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What do we do with CO_2?

Assessing pipeline infrastructure requirements for CO_2 transport

In a recent paper, GDM Pipelines shared the results of an analysis of existing Western Canadian pipeline infrastructure and its suitability to transport hydrogen at various blending levels. It is an important and timely discussion, as along with many other countries, in December 2020, the Canadian government released the *Hydrogen Strategy for Canada*. It lays out a detailed framework for actions that will utilize hydrogen as a tool to achieve our goal of net-zero emissions by 2050, and position Canada as a global, industrial leader of clean renewable fuels. A key factor in achieving this success will be our ability to use the abundance of hydrocarbons in the Western Canadian Sedimentary Basin to create hydrogen.

While there are different methods of extracting hydrogen, the most promising opportunity for Western Canada sits with Blue hydrogen, which involves creating hydrogen from Natural Gas either by generating hydrogen without releasing carbon emissions through hygienic extraction, or by capturing and sequestering the resulting CO_2 emissions.

These Carbon Capture, Utilization and Storage (CCUS) processes typically involve returning the CO_2 into underground storage, but to be successful, there must be a way to get it there. To more fully understand how this could occur in Western Canada, as a follow on to our analysis of infrastructure for hydrogen transport, we have also taken a deeper look at the requirements and potential for pipelines to transport CO_2.

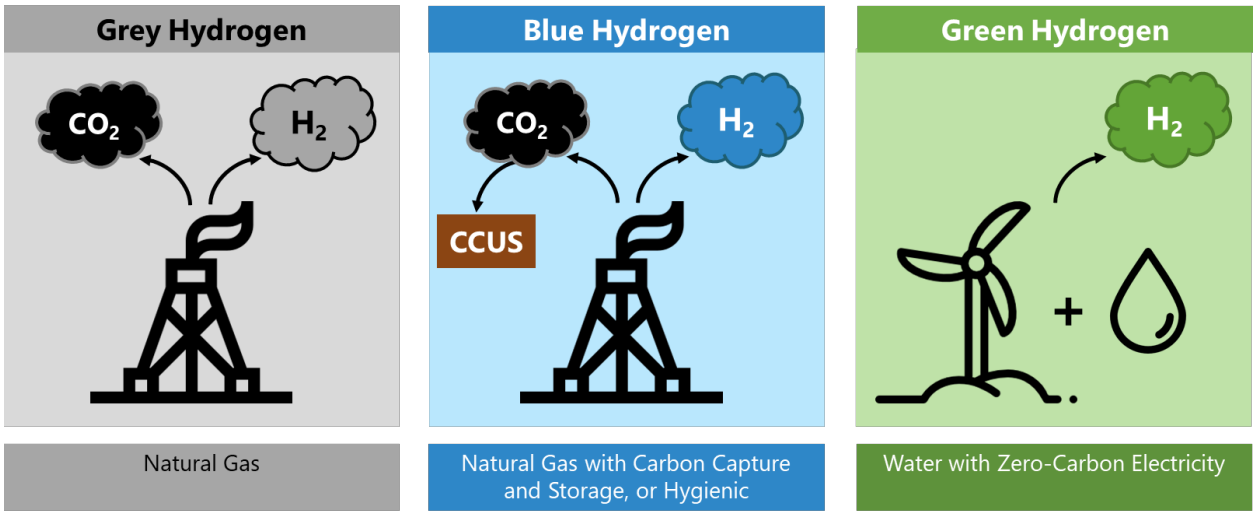

Figure 1: Grey Hydrogen involves Steam Methane Reforming (SMR) from Natural Gas, but it also involves CO2 emissions. Blue Hydrogen techniques can involve either Hygienic extraction techniques that are designed to release no carbon emissions, or, more commonly, SMR with Carbon Capture, Utilization, and Storage (CCUS). Green Hydrogen involves the production of hydrogen from renewable sources such as wind or solar.

CO_2 Properties

In general, carbon dioxide is less dangerous than most other hydrocarbon gasses. It is non-flammable, odorless, colourless, and has low toxicity. However, there are some factors to consider with respect to pipeline integrity and regulations.

Corrosion Considerations

When it comes to the transport of CO_2, the primary concern is internal corrosion if any quantity of water is present during transport.

While the CO_2 gas itself is inert and will have no significant impact on the interior pipeline wall, there are a few factors that must be considered. Upstream processing requires dehydration of CO_2 to a point where condensation is not possible during transport. Due to this, mixing CO_2 with any solution gas from oil and gas production, which will almost always contain water, must be avoided. This means CO_2 transport lines will always transport pure CO_2.

If it is known that water will be present from upstream sources, corrosion resistant alloys, non-iron base materials, or composite materials will be required. For primary transmission lines, carbon steel would be preferable.

Cracking Concerns

Cracking of the steel when transporting CO_2 is not considered to be a concern due to the lack of hydrogen. External cracking can still occur, as with any pipeline, but hydrogen-induced or sulfide-induced corrosion will not be a factor in pure CO_2 transport.

Low Temperature Fracture Resistance

In the event of a depressurization event, the rapid release of CO_2 would result in very low temperatures, meaning proven low-pressure notch toughness, such as Category 2 or 3 pipe, is desirable for CO_2 transportation.

If non-steel materials are to be used, it would require qualification for CO_2 service to account for the low temperatures during a depressurization event. To date, there is no literature available to prove that most composite materials would be suitable in these conditions.

Infrastructure

When it comes to the transport of CO_2 and understanding how existing infrastructure could be repurposed, there are several conditions which would need to be met. In general, the selection of pipelines for CO_2 would need to take pressures into account, as dense phase transport is the preferred method, and there is a higher risk when it comes to transporting CO_2 in this manner.

	CO_2 Pipeline Suitability Criteria
Status	Operating Non-Operating
Material Type	Steel No composite or fiberglass- requires qualification from manufacture for low temperature fracture resistance and resistance to CO_2 absorption
Material Grade	Category 2 or 3 only Category 1 pipe can not be used with >50% SMYS or >50 MPa
Age	1980 or newer Older pipelines may require review to operate at higher pressures
Proven Cracking Resistant Construction Practices and Materials	Existing systems that transport H_2S will be compatible with CO_2 service. Cracking risk makes sweet systems likely unsuitable.

Due to integrity considerations for corrosion, cracking, and low temperature fracture resistance mentioned above, as well as the requirement for dense phase CO_2 transport, any pipelines which are to be considered for CO_2 transport must be made of category 2 or 3 steel. It would also require repurposing pipelines that were built after 1980, and that are still either operating, or in a discontinued or suspended state.

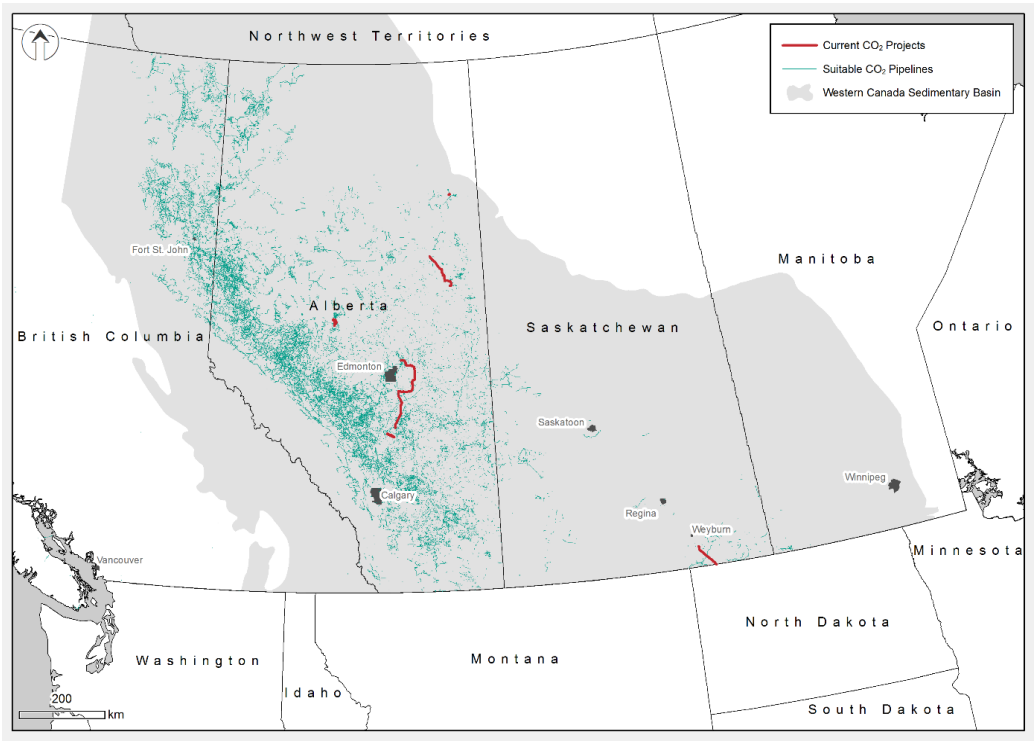

Figure 2: Infrastructure in Western Canada that would be suitable for transport of CO_2 .

Based on these requirements, approximately 17% of existing infrastructure in Western Canada would be suitable to transport CO_2.

Regulatory Requirements

Even once we have identified infrastructure that could be suitable candidates, there are significant regulatory considerations. While hydrogen is still largely considered a "miscellaneous gas" and does not have specific requirements, there *are* certain directives that are part of CSA Z662:19 that address requirements for CO_2 transport.

Specifically, it:

- Restricts the use of threaded connections in CO_2 service (CLAUSE 4.5.3.2)
- Requires deeper burial of CO_2 pipelines (TABLE 4.9)
- Requires proven notch toughness Category 2 or greater at >50MPa MOP (TABLE 5.1)
- Requires all CO_2 pipelines to undergo 100% radiography of girth welds (CLAUSE 7.10.3.2)
- Requires all CO_2 pipelines to undergo a pressure test to 1.5x MOP in class 2,3,4 locations (populated areas). (TABLE 8.1)
- Requires all CO_2 pipelines to be dried and cleaned prior to service. (CLAUSE 8.11.2)
- Requires all CO_2 pipeline operators be trained in Oxygen deficient atmospheres (CLAUSE 10.2.11)

With the restrictions above, it essentially means a full engineering assessment would be required to determine whether any existing pipeline could transport CO_2. Or, new infrastructure would need to be built for purpose.

However, this isn't to say that CO_2 projects are not possible. In fact, in March 2021, it was announced that the Alberta Carbon Trunk Line (ACTL), a 240 km pipeline designed to collect excess CO_2, had reached a significant milestone with the capture and sequestering of one million tonnes of carbon dioxide. The success of this project has also prompted the Alberta government to press for $30 billion in assistance and incentives from the federal government to support other CCUS projects.

With so much focus recently on hydrogen, and now CO_2 projects, it seems the obvious path forward for the oil and gas industry in Canada in its goal to meet net-zero targets is to continue to develop projects that exploit the massive stores of hydrocarbons beneath our feet. We have an abundance of infrastructure that could be repurposed, and the expertise to be able to capitalize on this opportunity. The key is in understanding how to leverage these resources, and GDM Pipelines is excited to be driving the conversation.

About GDM Pipelines

GDM Pipelines is the industry leader in providing comprehensive pipeline, facility, midstream and transportation information to the North American Oil and Gas Industry.

Based in Calgary, Alberta, and in operation since 1997, GDM Pipelines offers a broad range of information and services and is the only source for accurate and complete Canadian oil and gas infrastructure data.

For more information about GDM Pipelines, please visit gdm-inc.com.

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