An Update Report on the Integrated CCS Project at SaskPower's Boundary Dam Power Station

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Abstract

On October 2, 2014, the first-ever, commercial-scale, coal-fired power plant incorporating CCS began operation at the SaskPower Boundary Dam Power Station, Unit 3 (BD3), in Saskatchewan, Canada. The initial investment in the approx. 110 MW (net) BD3 power unit's retrofit and carbon capture plant was approximately C$1.467 billion.

The original IEAGHG report 2015-06[1] on the project issued in September 2015 covered the design, construction and startup of BD3. The update report, which is the subject of the proposed GHGT-14 presentation, was commissioned by the International CCS Knowledge Centre. It will summarize the experience of SaskPower from the date of the previous report to early 2018, a period filled with invaluable experience that could provide insights to other clean-coal initiatives.

The CO_2 captured at BD3 is geologically stored at two locations: in an oil reservoir approximately 1.4 kilometres deep at Whitecap Resources' (formerly Cenovus Energy) Weyburn oilfield and in a deep saline aquifer at Aquistore where it is injected into the Deadwood formation

[1] http://ieaghg.org/docs/General_Docs/Reports/2015-06.pdf

at 3.2 km depth (see Figure 1). The latter CO_2 geological storage facility is located near BD3. The related "Aquistore Project" is a measurement, monitoring and verification (MMV) research project initiated by the Petroleum Technology Research Centre (PTRC).

Early operation of the BD3 capture facility was a challenging undertaking for SaskPower for a number of reasons:

- An amine absorption capture process is based on chemistry and chemical engineering principles. This was unfamiliar territory for a power company.
- The Shell Cansolv process (see Figure 2) was unproven for commercial-scale operation at a coal-fired power plant. Additionally, SaskPower's low-rank coal, lignite, was particularly problematic, resulting in a process complications associated with fly ash and other contaminants.
- There were a significant number of design and construction issues to manage. Notably, significant levels of amine degradation in the capture facility complicated capture performance.

Nonetheless, the persistence of the SaskPower team resulted in overcoming these obstacles. Perhaps the most successful tactic employed by SaskPower during this troubleshooting period was a central vision, namely to reach 800,000 tonnes of captured CO_2 within a 12-month period from November 2015 to October 2016. This target was a public commitment by the company to directly address stakeholder concerns regarding the level of investment in BD3. The desire to achieve this vision drove many decisions that resulted in continued operation of the capture facility rather than frequent outages to address issues as they arose. Operation continued despite process upsets, degradation and fouling that penetrated deeper into the plant as time progressed. Consequently, operation became increasingly more complex but resulted in a richness in learning and understanding of the operational "bandwidth" of each process unit. The team became particularly adept at quickly deploying solutions to keep running with minimal downtime, while minimizing operating costs. Ultimately, the sustained operation of the facility led to better decisions regarding necessary enhancements to the facility to assure future reliable, long-term operation at design capacity. SaskPower met its publicly-announced CO_2 production target in late 2016.

During the period October 2015 to August 2017, major work was undertaken during a series of outages as follows:

- Address safety issues and construction deficiencies
- Mitigate fly ash entering the capture system
- Enhance thermal reclamation capability to achieve < 1% degradation specification
- Replace some carbon steel infrastructure with stainless steel
- Improve temperature control on various process units to meet design specifications
- Ongoing maintenance to clean fouling from heat exchangers
- Add isolation valves on heat exchangers and process units to enable "on-the-fly" maintenance
- Incorporate instrumentation to measure fouling within the process control system

As a consequence of these enhancements, SaskPower demonstrated operation at design capacity (3240 tonnes per day) by the end of 2017 and assured the ability to maintain 85% operational availability going forward.

By November 2016, 100,000 tonnes of CO_2 had been injected into at Aquistore on an intermittent basis. The Aquistore Project's MMV activities continued, including:

- Install and test a Digital Acoustic System VSP (DAS-VSP) to monitor the subsurface CO_2 plume
- Utilize Differential Interferometric Synthetic Aperture Radar (DInSAR) to determine regional vertical and horizontal ground deformation
- Conduct 3D Seismic surveys at 36,000 and 100,000 tonnes of CO_2 injection
- Monitor induced seismic activity utilizing regional seismometers installed in the Bakken shale formation
- Conduct twice annual groundwater and soil-gas surveys

The Fluid Recovery System at the Aquistore monitoring well could no longer be utilized after July 2015 due to CO_2 breakthrough. Installation of a second monitoring well is being contemplated.

The startup of BD3 was the culmination of decades of work by SaskPower focused on continued operation of coal-fired power-generating stations, while mitigating the climate change impact of associated air emissions. SaskPower is working steadily on developing its future GHG mitigation strategy. In order to assure a diverse blend of power generation capabilities and reasonable power pricing into the future, SaskPower is conducting an evaluation of BD3 with a view to deploying a 2 million tonne per annum CCS installation at a newer coal-fired power plant by 2020-2025. This evaluation entails:

1. A reliability study
2. An evaluation of cumulative capital and operating costs
3. A comparison of various capture technology options, and
4. A capacity study at Aquistore

SaskPower is actively engaged with the Government of Canada in developing an GHG equivalency agreement to assure continued operation of its entire fleet of power facilities, including coal-fired power generators, while meeting or exceeding provincial GHG reduction targets. A unique arrangement for Saskatchewan is essential given the federal government's 2016 announcement to mandate closure of all coal-fired power facilities across Canada by 2030.

Figure 1 - Aquistore Stratigraphy Including a Schematic of its Injection Well

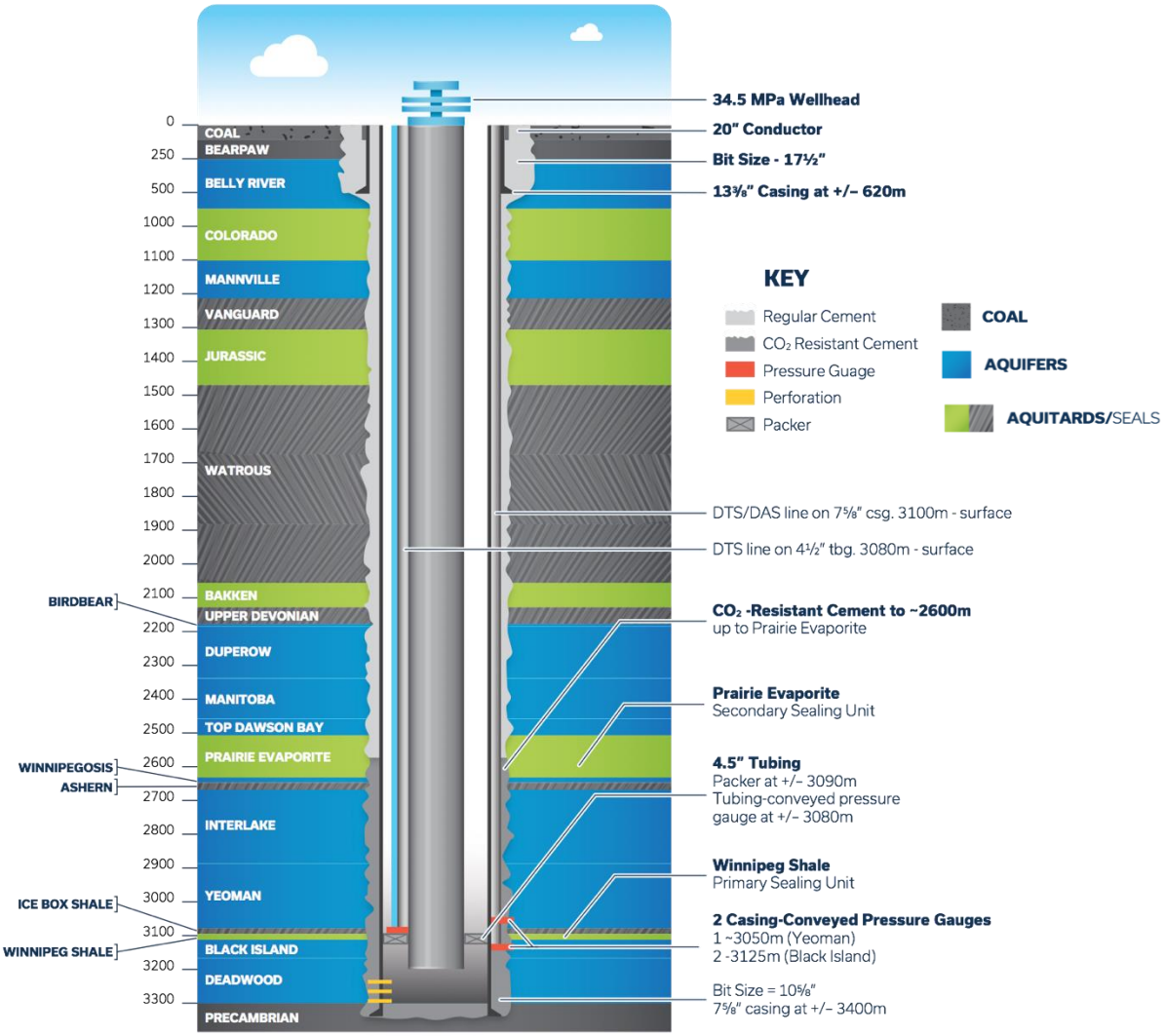

Figure 1 - Shell Cansolv's SO_2 and CO_2 Amine Capture System as Installed at SaskPower's BD3 Power Plant