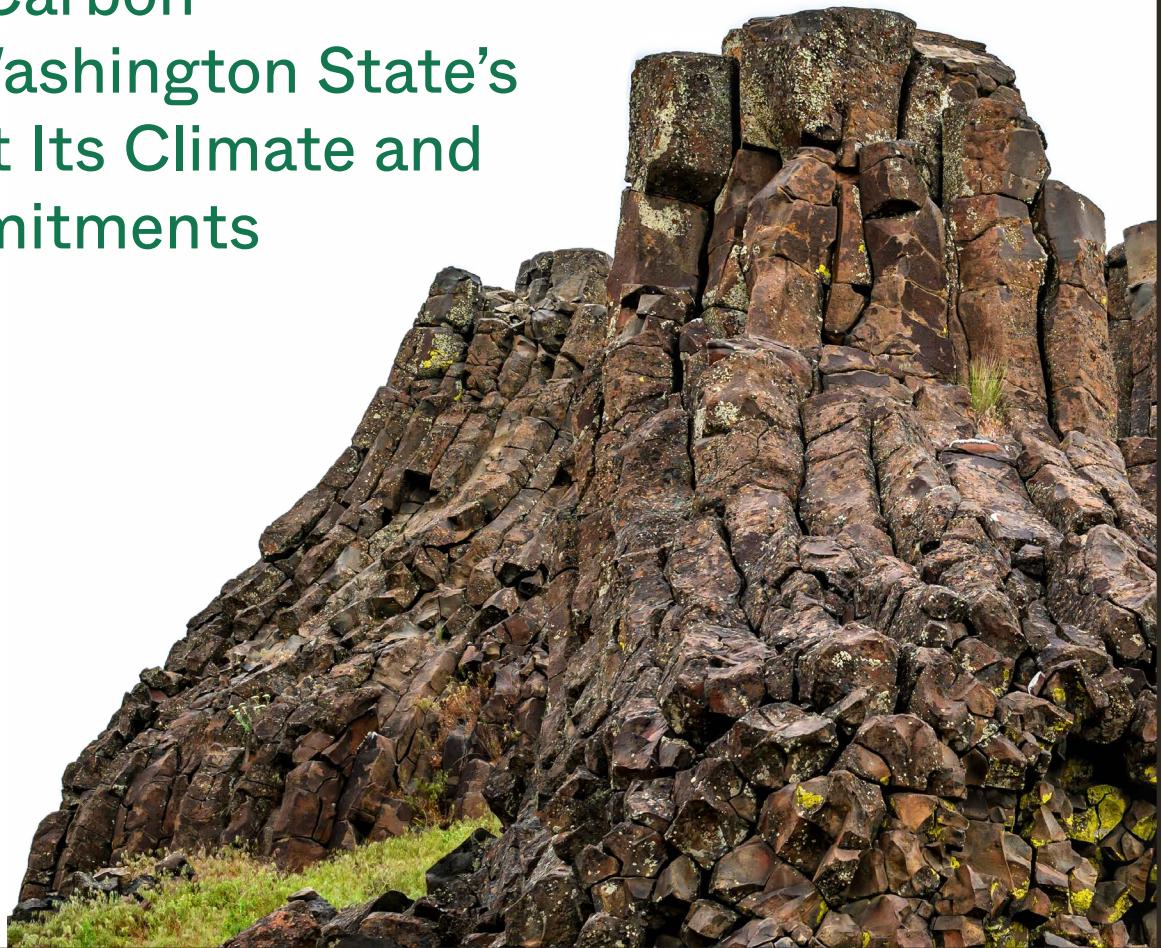


TrapRock

POLICYMAKERS' DIGEST

Enabling Geologic Carbon Sequestration on Washington State's Trust Lands to Meet Its Climate and Clean Energy Commitments

December 2025



Executive Summary

Humanity has failed to limit global warming to 1.5°C above pre-industrial levels. With concerted and resolute action, humanity may still restrain warming to below 2°C. A chief scientific adviser to the United Nations estimates that limiting warming to 1.7°C requires removing 10 billion metric tons (MT) of carbon dioxide from the atmosphere annually. How will this CO₂ be removed, and where will it be stored?

The Carbon Containment Lab is a public charity interested in this second question. The CC Lab researches and offers education about emergent climate solutions. We have spent several years exploring avenues to advance geologic carbon sequestration (GCS)—particularly in the Columbia River Basalt Group (CRBG) underlying parts of Washington, Oregon, and Idaho. Our investigation indicates that the magnitude of work to realize commercial-scale GCS in the CRBG is so tremendous that it cannot be timely achieved on a project-by-project basis. **Rather, Washington State must lead.**

We invite you to read, *TrapRock: Enabling Geologic Carbon Sequestration on Washington State's Trust Lands to Meet Its Climate and Clean Energy Commitments* (Gavin, 2025). The *TrapRock Report* proposes that the Washington State Department of Natural Resources (DNR) form a public-private partnership (P3) siting GCS on state trust lands, bringing revenue to the State and enabling it to meet its climate and clean energy commitments. A summary follows.

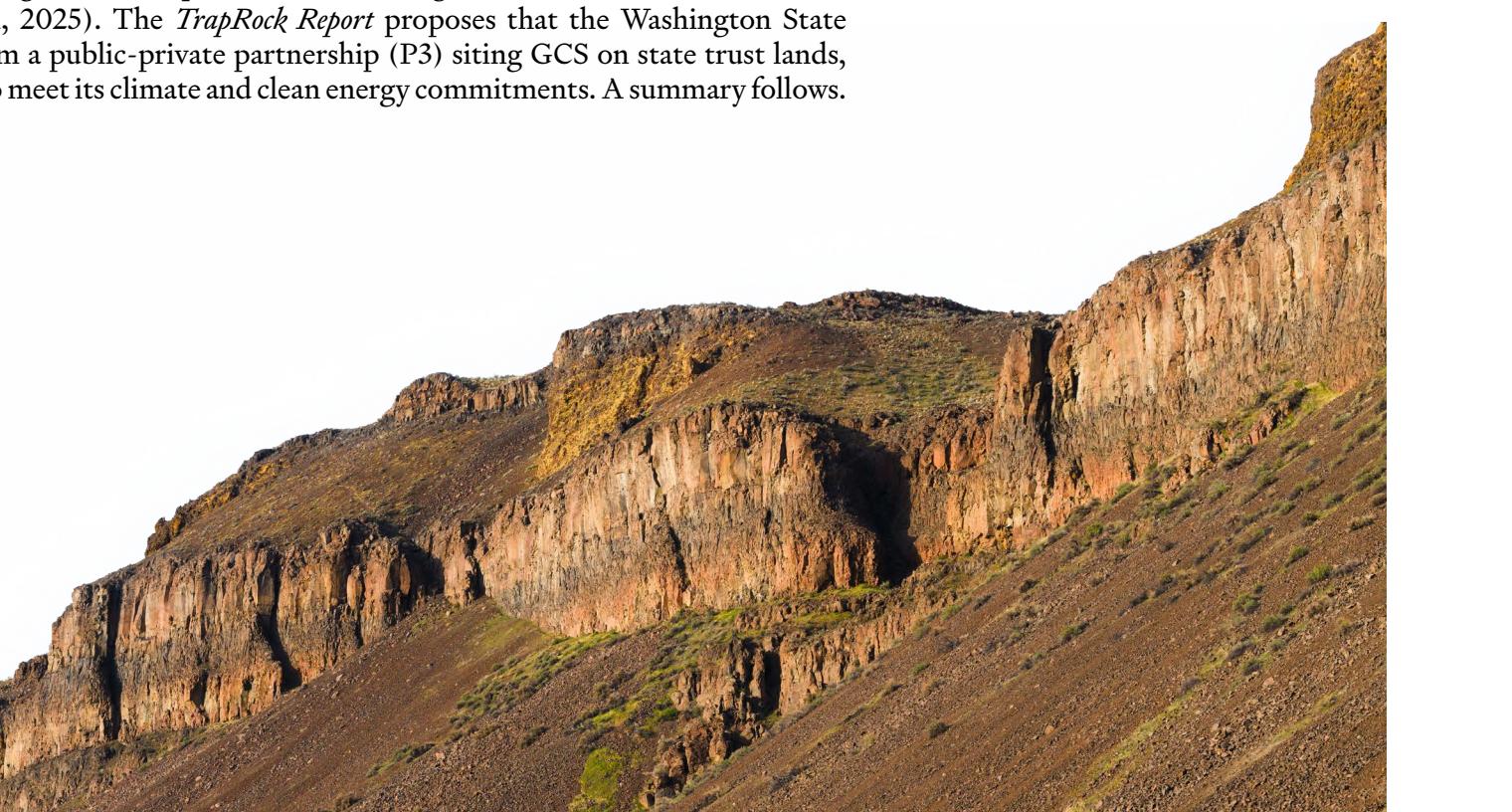


Fig. 1: Photo of CRBG, WA. Shutterstock

Washington faces a dual imperative: meeting its ambitious climate commitments while continuing to provide affordable, clean, and firm energy to its residents. Succeeding on both fronts will require utilizing carbon capture and removal and forming groundbreaking partnerships to transform the State into a GCS hub.

Washington is underlain by basalt formations capable of storing CO₂ for millennia. The CRBG, in particular, has great potential to store approximately 40 billion MT CO₂. Meanwhile, up to 38.7 million MT CO₂ captured in the State could have need for this storage solution annually, including 19.9 million MT if forests at risk of wildfire are thinned and if this biomass is utilized at new or existing bioenergy facilities. Growth of the direct air capture industry would increase this volume of CO₂ potentially needing permanent containment.

DNR can and should foster this critical climate solution. But, the agency alone cannot ensure development of an entire CO₂ storage ecosystem at the speed and scale necessary to combat the climate crisis. A P3 is best suited to rise to this challenge.

DNR and key public and private partners should collaborate to enable GCS on select state trust lands. A nonprofit Executive Secretariat should

provide administrative, policy, and outreach and engagement support, beginning with preparation of a statewide siting strategy informed by government-to-government (G2G) consultation with Indian Tribes. Geophysical research sponsored by the CC Lab indicates that initial surveying of potential sites can occur with no ground disturbance.

A preliminary analysis indicates that three regions within the CRBG are best suited for safe and permanent GCS: Cane Ridge/Horse Heaven Hills, Palouse Slope, and Rattlesnake Hills. 339 parcels of state trust lands, representing 127,588 acres, are situated within these three areas of interest (AOIs). Should DNR make these state trust lands available for lease for GCS, and if 5–10 sites become operational at average commercial scale, over a 75-year lease period, the agency could produce an additional \$3.8–\$6.5 million for the public education system and other trust beneficiaries.

With the agency's leadership and legislative backing, a coordinated effort among government, nonprofit, academic, and industry partners could, within three years, strengthen the State's position to meet its net-zero commitment, reduce wildfire risk, create new jobs, and generate a new revenue stream for public education.

It is the policy of the State "to promote the removal of excess carbon from the atmosphere through voluntary and incentive-based sequestration activities" and "to prioritize carbon sequestration in amounts necessary to achieve [our] carbon neutrality goal[.]" - RCW 70A.45.100(1).

Utilizing Washington's Extraordinary Basalt Resources

The Columbia River Basalt Group

The CRBG, Coast Range Basalt Province, and Cascade Range volcanic basalts endow Washington with the geologic resources for becoming a global hub for GCS, onshore and offshore. The CRBG is an especially ideal candidate for GCS. This expansive basalt province spans ~80,000 square miles and consists of a series of stacked, thick, and laterally extensive lava flows. Consequently, CO₂ can be injected into porous and permeable interflow zones bounded by confining, impermeable zones. CO₂ then reacts with metal ions present in basalt to form solid carbonate rock. Together, these trapping mechanisms protect against CO₂ leakage. The CRBG's storage potential is estimated at **40 billion MT CO₂**, far more than the entire U.S. needs to sequester to achieve net-zero emissions by mid-century.



Fig. 2. Generalized geologic map of the CRBG showing surface extents of three major basalt formations and their layered stratigraphy. Surface extents are visualized axonometrically.

Need for Geologic Carbon Sequestration

Washington cannot meet its climate and clean energy commitments under the Climate Commitment Act and Clean Energy Transformation Act without GCS.

Achieving Net-Zero Emissions by Mid-Century: State modeling indicates at least 6.2 million MT of residual non-CO₂ emissions will require annual offsetting via GCS by 2050 to reach net zero. The *TrapRock Report* identifies numerous CO₂ sources suitable, and either requiring or available, for GCS.

Clean Energy Security to Sustain a High Standard of Living for all Residents: Deployment of clean energy is failing to keep pace with rapidly rising energy demand, causing increased reliance on fossil-derived power. Safeguarding grid reliability and the State's goal of an electricity supply free of greenhouse gas (GHG) emissions by 2045 might require retrofitting natural gas and waste-to-energy plants far from retirement with carbon capture systems while renewable deployment catches up. If the 14 natural gas power plants and single waste-to-energy facility identified are retrofitted, 8.0 million MT CO₂ would be available for mitigation via GCS each year.

Maintaining In-State Operations of Energy-Intensive, Trade-Exposed Industries: Many EITEs produce materials essential for constructing clean energy infrastructure, yet they are hard-to-decarbonize. As the Legislature reduces the number of no-cost allowances available, these facilities may be forced to choose between ceasing operations or retrofitting with carbon capture systems. If the 17 EITE facilities identified as needing CCS are retrofitted, 6.7 million MT CO₂ would be available for mitigation via GCS each year.

Offsetting Residual GHG Emissions: Capturing biogenic emissions at biomass conversion facilities represents an opportunity to offset 4.1 million MT CO₂ annually.

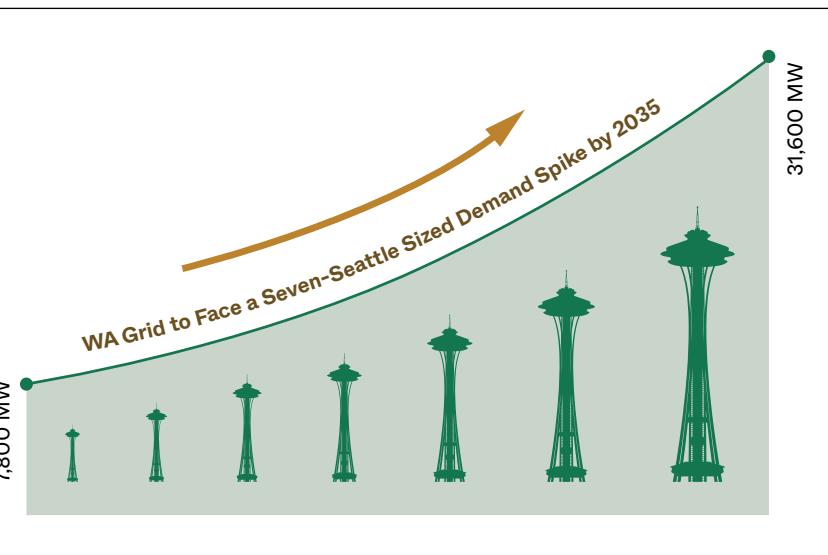


Fig. 3. Infographic of Washington's growing energy needs. *High Mountain Creative LLC*.

Reducing Wildfire Risk: Escalating wildfire intensity and frequency threatens communities and ecosystems. Thinning forests of low-value biomass to reduce wildfire risk as outlined in the U.S. Forest Service's 10-year strategy could produce an annual yield of 12.0 million bone dry MT. Processing this biomass at new and existing bioenergy with carbon capture and storage (BECCS) facilities would offset 19.9 million MT CO₂ annually—nearly double the State's forecasted need.

In sum, up to **38.7 million MT CO₂** captured in the State could have **need for GCS annually**. Including CO₂ from direct air capture and out-of-state sources raises this volume.

Scale of the Challenge

Since Pacific Northwest National Laboratory successfully piloted GCS in basalt in 2013, no GCS project has advanced in Washington, even as the industry accelerates in other states and countries. Hurdles obstructing deployment include:

- **a severe paucity of subsurface data**, which prevents development of a siting plan informed by G2G consultation and raises the cost of site characterization;
- **uncertainty over permitting pathways**, including whether existing regulations, which pre-date GCS in basalt, support a pathway to scale from Class V to VI wells;
- **gaps in regulatory authority over CO₂ pipeline siting and safety**, which spurs public opposition;
- **high capital costs for commercial-scale operations of \$400 million–\$1.08 billion**, with even higher premiums for a first-of-a-kind deployment; and
- **legal ambiguity regarding pore space ownership, unitization, encroachment, and long-term monitoring and liability**.

Without substantial support from the State, GCS project developers will continue to be deterred from deploying projects that leverage Washington's world-class basalt resources.



Fig. 4. Drill core showing calcium carbonate nodules (light color) resulting from carbon mineralization. *Pacific Northwest National Laboratory*.

A Public-Private Partnership Will Unlock the Basalts' Potential

Objectives

A P3 offers the best opportunity to transform Washington into a global GCS hub. State leadership and robust partnerships are needed to eliminate the hurdles preventing GCS deployment and to create the enabling conditions for it to flourish. A P3 can establish sufficient tailwinds for Washington to become a GCS leader.

- **P3's primary objective:** achieve GCS on state trust lands by 2033
- **P3's sub-objectives:** enact policies facilitating GCS & identify and prepare state trust lands for development

P3 Partners

DNR: lead agency; oversees GCS siting strategy, particularly geophysical surveying of trust lands to identify those to be bid

ECOLOGY: pursues delegated authority over Class VI wells

COMMERCE: provides funding and political support

LEGISLATURE: provides funding and enacts GCS legislation

INDIAN TRIBES: participate in G2G consultation; potential co-owners of new BECCS or other GCS-enabled facilities

EXECUTIVE SECRETARIAT: lead private entity; provides engagement, policy, administrative, and procurement support

ADVISORY BOARD: represents constituents' perspectives to inform GCS siting strategy

GCS PROJECT DEVELOPERS: bid to develop pre-selected trust lands and share subsurface data

CO₂ TRANSPORTATION COMPANIES: inform GCS siting strategy

CO₂ SOURCES: pursue CCS and inform GCS siting strategy

"All the public lands granted to the [S]tate are held in trust for all the people[.]" - WASH. CONST. art. XVI, § 1.

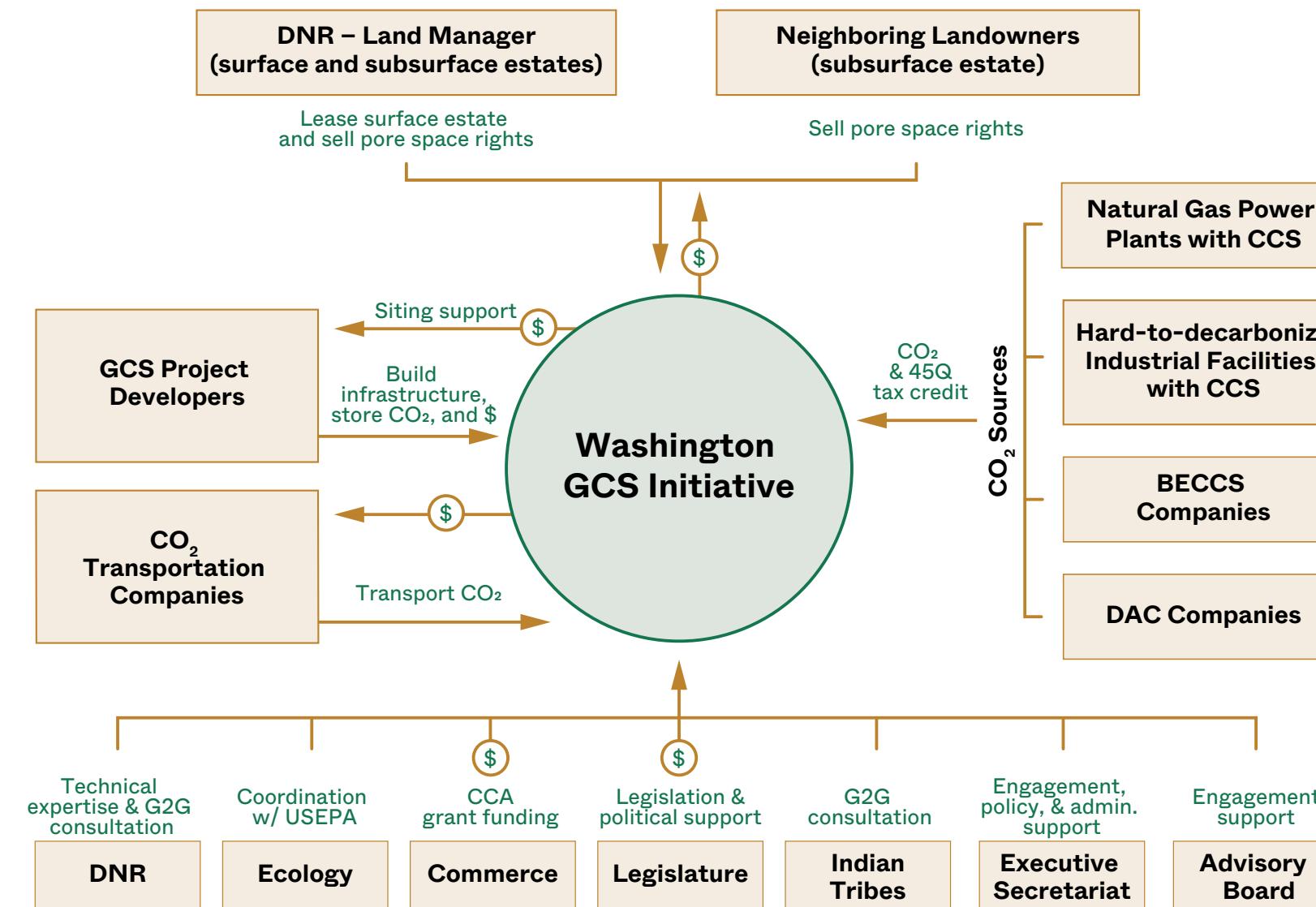


Fig. 5. Visual representation of P3 partners vital to establishing a GCS economy and their contributions. Federally-recognized Indian Tribes with reservations, ceded territories, and/or other Tribal interests overlying potential sequestration sites situated within the CRBG most likely include the Coeur d'Alene Tribe, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Colville Reservation, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Wanapum Reservation, the Cowlitz Indian Tribe, the Kalispel Tribe of Indians, the Nez Perce Tribe, and the Spokane Tribe of Indians. Additionally, the Wanapum Band of Native Americans have traditional lands and interests in the CRBG in Washington.

Step 1: Developing a Statewide Siting Strategy that Respects Tribal Treaty Rights

A preliminary analysis indicates three regions of the State are best suited for safe and permanent GCS: Canoe Ridge/Horse Heaven Hills, Palouse Slope, and Rattlesnake Hills. 339 parcels of state trust lands, representing 127,588 acres, are situated within these three AOIs.

Tribal Treaty Rights and Cultural Resources Literature Review

All three AOIs, at various places, contain low to very high risk for containing archaeological resources. Previously recorded archaeological sites, historic built environment resources, Traditional Cultural Places, and Properties of Traditional Religious and Cultural Importance are located within each AOI. Variability in risk is largely due to topography, proximity to water, soils, and other environmental factors.

- The Canoe Ridge/Horse Heaven Hills AOI has higher risk for archaeological resources along ridgelines, the Columbia River, and its tributaries.
- The Palouse Slope AOI has higher risk located along the Snake River and its tributaries, as well as ridgelines.
- The Rattlesnake Hills AOI has higher risk located along ridgelines, streams, and tributaries to the Yakima River.

Geologic and Hydrogeologic Assessment

Each AOI contains Grande Ronde and Wanapum Basalt formations of the CRBG province. These formations are ideal for GCS because they can support use of both proven injection techniques and have the structural and chemical composition needed for mineralization without leakage.

Geospatial Review of CO₂ Sources and Transportation

Four hard-to-decarbonize facilities suitable for retrofitting with carbon capture systems, four biomass conversion facilities with potential to become BECCS facilities, and one direct air capture facility are located within 100 miles of an AOI. Assuming 2023 emissions levels and a benchmark 90% capture rate, capturing/removing and sequestering CO₂ from these sources would prevent the release of ~1 million MT CO₂ into the atmosphere and offset ~300,000 MT CO₂ annually.

Field-based data collection (e.g., airborne remote sensing surveys) within these AOIs and feedback received during G2G consultation and community engagement should be used to narrow down which state trust lands within these AOIs are deemed suitable for development. Later, basalt provinces besides the CRBG should be considered.

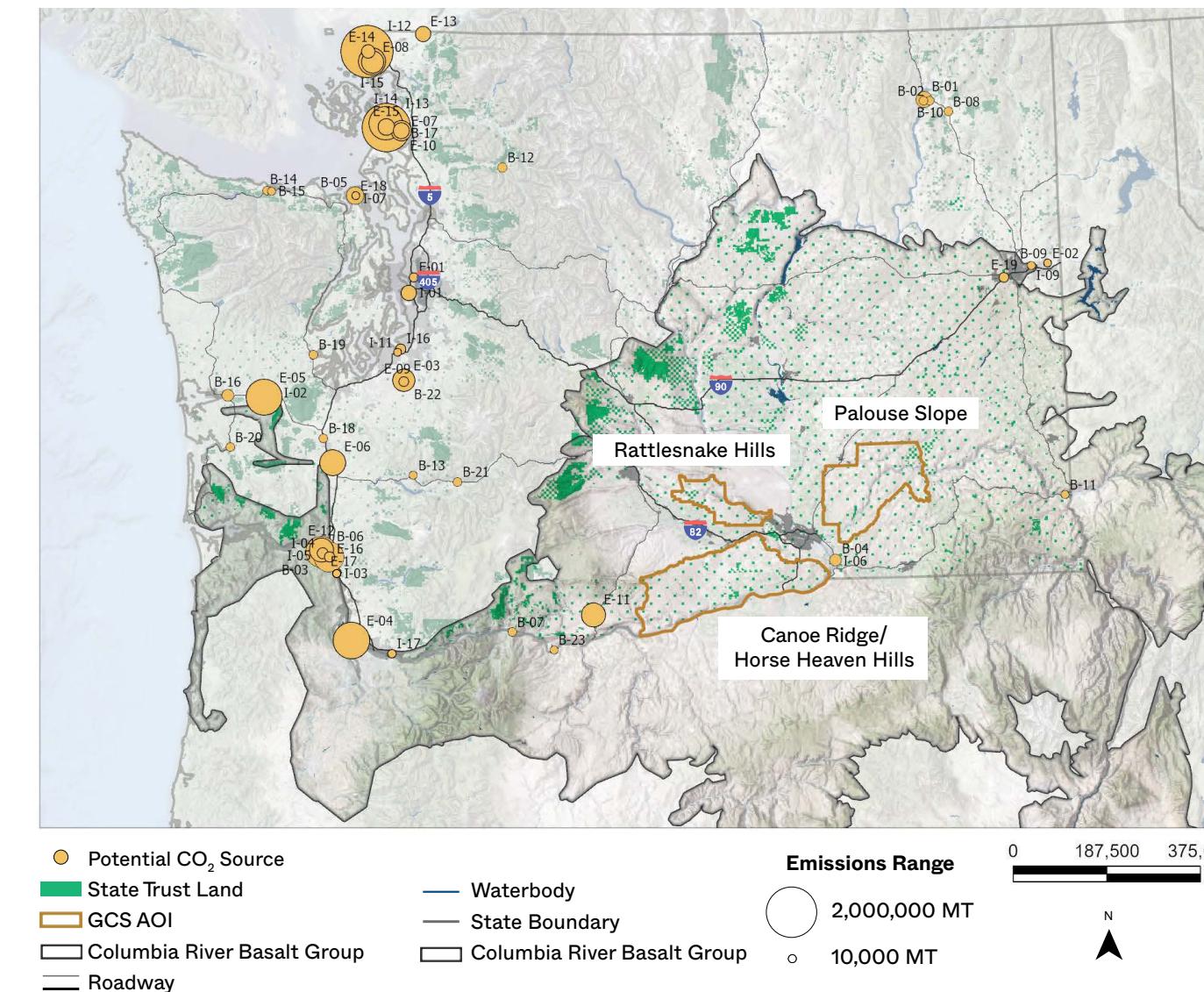


Fig. 6. Emissions volumes of point sources suitable for CCS (i.e., natural gas power plants and certain hard-to-decarbonize industrial facilities) and their locations relative to the CRBG; CO₂ offsetting potential of CDR+S facilities (i.e., biomass conversion facilities that could become BECCS facilities and one existing DACCS plant) and their locations relative to the CRBG; major roadways; state trust lands; and three AOIs identified for further GCS exploration. Attribute information corresponding to Facility Source IDs can be referenced in Tables 8 and 9 of the *TrapRock Report*.

Benefits of Geologic Carbon Sequestration

A GCS industry developed on state trust lands could create numerous co-benefits, including:

- **new clean electricity** from natural gas plants with carbon capture and converted or new BECCS facilities;
- **reduced wildfire risk** through forest thinning used to power BECCS facilities;
- **high-quality jobs and workforce development** across engineering, science, operations, and construction;
- **cleaner air and improved health outcomes** through capture of pollutants and lowered rates of respiratory illness;
- **enhanced understanding of groundwater resources**, supporting improved water management and planning; and
- **millions of dollars in new revenue** for public education, other trust beneficiaries, and local landowners.

Economic Value of GCS (Illustrative Only)

Assuming average commercial-scale operations, discovery and commercialization of 5–10 GCS sites across the three AOIs, including perfection of two new water rights reverting to DNR, could yield trust beneficiaries **~\$3.8–\$6.5 million** in incremental revenue over a 75-year lease term. Moreover, local governments could gain increased property tax revenue. Neighboring landowners collectively could receive more than **\$390 million in unitization payments (more than 99% of the total revenue)**.

	Unit Prices	GCS Only (\$)	GCS + Water (\$)
Pore space purchase/parcel (one-time)	\$1,092/acre	382,072	382,072
GCS surface lease revenue/parcel (75-year total)	5-yr Exploration: \$2/acre/yr 20-yr Injection: \$10/acre/yr 50-yr Monitoring: \$2/acre/yr	585	585
Lost lease revenue from alternative land use/parcel (75-year total)	(\$73/acre/yr)	(7,063)	(7,063)
Injection fees/parcel (20-year total)	\$50/acre/yr of pore space unit at \$5/MT CO ₂	170,878	170,878
Water incremental surface lease revenue/parcel (50-year total)	\$290/acre/yr		539,372
Total: Incremental revenue/parcel (75-year total)		546,473	1,085,845
Total: Incremental revenue for 5–10 GCS parcels, including 2 with new water right (75-year total)		2,732,363–5,464,726	3,811,107–6,543,470

Estimated revenue to DNR for trust beneficiaries from GCS and water resource commercialization on state trust lands. Calculations assume a project: leases five acres of a 350-acre parcel of trust land; replaces alternative surface use worth \$72.50/acre/yr; utilizes 50,000 acres of pore space; and injects at a rate of 500,000 MT CO₂/yr over 20 years. Future cash flows are discounted at 5% to show net present value.

Recommended Next Steps

To site GCS on state trust lands by 2033, P3 partners must take several steps in the next three years.

Lead Actor	Challenge/Risk to be Ameliorated	Proposed Action
DNR	<ul style="list-style-type: none"> • State's basalt resources remain underutilized compared to oil and gas fields or saline reservoirs elsewhere • Paucity of subsurface hydrogeologic data 	<ul style="list-style-type: none"> • Announces the State's intention to offer pre-selected state trust lands for GCS, for the benefit of public education • Oversees subsurface characterization and G2G consultation to inform a geospatial database of subsurface resources
Ecology	<ul style="list-style-type: none"> • Regulatory uncertainty given untested, complex, and overlapping federal/state regimes 	<ul style="list-style-type: none"> • Pursues primacy over Class VI wells and issues guidance clarifying basalt-specific permitting requirements
Commerce	<ul style="list-style-type: none"> • Project costs for first-of-a-kind GCS in basalt are comparatively too high 	<ul style="list-style-type: none"> • Commits CCA grant funds to GCS characterization and pilot projects
Legislature	<ul style="list-style-type: none"> • Risk of siting in areas with protected environmental resources 	<ul style="list-style-type: none"> • Funds nonproject programmatic environmental impact evaluation of GCS development on state trust lands, to be led by DNR
Indian Tribes	<ul style="list-style-type: none"> • Risk of siting in culturally sensitive areas 	<ul style="list-style-type: none"> • Engage with DNR in G2G consultations, including to identify suitable injection sites and transportation corridors, and, if desired, participate on Advisory Board
Executive Secretariat	<ul style="list-style-type: none"> • Lack of state laws on pore space ownership and liability • Co-leads G2G consultation and outreach processes to build public trust in GCS, ensure concerns are addressed, and reduce duration of pre-construction process • Generates and socializes a project plan to achieve the first GCS well on state trust lands running from inception to contracting 	<ul style="list-style-type: none"> • Drafts legislation and template agreements concerning pore space ownership and liability • Shares expertise and represents the perspectives of constituents to inform development of siting strategy and criteria on which to judge GCS developers' RFP responses
Advisory Board	<ul style="list-style-type: none"> • Uninformed siting 	



View the full report and references by visiting:
CarbonContainmentLab.org/Publications/TrapRock-Report-2025



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