Emerging LCA Issues: Oil Sands and Biofuels

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Presentation overview

1. What are the key outstanding issues related to LCA of oil sands fuels and biofuels?

2. Are modeling tools sufficient to estimate well-to-wheel GHG emissions from emerging fuel pathways?

3. What are the short-term data needs?

- Context – Insights from
  - LCA of Oil Sands Technologies (LCAOST) project
  - Biofuel projects for industry and government

Alberta's Oil Sands

3rd largest proven reserves 170 billion barrels

2010 Production: 1.5 million bpd bitumen

Supply 1.4 million bpd to U.S. (2011)

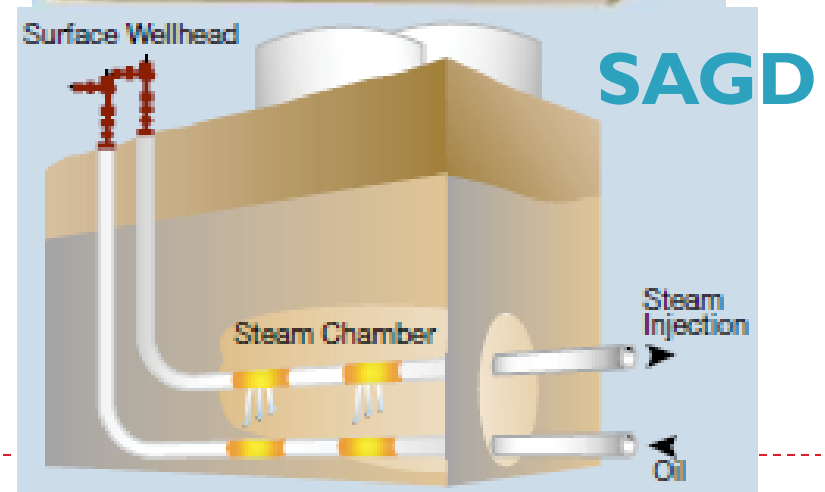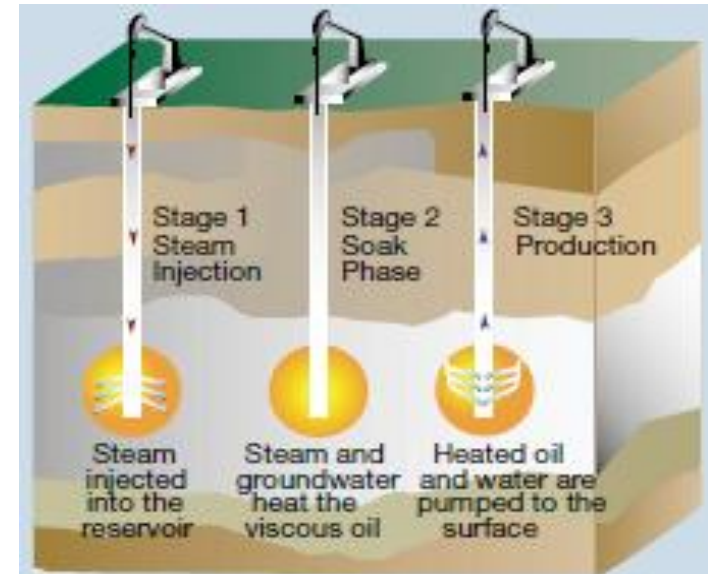Combination of clay, sand, water, and **bitumen**, a heavy viscous oil
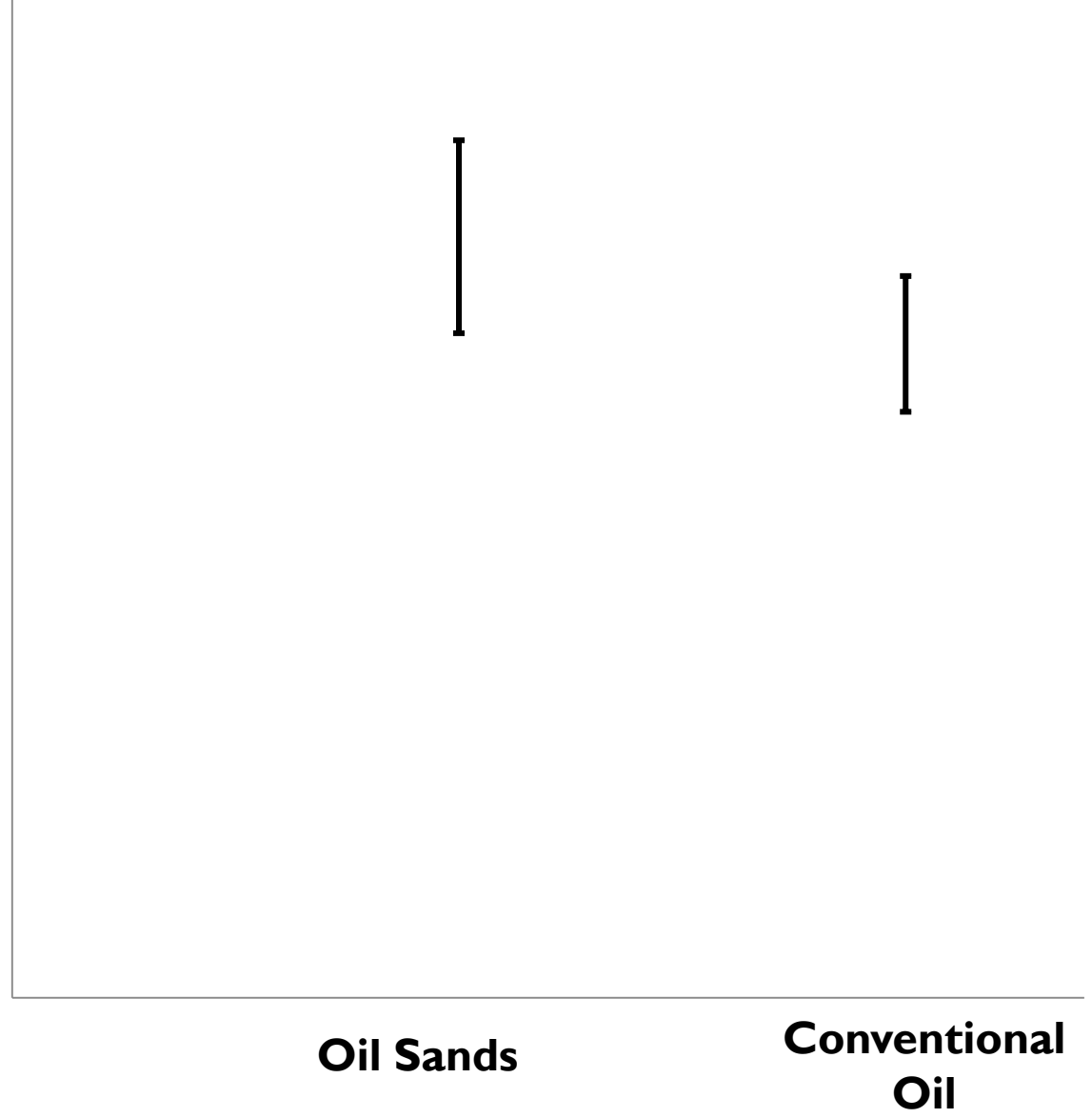

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Oil Sands Extraction Processes

Surface mining

In situ

CSS

Stage 1 Steam Injection — Steam injected into the reservoir

Stage 2 Soak Phase — Steam and groundwater heat the viscous oil

Stage 3 Production — Heated oil and water are pumped to the surface

SAGD

Surface Wellhead

Steam Chamber

Steam Injection

Oil

Source: Suncor Energy Inc., David Dodge, the Pembina Institute, Alberta Energy (2011), CAPP (2010)

Overall issues – All fuels

▶ What is the goal of the LCA? For what purpose will it be used?

  ▶ To estimate the 'actual GHG emissions' of fuel/vehicle pathways?

    ▸ Number of significant digits vs. precision of estimates

    ▸ Variability among projects within 'same/similar' pathways

  ▶ To determine relative GHG performance among pathways?

    ▸ Differentiation among pathways → are they really different?

  ▶ Regulatory or funding implications?
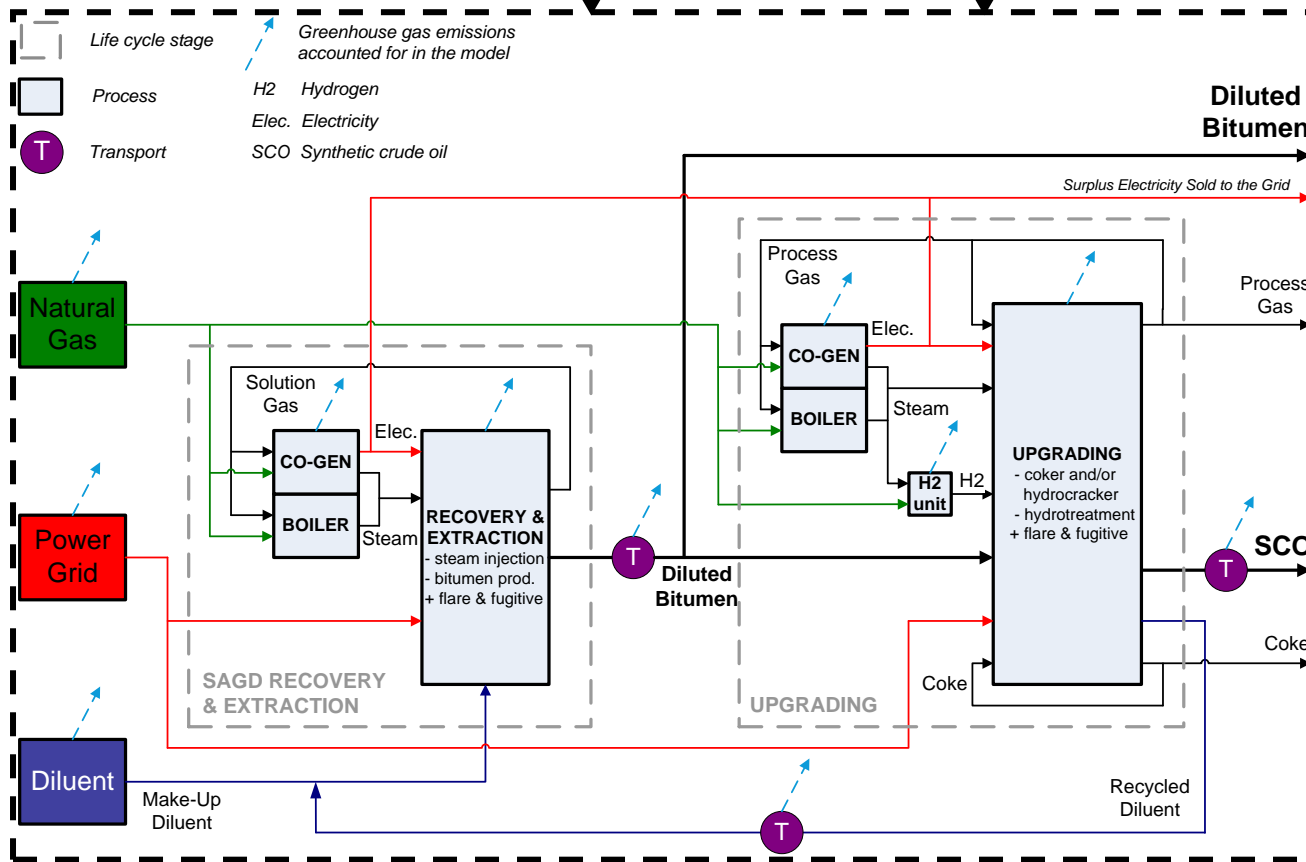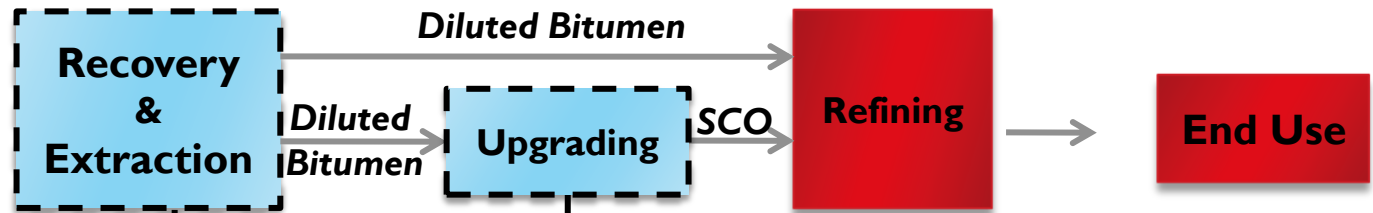
  ▶ Avoid unintended negative consequences?

Overall issues – All fuels   contd.

▸ Data verification and model validation challenges

▸ Model complexity vs. transparency tradeoffs

▸ Allocation or system expansion issues
  ▸ Oil sands: Cogeneration
    ▸ Can negate almost all emissions from oil sands production under some scenarios (Doluweera et al. 2011. Energy Policy)

  ▸ Biofuels: Incentives/disincentives for producing different co-products with current 'fuel' focus (McKechnie et al. BioFPR)

▸ LCA provides a foundation but additional analyses/insights must be employed for informed decision-making

Sufficiency of modeling tools for GHG emissions of emerging fuels pathways
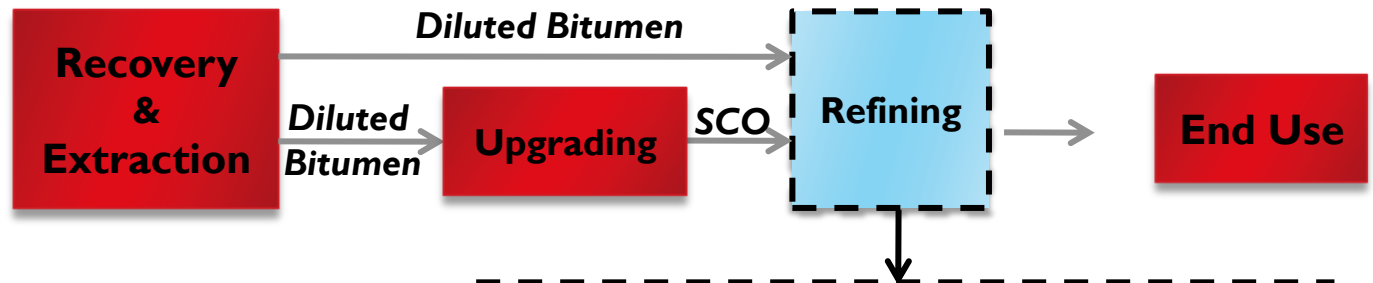
▸ **Modeling tools**

- ▸ Likely to require further refinement to reasonably capture performance of some new technologies
  - ▸ Oil sands: Extraction and refinery life cycle stages
  - ▸ Biofuels: 'Carbon neutrality' assumption and chemical / enzyme inputs to conversion processes

- ▸ Ensure technology innovations that improve life cycle performance can be quantified with the models, and therefore acknowledged / rewarded

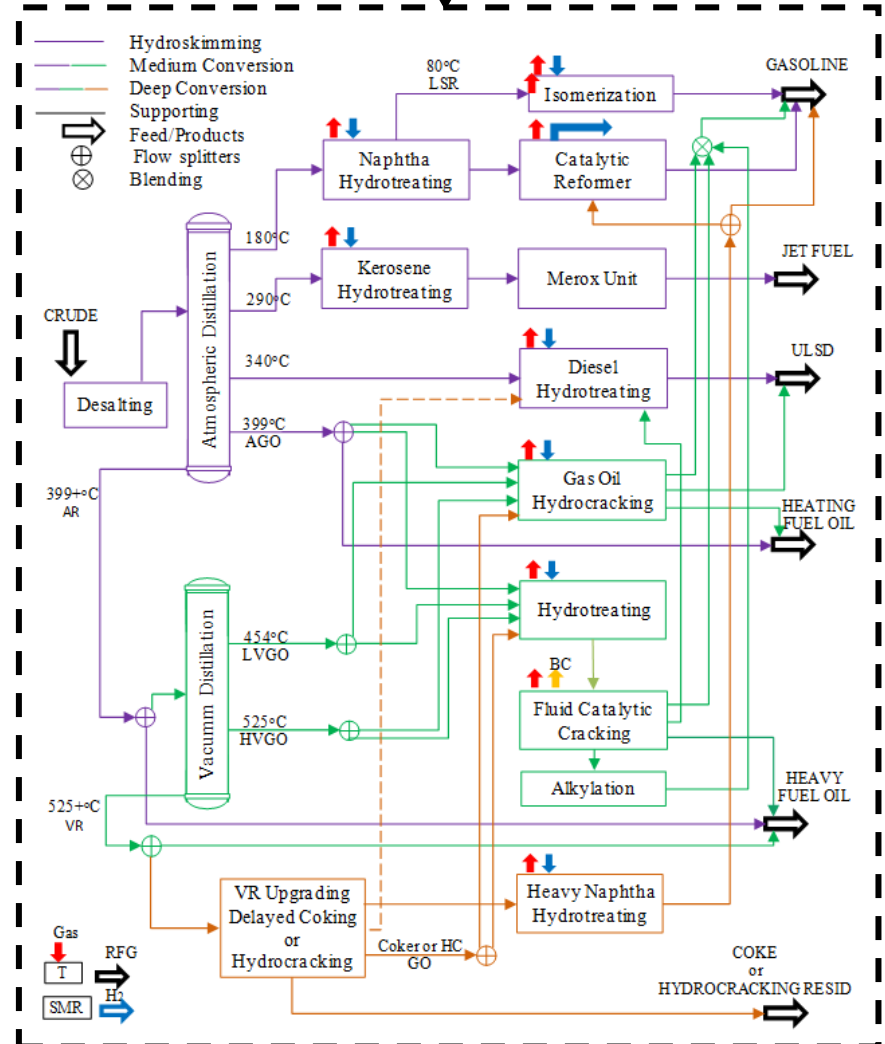- ▸ Gaps in documentation / transparency

GHOST Model

Explores ranges of key parameters informed by;
-Public data
-NDA data
-Industry experts

Charpentier, Kofoworola, Bergerson, and MacLean. 2011. ES&T.

Refinery Model

Refinery configuration and crude quality are biggest drivers of differences in emissions

Sufficiency of modeling tools for GHG emissions of emerging fuels pathways contd.

‣ **Data quality, completeness**

  ‣ Pilot – demonstration – scale-up issues

  ‣ Proprietary data issues

  ‣ Even if data provided under NDAs, if outcome of study is;

    ‣ Improved GHG performance – 'implies' analyst's endorsement of technology's performance

    ‣ Poorer GHG performance – implications for technology developer or analyst in publishing the results

  ‣ Avoid generalizations – support with robust analysis

    ‣ Generalizability of performance to other reservoirs?

  ‣ Importance of acknowledging higher uncertainty in emerging technologies

Short-term data needs

- **Current projects / technologies**
  - Higher quality and more data in public realm
  - Collect under NDAs and then organization with data management expertise to manage the data to prevent disclosure of confidential information
  - Ranges of data should be developed if specific project data cannot be reported / released
- **Emerging technologies**
  - Development of collaborative plan to facilitate robust analysis of emerging technologies
  - Industry, government, researchers / life cycle analysts
  - Methods to deal with highly confidential data
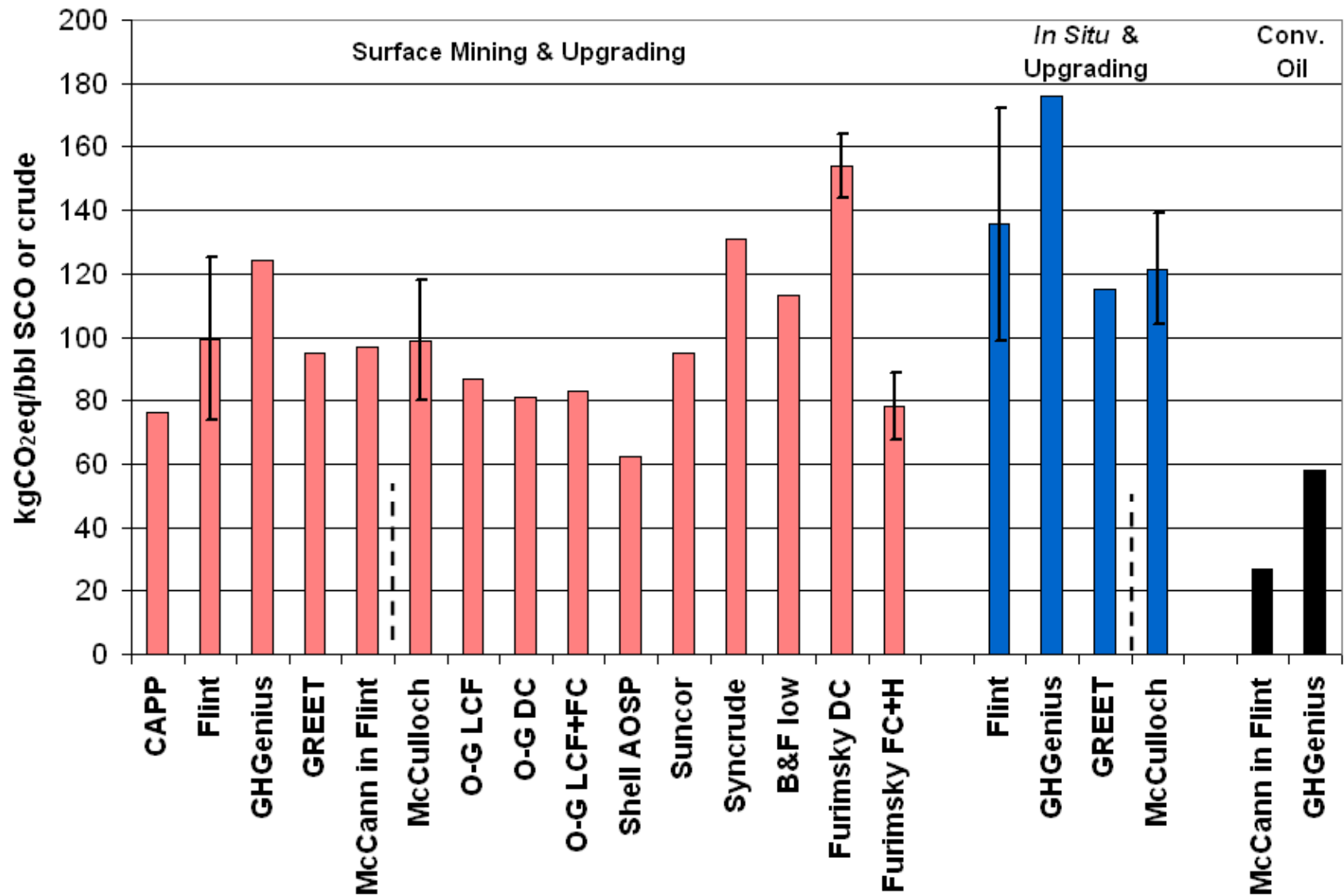 - 'Fair' treatment of technologies not yet at commercial scale

Acknowledgments

▸ Life Cycle Assessment of Oil Sands Technologies Project Team (U. of Toronto and U. of Calgary)

▸ Biofuels Project Teams (U. of Toronto, Michigan State U.)

▸ Funding

  ▸ Alberta Innovates: EES

  ▸ AUTO21 Network Centre of Excellence

  ▸ Genome Canada and Ontario Genomics Institute

  ▸ Natural Resources Canada

  ▸ Natural Science and Engineering Research Council (NSERC)

  ▸ Industry partners (auto, oil and bioenergy industries)

Additional Slides

Previous work on LCA of oil sands

Source: Charpentier, Bergerson and MacLean, ERL, 2009.

Conclusions from oil sands review

▸ Considerable number of studies

▸ We examined these in detail and present the ranges

▸ However, **no reasonable conclusions can be drawn**

  ▸ About the relative performance of the different categories of oil sands projects (in situ, mining) or of conventional petroleum

  ▸ Whether the full range of possible emissions have been captured and is robust
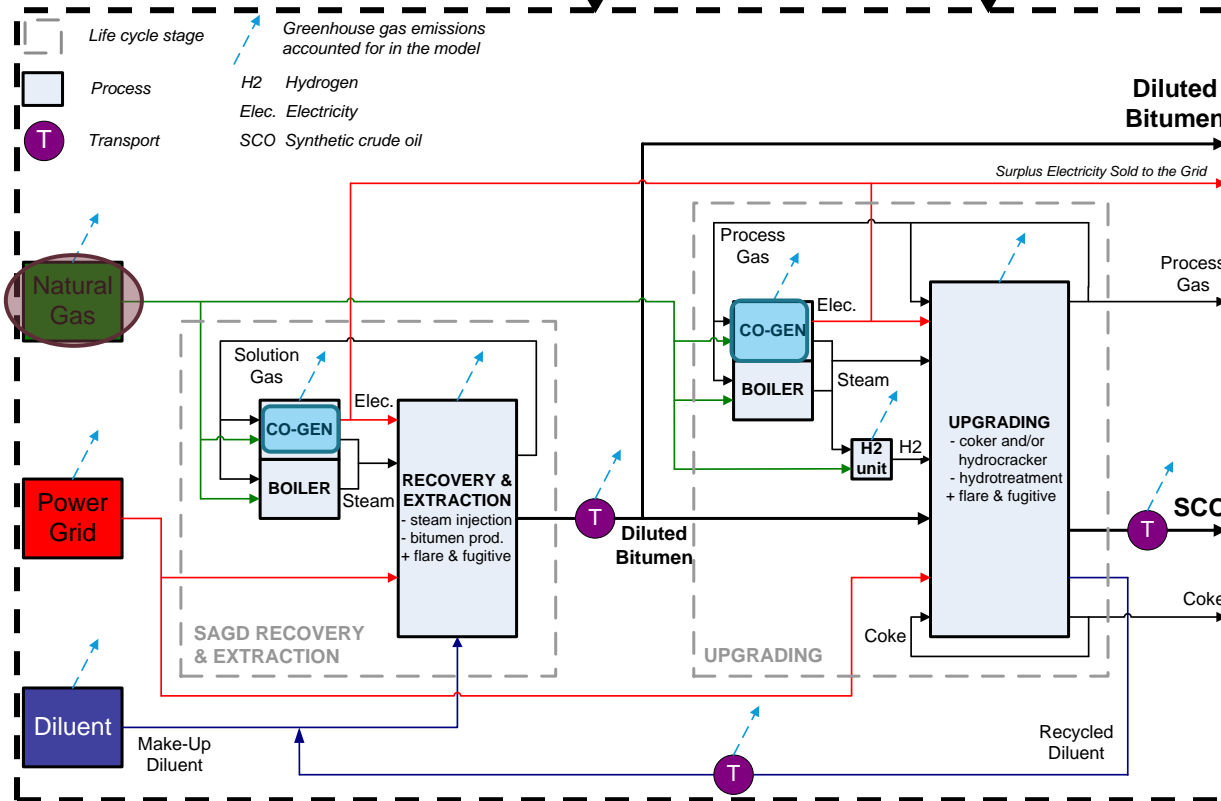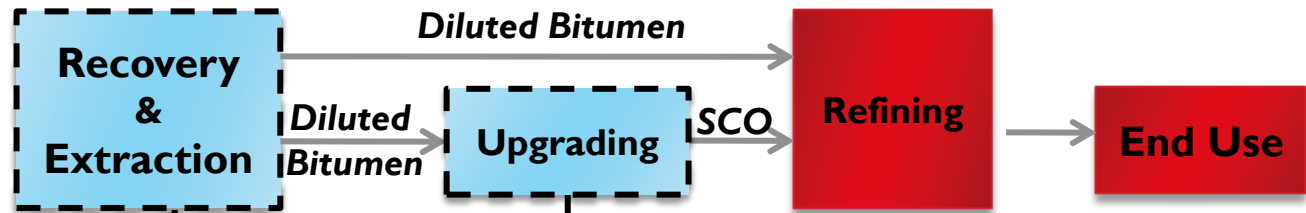
GHOST Model – Baseline extraction model

▸ Excel based software tool that characterizes energy use and GHG emissions associated with existing oil sands technologies

▸ Explores ranges of key parameters informed by:

  ▸ Public data (EIAs, Sustainability Reports, ST-43 etc.)

  ▸ Bottom-up data (obtained under NDAs with oil sands companies)

  ▸ Direct industry feedback on reasonable ranges for each parameter

Charpentier, Kofoworola, Bergerson and MacLean. 2011. Environmental Science & Technology.

Insights from GHOST development

▶ Assigning one value for the entire range can be problematic

  ▶ E.g., Incentives for reductions

▶ Understanding variability and uncertainty is helpful

  ▶ E.g., To measure innovations

▶ More sophisticated treatment for oil sands pathways needed

Cogeneration

- Allocation procedure matters

- Cogeneration has the potential to reduce intensity of Alberta electricity grid in the near term

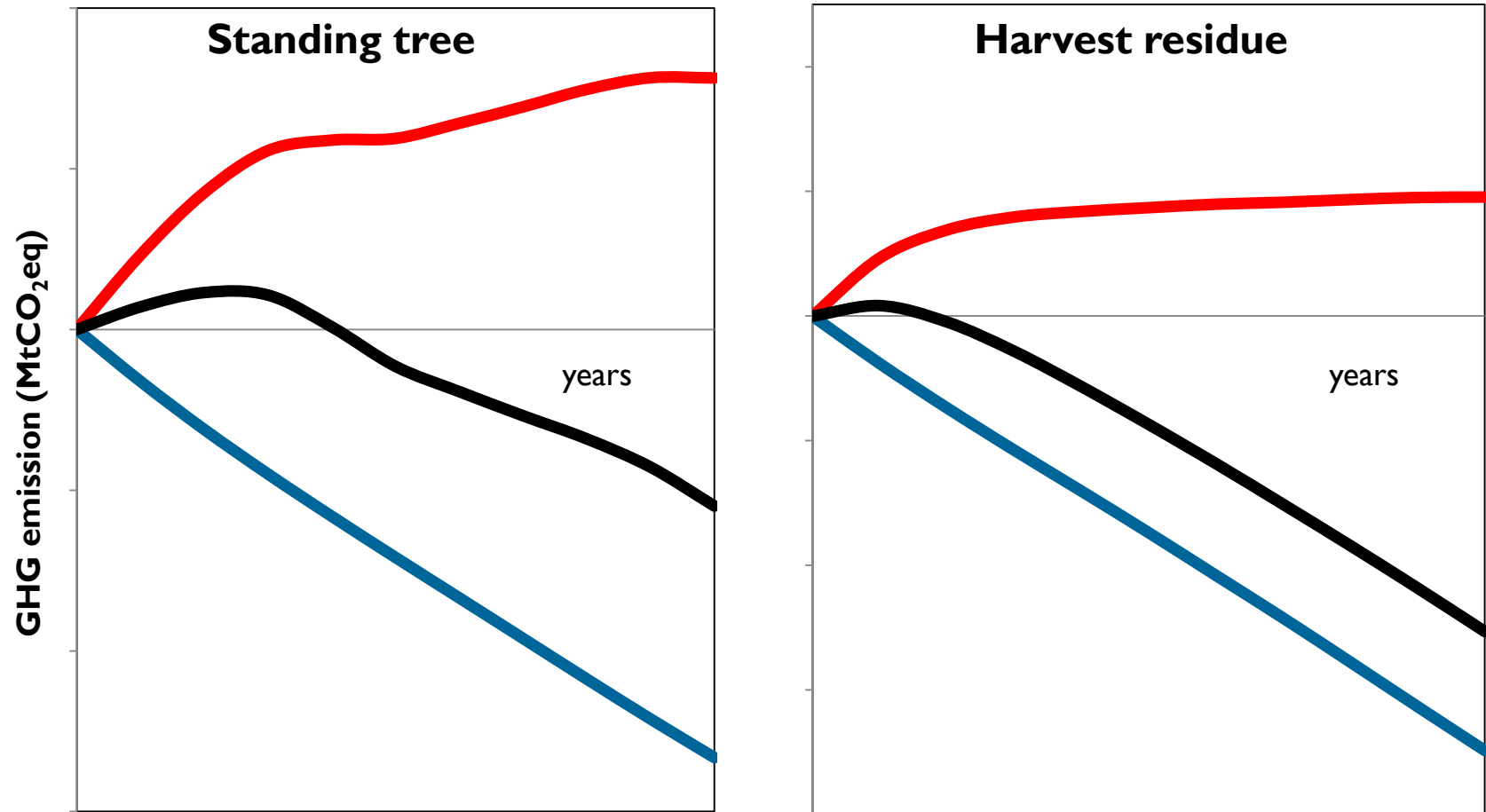 - Can negate almost all emissions from oil sands production under some scenarios

Doluweera, Jordaan, Moore, Keith and Bergerson. 2011. Energy Policy.

Insights from refinery model work

▸ Refinery configuration and crude quality are the biggest drivers of differences in emissions

▸ API and S of the whole crude are not sufficient to characterize GHG emissions associated with refinery

▸ Not differentiating among refinery emissions can be problematic

  ▸ E.g., Incentives for reduction

Forest carbon implications delay and reduce GHG mitigation with wood pellets

Continuous pellet production, displace coal

McKechnie et al. 2010. ES&T

Table 1. Lignocellulosic ethanol plant configuration scenarios and operations data.

Scenario	Co-location	Process energy[1]			Co-product[1]		
		Residual biomass (dry)	Steam import (NG or adjacent facility)	Electricity import (grid or adjacent facility)	Electricity	Pellet	Steam
		Mg/yr	GJ/yr	GWh/yr	GWh/yr	Mg/yr	GJ/yr
1-Electricity	Stand-alone	68 800	-	-	37.2	-	-
1-Pellet	Stand-alone	44 700	-	-	-	24 600	-
1-Max pellet	Stand-alone	-	533 000 (NG)	20.0 (grid)	-	66 200	-
2-Steam	Energy importing facility	68 800	-	-	-	-	357 000
3-Steam/ Electricity	Energy exporting facility	-	533 000 (adjacent facility)	20.0 (adjacent facility)	-	66 200	-
3-Steam	Energy exporting facility	-	533 000 (adjacent facility)	20.0 (grid)	-	66 200	-

Notes: 1. For all scenarios, operations data are based on annual ethanol production of 49.8 million liters (13.2 million USG) from 318 000 Mg (350 000 short tons) poplar feedstock.

McKechnie et al. 2011. BioFPR

Scenarios of alternative co-products, co-location and process energy options for ethanol production from hybrid poplar

ILUC not included

McKechnie et al. 2011. BioFPR