The CCUS workgroup mission is to accelerate commercial carbon capture in Alaska

Alaska CCUS Workgroup

SPE Paper 213051: "*Alaska CCUS Workgroup and a Roadmap to Commercial Deployment*"

Frank Paskvan, Brent Sheets, UAF-INE; Tom McGuire, Kevin Connors, EERC; Haley Paine, DNR; Christine Resler, Esther Tempel, ASRC

Download paper from item #6 at http://INE.UAF.EDU/Carbon

Cook Inlet Region Low Carbon Power Generation with Carbon Capture, Transport, and Storage Feasibility Study

Download study from item #9 at http://INE.UAF.EDU/Carbon

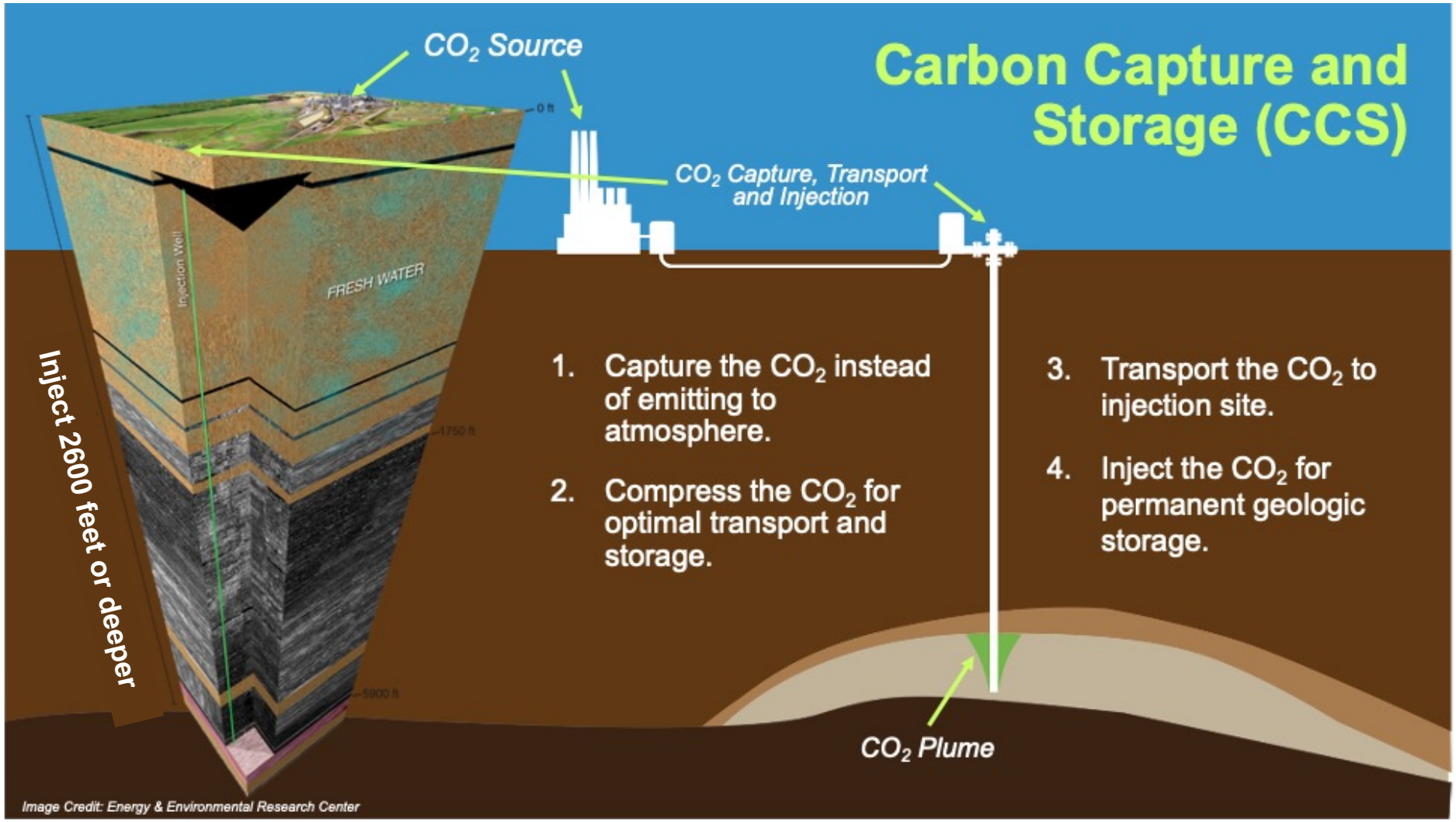
For more information email CCUSAlaska@gmail.com

Critical Challenges. Practical Solutions.

UAF-INE Work on CCUS

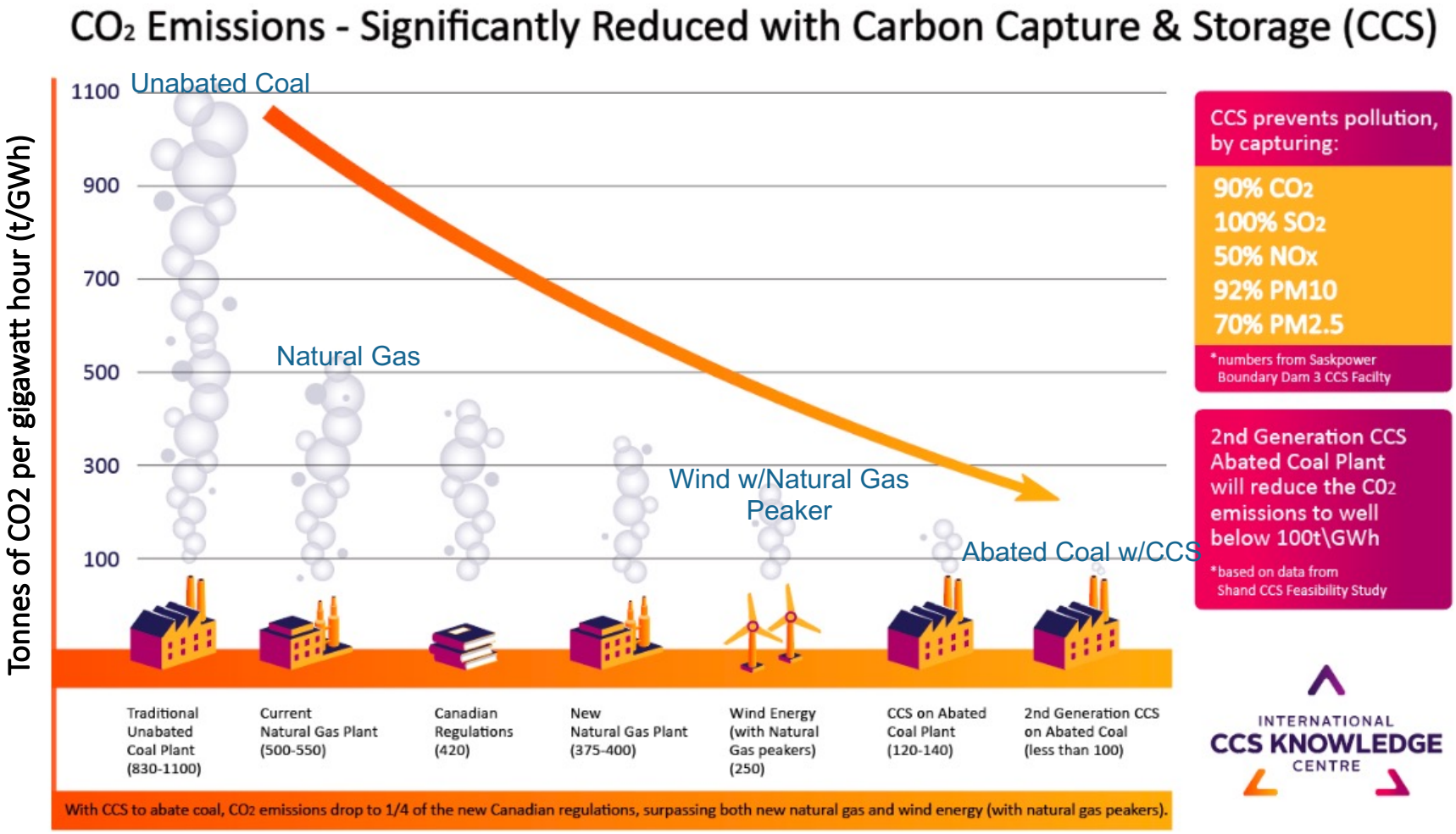
- In 2019, began working on Carbon Capture Use and Storage (CCUS) per request of the Congressional Delegation
  - UAF-INE joined PCOR, Plains CO_2 Reduction Partnership, led by EERC at U. of North Dakota
- In 2022, UAF initiated Alaska CCUS Workgroup to engage industry, government, academia, and stakeholders
  - Supported Carbon Storage Bill
  - Hosted Discussions, Offered to Perform Studies
  - Power Generation CCUS Feasibility Study resulted→
- In 2024, initiate ARCCS Project to determine CO_2 storage volume northern Cook Inlet (pending matching funds)
- In 2024, applied for DOE DE-FOA-3014 RITAP funding to:
  - Continue CCUS Workgroup
  - Expand Alaska CCUS technical support via UAF B.S. Energy Resources Engineering (formerly Petroleum)

What is CCS?


CO_2 Source
Carbon Capture and Storage (CCS)
CO_2 Capture, Transport and Injection
Injection Well
FRESH WATER
0 ft
1750 ft
5900 ft
Inject 2600 feet or deeper
1. Capture the CO_2 instead of emitting to atmosphere.
2. Compress the CO_2 for optimal transport and storage.
3. Transport the CO_2 to injection site.
4. Inject the CO_2 for permanent geologic storage.
CO_2 Plume
Image Credit: Energy & Environmental Research Center

Why CCUS?

- World faces dual challenge of increasing energy demand and risks of climate change
- Carbon (CO_2) Capture and Storage (CCS) also removes other pollutants
- CO_2 Use (CCUS) like agriculture can make electricity net-zero emissions, supports food and energy security
- Cost for clean energy security globally more than doubles without CCUS [1]
- CO_2 Emissions Reductions May be Voluntary or Required, e.g., by Clean Air Standards like WA-GREET



[1] Intergovernmental Panel on Climate Change, IPCC

Railbelt Power System Analysis

- Coal is Lowest Cost Fuel ~ $4/MMBtu
  - $7 to $10/MMBtu natural gas now
  - $20 to $35/MMBtu diesel
  - Imported LNG $15 to $25 /MMBtu [2]
- Coal Supply Local and Abundant
- With CCS, Coal CO_2 emissions:
  - Half to quarter that of natural gas
  - Half of wind power supported with natural gas power
- With CCS, biomass-coal net-negative

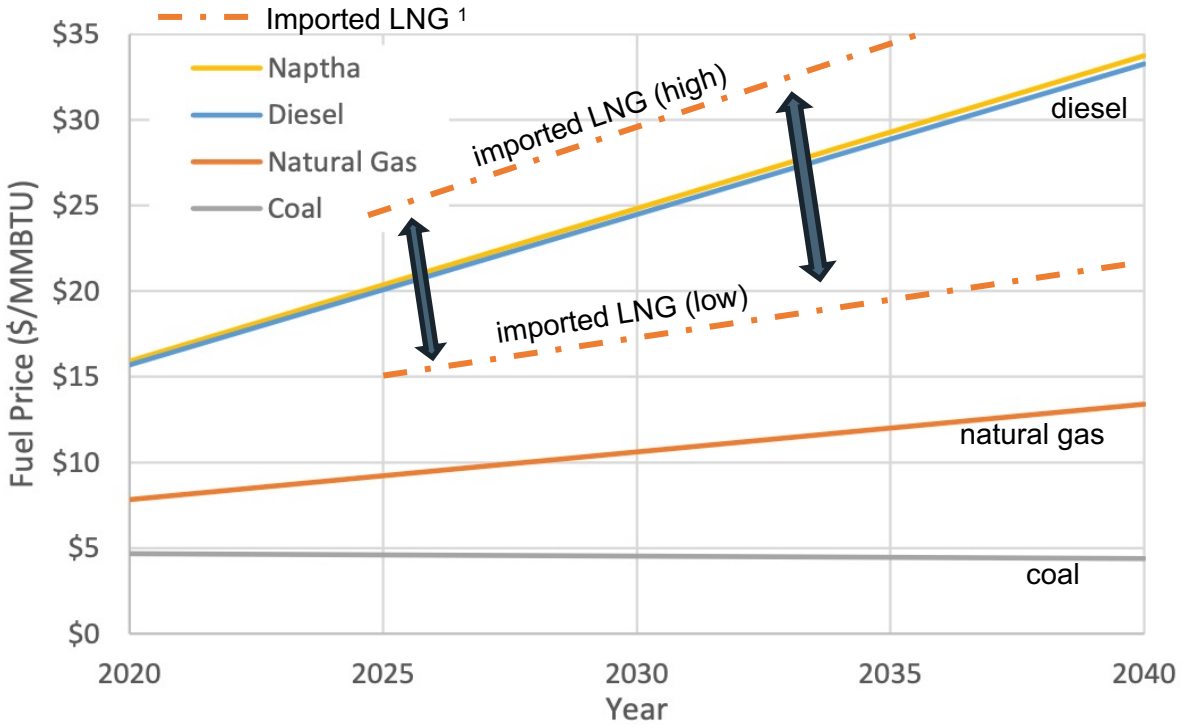


Figure 5. Assumed fuel price trajectories (2020$)

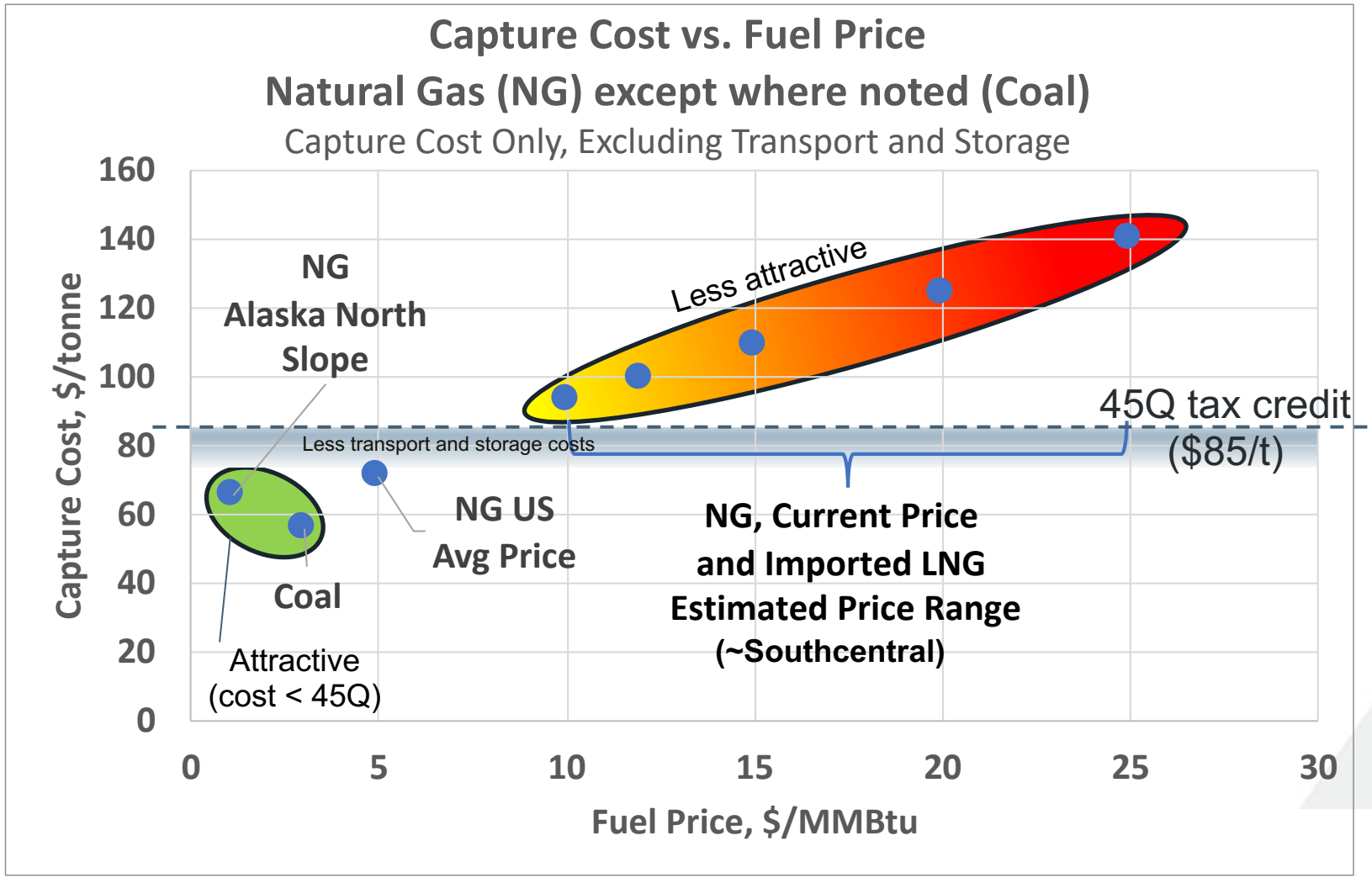
Fuel price forecasts from the Alaska Energy Authority, ref. *NREL Renewable Portfolio Standard Assessment for Alaska's Railbelt, 2022*, NREL/TP-5700-81698, https://www.nrel.gov/docs/fy22osti/81698.pdf

[1] Imported LNG price estimate from *"Cook Inlet Region Low Carbon Power 2024"*

Alaska CCUS: CO_2 Capture Costs

- **Alaska Capture Screening**
  - Using typical Lower 48 costs
  - Fuel price a key cost driver
  - Capture cost only, excluding transport & storage costs
- **With Lower 48 costs and 45Q**
  - Natural gas capture attractive on North Slope
  - Natural gas capture less attractive for Southcentral
  - Coal capture looks attractive Statewide
- **Further work should be done for attractive projects**

Based on SPE paper 213051 Table 1, Paskvan et. al. [1]



[1] Cost methodology benchmarked against NETL, U.S. Department of Energy National Energy Technology Laboratory, 2015,
"Cost and performance baseline for fossil energy plants volume 1a: Bituminous coal (PC) and natural gas to electricity" revision 3. July 6, 2015, DOE/NETL-2015/1723.

Low Carbon Biomass-Coal Power with CCS Technical & Economic Feasibility Study

- **Cook Inlet Region Low Carbon Power Generation with Carbon Capture, Transport, and Storage Feasibility Study**
  - Download from item #9 at http://INE.UAF.EDU/Carbon

- **Study evaluates technical and economic feasibility of low carbon (CO_2) power generation biomass-coal-fueled power plant with CCS in Southcentral for the Railbelt Grid**

- **Cost of electricity from biomass-coal power compared to natural gas power**
  - With and without CCS
  - At current and future natural gas fuel prices

Low Carbon Biomass-Coal Power with CCS Study Conclusions

- Biomass-coal electricity with CCS is attractive, delivers affordable, reliable, clean, long-term energy security:
  - Lower cost electricity than natural gas with or without CCS
  - Lower CO_2 emissions than existing natural gas power
  - Hundreds of years of local fuel supply
- CCS lowers biomass-coal electricity cost since 45Q tax credits exceed CCS cost
- CCS increases natural gas electricity cost since costs exceed 45Q tax credits, especially at high gas prices in the region
- Biomass-coal power generation lowers electricity cost to Railbelt and Southcentral, and through Power Cost Equalization, lowers Rural electricity costs across Alaska

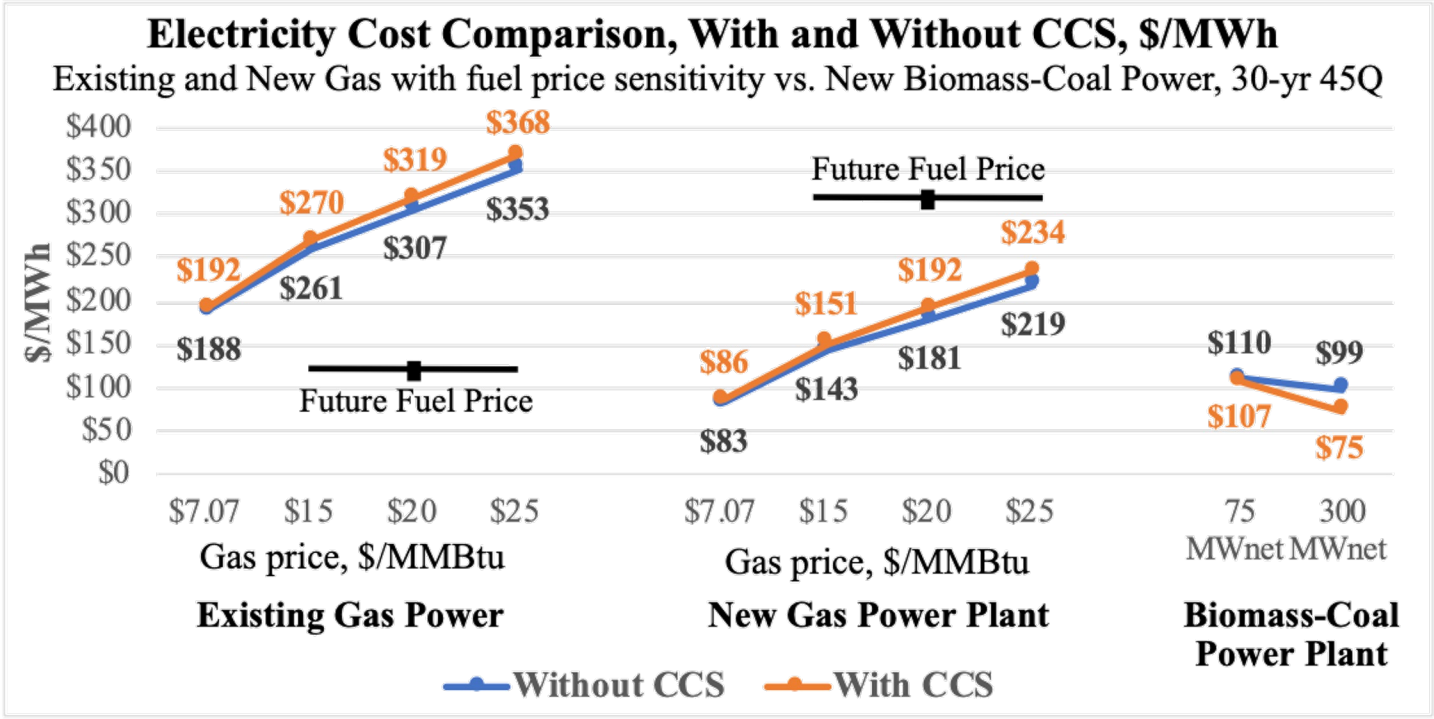


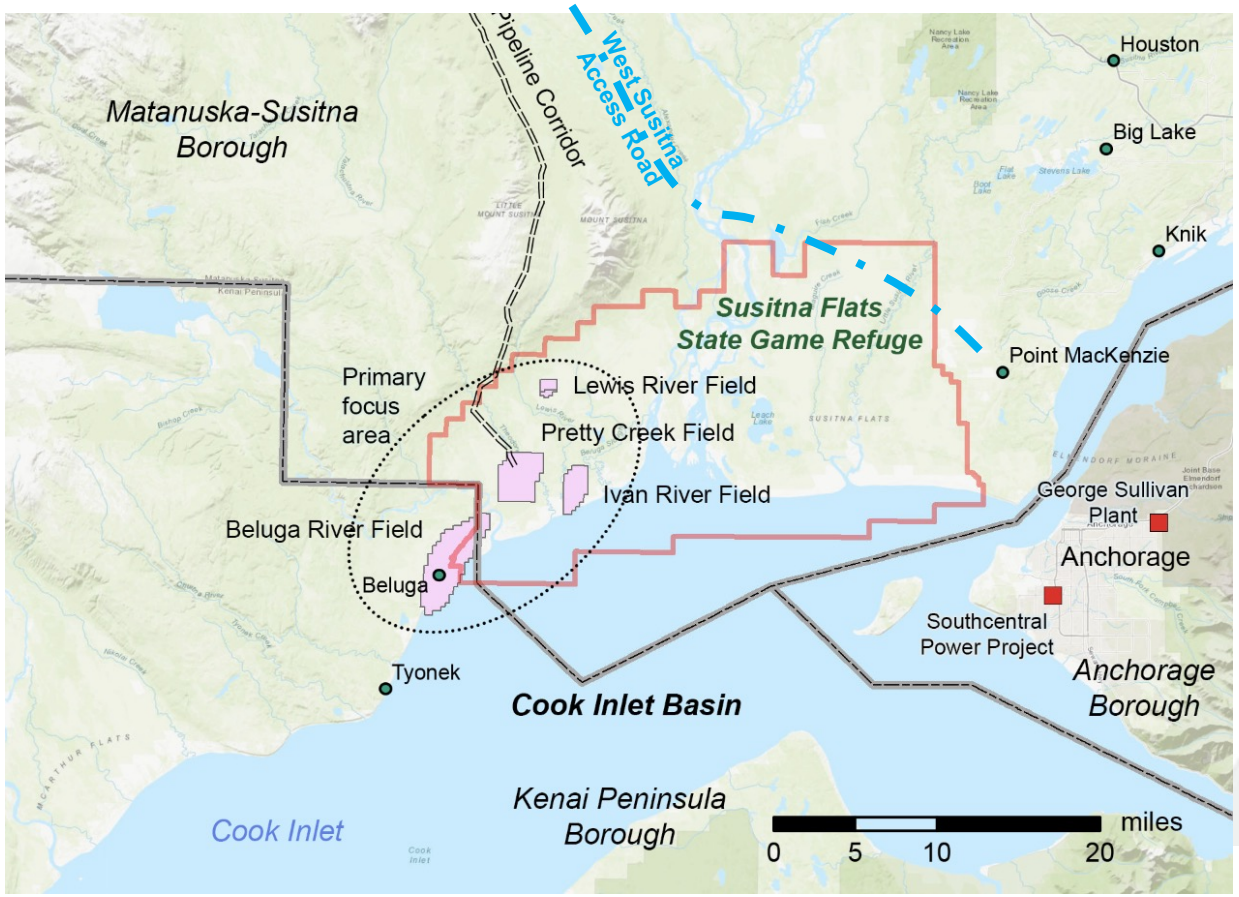
Figure 14. Electricity Cost Comparison, With and Without CCS, $/MWh Existing CEA G&T Gas and New Gas Power with fuel price sensitivity vs. New Biomass-Coal Power, 30-year tax credit scenario.

ARCCS Project Study Basis

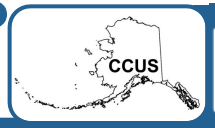
Assess CO_2 storage volumes using CarbonSAFE

- Beluga River Field has 60+ years storage for 300 MW net biomass-coal power plant with CCS
- Natural gas produced from depleting gas fields while simultaneously beginning CO_2 injection
- Consider aggregating CO_2 from two natural gas power plants in Anchorage
- Acquire 2D Seismic and evaluate saline aquifer alternates
- Significant Emphasis on Community Benefits Planning and Engagement
- Agricultural use of CO_2 and heat can enhance food and energy security while lowering emissions

Alaska Railbelt Carbon Capture and Storage (ARCCS) Project



Low Carbon Biomass-Coal Power with CCS Study Recommendations



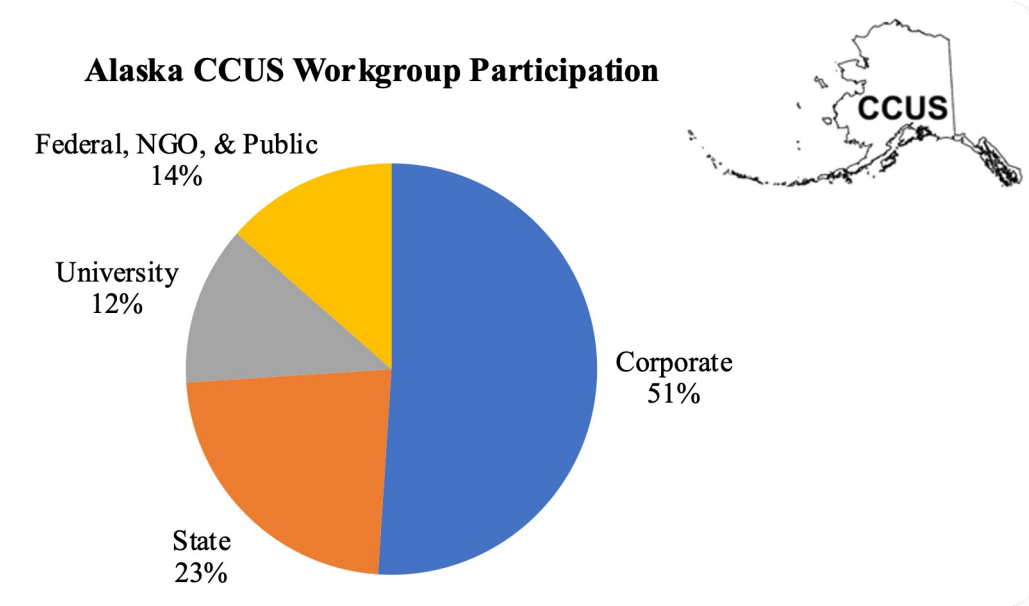
- Progressing a new biomass-coal power plant with CCS to deliver affordable, reliable, clean, long-term energy security is recommended:
  - Establish the legal and regulatory framework to enable carbon storage.
  - AOGCC should gain Class VI permitting primacy from the EPA.
  - The Alaska Railbelt Carbon Capture and Storage (ARCCS) Project should be performed (matching funds are in this year's UA budget request).
  - Regional utilities and the State should form a power purchasing buyer's group, solicit offers for baseload power, and enter into Power Purchase Agreements, which will enable developers to pursue Project funding.
  - Project owners, State, and Utilities should jointly seek funding, including U.S. DOE loans and grants available in amounts as high as $500M.

- **Questions?**

- **Website: http://INE.UAF.EDU/Carbon**
- **Follow-up: CCUSAlaska@gmail.com**

Alaska CCUS Workgroup

- Alaska CCUS Workgroup meets monthly to quarterly, ~ 150 invitees, 40 to 50 typically attend in person or online
- University of Alaska Fairbanks—Institute of Northern Engineering, has the lead role
- Leadership team includes Academia, Industry, and Government
- Funded by U.S. Dept. of Energy via PCOR, the Plains CO_2 Reduction Partnership, of University of North Dakota



Subcommittee focus areas:

- Develop a State legal and regulatory framework
- Track and respond to funding opportunities
- Perform public education and outreach
- Develop a Roadmap to accelerate commercial CCUS

Carbon Storage Legislation (as of Dec-2023)

- Governor Introduced Carbon Storage Bills January 2023
- Moving through Legislative Committees
- Legislature approved in 2023 AOGCC may seek Class VI CO_2 injection well management primacy from EPA

Status of Legislation

As-of Dec-2023

HB50

HRES
9 Hearings
Passed out of committee

HFIN
5 Hearings
Awaiting committee vote

SB49

SRES
5 Hearings
Awaiting committee vote

SFIN
Not yet scheduled

Continued Efforts

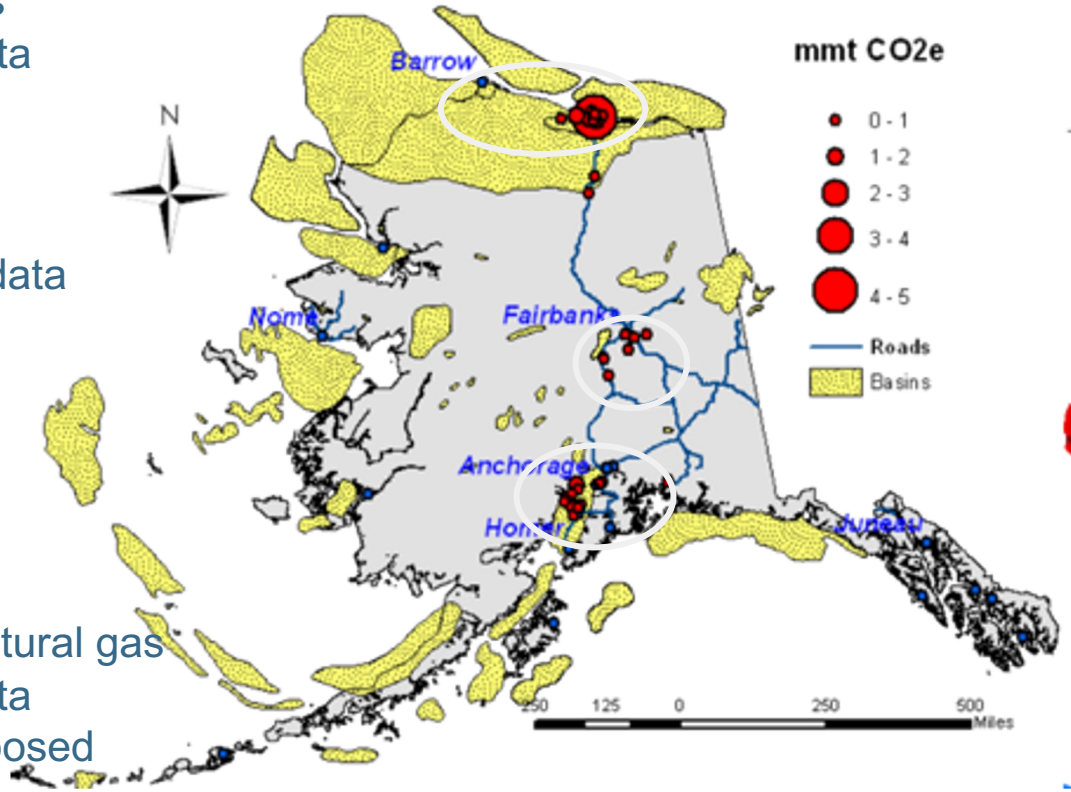
- AOGCC Class VI primacy
- Department of Revenue coordination
- Carbon storage lease agreements on other state-owned lands
- Advancing CCUS database focused on Cook Inlet

Alaska CO_2 Sources and Storage Potential

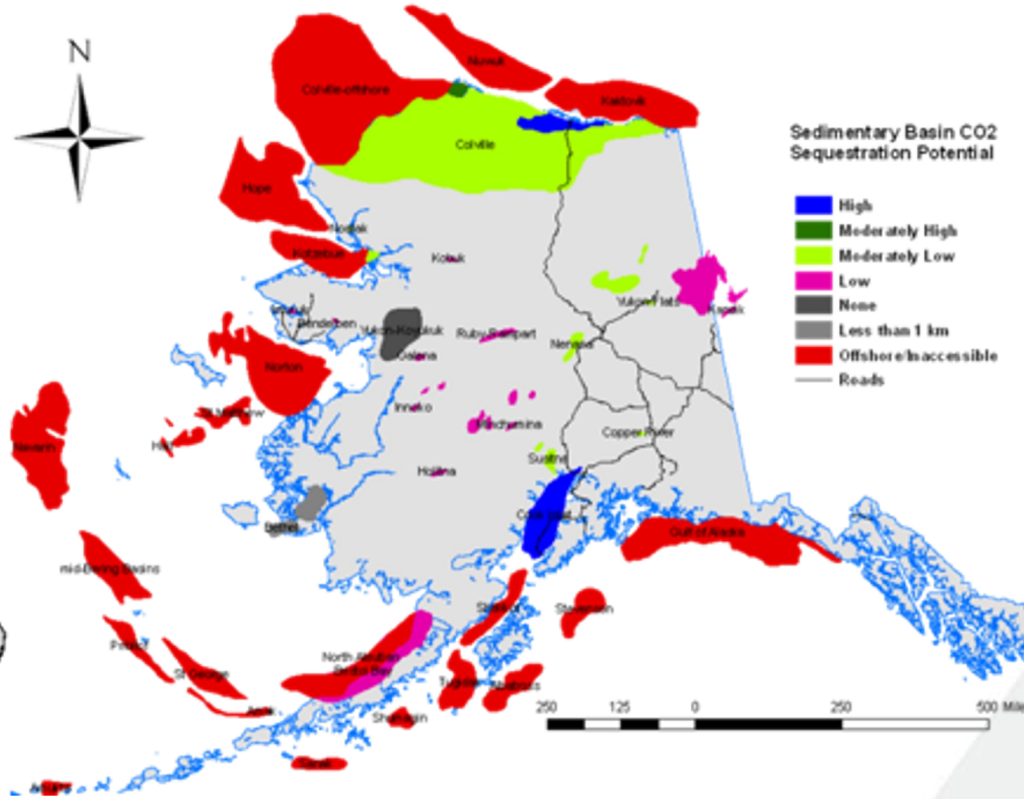
North Slope
* Natural gas fired
* Low cost natural gas
* O&G Subsurface data

Interior
* Coal fired
* Limited subsurface data
* Subsurface poorly understood, caprock concerns

Southcentral
* Natural gas fired
* High cost, scarce natural gas
* O&G Subsurface data
* ARCSS Project proposed



CO_2 Stationary Sources (red) & Deep Sedimentary Basins (yellow).



Sedimentary Basin Sequestration Potential (Shellenbaum and Clough, DNR, 2010)

CCUS Roadmap: Opportunities and Needs

Institute of Northern Engineering
University of Alaska Fairbanks

North Slope

Advantaged by low-cost natural gas

- Natural gas-fired capture
- Direct Air Capture (DAC)
- **Subsurface data integration & site-specific data gathering needed**
- 40 year track record of successful CO_2 storage and use, ~15 TCF
- Major Gas Sales 2015 LNG plan sequestered CO_2 back in reservoir

Interior

Existing coal plant infrastructure

- Coal-fired capture
- **Basic regional subsurface data gathering needed.**
- **Address geotechnical concerns**[1]

Southcentral

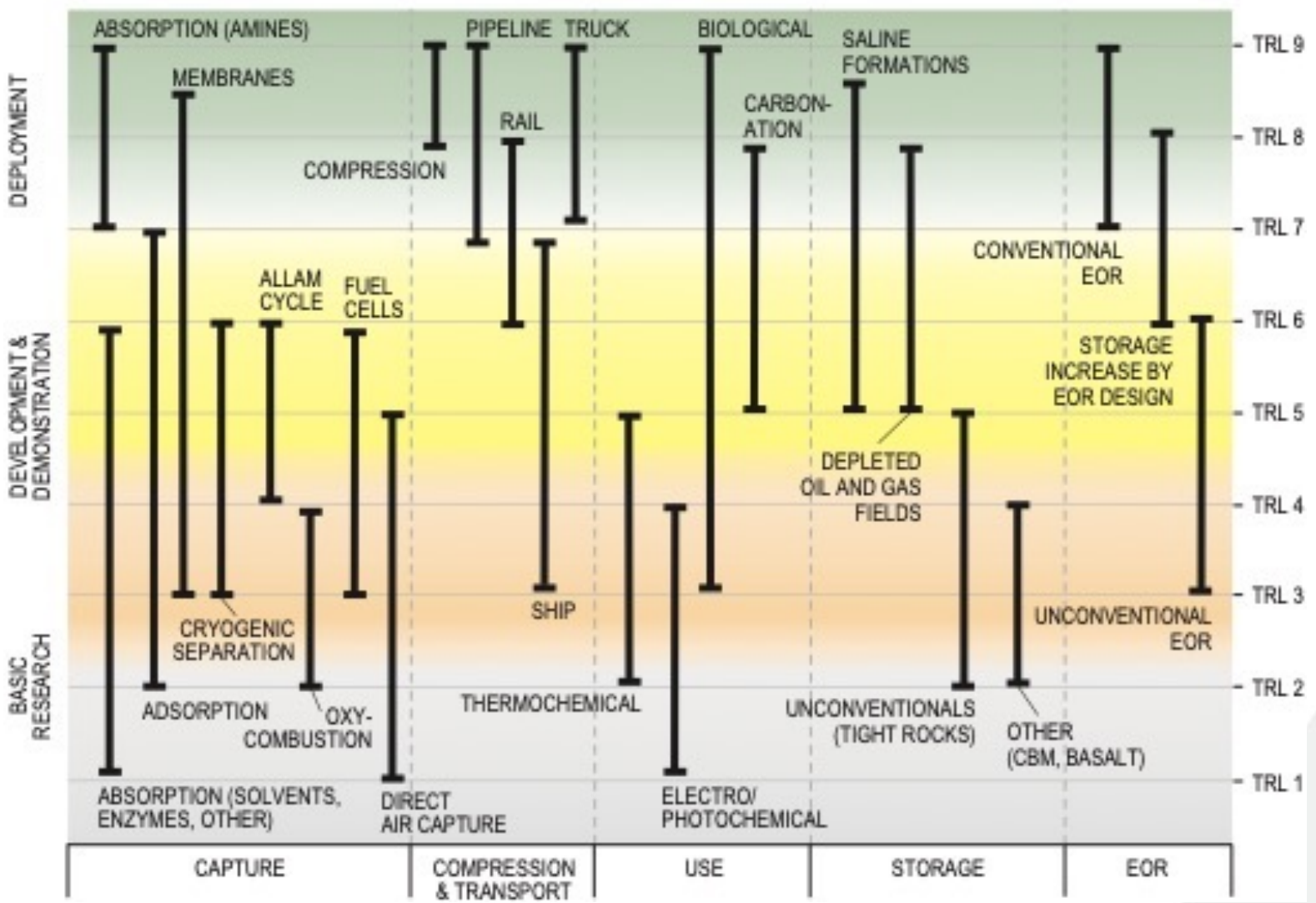
Proximity to Port, potential for import

- Capture not attractive at natural gas plants or refineries due to gas supply shortage & high price
- Coal or Hydrogen power with CCS can address natural gas shortage, food security, lower emissions
- Imported CO_2 storage (US West Coast or Asia-Pacific)
- **Subsurface data integration & site-specific data gathering needed**

[1] ***Open Link***: Seismic Hazard Considerations for Carbon Sequestration in Alaska

CCUS Technology Readiness

- Feasibility Study selected "Ready for Deployment"-level Technologies
  - Technology Readiness Level (TRL) 8 or 9:
    - Amine Absorption
    - Compression & Pipeline
    - Depleted gas fields (Saline aquifer backup)
- Technology will continue to evolve toward lower cost and higher efficiency systems

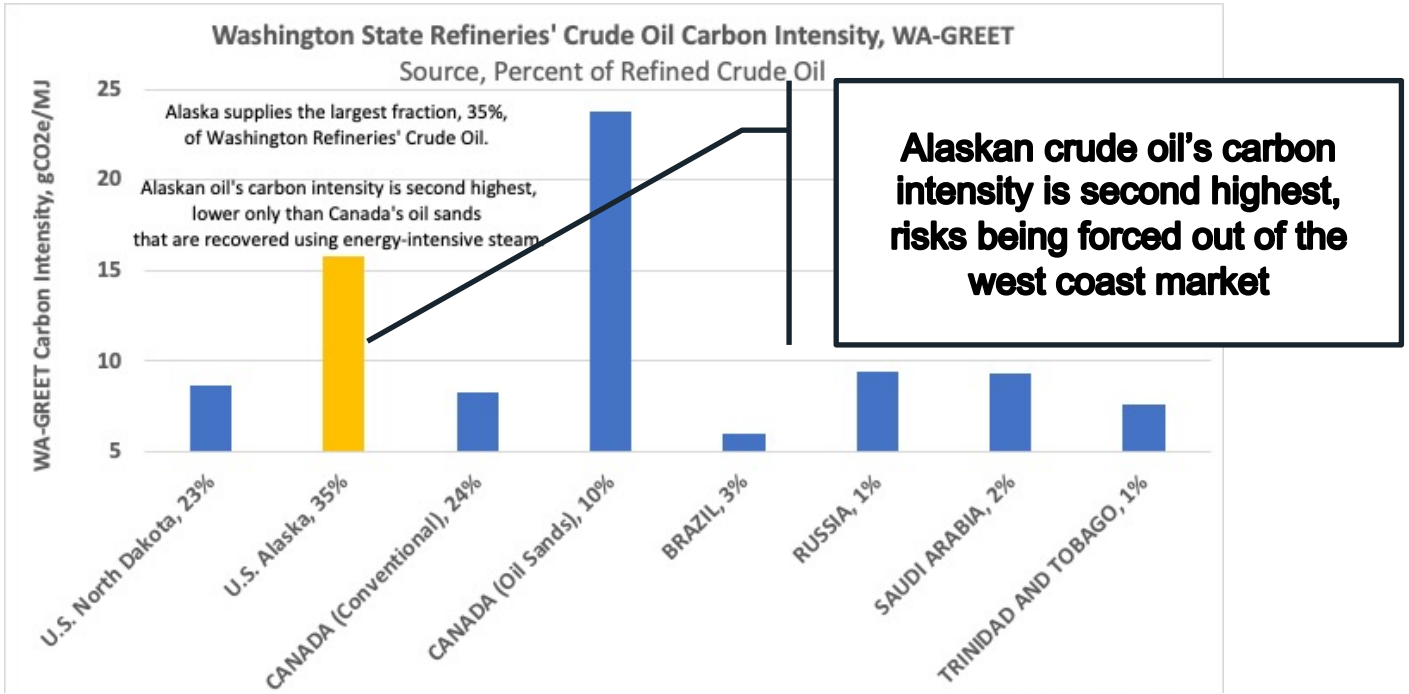


Source: NPC Roadmap, p. 32, 2019

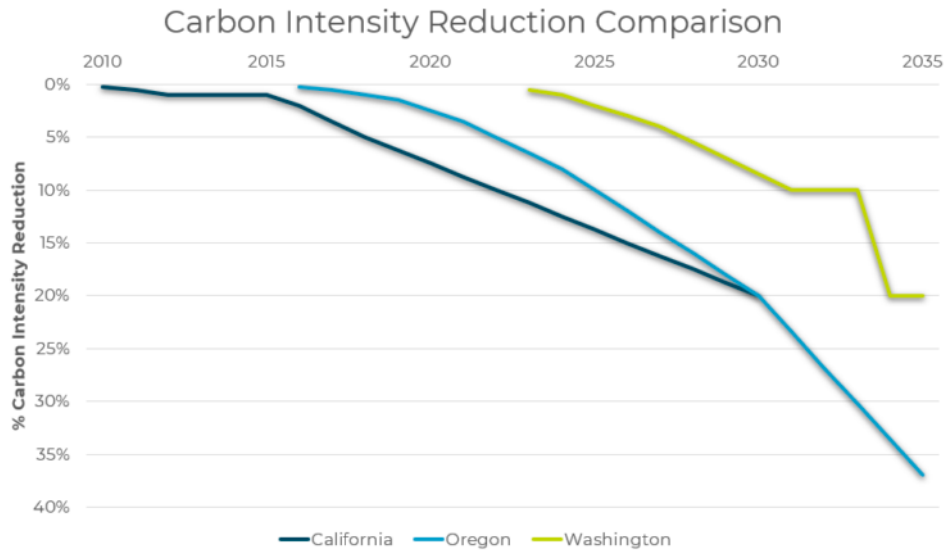
Critical Challenges. Practical Solutions.

Why CCS?
Voluntary or Required CO_2 Emissions

- **Producers may volunteer to reduce CO_2 emissions, or may be forced to by regulations**
  - California, Oregon, and Washington adopted their own clean fuel standards.
  - Washington, passed by the Legislature in 2021, requires fuel suppliers to reduce the carbon (CO_2) intensity of their products 20% below 2017 levels by 2038. (WA-GREET model)
  - Carbon Capture and Storage, CCS, is one of the most cost-effective ways to reduce crude oil carbon intensity. CCS may enable Alaskan Crude to remain acceptable to the market.



Source: WA-GREET 0.7a July 15, 2022, Paskvan calculations.



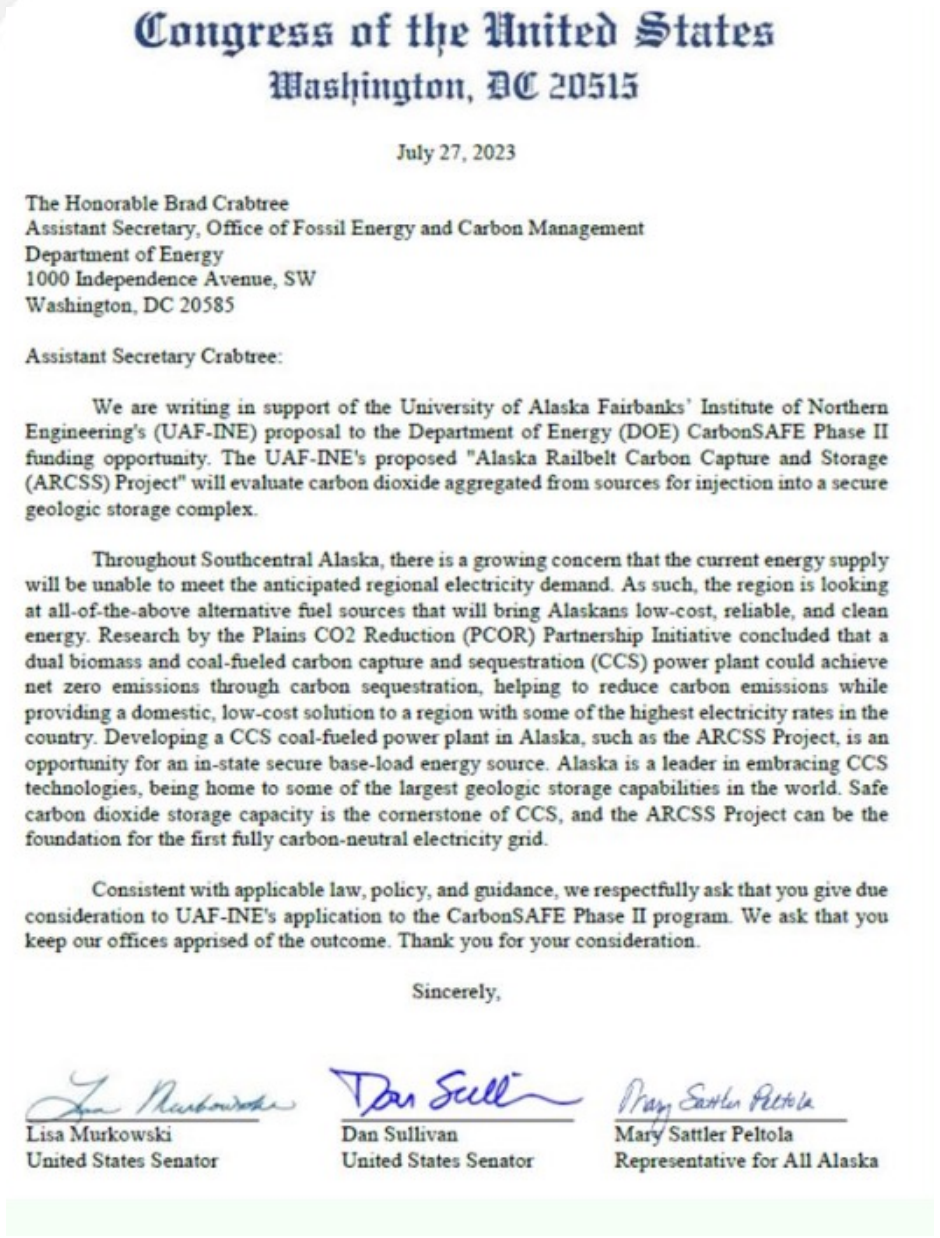
Source: https://www.usgain.com/resources/education-center/what-should-you-know-about-washingtons-clean-fuel-standard-cfs/

ARCCS Project Tasks (Alaska Railbelt Carbon Capture Storage)

- ARCCS Project
  - UAF leads with support from EERC and ARI and other project partners

- Project Tasks, AOI-4, CarbonSAFE Phase II:
  - Task 1.0 – Project Management and Planning
  - Task 2.0—Site Specific Characterization & Assessment of the CO_2 Storage Complex
  - Task 3.0—Preliminary Project Risk Assessment with Mitigation & Management Plans
  - Task 4.0—Plan for Subsequent Detailed Site Characterization & UIC Class VI Permitting
  - Task 5.0—Project Technical & Economic Feasibility Assessment, Including Conceptual-Level Design Study for CO_2 Transport
  - Task 6.0 – Community Benefits Plans (CBP)

ARCCS Project Support



Congress of the United States
Washington, DC 20515

July 27, 2023

The Honorable Brad Crabtree
Assistant Secretary, Office of Fossil Energy and Carbon Management
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Assistant Secretary Crabtree:

We are writing in support of the University of Alaska Fairbanks' Institute of Northern Engineering's (UAF-INE) proposal to the Department of Energy (DOE) CarbonSAFE Phase II funding opportunity. The UAF-INE's proposed "Alaska Railbelt Carbon Capture and Storage (ARCSS) Project" will evaluate carbon dioxide aggregated from sources for injection into a secure geologic storage complex.

Throughout Southcentral Alaska, there is a growing concern that the current energy supply will be unable to meet the anticipated regional electricity demand. As such, the region is looking at all-of-the-above alternative fuel sources that will bring Alaskans low-cost, reliable, and clean energy. Research by the Plains CO2 Reduction (PCOR) Partnership Initiative concluded that a dual biomass and coal-fueled carbon capture and sequestration (CCS) power plant could achieve net zero emissions through carbon sequestration, helping to reduce carbon emissions while providing a domestic, low-cost solution to a region with some of the highest electricity rates in the country. Developing a CCS coal-fueled power plant in Alaska, such as the ARCSS Project, is an opportunity for an in-state secure base-load energy source. Alaska is a leader in embracing CCS technologies, being home to some of the largest geologic storage capabilities in the world. Safe carbon dioxide storage capacity is the cornerstone of CCS, and the ARCSS Project can be the foundation for the first fully carbon-neutral electricity grid.

Consistent with applicable law, policy, and guidance, we respectfully ask that you give due consideration to UAF-INE's application to the CarbonSAFE Phase II program. We ask that you keep our offices apprised of the outcome. Thank you for your consideration.

Sincerely,

Lisa Murkowski
United States Senator

Dan Sullivan
United States Senator

Mary Sattler Peltola
Representative for All Alaska

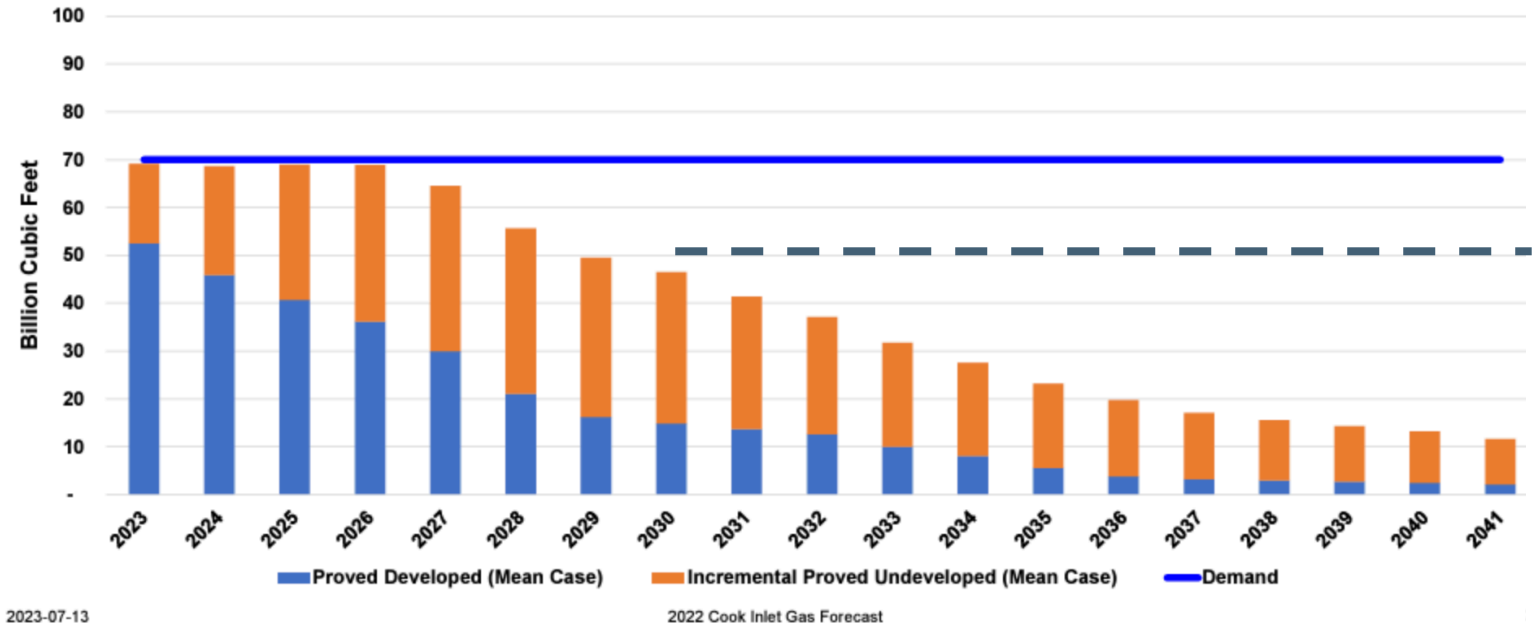
ARCCS Cost Share Commitments from:

- State of Alaska Office of the Governor
- Advanced Resources International
- Flatlands Energy Corporation
- State of Alaska Department of Natural Resources
  - Division of Oil and Gas
  - Division of Geological and Geophysical Surveys
- Friends of West Susitna
- blueprint Alaska

ARCCS Project Support Letters from:

- The Alaska Congressional Delegation
- Hilcorp Energy Corporation
- Chugach Electric Assn.
- Cook Inlet Region Inc.
- Matanuska Susitna Borough
- Alaska Native Science and Engineering Program
- Alaska Energy Authority
- Nova Minerals Ltd
- U.S. Gold Mining Inc.

Low Carbon Biomass-Coal Power with CCS



Gas demand

Gas Demand with
Low Carbon Power Generation

Figure 4b. Cook Inlet Proved Developed+Proved Undeveloped Mean Forecast, Truncated, DNR.

- **Startup ~ 7 years from start of Front End Engineering Design (year 00)**

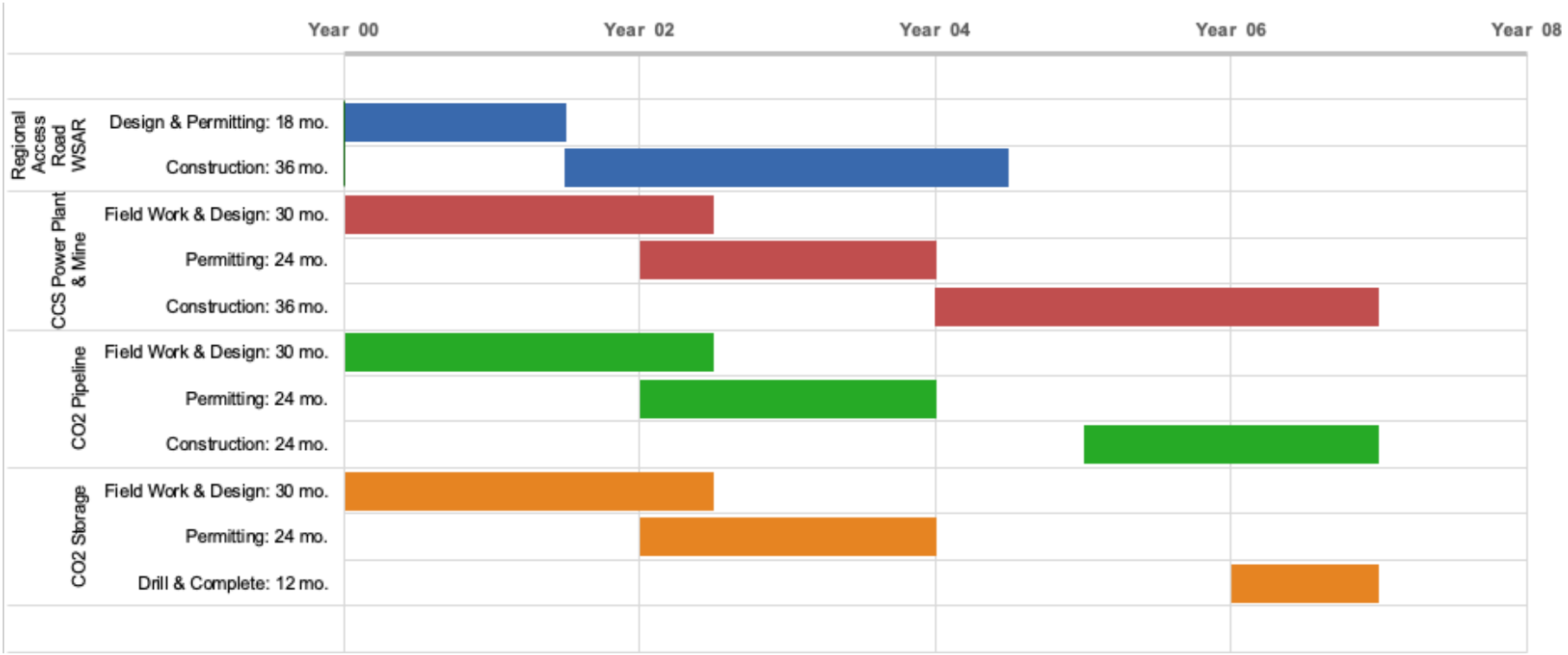


Figure 16. Project Timeline (created with Vertex42©).

Low Carbon Biomass-Coal Power with CCS Cost Estimates

Table 8. Combined Project Cost, Low Carbon Biomass-Coal Power Generation with CCS, 30-yr

	Units	Power Plant with CCS	
Power Plant Generation Net with CCS	MWe net with CCS	75	300
Total Capital: Power Plant, CCS Plant, Pipeline, Well, Storage	Net present US$MM	**1149**	**3627**
Total Operating Capital Cost (30 years, 2.5% plant cost/yr)	Net present US$MM	464	1555
Total Expense Cost (30 years)	Net present US$MM	1657	6129
Power Plant Capital Cost (excluding power transmission)	Net Present US$MM	650	2229
Power Plant Ongoing CAPEX (30 years, 2.5% plant/yr)	Net present US$MM	319	1092
Power Plant OPEX (30 years)	Net present US$MM	1190	4567
Carbon Capture Plant Capital Cost	Net present US$MM	296	944
Carbon Capture Plant Ongoing CAPEX (30 years, 2.5% plant cost/yr)	Net present US$MM	145	463
Carbon Capture Plant OPEX (30 years)	Net present US$MM	389	1410
Pipeline Capital Cost	Net present US$MM	97	133
Pipeline OPEX (30 years)	Net present US$MM	17	17
Well Cost	Net present US$MM	45	186
Storage (monitoring, facility fees, inspection, and testing)	Net present US$MM	61	135

Alaska CO2 Reduction Network (ACORN)

Institute of Northern Engineering
University of Alaska Fairbanks

- **UAF-INE applied for Regional Initiative for Technical Assistance Partnerships (RITAP) funding from DOE DE-FOA-3014 to:**
  - Continues CCUS Workgroup
  - Expands CCUS technical support in Alaska via UAF B.S. Energy Resources Engineering (formerly Petroleum)
  - Funds for three years, if awarded
- **Builds Alaska capability to perform feasibility studies and geotechnical evaluation of secure CO_2 storage**
- **Supports Energy Industry Training for the Next Generation**

Project Title: **Alaska CO_2 Reduction Network (ACORN) Project**

Applicant Name: University of Alaska Fairbanks (UAF)

Principal Investigator: Dr. Abhijit Dandekar

Associated Organization: DNR Division of Geological & Geophysical Surveys, Marwan Wartes

Project Objectives:

Carbon capture use and sequestration (CCUS) in Alaska can attract new investments and create decarbonization options for power generation, industrial processes, and oil and gas operations that are vital to the State's economy. Decarbonizing in a safe, reliable, and cost-effective manner can enable continued clean operation of equipment, improve community health and welfare, and mitigate carbon risks. Building on UAF's momentum and past successes, the Alaska CO_2 Reduction Network (ACORN) Project will expand collaboration between industry, regulators, educators, technology providers, and investors. ACORN assists commercial CCUS deployment in the following ways:

- Supports transitioning UAF's successful, ABET-accredited B.S. Petroleum Engineering (PETE) program into Energy Resource Engineering (ERE). ACORN supports Faculty hiring (engineering, geosciences, and energy focused) for curriculum development and delivery. These Faculty will develop Alaska and America's future energy industry workforce, graduating versatile, robust professionals prepared for the energy challenges facing society.
- Supports ERE Faculty who will provide expert carbon capture and sequestration (CCS) technical assistance to industry projects and prepare CCS studies and feasibility reports. Reports and data will be publicly available via the new CCS database constructed by the Alaska Dept. of Natural Resources (DNR), and Alaska Oil and Gas Conservation Commission (AOGCC).
- Provides support from the DNR Division of Geological and Geophysical Surveys (DGGS), from the U. of North Dakota's Energy and Environmental Research Center (EERC), and from Petrotek. Their staff, among others, will serve on ACORN's Industry Advisory Board and be available to answer questions and support the ERE Faculty.
- Creates a stronger network and positive environment for CCS development in Alaska by continuing the Alaska CCUS Workgroup. The CCUS Workgroup has been meeting since 2021. ACORN will enable continuation of this Workgroup whose funding would otherwise expire September 2024.
- Creates Forums to promote interchange of ideas and sharing of experiences. Forums will employ the philosophy and guidelines of Society of Petroleum Engineers (SPE) Forums, designed to be collaborative, idea-generating meetings that stimulate new ideas and innovation to meet upcoming challenges to the industry. They bring together top technologists, innovators, and stakeholders to address specific industry challenges.
  - Technical Forums will be established by sub-basin and technical topic, inviting key individuals to collaborate across projects, interchange ideas, and share experiences.
  - A Community Benefits Forum will be established where Alaska's multiple CCS project teams can discuss and align on best practices, public engagement, and community benefits plans.
- Supports the DNR DGGS expansion of CCS data and report compilation for sedimentary basins around the state into the DNR and AOGCC's Alaska CCS database.

Electricity Powers Progress: Community Benefits

- Affordable, reliable power essential to human well being
- Alaska Electricity costs are high, energy demand per capita is second-highest in the nation, and Alaska is home to some of the lowest income socioeconomic groups in USA
- With Alaska's Power Cost Equalization (PCE) Program, Investments lowering Railbelt energy cost also lowers power costs Statewide
  - PCE serves 82,000 Alaskans in 193 communities largely reliant on diesel fuel for power generation by lowering electricity cost to level comparable to Railbelt cost.
  - See article by the State Governor on the railbelt grid: https://gov.alaska.gov/state-labor-and-utilities-are-aligned-on-modernizing-the-railbelt-grid/
  - Alaska facts: https://www.eia.gov/state/print.php?sid=AK