

CALGARY





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INTRODUCTION

Steam Assisted Gravity Drainage (SAGD) is the most commonly used method to extract bitumen from Alberta's Oil Sands [1], the largest contributor to Alberta's GDP [2]. The and electricity requirements are steam currently met by natural gas cogeneration (CHP). Using small modular nuclear reactors (SMNR) for CHP is a promising alternative to current processes, as it would significantly

reduce GHG **Bitumen Extraction & Natural Gas Price Forecasts** and air SAGD Bitumen pollution Extraction (million bbls/d) emissions, History and may **CanESS Forecast** become economically Natural Gas Price (\$/GJ) competitive dependent on future natural Forecast +2%/year History **Forecast** gas and 2000 2040 carbon tax Fig. 1: Natural Gas Price [3] and Bitumen prices. **Extraction Forecasts [4]**

METHODS

Using standard conversion factors, the following assumptions were made to generate our nuclear CHP transition scenario:

- SMNR designs will require a period of development and testing to meet SAGD electricity and steam demands shown on the "Reference" scenarios in Fig 2
- In 2032 [5], first SMNRs will be gradually implemented at an annual rate of 3%
- Electricity will be provided through CHP generation and remaining steam demand will be met through steam-only generation



Fig. 2:SAGD Energy Demand Distribution

Nuclear CHP: The Oil Sands Solution? Small Modular Nuclear Reactors for SAGD Cogeneration in Alberta Oil Sands



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SAGD Emissions

- SAGD officially started in 2001 [6]
- The 47 kg CO₂e/bbl bitumen [4] emitted by natural gas CHP could be avoided by using SMNRS
- Figure 3 analyzes annual SAGD emissions using combustion [4] and life cycle emissions [7,8] for natural gas and nuclear

Canada Emissions

- Canada currently emits 703 MT of CO₂e [4]
- In 2020, Canada aims to reduce emissions by 17% of 2005's emissions [9]
- Implementing Nuclear could help meet these future emissions targets

Economics

- Current SAGD costs are susceptible to fluctuating natural gas prices
- As natural gas price and carbon taxes rise, nuclear energy becomes more and more competitive
- Nuclear will be competitive with natural gas prices of \$6-\$9/GJ [10]









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DISCUSSION

Challenges Regarding Nuclear Implementation:

- Current SMNR technologies need to be
- adapted for oil sands implementation
- Lengthy licensing process
- Current nuclear regulations may need
- revision based on risk analysis and
- depending on siting [11]
- Negative public perception of nuclear

Future Potential for Nuclear in Oil Sands:

- Using surplus electricity from nuclear CHP for hydrogen production to be used for upgrading
- Selling excess electricity to provincial power grid
- Consolidating Alberta's power generation and heat demand in the oil sands by maximizing CHP potential (2:1 heat to
- power ratio) to match SAGD heat demand and selling electricity to grid

CONCLUSIONS

- SMNRs may provide a feasible alternative to natural gas energy for SAGD operations within the next 15-20 years
- Switching large amounts of natural gas CHP to nuclear CHP for SAGD extraction in Alberta would significantly reduce the GHG footprint of Alberta's oil sands and
- help Canada move towards achieving its GHG emissions targets
- Other opportunities for nuclear energy implementation in the oil sands exist which can help decrease GHG emissions even further

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