Review of Carbon Capture, Utilization, and Sequestration Options for Natural Gas-Fired Power Generation

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Research Questions

- What is the role of CCUS in NGCC Power plants?
- How will NGCC Power plants continue their relevance in the clean energy space?

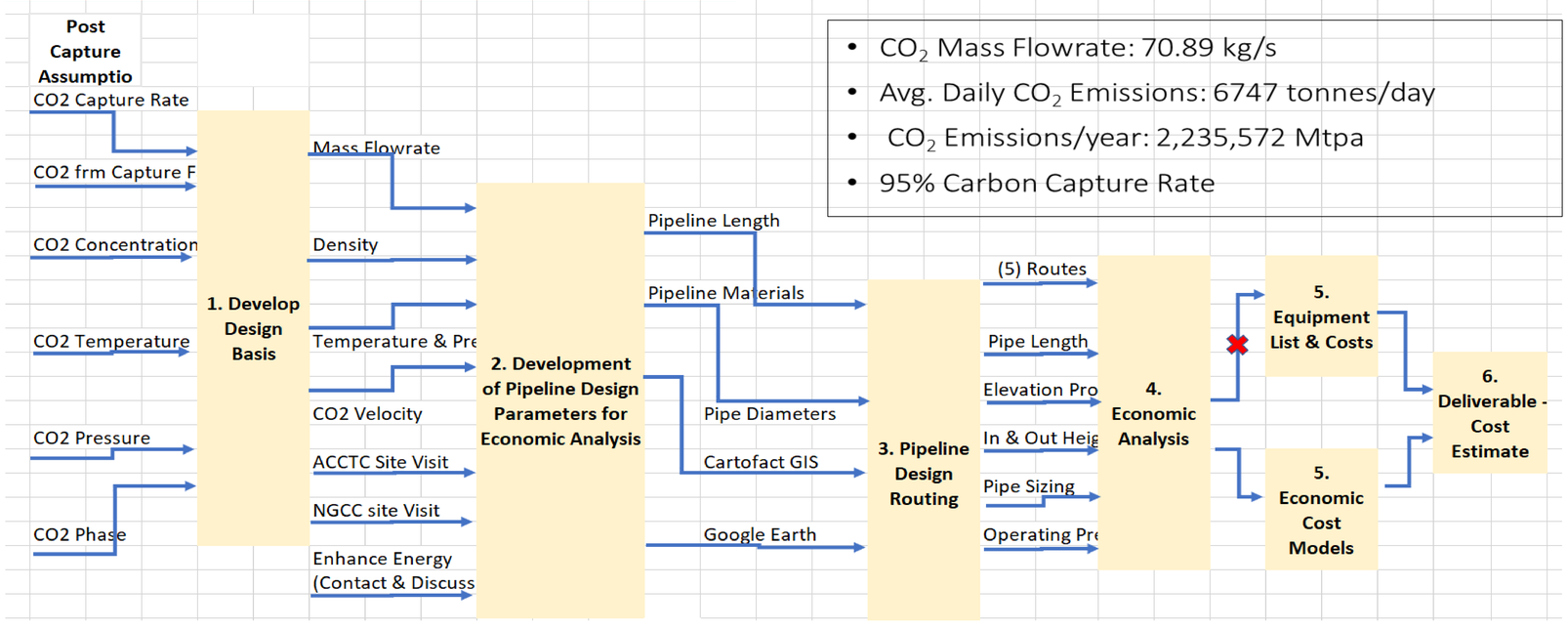
Research Goal & Objectives

- Techno-economic viability of CCUS options in the energy sector
- Literature review of CCUS options
- CO2 transportation from an NGCC PP to the ACTL for permanent geological storage

Background

- Global GHG problem with CO2 as the most prolific gas causing global warming
- A struggle to keep the global atmospheric temperature at 1.5 degrees Celsius
- Largest industrial-scale GHG emissions come from the burning of fossil fuels
- CCUS is one of the options to curtail the rise in global temperatures

Methods



Data Analysis

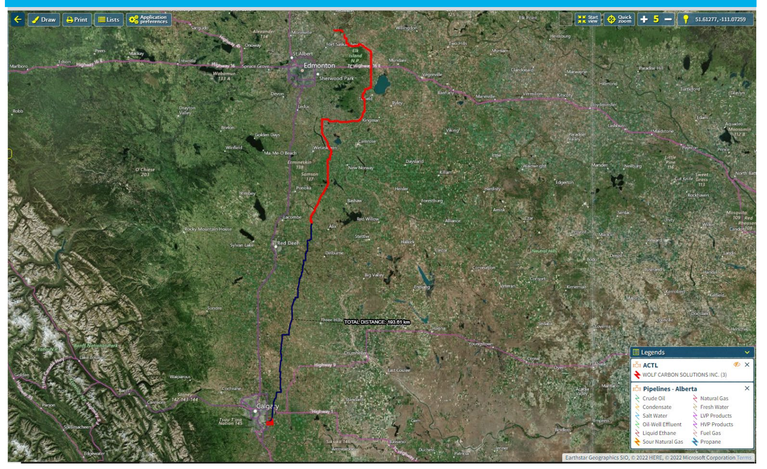
- CO2 Transportation – 5 Pipeline Sizing Models
- CARTOFACT GIS – 5 Optimized Pipeline Routing Options
- GOOGLE Earth – 7 Pipeline Elevation Profiles
- Economic Analysis – 7 Pipeline Cost Models
- Carbon Pricing
- Carbon Offsets

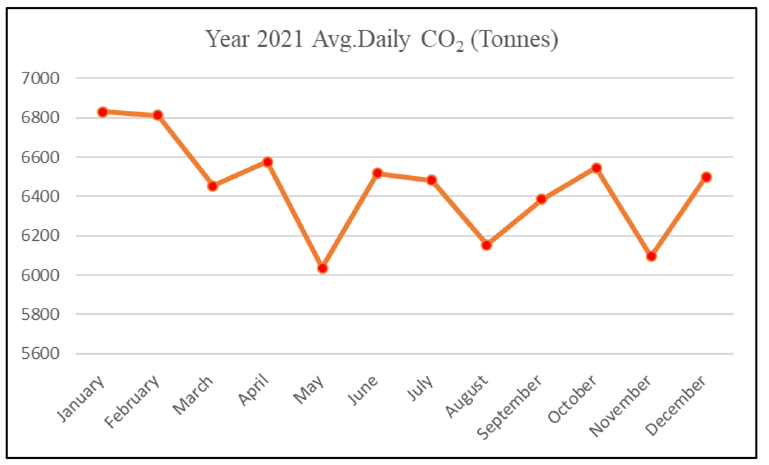
Techno-Economic Results

Description	Route 1
Pipeline Length	193.61
Mass Flow rate	70.89
Pipe Outer diameter (inch)	16
Pipe inside diameter (inch)	14.8
Pipe Wall Thickness (inch)	0.6
Inlet Height (meters)	1027
Outlet Height (meters)	911
Max Height	1066
Min Height	790
Avg. Height	951
Max Operating Pressure (kPa)	17930
Inlet Pressure (P1) (kPa)	15000
Outlet Pressure (P1) (kPa)	13200
Inlet Temperature (◦C)	25
Outlet Temperature (◦C)	5
Pipeline Cost (2020)	$C292M
Pipeline Cost (2022)	$C324M

- CO_2 Mass Flowrate: 70.89 kg/s
- Avg. Daily CO_2 Emissions: 6747 tonnes/day
- CO_2 Emissions/year: 2,235,572 Mtpa
- 95% Carbon Capture Rate

Pipeline Routing Result





Conclusion

- The preferred pipeline route was 194 km long costing CAD324M to construct. Route selected using 5 pipeline sizing models, 5 GIS routing options, and 7 costing models
- Carbon pricing & social considerations used as justification for project viability
- Vast quantities of CO2 emitted devoid of an established CO2 utilization value chain. CO2 storage is the favored end strategy

Future Research

- Existing pipeline corridor and Right-of-Way studies can be researched to enhance pipeline routing optimization
- Research extension to cover other aspects of the CCUS value chain for extensive economic analysis
- Extensive seismic reservoir 3D/4D studies for more localized CO2 storage

Works Cited

- Canada Energy Regulator. (2021). Canada's energy future 2021. https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/canada-energy-futures-2021.pdf
- Craig, R., & Butler, D. (2017). Canada oil sands innovation alliance. Oil sands CO2 pipeline network study. https://cosia.ca/sites/default/files/attachments/Final%20Report%20COSIA%2018%20July.pdf
- Government of Alberta. (2021). Alberta carbon trunk line. https://majorprojects.alberta.ca/details/Alberta-Carbon-Trunk-Line/622
- Knoope, M. M. J. (2015). *Costs, safety and uncertainties of CO2 infrastructure development*. 359. https://dspace.library.uu.nl/handle/1874/319516