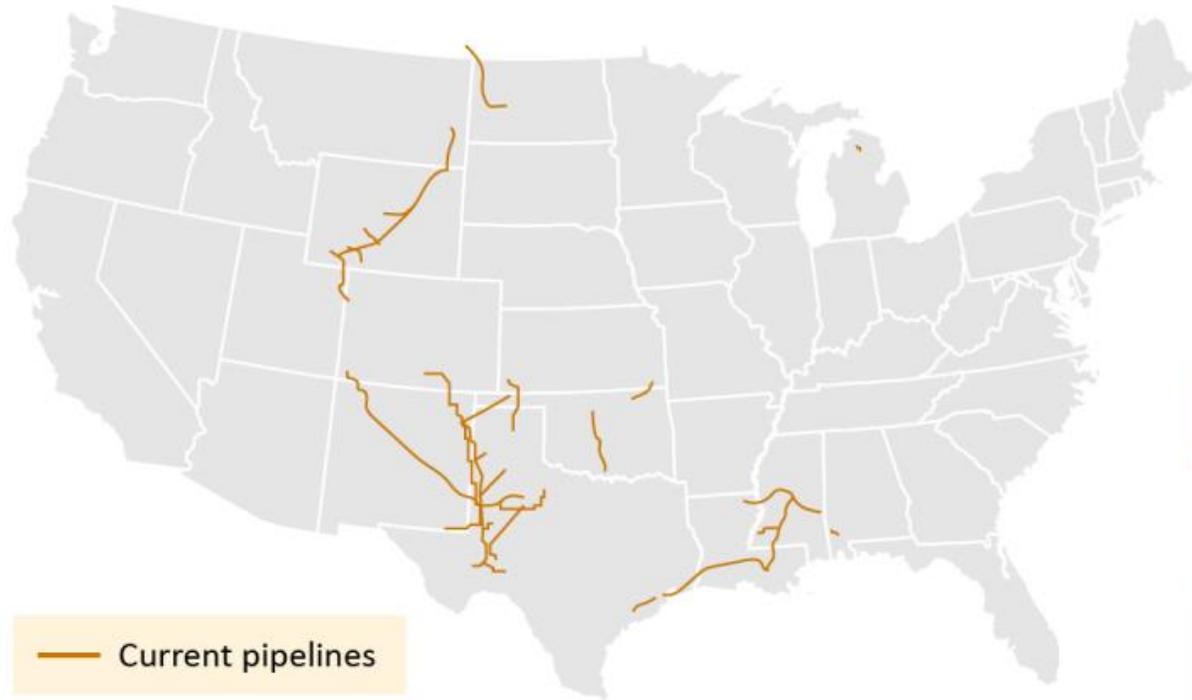
Carbon storage among 14 regional hubs in the United States



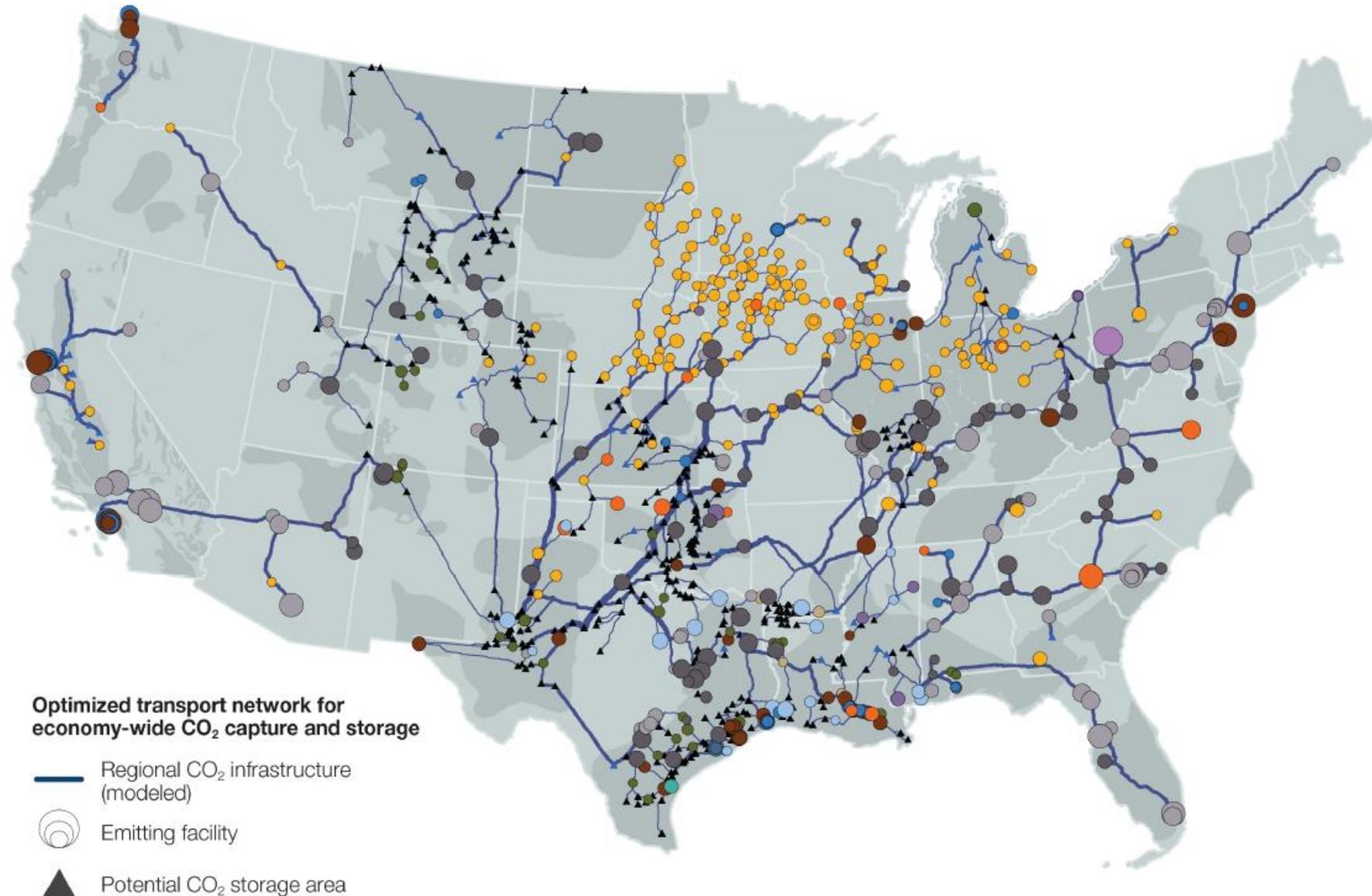
Hydrogen potential among 14 regional hubs in the United States



An optimized transport network for carbon dioxide storage across 14 regional clusters in the United States



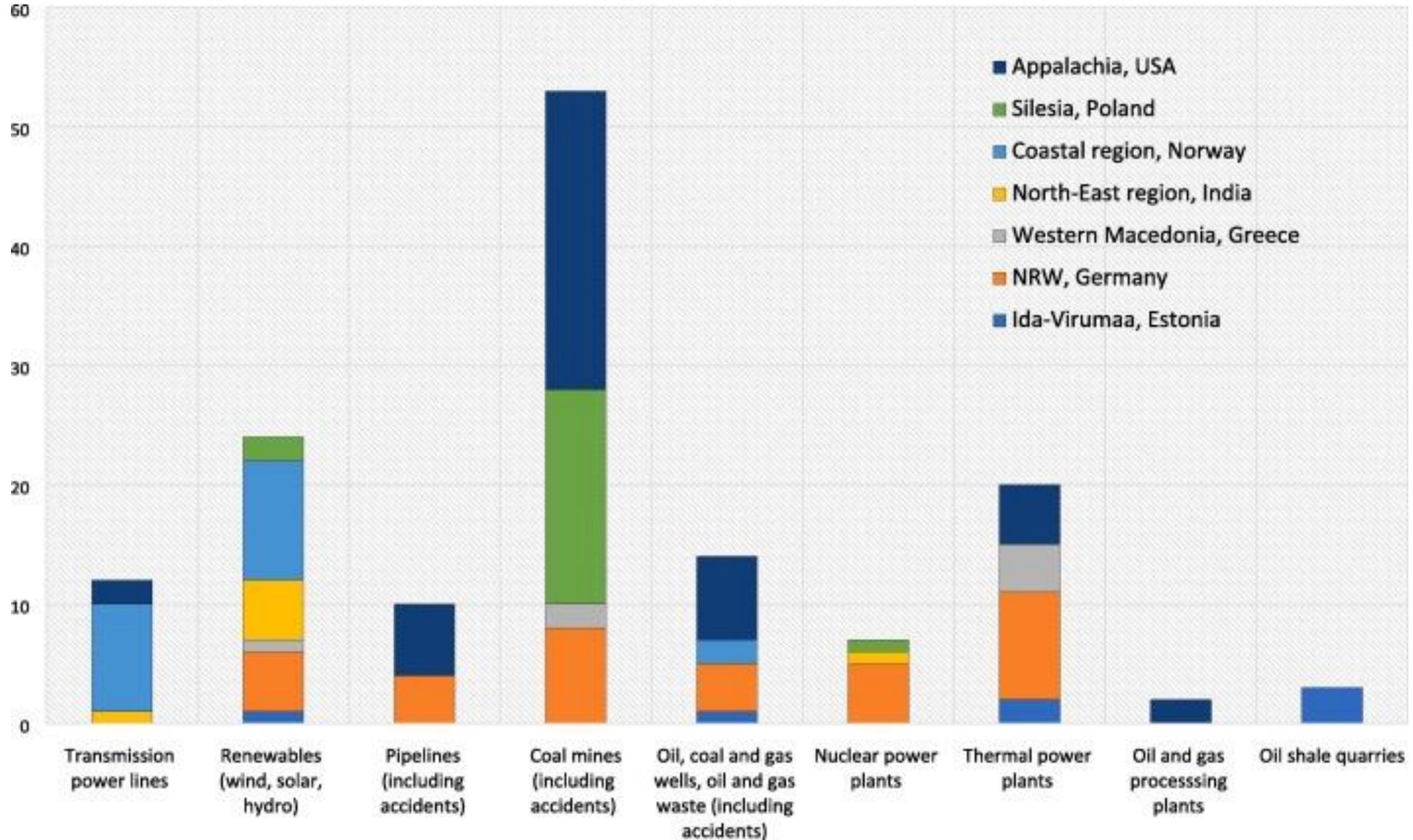
An optimized transport network for carbon dioxide storage across 14 regional clusters in the United States



Cases studies of strong pipeline opposition resulting in a no-build outcome

Pipeline	Developer's rationale	Proximate events
Access Northeast	Inconsistent state energy policies	Massachusetts Supreme Court blocked utilities from charging ratepayers to finance construction. Other state agencies and legislatures were also engaged in blocking decisions.
Atlantic Coast	Legal uncertainty	The developers cited one specific federal court case that created ongoing uncertainty, but there were other federal court cases pending and unresolved.
Bluegrass	Lack of customer commitments	State courts ruled against the right of eminent domain for this case; state legislature bills to limit eminent domain were introduced but not passed at the time of the decision.
Constitution	Lack of risk-adjusted return	State agencies were engaged in ongoing legal battles to withhold certification for the pipeline.
Northeast Energy Direct	Lack of customer commitments, lack of state regulatory procedures regarding binding contracts	Local and state governments continued to litigate over land access. Strong opposition from U.S. Congressional representatives and senators.
Pacific Connector and Jordan Cove	Lack of state government permits	State government agencies denied certification. FERC upheld state's denial of clean water certification.
Palomar Bradwood Landing	Lack of customer need due to changing economic circumstances	Federal court vacated the FERC approval. State government agencies denied permits and certification.
PennEast	Challenges in obtaining state government permits	Litigation with state government over eminent domain for public land. State government did not grant certification.
Via Verde	Developer (public power agency) responds to opposition with alternatives to solve electricity power needs	High public opposition led the governor to reverse position and end support prior to an election.

Opposition and community mobilization against energy infrastructure (N=130 cases)



U.S. DOE 2023 report, 7 barriers

1. Challenging economics with long payback periods and a subsequent lack of first-of-a-kind projects that are at very early levels of technological readiness, even after incentives from the Inflation Reduction Act are taken into consideration;
2. Operational roadblocks delaying implementation of decarbonization retrofits, such as alignment of decarbonization investments to asset downtime windows;
3. Overreliance on a small portfolio of technologies with relatively low deployment rates (e.g., carbon capture and storage, hydrogen);
4. Nascent ecosystem of value chain partners and lack of enabling infrastructure (e.g., carbon dioxide and hydrogen pipelines);
5. Capital formation challenges due to relatively lower returns on investment, higher volume of capital needed, perceived risks of retrofits and a threat to existing assets;
6. Limited ambition (to date) among regulators as well as producers and consumers for low-carbon industrial products;
7. Inconsistent public acceptance due to environmental and human health risks, environmental justice, and labor concerns.

GAO report, 3 barriers

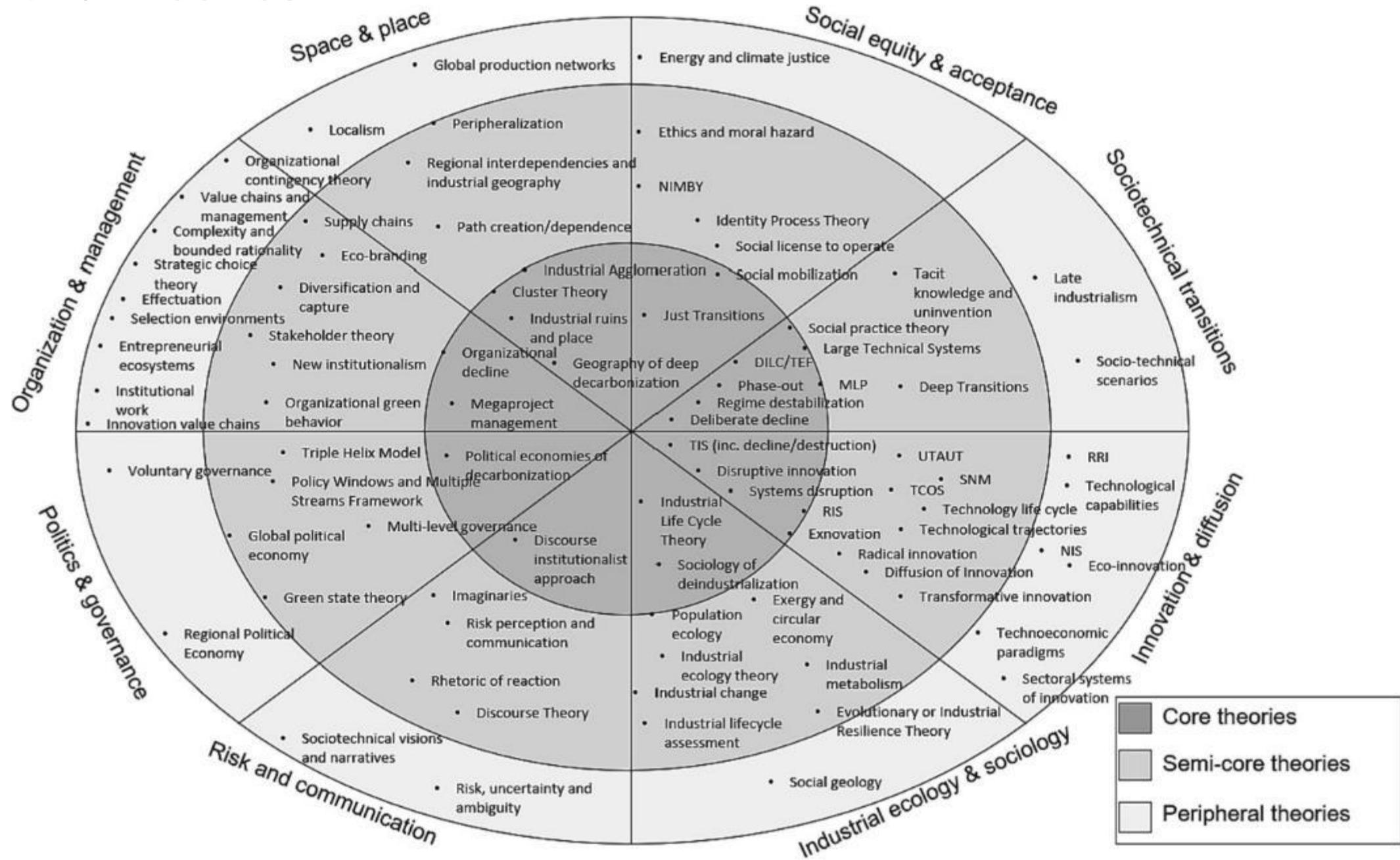
1. Cost, as deploying carbon capture still represents an added cost to doing business and offers few opportunities to generate revenue for firms;
2. Infrastructure, as widespread deployment will require transport and storage but these issues remain hampered by land access and rights of way among transport corridors;
3. Community engagement, as previously local opposition has led to the cancellation or relocation of projects.

Six research gaps and needs

Text Box 1: Future research gaps and data needs generated by the review

1. **Develop theories and conceptual frameworks specific to industrial decarbonization.** It is difficult to find conceptual approaches or frameworks specifically created for net-zero industry. Therefore, new heuristics may be warranted to help guide research, analysis, and policy.
2. **Broaden consideration of co-benefits.** Existing research focuses mostly on air pollution, health, and carbon emissions, but may miss other co-impacts across political, social, and economic dimensions.
3. **Utilize representative national or local surveys specific to industrial decarbonization, rather than decarbonization generally.** This can include sector-specific surveys covering various modes of industry, or specific forms of transport such as carbon pipelines.
4. **Move beyond models and surveys to a stronger evidence base.** Other forms of evidence include stated preference techniques such as community interviews, household diaries, or focus groups, or revealed preference techniques such as embedded ethnography, naturalistic observation, or spatial analysis.
5. **Better understand the portfolio aspects of technical industrial decarbonization options and crosscutting trade-off risks.** Options differ in their risk, uncertainty, investment needs, intersections across sectors, and timing.
6. **Appreciate the stakeholder networks and regional governance dynamics of industrial decarbonization.** This may be done via a multi-actor, multi-technological, multi-scalar approach via hubs and clusters.

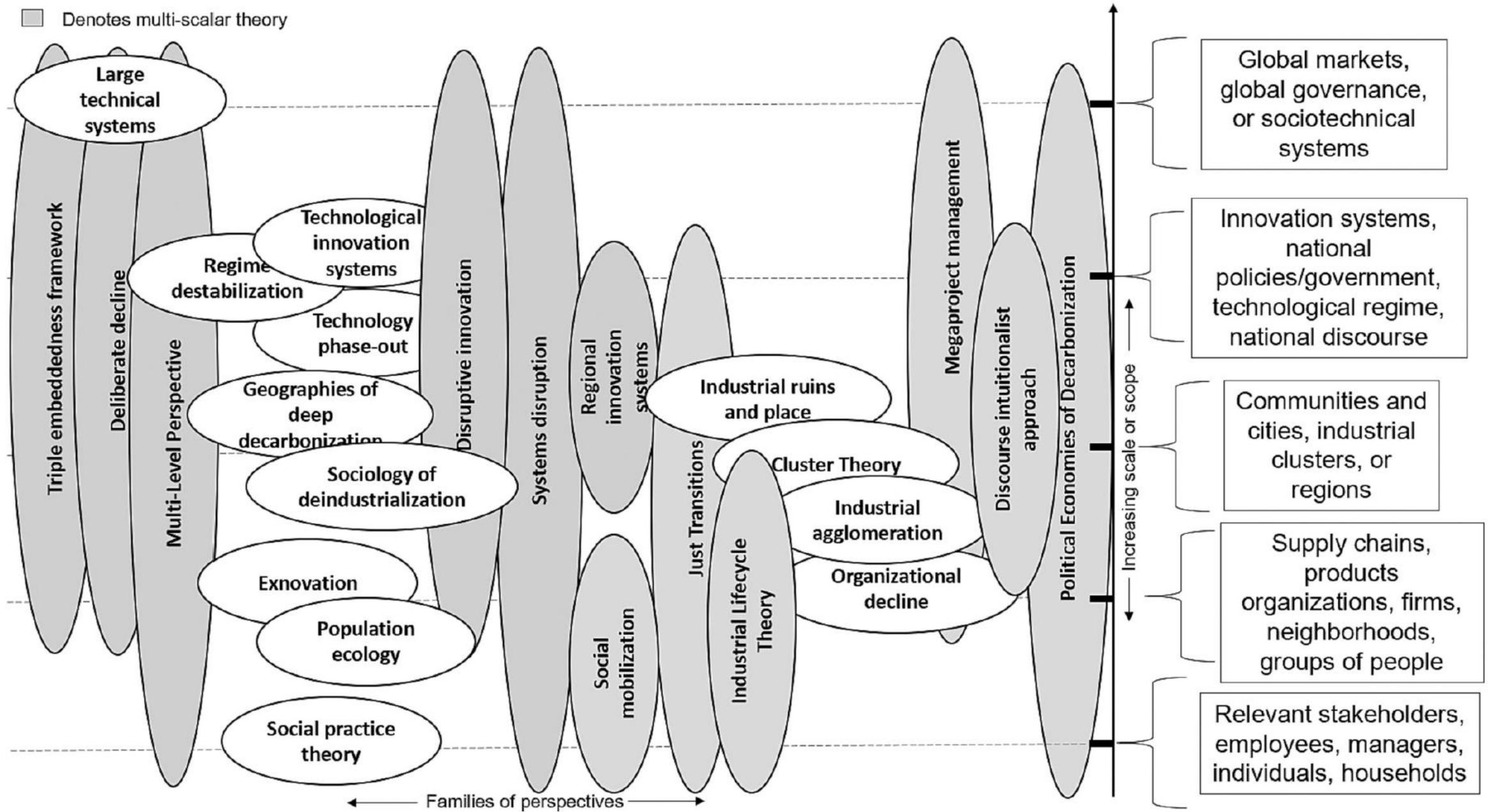
Point 1: Theories



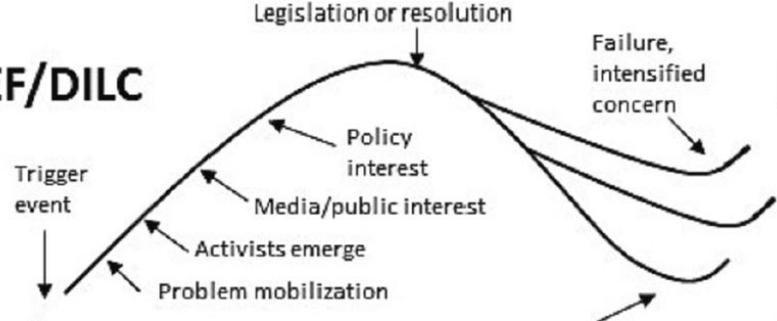
Point 1: Theories

Family of perspectives	Core theories	Common elements or focus	How industrial decarbonization is defined	What or who shapes it?	To what effect?
<i>Theories of sociotechnical transitions</i>	Triple Embeddedness Framework, Deliberate Decline, Regime Destabilization Framework, Technology Phase Out, Multi-Level Perspective on Transitions, Social Practice Theory, Large Technical Systems	Sociotechnical system, path dependence, lock-in	A process of disruption, decline, or phase-out to established unsustainable sectors or technologies, and the emergence of new alternatives	A coevolutionary competition between new entrants (or niches) and incumbents (or regimes)	To transform or reorient sociotechnical systems towards carbon-neutral platforms
<i>Theories of innovation and diffusion</i>	Technological Innovation Systems, Disruptive Innovation, Systems Disruption, Regional Innovation Systems, Exnovation	Technology, processes or products	A contest between old innovations and new ones, embedded in innovation systems	Inventors, entrepreneurs, innovators and firms, policymakers, consumers	Incorporation of new technology, to develop and sustain more sustainable and lower-carbon industries
<i>Theories of social equity and acceptance</i>	Just Transition, Social Mobilization	Social protection, justice	A socioeconomic phenomenon that threatens to harm communities hosting industrial clusters or infrastructure	Social attitudes, legitimacy, resistance	To ensure a fairer, more accountable, more equitable low-carbon future
<i>Theories of space place and geography</i>	Geographies of Deep Decarbonization, Industrial ruins and place attachment, Cluster Theory, Industrial Agglomeration	Territorial embeddedness, marginal and peripheral spaces	A relational and multi-scalar effort to generate new low-carbon regimes across different places, spaces, and scales	Structural spatial, economic, and political patterns	To promote less uneven development within and across countries
<i>Theories of organizational behavior and management</i>	Megaproject Management, Organizational Decline	Projects, organizations, business models	A strategic and tactical challenge facing managers and firms	Corporate managers, employees, innovators, stakeholder networks	To manage tensions and take advantage of opportunities
<i>Theories of politics and governance</i>	Political Economies of Decarbonization	Collective action dilemmas, leakage	A political act that affects the market power of incumbents	Transnational elites, state and non-state institutions	To better account for winners and losers within decarbonization pathways
<i>Theories of risk and communication</i>	Discourse Institutional Approach	Construction of risk, rhetoric, ideas formation	A risk and opportunity facing particular communities	Institutionalization, disruption of power systems and ideologies, competing discourses	Successful challenging of dominant climate imaginary and the value system behind it
<i>Theories of industrial ecology and sociology</i>	Industry Life Cycle Theory, Sociology of Deindustrialization, Population Ecology Theory	Communities of place, organization	An evolutionary struggle for fitness among a population of organizations and various selection pressures	Organizational strategy and industrial metabolism	To achieve a dominant design or thrive in a low-carbon society

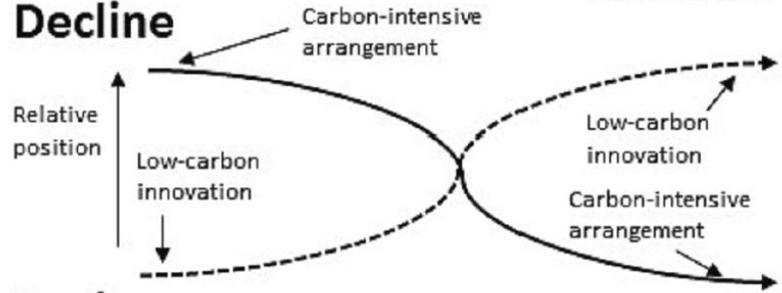
■ Denotes multi-scalar theory



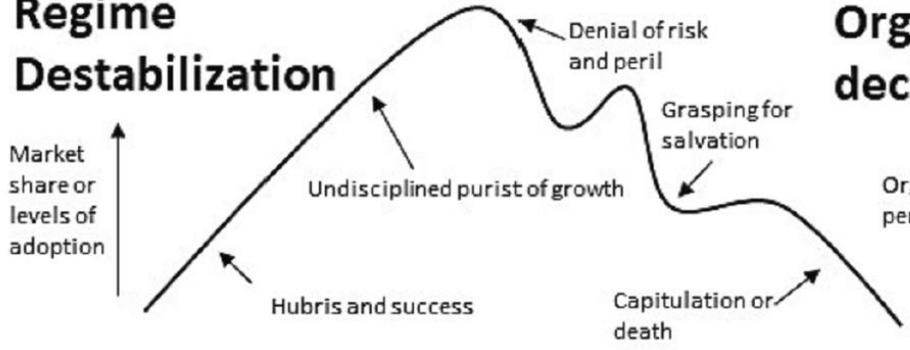
TEF/DILC



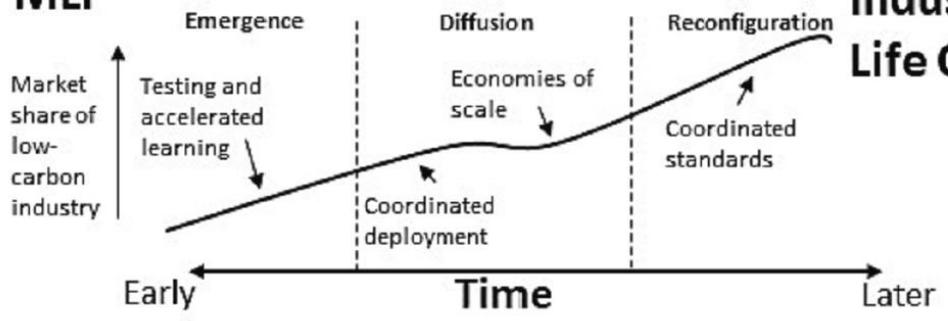
Deliberate Decline



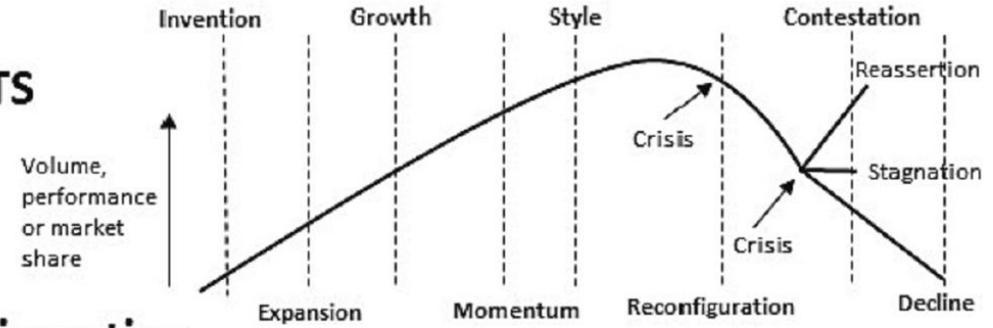
Regime Destabilization



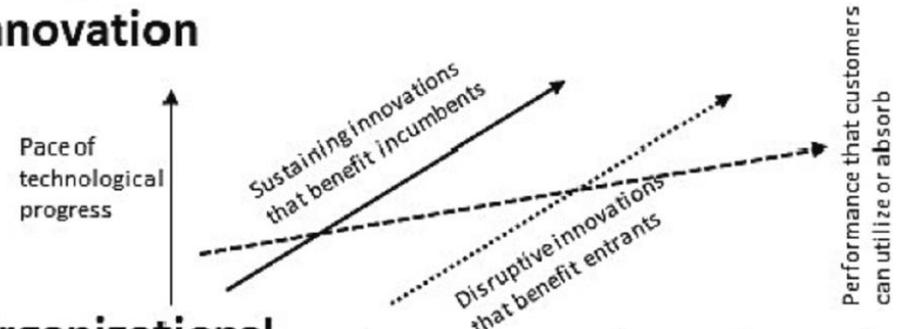
MLP



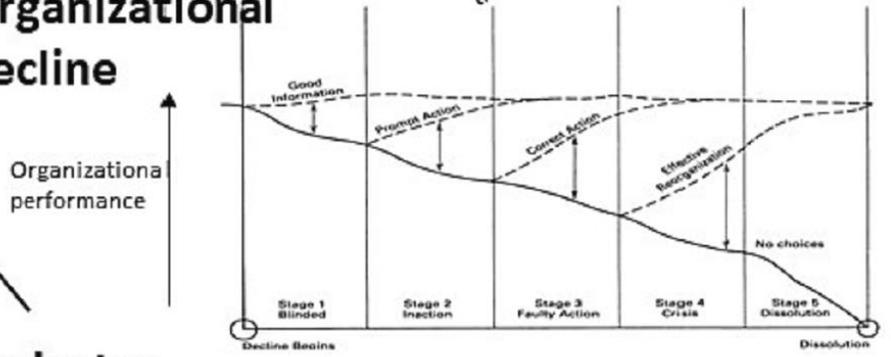
LTS



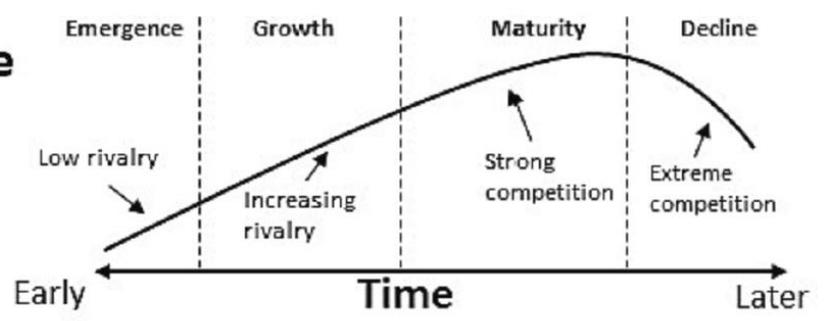
Disruptive Innovation



Organizational decline



Industry Life Cycle

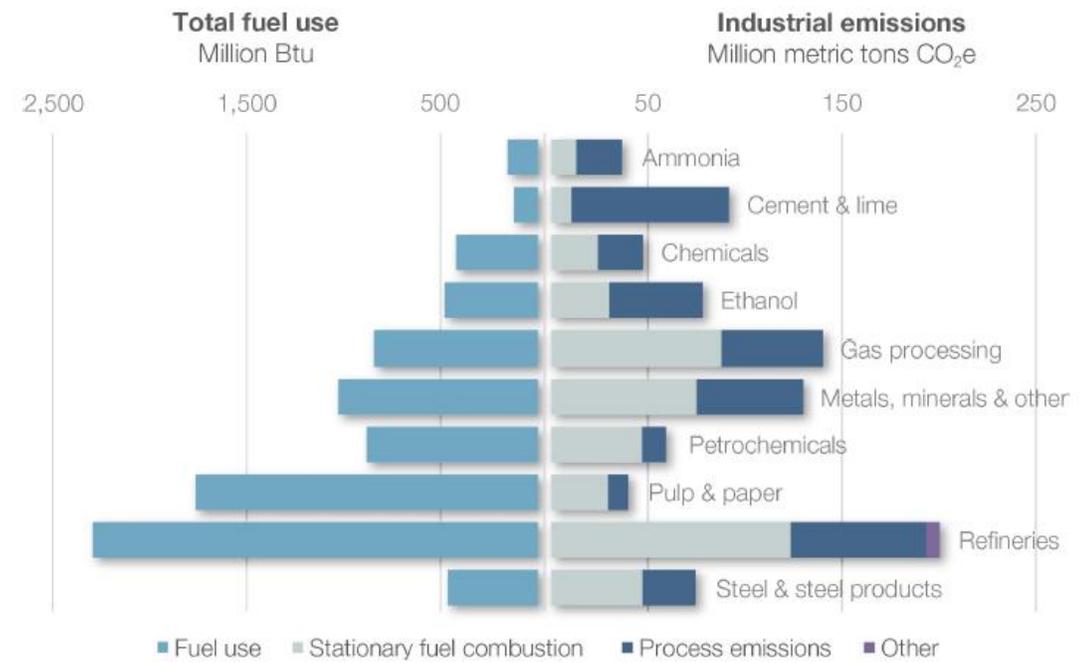


Point 2: Co-benefits

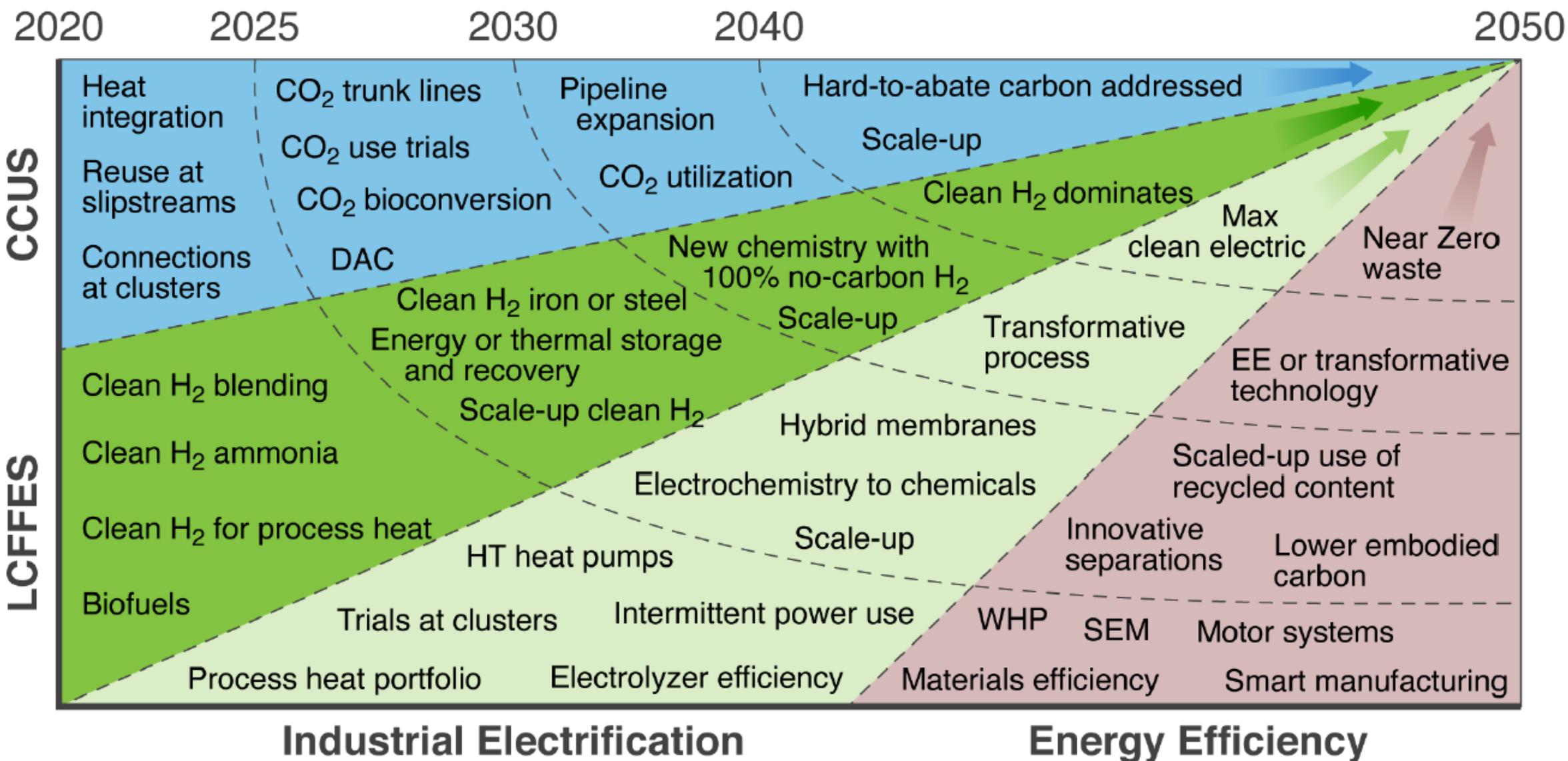
- Financial and economic co-impacts such as the expansion of markets, business models, government revenues, and carbon credits (among others)
- Socioenvironmental co-impacts such as protection of habitats, forests, oceans or species, or the provision of decent work and high paying jobs
- Technical co-impacts such as the improved performance of systems, disruptive or positive innovation patterns for a sector, enhanced efficiency, or positive and negative learning and experimentation
- Political and institutional co-impacts such as the achievement of policy goals (relating to industrial strategy, equity and leveling up, or energy security) or the creation of a moral hazard

Point 3 and 4: Stronger evidence

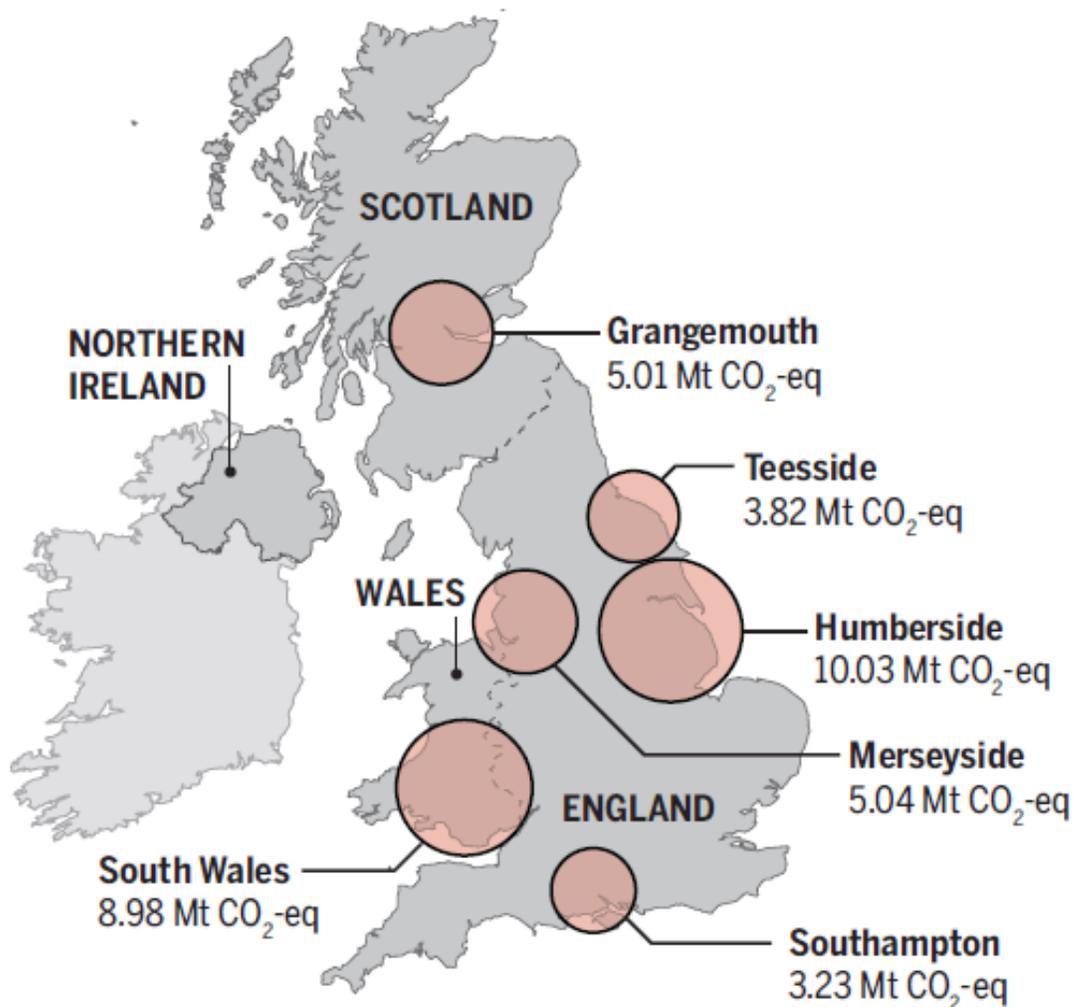
- Point 3: Survey evidence *specific* to industrial decarbonization or work that explores community lived experiences in depth, or sector specific assessments
- Point 4: the use of more focus groups, community or expert interviews, household diaries, or expert elicitation workshops, or ethnography
- New informational tools such as online inventories of coping strategies, citizens assemblies, collecting energy biographies, or citizen science data collection are possible



Point 5: Portfolio, innovation and risk management



Point 6: Towards regional governance and clusters



Summary of decarbonisation opportunities in Australian industrial regions

Pilbara

TOTAL ABATEMENT POTENTIAL:	30.6 MtCO ₂ e
ADDITIONAL RENEWABLE ENERGY REQUIRED:	25.3 to 53.8 TWh
ADDITIONAL INVESTMENT REQUIRED:	A\$17.8 to A\$38.4 billion
ESTIMATED JOBS OPPORTUNITY:	102-243k

Kwinana

TOTAL ABATEMENT POTENTIAL:	2.1 MtCO ₂ e
ADDITIONAL RENEWABLE ENERGY REQUIRED:	4.8 to 9.7 TWh
ADDITIONAL INVESTMENT REQUIRED:	A\$3.9 to A\$7.3 billion
ESTIMATED JOBS OPPORTUNITY:	15- 31k

Bubble size is related to total potential abatement.

*Analysis of the opportunity in Gladstone is presented in appendix, a detailed focus on this region was not undertaken

Gladstone*

TOTAL ABATEMENT POTENTIAL:	21.2 MtCO ₂ e
ADDITIONAL RENEWABLE ENERGY REQUIRED:	14.8 to 37.5 TWh
ADDITIONAL INVESTMENT REQUIRED:	A\$14.2 to A\$33.6 billion
ESTIMATED JOBS OPPORTUNITY:	34-89k

Hunter

TOTAL ABATEMENT POTENTIAL:	9 MtCO ₂ e
ADDITIONAL RENEWABLE ENERGY REQUIRED:	11.2 TWh
ADDITIONAL INVESTMENT REQUIRED:	A\$10.3 billion
ESTIMATED JOBS OPPORTUNITY:	24k

Illawarra

TOTAL ABATEMENT POTENTIAL:	6.6 MtCO ₂ e
ADDITIONAL RENEWABLE ENERGY REQUIRED:	12.1 to 13.7 TWh
ADDITIONAL INVESTMENT REQUIRED:	A\$6.6 to A\$10.7 billion
ESTIMATED JOBS OPPORTUNITY:	37-74k



Point 6: Towards regional governance and clusters

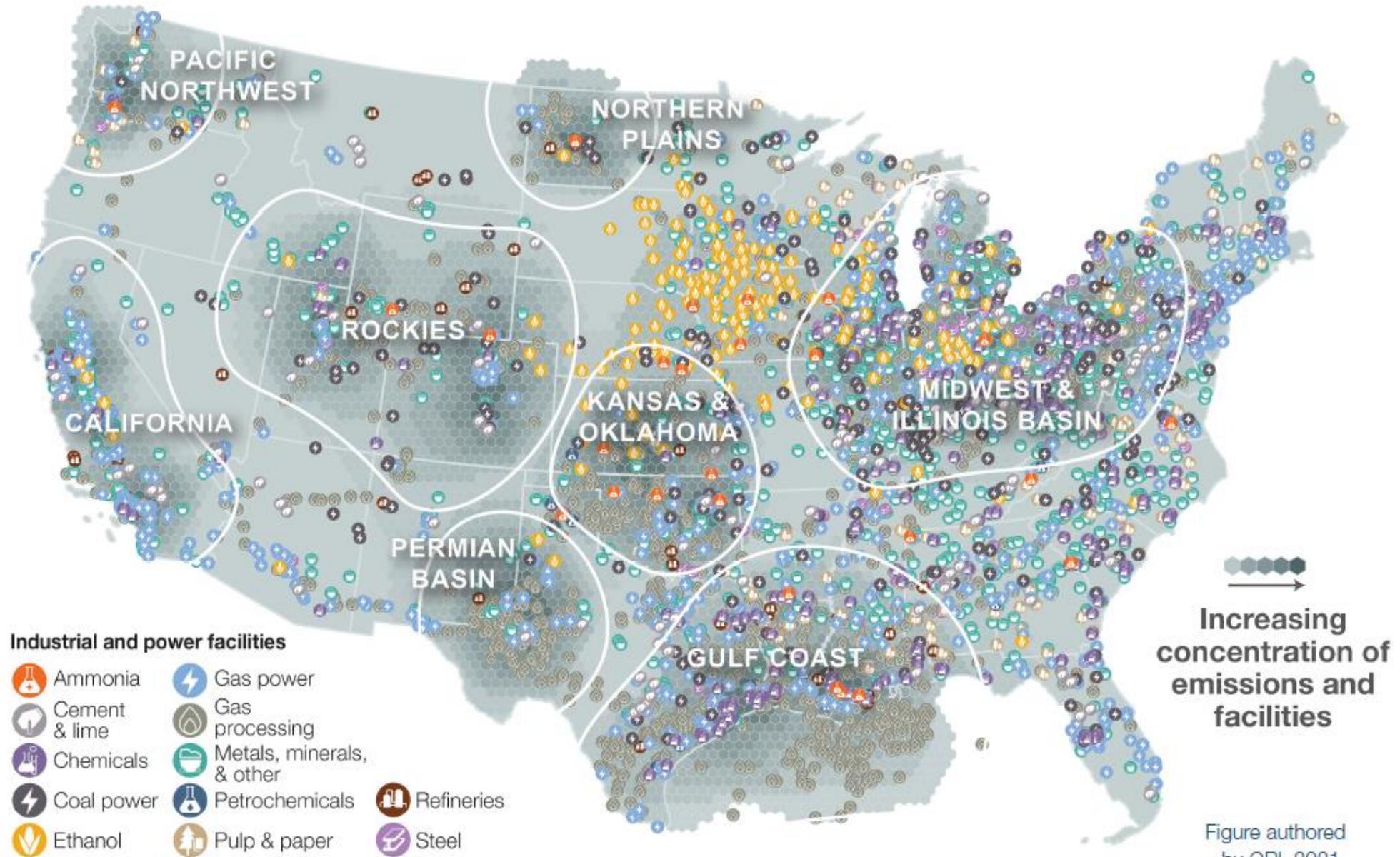


Figure authored by GPI, 2021.

Point 6: Towards regional governance and clusters

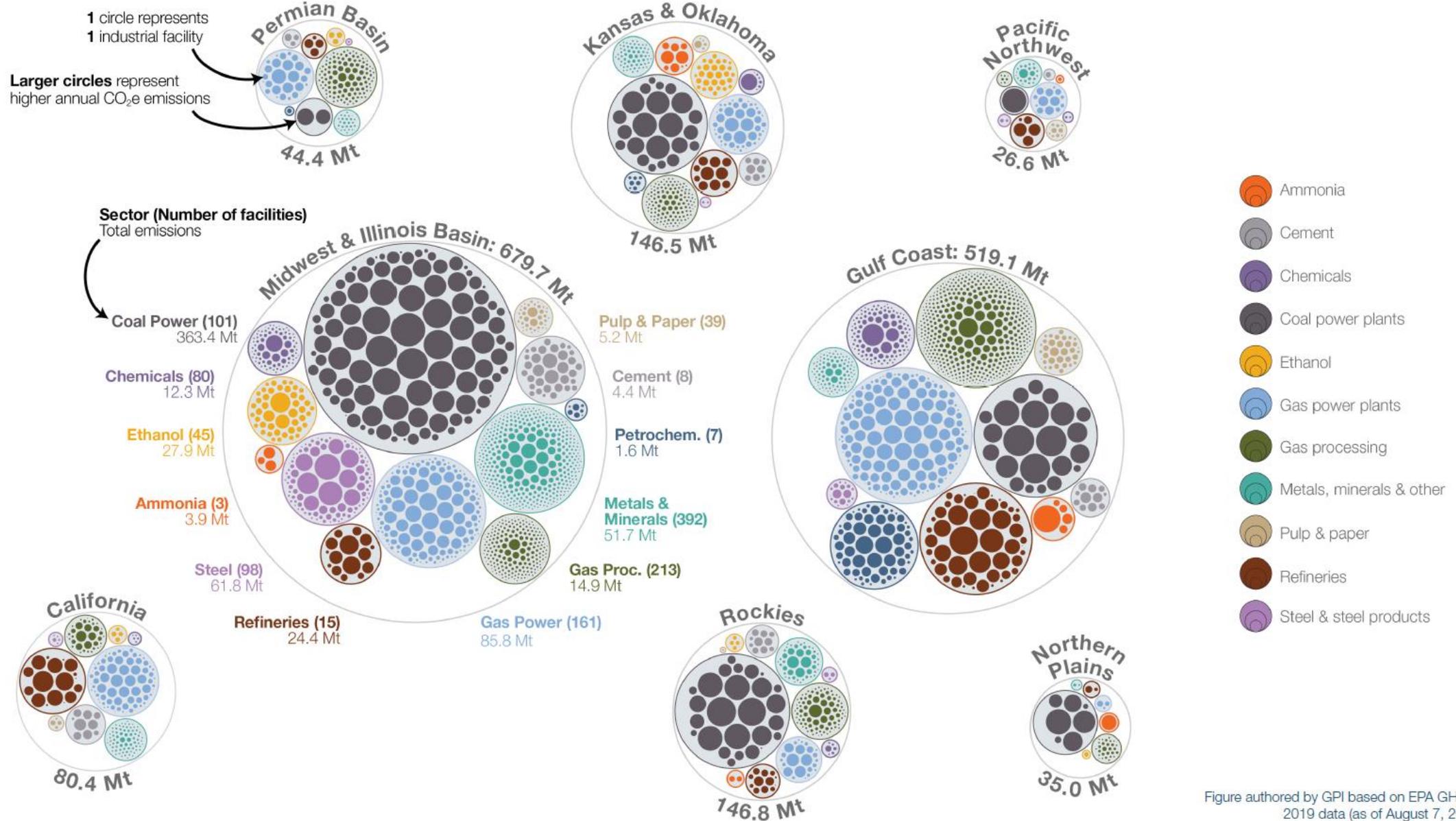


Figure authored by GPI based on EPA GHGRP 2019 data (as of August 7, 2021).