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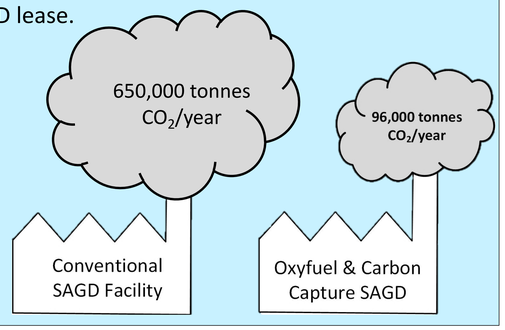
SAGD Oxyfuel CO_2 Capture and Cogeneration Project

Project Scope

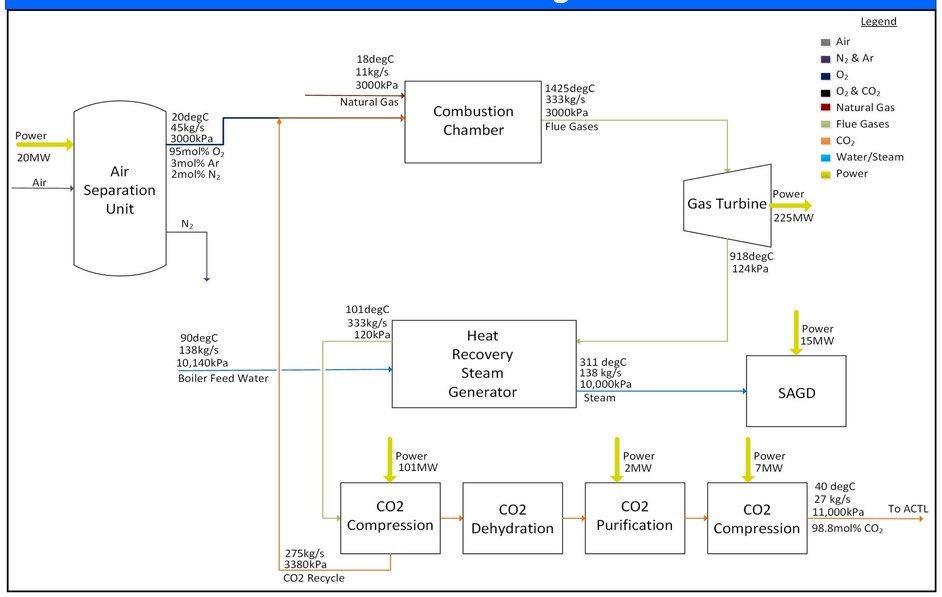
This project involves the design of an oxyfuel cogeneration process used to supply steam to a 25,000 BPSD steam assisted gravity drainage (SAGD) facility. The design is made for a typical northern Alberta SAGD lease.

Key design components include:

- Uses high pressure oxy-fuel for combustion of natural gas to produce power and steam
- Capture, purification and compression of CO_2 from the flue gas to meet the Alberta Carbon Trunkline (ACTL) specification for transport

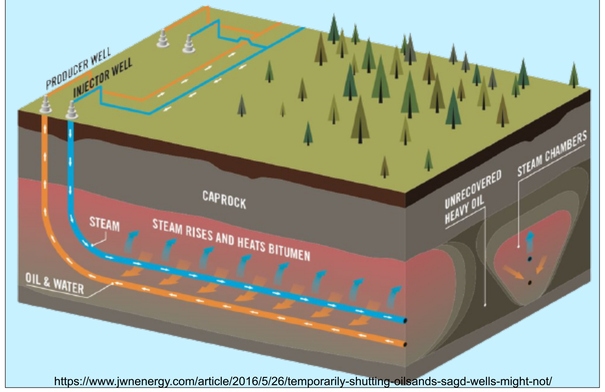


Process Flow Diagram



Steam-Assisted Gravity Drainage (SAGD)

Enhanced oil recovery technology to produce bitumen



https://www.jwnenergy.com/article/2016/5/26/temporarily-shutting-oilsands-sagd-wells-might-not/

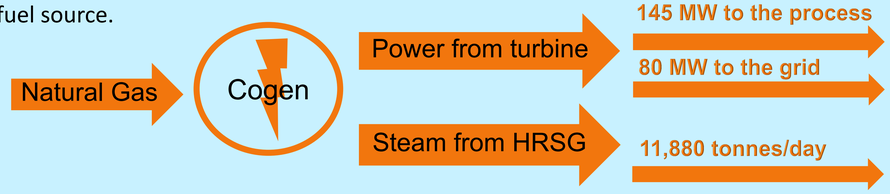
Process Steps

Air Separation Unit (ASU): The ASU produces high purity oxygen for oxyfuel combustion of natural gas in the turbine. Oxyfuel is advantageous because the products of combustion consist primarily of CO_2 and H_2O making carbon capture a simpler process.

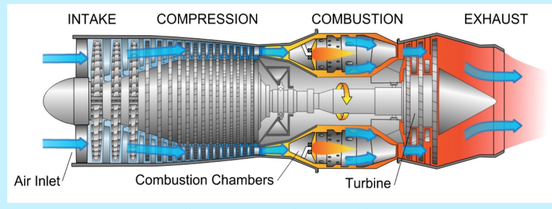
$$CH_4 + O_2 \rightarrow CO_2 + 2H_2O$$

$$N_2 + O_2 \not\rightarrow NO_x$$

Cogeneration: Cogeneration is the production of two of more sources of energy from one fuel source.

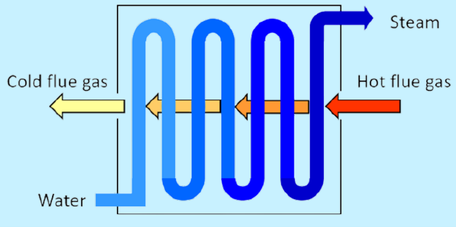


Gas Turbine (GT): The GT is used to generate electricity through shaft work. The shaft work is generated from the pressure difference between the inlet and outlet as hot gases from oxyfuel combustion pass through.



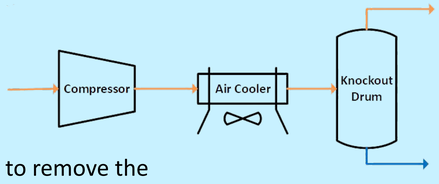
https://energyeducation.ca/encyclopedia/gas_turbine

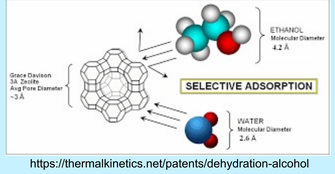
Heat Recovery Steam Generator (HRSG): The HRSG produces saturated steam at 10MPa through heat exchange between the flue gas from the turbine and boiler feed water (BFW).



Carbon Capture: Carbon capture and storage (CCS) can be used to mitigate the greenhouse gas (GHG) emissions associated with energy production.

CO_2 Compression: Multiple compression stages are used to compress the CO_2. Each compression stage includes a compressor, air cooler and knockout drum.

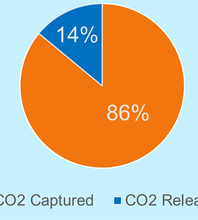




https://thermalkinetics.net/patents/dehydration-alcohol

CO_2 Dehydration: A molecular sieve is used to remove the remaining water the CO_2. This step is required to prevent freezing in the cryogenic purification unit (CPU).

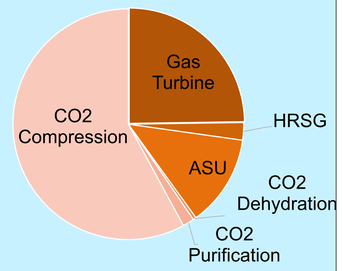
CO_2 Purification: The CPU separates nitrogen, argon, carbon monoxide and oxygen from the CO_2 to meet the ACTL specifications for transport. The unit consists of two cryogenic flashing stages and a stripping column.



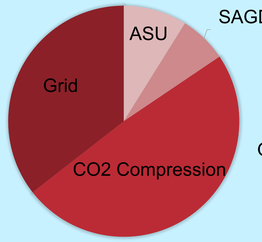
Economic Analysis

Project Capital Cost Breakdown

Capital Cost: **$670 Million**

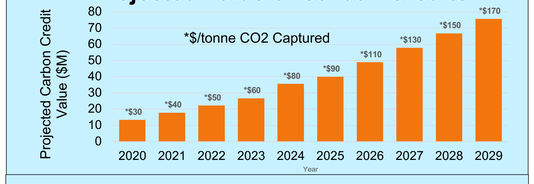


Power Allotment



Total Power Produced: **225MW**
Power Sold to Grid: **80MW**
Gross Utility Consumption (per year): **$142 Million**

Projected Value of Carbon Credits



844,375 tonnes CO_2/year captured = 187,733 cars off the road

Conclusions

- Captured carbon meets ACTL pipeline specifications
- Steam produced meets SAGD demand and specifications
- Total capital cost: $670 million
- Break-even profit on steam (20-year loan, without consideration of carbon credits): $9.89/tonne
- By 2026, sale of carbon credits alone will cover both operating cost and capital cost repayment (20-year loan)
- Net power to grid: 80 MW

References and Acknowledgements

Acknowledgements:

- Doug Colborne – **Resident Engineer**
- Dr. Jan Haelssig – **Dalhousie University**

References:

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