

Life Cycle Analysis of North American and Imported Crude Oils

Post-Workshop

Stakeholder Input

Jeremy Moorhouse

The Pembina Institute
200, 608 7th ST SW
Calgary, T2P 1Z2
Phone: 403-269-3344 ext. 123

► **Surindar Singh**

500 Phipps-McKinnon Building
10020 – 101 A Avenue
Edmonton, Alberta
T5J 3G2
Phone: 780-422-0046

Dear Surindar,

Although I was not able to attend the final workshop on June 15th I have reviewed both of TIAX's and Jacobs's final reports (provided before June 15th) and have spoken with several individuals in attendance at the final sessions. I'd therefore like to provide some final comments on the reports, the results and on the overall process.

First, I'd like to thank you for including the Pembina Institute as a member of the steering committee. We appreciated the opportunity to provide input in the design and implementation of the life cycle assessment process.

However, while Pembina agrees with the necessity of these studies it cannot publicly support the results until some further issues are addressed. Pembina's outstanding concerns our detailed below:

1. An independent detailed technical review is still required.

- Although the steering committee was able to provide directional advice, it is clear that this group was never intended to provide an independent technical review. As such, both reports should be submitted to a third party technical review, and this review should accompany the eventual release of these reports.

2. Differences in results have not been addressed

- There are clear differences between the TIAX and Jacobs results that need to be reconciled and the differences in results explained.

3. Primarily theoretical data was applied



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- Neither report validates its theoretical results with data from operational facilities. Quality data for operating facilities is difficult to find; however, estimates can be made based on available information. For example, Suncor and Syncrude provide annual GHG emissions. Natural gas and electricity use are also available for these operations.
 - The presentation of results, especially those in the Jacobs report, can be considered misleading. The results are presented as point estimates as opposed to ranges but it is unclear how those point estimates were determined. Failure to present and explain the results properly risks misinterpretation of the results, as evidenced by recent media coverage of this analysis.¹
 - The cogeneration credit is an important factor in the presentation of the Jacobs results but key assumptions about its calculation are not included in the report. For example, it is unclear what Jacobs assumed the percentage of exported electricity produced by a cogeneration facility is relative to that used on site by an in situ oil sands facility.

4. Outstanding concerns have not been addressed

- Neither the steering committee nor the other stakeholder comments on the final results have been addressed as there was no adequate time provided for this.
- The final information session would ideally have been a feedback process on both reports instead of a presentation of the two final reports. In addition we were informed that some stakeholders were asked to provide comments on the reports and received no response to those comments. Comments should only be requested if time is made to respond to them.
- While TIAX was diligent in recording comments prior to those made on the final results, there is no record of comments in the Jacobs report nor how those comments were addressed.

These concerns are not meant to undermine the incredible effort made by both TIAX and Jacobs, nor the integrity of their work. However, without due process such as taking time to clearly address outstanding concerns as well as ensuring an independent detailed technical review Pembina is not able to publicly support the conclusions.

None-the-less, Pembina would like to recognize several positive elements of the reports and the process followed to develop the reports. These positive elements are listed below:

¹ See Calgary Herald "Oil Sands not much dirtier than other types of oil"
<http://www.canada.com/Oilsands+much+dirtier+than+other+types+study/1706823/story.html>

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1. The steering committee and the stakeholder information sessions were both essential components of this process. The steering committee provided effective direction and data to the consultants. The stakeholder information sessions also helped to identify problem areas, such as the lack of understanding of the GREET model, before the final reports were written.
 2. Both reports contain considerable new data and analysis that can be built upon in the years to come.
 3. The selected fuel pathways, but not in all cases the modeling, appropriately represent current oil sands operations and other significant oil sources in the world.
 4. Both reports provide a much more detailed assessment of other crude oil sources, such as Nigeria, Venezuela and Mexico than can be found in current literature sources.
 5. The TIAX report did an excellent job at recording stakeholder comments and indicating how those comments were addressed.

Thank you again for including Pembina in the steering committee and we congratulate AERI for leading this important and complex project.

Sincerely,

Jeremy Moorhouse

Jeremy Moorhouse E.I.T.

Technical Analyst

Pembina Institute

7/6/2009

Memorandum

To: Eddy Isaacs, Alberta Energy Research Institute (AERI)

Surindar Singh, AERI

From: Joule Bergerson, University of Calgary

David Keith, University of Calgary

Heather L. MacLean, University of Toronto

Date: July 16, 2009

Re: Public Release of Jacobs Consultancy Inc./Life Cycle Associates and TIAX/MathPro Inc. Studies on Life Cycle Assessment Comparison of North American and Imported Crudes

We have reviewed the Jacobs Consultancy Inc. and Life Cycle Associates (hereafter referred to as Jacobs) and TIAX and MathPro Inc. (hereafter referred to as TIAX) reports dated June 2009 and May 29, 2009, respectively (and updated final reports sent on July 7, 2009), and attended the oral presentation of the studies by the companies on June 15, 2009. Two of us (Bergerson and Keith) were also members of the Project Advisory Committee for the studies and at least one of us attended all but two of the Project Advisory Committee meetings. Based on the aforementioned we would like to provide some technical comments on the studies undertaken by AERI.

In our judgment the studies add to the existing literature on life cycle (well-to-wheel) greenhouse gas emissions performance of a set of US domestic, US imported conventional and oil sands-derived crude oils. However, there is not sufficient documentation of assumptions, methods, treatment of uncertainty, comparison to existing estimates or a technical review to allow us to support the results/conclusions of the studies.

Technical Comments

- 1. Reconciliation of study results.** The results for life cycle greenhouse gas emissions for fuels derived from conventional as well as from oil sands crude oils presented in both the Jacobs' and TIAX' reports differ significantly from those in the peer-reviewed and grey literature. The results also differ between the two consultants' studies. Neither Jacobs nor TIAX has taken steps to reconcile their results and to explain sources of these differences.
- 2. Representativeness of the conventional crude oils examined:** The studies do not discuss how representative the conventional crudes examined are of those refined in the US. The average API gravity of the conventional crudes analyzed in the Jacobs' study is 25.5 and in the TIAX study is 26.8. Both of these averages are lower than that of the average API of crudes entering US refineries (30.4 as cited by TIAX), indicating that on average the conventional crudes analyzed are heavier than those currently imported. For example, both studies only examined California's heavy crude which represents only 50% of CA production and did not examine the State's light crude. Because GHG emissions are generally higher for heavier crudes, the analysis

of a heavier conventional slate may result in more overlap in GHG emissions between conventional and oil sands-derived crude oils. This might explain why the Jacobs study reported higher WTW GHG emissions for conventional crudes than what is in the current literature (oil sands pathways were also generally higher than current literature but to a lesser extent). Further justification/data related to the selection of crudes in the studies is required.

- 3. Oil sands pathways: selection of pathways:** The oil sands pathways considered in the studies, particularly those representing surface mining are insufficient to characterize current operations in the industry.
- a. **Steam-to-oil ratio (SOR) for *in situ* projects.** This is the most common single parameter used to characterize direct energy input to *in situ* oil sands production processes. Jacobs' showed a range of SORs from 2-8 (with an average just below 4) based on data from Jan-June 2006 from EnCana. The higher the SOR, the more steam input required for a unit output of product. A value of 3 was then assumed in their analysis. The sensitivity analysis of this key parameter (presented in Figure E-5) only considers a range between 3 and 5. A discussion is warranted that explains the range of SOR values considered, that the SOR value will vary during the lifetime of projects and that the SORs reported for the projects in their report will not be the same in the next 6 months, 1 yr, etc. TIAX, for the *in situ* and upgrading pathway, selected an atypical project (OPTI/Nexen's Long Lake Project), a project that gasifies 'heavies' (asphaltenes), and is not representative of current industry practice. TIAX's position on the exclusive use for the oil sands pathways of publicly available data has been transparency. This may be the preferable route to take if such information is available and of reasonable quality, however, this is not the case for oil sands operations. In addition, TIAX does not maintain this criterion of transparency for all of components of their study (e.g., the use of proprietary refining models).
 - b. **Surface mining projects.** This pathway is of particular concern in both the Jacobs and TIAX reports. For example, Jacobs, when asked how they determined the amount of energy/natural gas required for the oil sands surface mining pathway, responded that they assumed half of the energy required of an *in situ* oil sands project (halved the steam-to-oil ratio/SOR) and adjusted for electricity consumption variation. Considering that there are a number of mining projects operating, this assumption is insufficient. TIAX, for their mining pathway, utilized data from an Environmental Impact Assessment (EIA) for CNRL's Horizon Project, which only recently began operation and the company did not compare this EIA data with that of the three main operating mining projects (Suncor, Syncrude and Albion Sands). TIAX also reported no emissions from the tailings ponds. The mining value reported by TIAX is ~12 g CO₂ eq./MJ synthetic crude oil (SCO) is lower than Suncor and Syncrude's reported GHG intensities ~16 g CO₂ eq./MJ SCO and 21 g CO₂ eq./MJ SCO respectively (calculated from their most recent sustainability reports). There may be good justification for this difference but TIAX's report does not address this issue.

4. **Assumptions related to cogeneration in the oil sands:** A significant number of oil sands projects generate electricity and heat (for producing steam) through cogeneration. The results presented by Jacobs show significant benefits for the oil sands pathways when cogeneration is assumed. Jacobs' results show the impact of one set of assumptions for the treatment of cogeneration. The oil sands pathways in this study (in the main scenario as presented in Figure E-7 of the Executive Summary) receive a credit for 99 kWh/bbl (for SAGD) and 48 kWh/bbl (for mining) of exported electricity and this credit is assumed to offset a grid with 80% coal-fired power. Under these conditions several of the oil sands pathways have lower GHG emissions than most of the conventional crudes studied. This is an important finding and while the discussion of the scenarios considered, the assumptions made, and the need for further exploration has been improved in the final version of the report, it is not clearly stated that the estimates presented do not reflect current operations. For example, the amount of exported power is more than 4 and close to 5 times higher than currently exported by in situ and mining operations respectively. The findings related to cogeneration need detailed discussion so they are interpreted correctly.
5. **Upgrading of oil sands bitumen:** The Jacobs' results imply that there is little benefit of upgrading bitumen in Alberta and then refining the SCO in the US. That is, upgrading adds significantly to GHG emissions while providing a very small benefit in terms of reducing refinery emissions. It is unclear how robust this result is as a range of bitumen/SCO pathways were not explored and there is no discussion of the applicability of the results.
6. **Presentation of crude oil pathway results:**
 - a. **Crude oil production.** The characteristics of the products resulting from the various conventional crude and oil sands production processes vary greatly (API gravity, sulfur content, etc.). This aspect is not sufficiently discussed in the studies. For example, in the Jacob's report, pg. 8 Figure E-5 shows GHG emissions from crude production for various production pathways. It may be that a heavy sour (high sulfur) crude could be shown to have lower GHG emissions than a light sweet crude and therefore a reader may view the heavy sour crude as being more attractive from a GHG perspective, which could be misleading due to it requiring more upgrading/refining than the light sweet crude to attain an equivalent end-product. It is unfortunate that there is no discussion of the qualities of the crudes and a caveat to the reader that this is not an 'apples-to-apples' comparison.
 - b. **Life cycle/well-to-wheel results.** While some ranges of input parameters were examined in both the TIAX and Jacobs' studies, Jacobs' presents their final results as point estimates. Jacobs does not provide sufficient documentation to enable a reader to understand how these point estimates were derived, in spite of the critical importance of these results.

-----Original Message-----

From: Pierre duVair [<mailto:Pduvair@energy.state.ca.us>]

Sent: Wednesday, July 22, 2009 11:29 AM

To: Surindar Singh

Cc: McKinley Addy; Bill Keesom

Subject: Re: FW: Final LCA Reports

Hi Surindar,

Thank you for sending the final reports.

I want to acknowledge the efforts of Jacobs/LCA Associates in making last minute changes to the final report. They did a very good job addressing my concerns and I believe the main findings of their analysis will stand out to readers of the report - all thermally enhanced oil recovery methods are GHG-intensive.

I look forward to future research efforts that you lead at AERI, Surindar.

Regards,

Pierre

-----Original Message-----

From: Pierre duVair [<mailto:Pduvair@energy.state.ca.us>]

Sent: Tuesday, July 14, 2009 4:26 PM

To: Jon Moretta

Cc: McKinley Addy; Surindar Singh; Bill Keesom; Stefan Unnasch

Subject: Re: Updated Jacobs Consultancy Life Cycle Report

Hello Jon,

Thank you for sending this edited version of your final report. Unfortunately, the very minor edits you have made do not address the concerns I raised related to coverage of cogeneration in the report. Bill hinted that changes might not satisfy my concerns, he certainly was correct. The report continues to present a very biased treatment of cogeneration.

For the record, I provide a few additional comments on your revised final report:

1) Does not delete CA TEOR from Fig. E-7 and E-8. Gives a biased presentation of results that are intended for use as comparative LCA of products/product systems.

2) Discussion of cogeneration (in Exec. Sum. & Chap. 8) does not adequately identify the very limited scope and treatment of cogen within your analysis. A significant methodological jump is made from allocating positive/direct GHG emissions to steam & electricity, to the issuance of "credits" against electricity on the Alberta grid. The introduction of "indirect impacts" into the LCA is not adequately discussed. The avoided construction and/or operation of other electric generation is only one type of indirect impact, assessing indirect effects is complex - more so than the limited identified factors provided on p. 8-17.

3) Exec. Sum. p. 8-7 identifies one type of "ignored" GHG emission source, but does not address other ignored sources within the analysis. Without a discussion of other ignored emission sources, this provides a biased presentation of ignored emissions sources.

4) On p. 8-17 report states that exported power "displaces electricity from the grid" - this is not an accurate description of electricity system generation, transmission, and distribution. Oil sands (and CA TEOR) cogeneration provides a supply of electricity that is co-produced with a useful steam product. The availability of this electricity supply may avoid the need to construct some type of new power plant or need to procure the same amount of electricity from some other source. It may also cause excess capacity and inefficient operation of other electricity generation resources. These are not trivial semantics or trivial LCA issues. The one-line reference to LCA Associates model lacks transparency. I reiterate my concern stated in the July 9th communication - the write-up of cogeneration in this report is likely to taint the quality of the whole effort by Jacobs/LCA Associates. Based upon the lack of edits provided in this revision, I can only assume that Jacobs/LCA Associates is content with risking such a result, I do not believe that AERI should be.

5) Revised report does not delete sentence on p. 8-17 that claims CA TEOR cogen electricity competes with natural gas & renewable sources in California. This is an inaccurate statement.

6) Figures 8-4 and 8-5 still retain CA TEOR within the graphics. As stated above, this is a biased presentation for comparative purposes of product LCAs. It is insufficient to state within the text that CA TEOR cogen credit was not considered. Such a statement does not rectify the bias contained within the graphics.

7) Finally, the 2nd paragraph on p. 8-19 simply provides an inadequate discussion of the issues associated with incorporation of indirect effects within an LCA, such as an attempt to estimate avoided electricity generation. Because there are many ways to approach cogeneration and allocation to co-products and this report does not address the range of issues comprehensively or objectively, the report goes too far in presenting incomplete results from subjective assumptions and methods related to cogeneration.

At this point, I believe my concerns have been clearly presented in both the July 9th and this email communication.

Regards,

Pierre H. duVair, Ph.D.
Senior Climate Policy Analyst
California Energy Commission

"Moretta, Jon" <Jon.Moretta@jacobs.com> 7/14/2009 12:43 PM >>>

Hello Pierre,

Bill Keesom asked that I send you an updated version of our final LCA report reflecting the recent discussion you had with Bill on cogeneration. I would very much appreciate your review of the attached, with focus on the cogen discussions in the Executive Summary and Section 8. If you think this addresses the issue adequately, we will finalize and reissue. If you have any further comments, please let both Bill and myself know. He is out on vacation for the next couple weeks.

Thanks for your help in advance,

Jon Moretta

Director - Petroleum, Chemicals & Energy Practice Jacobs Consultancy

-----Original Message-----

From: Pierre duVair [<mailto:Pduvair@energy.state.ca.us>]

Sent: Tuesday, June 16, 2009 6:54 PM

To: Surindar Singh

Cc: John Courtis; McKinley Addy; Bill Keesom; Stefan Unnasch; Jennifer Pont

Subject: Future AERI work....

Hi Surindar,

Thanks for the webinar option of the final AERI LCA Study workshop. The telephone logistics was a bit challenging, but overall we could hear what was said fairly well. I think it was valuable for you to bring a large group together to hear the presentation of results, although probably could have spent a day with each team. I have little doubt that both teams went over budget on this project. I hope you will send all final documents to McKinley, John, and me.

Regarding a few thoughts on keeping up momentum and possible topics for future work:

- You headed off my comment at the end regarding need for a "trends analysis", when you noted that both teams used numerous static or dated values/averages, technologies, efficiencies, processes, emission factors. I completely agree that an analysis of trends in key drivers or components of the petroleum LCA would be quite valuable (WOR/WAG, refinery efficiencies/product slates, technologies/capacities cogen & grid mixes, etc.).
- Alternative ways to handle Co-products - more analysis on the implications of alternative ways to allocate/account for BOTH process energy and end use emissions (note: some effort on indirect GHGs could be worthwhile - end use of all refinery products, military-related emissions).
- Alternative ways to handle co-generation - more analysis of current oil-related electricity use/supply and trends; implications of alternative ways of allocating energy/GHGs to electricity/steam co-products; smart grid and co-gen potential. Note: see attached report from Kern River Cogeneration Company to CA Climate Action Registry, I don't believe one can assume no credit for cogen with CA Kern TEOR, just because CA's grid mix is not 80% coal as assumed for Alberta mix.
- Direct and Indirect Land Use Change - I understand that Univ. of Calgary has work underway for LCA of oil sands related to land use, AERI could build upon that work for a comprehensive look at land use implications of various crude oil pathways; fill in other smaller components of the LCA (embodied energy in equipment, embodied energy in water, black carbon contribution as climate forcing agent).
- As note yesterday, Carbon Capture & Sequestration is a hot topic in several sectors (electricity, oil, agriculture, forestry, cement/heavy industry); LCA implications and various performance metrics of alternative petroleum/biofuel blends could be valuable as well.

It's been a pleasure following this project and contributing as I could. I hope you keep in contact with McKinley and me as you move forward on additional work. We were fortunate to get some of John Courtis' time and I suspect that LCA/Full Fuel Cycle Analysis work will continue at all of our agencies for some time.

Regards,

Pierre