2nd Generation CCS –– A case study for implementing CCS technology on SaskPower's Shand Power Station at reduced capital costs and increased performance flexibility

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SaskPower, Saskatchewan's (Canada) provincial electrical utility provider, needs to provide base load power which regionally is only available from coal or natural gas. Regulations in Canada are closing the window on coal-fired power generation without carbon capture. Previously, SaskPower completed the world's first industrial scale carbon capture facility on a coal fired power plant when Unit 3 of the Boundary Dam Power Station was retrofit with CCS in 2014. Shand Power Station is a single unit plant located 12 km from Boundary Dam. With a gross output of 305 MW, Shand's current capacity is approximately twice that of BD3. Shand Power Station is also SaskPower's newest coal-fired power plant and is ideal should SaskPower proceed with a next CCS project.

A feasibility study resulting in a 90% carbon capture facility with a nominal annual capacity of 2 million tonnes per year was completed on Shand Power Station. Mitsubishi Heavy Industries' (MHI's) KM-CDR Process®, currently used at Petra Nova (the world's largest CCS plant), was evaluated during this study. The "cost of capture" was evaluated in terms of capital costs and electricity lost due to capture plant operations.

Results indicated that:

- Economies of scale are a fundamental driver in the utility industry; a larger facility results in a lower capital cost per tonne of CO2 captured;
- Reductions in capital costs have been evaluated and are projected at 67% less expensive than they were for BD3 on a cost per tonne of CO2 basis;
- The larger Shand CCS facility would also offer lower operating costs compared with BD3. The anticipated cost of capture from the Shand CCS Facility would be $45US/tonne of CO2, assuming a 30-year sustained run-time of the power plant and purchasing of lost power at costs consistent with new Natural Gas Combined Cycle (NGCC) power projects;
- Designing the heat rejection system requirements so that no additional water draw is required and practical. This is particularly favorable as many power generating facilities are often constrained by water availability;
- Site layout and modularization decreases overall capital costs;

- Cost efficient modifications of the existing steam cycle requiring “bolt-in” turbine changes greatly reduce capital cost with a relatively minor loss of net power;
- Flexibility of the capture plant is facilitated by designing the thermal cycle for planned curtailment by adding a butterfly valve in the IP-LP cross-over for steam throttling at reduced power plant loads, therefore allowing continued capture operations at full capacity;
- A capture rate exceeding 90% on a partial stream of flue gas is also facilitated by the butterfly valve. Capture rates reaching in excess of 96% at 62% load on the power station were demonstrated, which decreases the power plant’s emission profile; and
- Increase in capital costs to facilitate increasing the capture rate from 90% to 95% produces a lower overall “cost of capture”, per tonne of CO2 captured, suggesting that 95% capture may be the new benchmark.