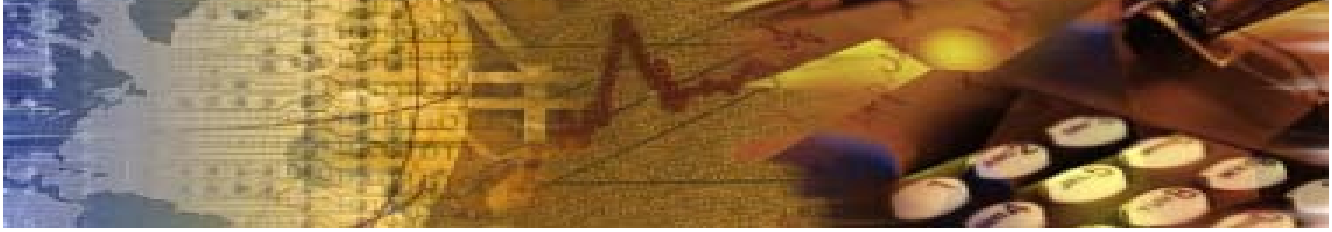
SAGD Energy Efficiency Study



Prepared For

Alberta Energy Research Institute

September 2009

JACOBS Consultancy

JACOBS Consultancy

525 West Monroe, Suite 1350
Chicago, Illinois 60661
Phone: +312.655.9207
Fax: +312.655.9706

SAGD Energy Efficiency Study

Prepared For

AERI

For Jacobs Consultancy

Ian Buchanan

Denis Westphalen

Simon Davies

Neera Chawla

John Gieseman

September 2009

Table of Contents

Section A.

Executive Summary

Alberta Energy Research Institute ("AERI") commissioned Jacobs Consultancy Inc. ("Jacobs Consultancy") to determine the efficiency of a typical SAGD facility and the preferred and most economic means to decrease its energy usage. This Study is important for the Canadian government as it hopes to determine the best means to reduce greenhouse gas emissions in the production of crudes from the oil sands. Significant savings in energy at these facilities would translate into significant reductions in greenhouse gases.

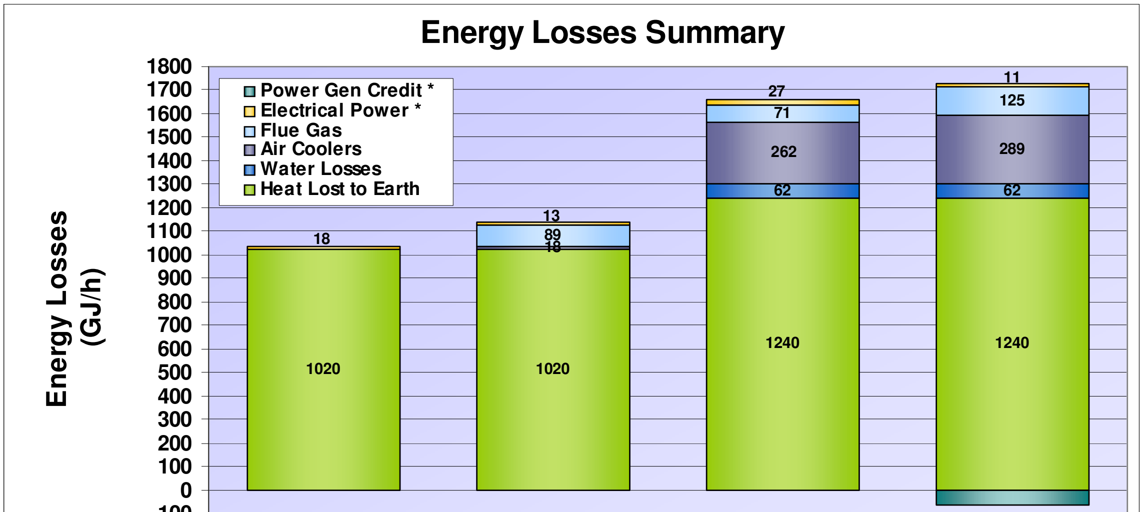
Jacobs Consultancy approached this Study by first determining how much energy would be consumed for a 33 kbpd facility, a typical building block size for a producing field, in the "ideal" case. The ideal case was constructed assuming: 1) an efficient mechanical lift to minimize reservoir pressure and thus heat losses to the earth; 2) oil/water separation and water treatment at wellhead temperatures; and 3) efficient firing in the heaters that supply the steam for the process. By understanding how the parameters of each reservoir interact with the surface facilities, Jacobs Consultancy was able to determine the ideal energy usage for fields of various depths and characteristics. This preferred operation is termed the Ideal SAGD Heat Cycle™.

Based on public data, Jacobs Consultancy determined the energy usage for typical cases with and without cogeneration facilities. The typical cases consumed about 60% more energy than their ideal counterparts (see Figure A-1). Jacobs Consultancy then applied various technologies in stages to the typical facilities and was able to reduce the overall gap to 14 percent. These stages were to:

1. Reduce the downhole pressure
2. Minimize the use of glycol and optimize the above ground separation
3. Minimize the stack losses

Surprisingly, a fourth item—minimize the blowdown through the use of drum boilers and evaporators—did not prove to be energy efficient.

Figure A-1.
Energy Losses Summary



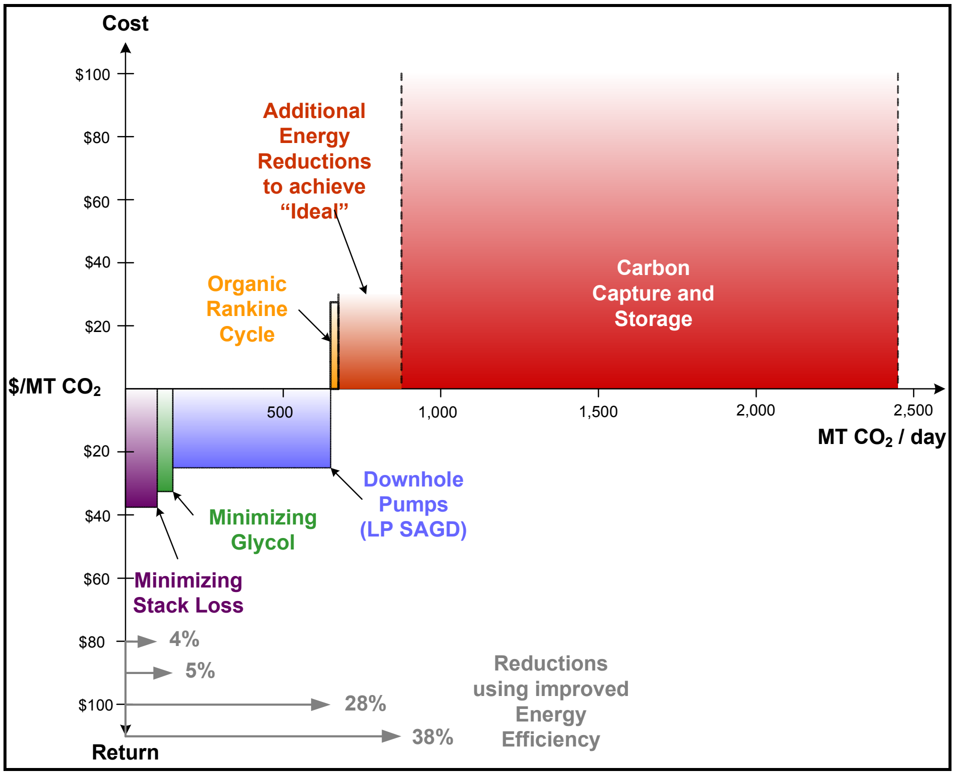
	Ideal	Ideal with Cogen	Typical no Cogen	Typical with Cogen
Power Gen Credit *		-4		-63
Electrical Power *	18	13	27	11
Flue Gas		89	71	125
Air Coolers		18	262	289
Water Losses			62	62
Heat Lost to Earth	1020	1020	1240	1240

Jacobs Consultancy also analyzed the effect of reservoir pressure, the viability of implementing Organic Rankine Cycle (ORC) facilities, and the effectiveness of cogeneration facilities. The results related to the cogeneration and ORC were mixed and are sensitive to the existing reservoir characteristics as well as the existing (or planned) above-ground facilities. Lower pressures in the reservoir have a significant positive effect on energy conservation.

Data from the above cases were compiled and rough cost estimates were performed to determine the economics of implementing the improvements to typical fields or for new designs. If a production company was to implement grassroots designs that incorporated downhole pumps, stack/air preheat, and direct heat exchange minimizing glycol use, the IRR of a project would increase from 10% to 12% given the base assumptions outlined in Section C.

Finally, Jacobs Consultancy converted the possible energy savings to CO_2 reductions and prepared a CO_2 abatement chart (see Figure A-2). The chart shows that for the typical case shown it would be possible to reduce greenhouse gas emissions 28% before more costly measures such as carbon capture and storage are employed.

Figure A-2.



Future Work

There are a number of items that were uncovered during the work that should merit further study. Among them, is the need to better quantify the efficiency and CO2 saving by implementing specific strategies for existing plants. It is important to note that this study was for a grassroots facility with an approximate average of key characteristics of existing SAGD fields. To determine the improvement realized by applying the various strategies or technologies, we redesigned the facility each time to make it more efficient and, at the same time, more economic - in short, closer to ideal. We then used our best engineering judgment and conservative pricing in our calculations in an effort to ensure the new design remained a practical one.

What could have a more immediate impact, however, is determining how these same strategies should be economically applied to existing SAGD facilities. This would capture the intricacies and complexity of an actual oil sands reservoir along with the retrofit capabilities of each option to improve efficiency and reduce the CO_2 footprint. Key considerations include: a) mix of good and bad wells, b) unique reservoir characteristics (gas over bitumen, water, inclusions, etc.), and c) distance and distribution of wellpads to the central processing facilities. It must also take into account the integration of the various staged plants using the different technologies within a single site.

A better examination of an actual site will allow for a producer (and ultimately the industry in general) to determine which improvements really provide for the greatest economic and environmental gain for existing operations. By "field testing" our methodology, we can move this work from "a paper study", to an actual test case for improving existing operations.