Radioing Oil Sands

The feasibility, emissions impacts, and adoption of radio frequency technologies in oil extraction

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CESAR CANADIAN ENERGY SYSTEMS ANALYSIS RESEARCH

INTRODUCTION

In-situ oil production technologies, such as Steam Assisted Gravity Drainage (SAGD), are CO_2 intensive (about 76 kg CO_2e/bbl [1]) and with growth predictions, total emissions could more than double to 84 Mt CO_2e/yr by 2060.

Two new oil extraction technologies using radio frequency (RF) heating are currently in development: **ESEIEH** developed by the Harris Corporation, and **RF XL** developed by Acceleware. This study explores how their adoption could impact Alberta's Oil Sands emissions.

METHODS

Given the estimated Technology Readiness Level of the RF technologies (TRL6-7) large scale adoption was not projected to occur until the 2030's, a time when the Alberta grid should have a lower emissions intensity (Fig. 1).

Technical reports on the SAGD [1], ESEIEH [2] and RF XL [3] technologies were used to generate mass and energy flows (Fig. 2) which were used to create scenario models.

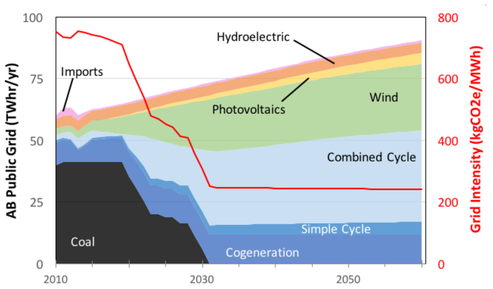


Fig. 1. AB Generation Fuel Types and Intensity [4]

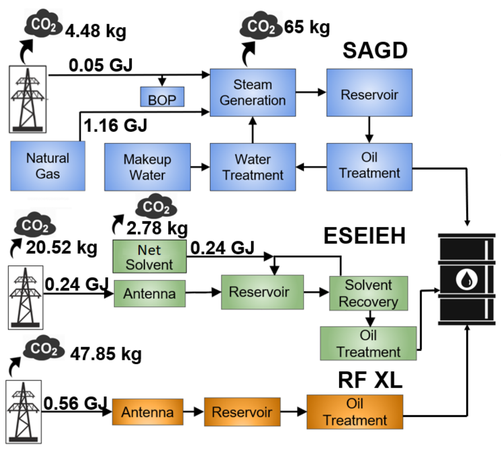
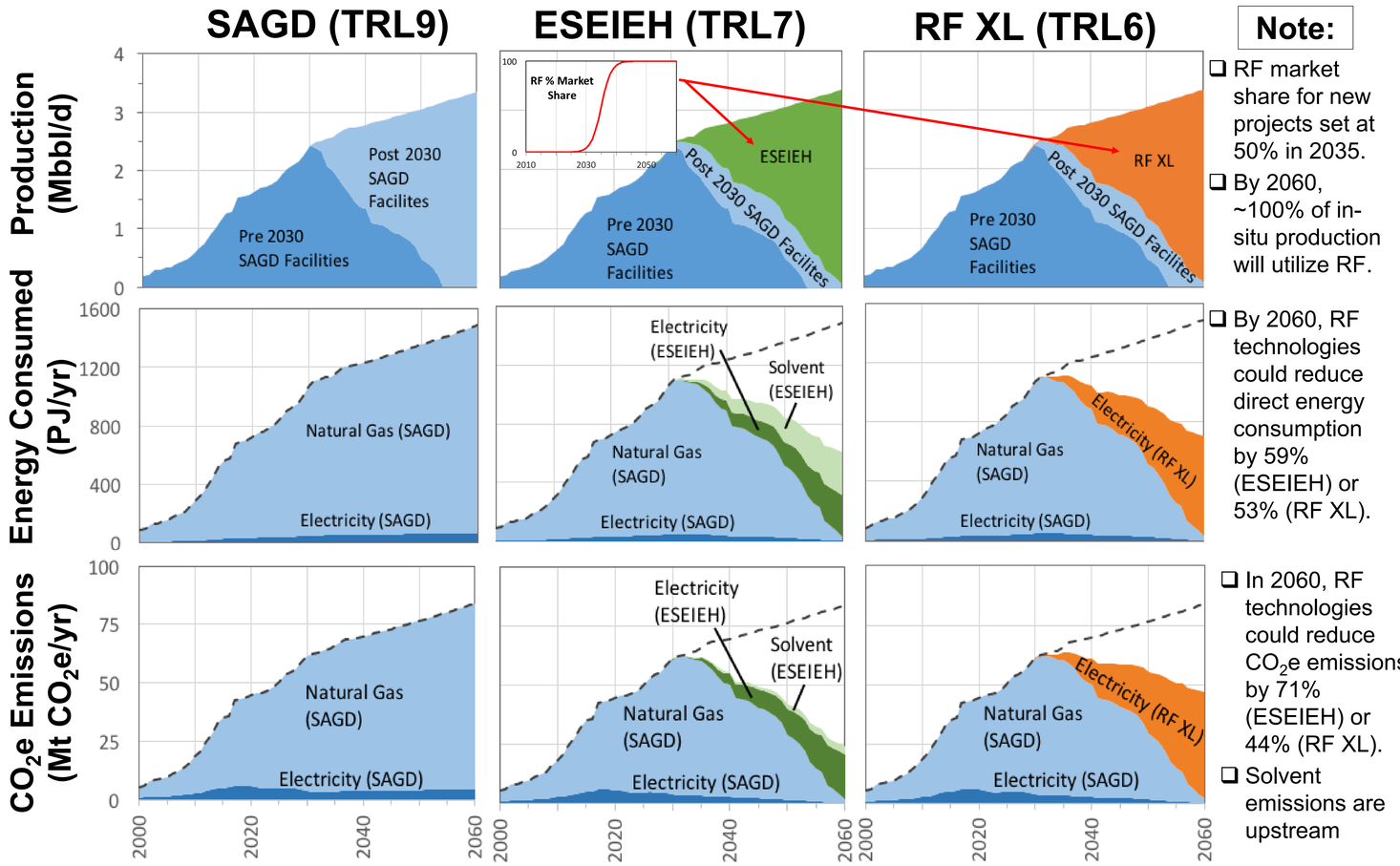


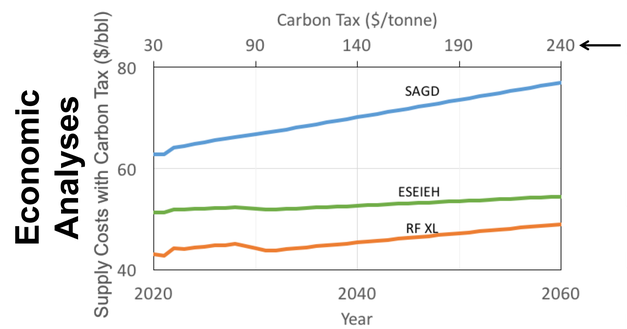
Fig. 2. Simplified Energy and Mass Flow Diagram for 1 bbl of oil in 2030 [3,4,5]

RESULTS



Note:

- RF market share for new projects set at 50% in 2035.
- By 2060, ~100% of in-situ production will utilize RF.
- By 2060, RF technologies could reduce direct energy consumption by 59% (ESEIEH) or 53% (RF XL).
- In 2060, RF technologies could reduce CO_2e emissions by 71% (ESEIEH) or 44% (RF XL).
- Solvent emissions are upstream



- The economic analyses assumed a constantly rising cost for CO2e emissions between now and 2060
- RF technologies promise a lower production cost than SAGD, in part because of the higher fuel energy cost for SAGD, and in part because of their lower CO2 emissions and the tax savings that would result from that.
- The RF XL was estimated to have lower capital cost than ESEIEH since solvent recovery would not be needed
- However, ESEIEH was estimated to have a lower operating costs since the reservoir temperature does not need to be heated as high as for RF XL
- Initial supply costs were obtained from public reports

Fig. 3. Supply costs of SAGD, ESEIEH, and RF XL with Carbon Tax [2, 3, 6]

CONCLUSIONS

The adoption of these technologies has potential to decrease CO_2e emissions by 71% in 2060 with a cumulative reduction of 800 Mt CO_2e by 2060 for the ESEIEH scenario. For the RF XL scenario, CO_2e emissions can be reduced by 44% in 2060 with a cumulative reduction of 500 Mt CO_2e by 2060.

Even greater emission reductions are possible with these technologies if the carbon intensity of the Alberta grid were to continue to be improved beyond 2030. This should be a focus for decision makers in the province.

The adoption of the RF technologies is expected to be rapid once commercialized due to superior proposed economics. In addition, the maturity of horizontal drilling techniques will result in a more rapid adoption than SAGD.

The regulatory approval process can drastically affect the rollout. Ensuring clear and transparent regulations and extensive consultation with all stakeholders will allow the most significant reductions in CO_2e emissions.

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REFERENCES

[1] Candor Engineering Ltd (March, 2017). COSIA SAGD Reference Facilities Project Report.

[2] Wise, S., & Patterson, C. (2016). Reducing Supply Cost With Eseieh™ Pronounced Easy. SPE Canada Heavy Oil Technical Conference
Harris Corporation, Laricina Energy Ltd., "Effective solvent extraction system incorporating electromagnetic heating", US 8616273 B2, 2013.

[3] Acceleware Ltd. (July, 2017). Corporate Presentation.

[4] whatIf? Technologies Inc., 2017. Canadian Energy Systems Simulator (CanESS) - version 7, reference scenario.

[5] Energetics Inc. (2009). Propane Reduces Green House Gas Emissions: A Comparative Analysis.

[6] Canadian Energy Research Institute (February, 2016). Canadian Oil Sands Supply Costs and Development Projects (2016-2036). Retrieved October 25th, 2017

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