Environmental and techno-economic assessments of the new bitumen extraction technologies

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BACKGROUND

Bitumen, unlike conventional oil, is viscous [1]. The established in-situ extraction techniques like steam-assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS) use steam to extract bitumen which makes these techniques energy- and greenhouse gas (GHG) emissions-intensive [2].

Due to strict environmental regulations, it has become imperative to develop process that can lower the well-to-wheel (WTW) GHG footprint of oil sands-derived transportation fuels: gasoline, diesel, jet fuel, etc.

Various extraction technologies have been proposed to offer cleaner and efficient operations relative to the current processes. However, life cycle thinking based environmental and techno-economic assessments of these processes are required to ascertain their sustainability. There is sparsity of research examining the environmental and economic impact of these technologies. This research study is aimed to fill these gaps.

AIMS AND OBJECTIVES

The aim of this study is to provide a holistic assessment of the new bitumen extraction technologies. Of the proposed methods, the vapor solvent extraction was investigated using life cycle assessment (LCA) model.

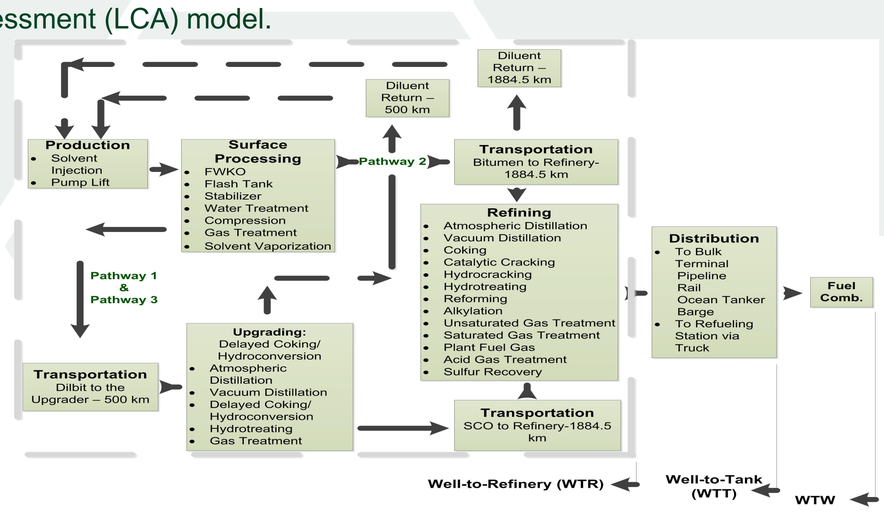

Figure 1: WTW Production Pathways

RESULTS

EXTRACTION AND SURFACE PROCESSING ENERGY CONSUMPTION

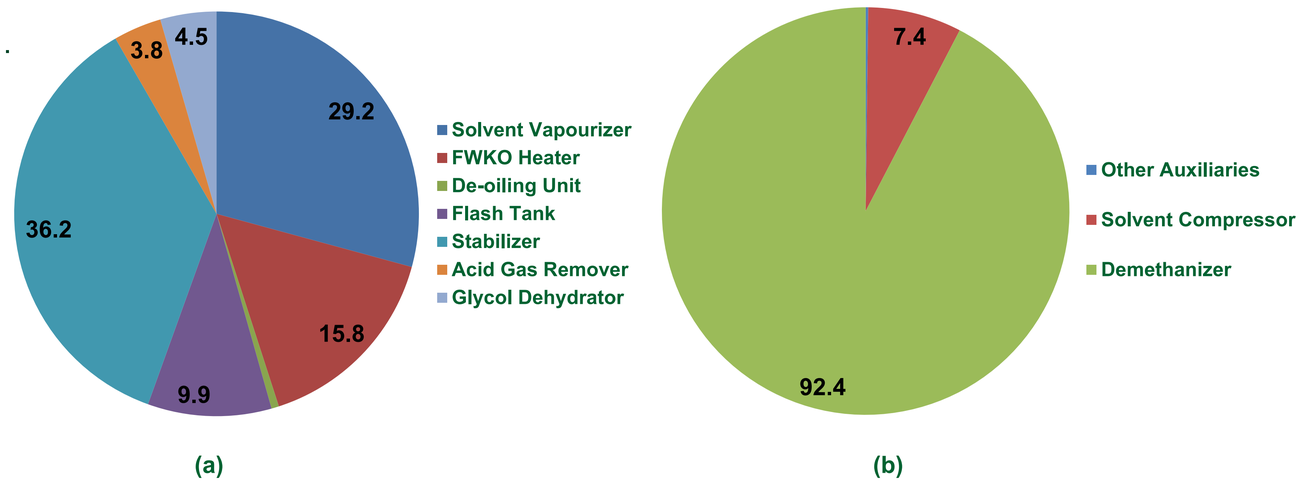

Figure 2: (a) Heat and (b) Electricity Consumption Distribution (%)

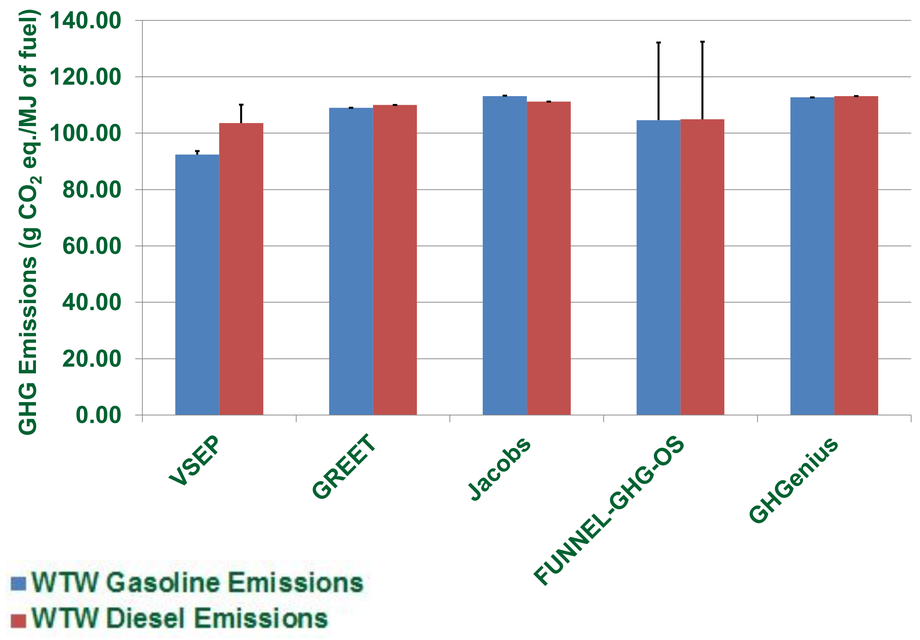

Figure 3: Comparison of Emissions with the Major LCA (CSS [4], SAGD [5]) Models

FUTURE DIRECTIONS

CONCLUSIONS

- The WTW gasoline GHG emission from the vapor solvent extracted-bitumen ranges between 92.3 – 93.8 g CO_2 eq./MJ of gasoline. The WTW gasoline GHG emissions reported in the other LCA models based on thermal extraction techniques (SAGD, CSS) varies between 104.6 – 132.14 g CO_2 eq./MJ of gasoline [3].
- Bitumen extracted from the VSEP can be refined directly without upgrading (Pathway 2) which results in lower WTW GHG emissions.
- Uncertainty in refining GHG emissions due to the variation of the energy- and emissions-intensive parameters ranges between 66.2-83.2 kg CO_2 eq./bbl of bitumen while for upgrading operations GHG emissions range is 52.4-67.8 kg CO_2 eq./bbl of bitumen.

FUTURE RECOMMENDATIONS

- To commercialize vapor solvent extraction process, economic factors needs to be evaluated.

PARTNERS

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FES PROJECT OVERVIEW

Eg. T13-M01
Understanding energy systems at a system-wide level means recognizing the countless ways that they integrate into our daily lives. From the instant when an energy source is first captured, to the moment you access it by flipping a light switch or starting your engine, it has traveled through a system to reach you. Systems modeling allows us to identify and quantify each step along the way, to simulate the impact of alternative systems, and to predict the potential consequences of change.
System-wide analysis and modeling will never provide a guaranteed forecast of the future, but it can identify possible benefits and disadvantages to change, highlight areas requiring additional study, and help us to consider the viability of an entirely new energy future.

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