

Alberta Oil Sands Future Positioning

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Alberta Innovates, Energy & Environment Solutions (AIEES)

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Gerald W. Bruce, CCQTA

Who is AIEES

- Alberta Innovates – Energy and Environment Solutions
 - Technology implementation arm of the Government of Alberta Ministries of Energy and Environment
 - Last known as AERI, 2000 to 2009
 - Alberta Energy Research Institute
 - Remember AOSTRA ? (1974 → 2000)
 - *Alberta Oil Sands Technology and Research Authority*
 - *SAGD development*



Develop innovative, integrated ways to convert Alberta's natural resources into market-ready, ecologically responsible energy

- ***Research, innovation and technology development***
- ***Funding***

Overview

- Alberta Government Programs and Initiatives
 - Advancing technology for:
 - Upgrading bitumen, GHG emission reduction, alternative energy, carbon capture
- Sustainability focus
 - Life Cycle Analysis Project
 - Well to wheels

Government Programs and Initiatives

Program/Initiative	Description
Carbon Capture and Storage (CCS) Fund – (\$2 billion)	<i>Large-scale demonstration plants capable of storing 5 million of CO₂ annually by 2015. Three projects qualified for potential funding – EPCOR Clean Coal, Shell and Enhance Energy.</i>
Climate Change & Emissions Management Fund (currently at ~\$120 million)	<i>Technology fund to offset emissions from large facilities and promote GHG reductions – ‘greening’ of energy system, efficiency, CCS. Expression of interest process underway.</i>
Innovative Energy Technology Program (\$200 million)	<i>Develop new energy supplies from existing oil and natural gas reserves, as well as from in situ bitumen and heavy oil deposits. Over 20 pilot projects underway.</i>
EcoTrust Fund (\$156 million).	<i>Reduce GHG and air emissions of concern. Thirteen projects approved and agreements being negotiated.</i>
AERI-Industry Programs. (\$44 million last year) with similar or greater investment by industry	<i>Technology development and demonstration in 6 strategic areas</i>
Bitumen royalty-in-kind.	<i>The government royalty share of bitumen made available to upgrade to higher valued products in the province. Selection of projects underway.</i>

Research and Technology Development Activities

(Partnership with industry & other government programs)

Production

- **Mined Oil Sands:** Reduce water for extraction
 - Dense phase processes
 - Solvent-Water processes
- **In situ extraction:** Reduce Water, Natural Gas and Diluent Requirements
 - Enhancements to SAGD
 - Thermal-solvent processes
 - Heated solvent
 - Combustion
 - Electrical heating
- **Upgrade Bitumen to higher value products**
 - Advanced Upgrading and Gasification Technologies:
- **Unconventional natural gas**
 - Develop economic recovery technologies for Coal Bed Methane, Tight Gas and Shale Gas
- **Coal**
 - Clean Power Generation: IGCC with CO₂ capture
 - Underground Coal Gasification

Environment

- **Water recovery from tailings ponds:**
 - Reduce use of tailing ponds**
 - Consolidated tailings process: Currently practiced
 - Improved thickening - better flocculants,
 - Dry tailings – filter belts,
 - Evaporative/Chemical Drying
 - Paste technology
 - CO₂ for Consolidated Tailings processes
- **Carbon Capture and Storage (CCS)**
 - Pre- post combustion capture technologies
 - Integrated Coal Gasification Combined Cycle (IGCC) with CO₂ capture
 - CO₂ Enhanced Oil Recovery
 - End-to-end Demonstration Plants (\$2 B government investment)

Achieving Clean Energy Goals – Oil Sands Technology Framework

- New wave - efficient oil sands production technologies
- Next generation upgrading technologies (integration with gasification and CCS)
- Carbon capture & storage
 - Includes CO₂ EOR
- Gasification of pet coke, asphaltenes, coal, biomass
- Combustion of liquid/solid fuels
- Unconventional natural gas
- Nuclear outlook

- Research & technology adaptation costs
- Capacity – human, infrastructure
- Large scale deployment time horizon
- Comparative Life Cycle Analysis

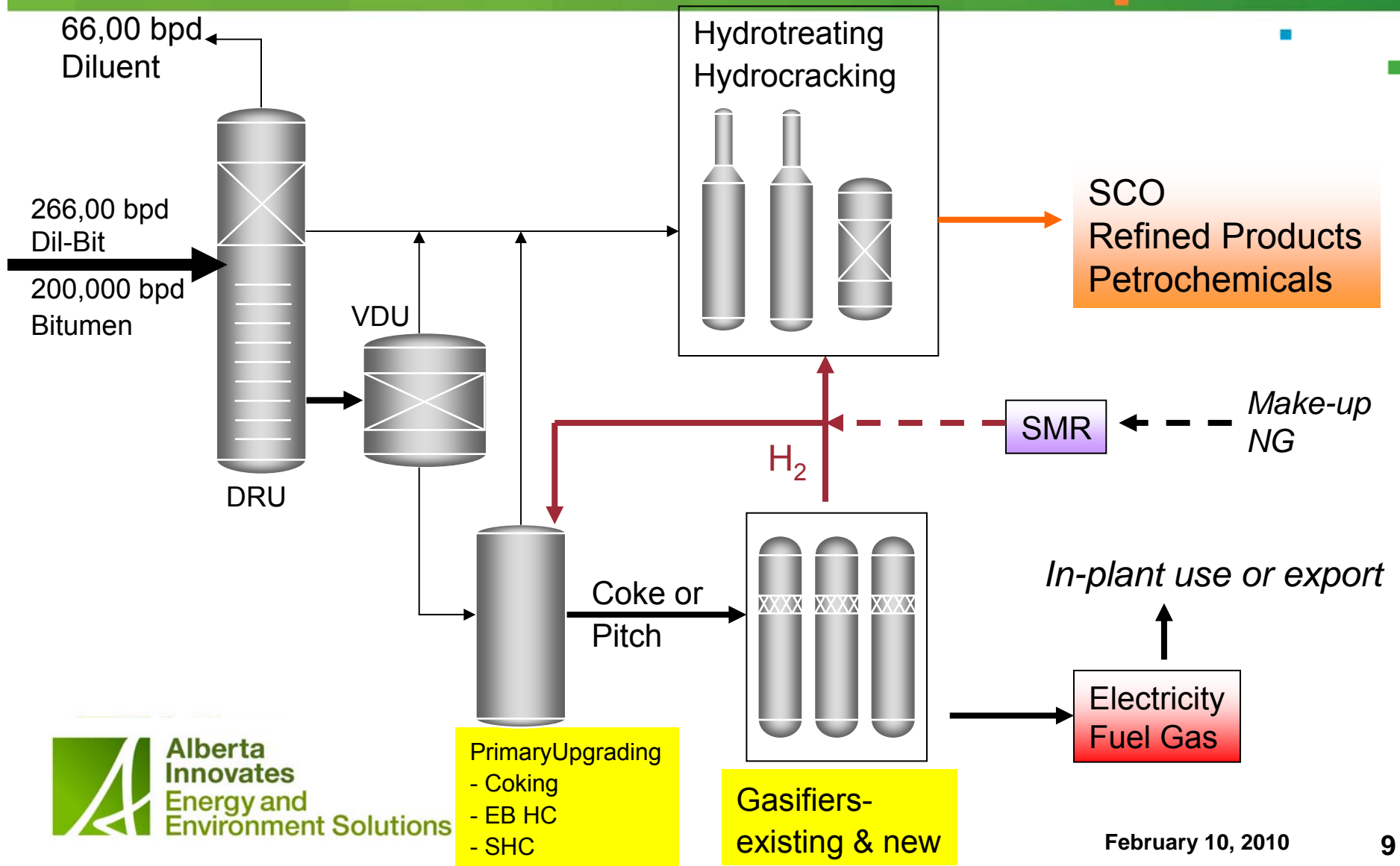
Hydrocarbon Upgrading Demonstration Program and Related Studies

- 2005 government – industry workshops
 - identified barriers to upgrading bitumen to high value products in Alberta
- Hydrocarbon Upgrading Development Program (HUDP) focused on ‘breakthrough’ technologies
 - to reduce the cost and environmental footprint of upgrading bitumen to
 - high value products
 - *Synthetic Crude Oil (SCO) and beyond*
- Screening study with industry group
 - Considered 100 process/technologies.

Programs and Studies - continued

- Stage-gated industry-government engineering and piloting studies of selected technologies.
 - 2007 to date
- Broadened scope
 - to include partial Upgrading technologies.
- Life Cycle Analysis (LCA) GHG emission studies
- Energy efficiency studies
- GHG mitigation roadmap

Primary Upgrading and Residue Gasification Schemes Evaluated



Status of Hydrocarbon Upgrading Development Program (HUDP) Projects

- ***ETX System Cross-flow Coking:***

- Lower coke yield
- Higher and better quality products
- Completed 1 b/d pilot tests (NCUT = National Centre for Upgrading Technology)
- Want to move build demonstration plant

- ***UOP Slurry Phase Hydrocracking:***

- Advanced secondary upgrading process (slurry phase hydrocracking)
- Higher conversion: 90% +
- Based on 5000 bpd demonstration tests of the process at the Petro-Canada Montreal refinery in 1980's
- Currently being piloted at UOP, NCUT and StatoilHydro
- Developing advanced catalysts to further improve performance.

Status of HUDP Projects- continued

- ***Nova Chemicals:***

- Converts bitumen-derived heavy gas oils into paraffinic petrochemical feedstocks.
- Catalysts work in China and Germany
- Performance tests at NTRC, Calgary
- Piloting underway at NCUT, Devon
- On-going R&D aims to broaden the range of feedstocks

- ***Great Point Energy:***

- Single stage catalytic gasification of coke to Synthetic Natural Gas (SNG)
 - Fluidized bed reactor
- Completed pilot trials with coke and coal at GTI, Chicago
- Seeking partners for demonstration project

Status of HUDP Projects - continued

- **Pratt & Whitney Rocketdyne:**

- Advanced compact dry feed gasifier
- Potentially lower capital & operating costs
- 18 t/d pilot plant being commissioned at GTI
- High pressure solids feed pump being developed at EERC
 - EERC = Energy and Environment Research Centre, Grand Forks, ND

ExxonMobil
Research and Engineering

AERI

U.S. DEPARTMENT OF
ENERGY

ZEEP

Pratt & Whitney Rocketdyne

- **Advanced Solvent Deasphalting:**

- Novel solvent de-asphalting concept
- Conceived during the initial phase of HUDP
- Potentially lower capital & operating costs
- Being evaluated in bench scale test with bitumen-derived feedstock

Technology Summary

- Alberta will play an increasing role in meeting world energy demand growth:
 - size of resource, secure supply, strategic location in NA, future access to Asian markets
- Existing government strategies to improve competitiveness and environmental footprint of oil sands operations
- Oil sands products meet current refinery quality specifications
 - (alone or as blended feeds) and can be processed further to meet more stringent market requirements
- Opportunities for international participation
business and technology developments



Sustainability and Environmental Focus

LIFE CYCLE ANALYSIS PROJECT

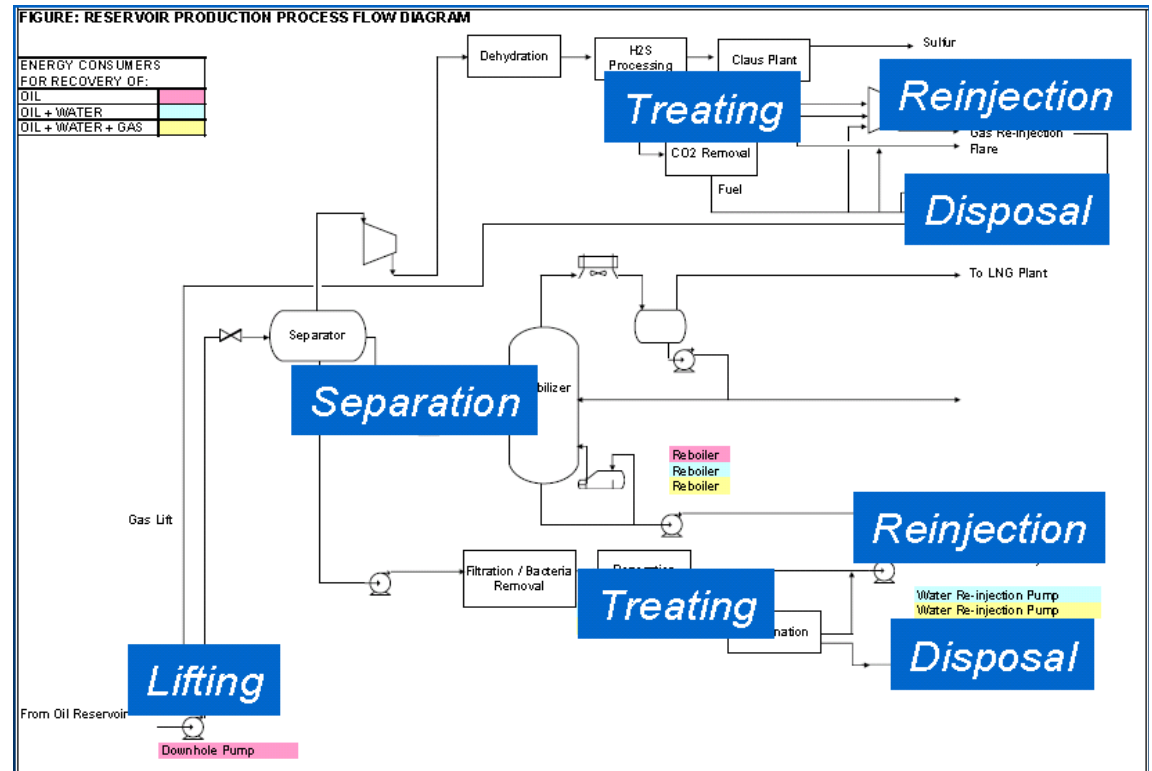
EES Life Cycle Analysis Project

- Life Cycle Analysis (LCA) was started to understand the impact of oil resources on greenhouse gas (GHG) emissions
- Limitations of prior LCA
 - Simplified, generic model representations
 - » Crude production and refinery configurations not well differentiated
- Decision to conduct two independent studies (TIAX LLC and Jacobs Consultancy) to establish the impact of crudes processed in U.S. refineries
 - Well-to-wheel LCA direct emissions only

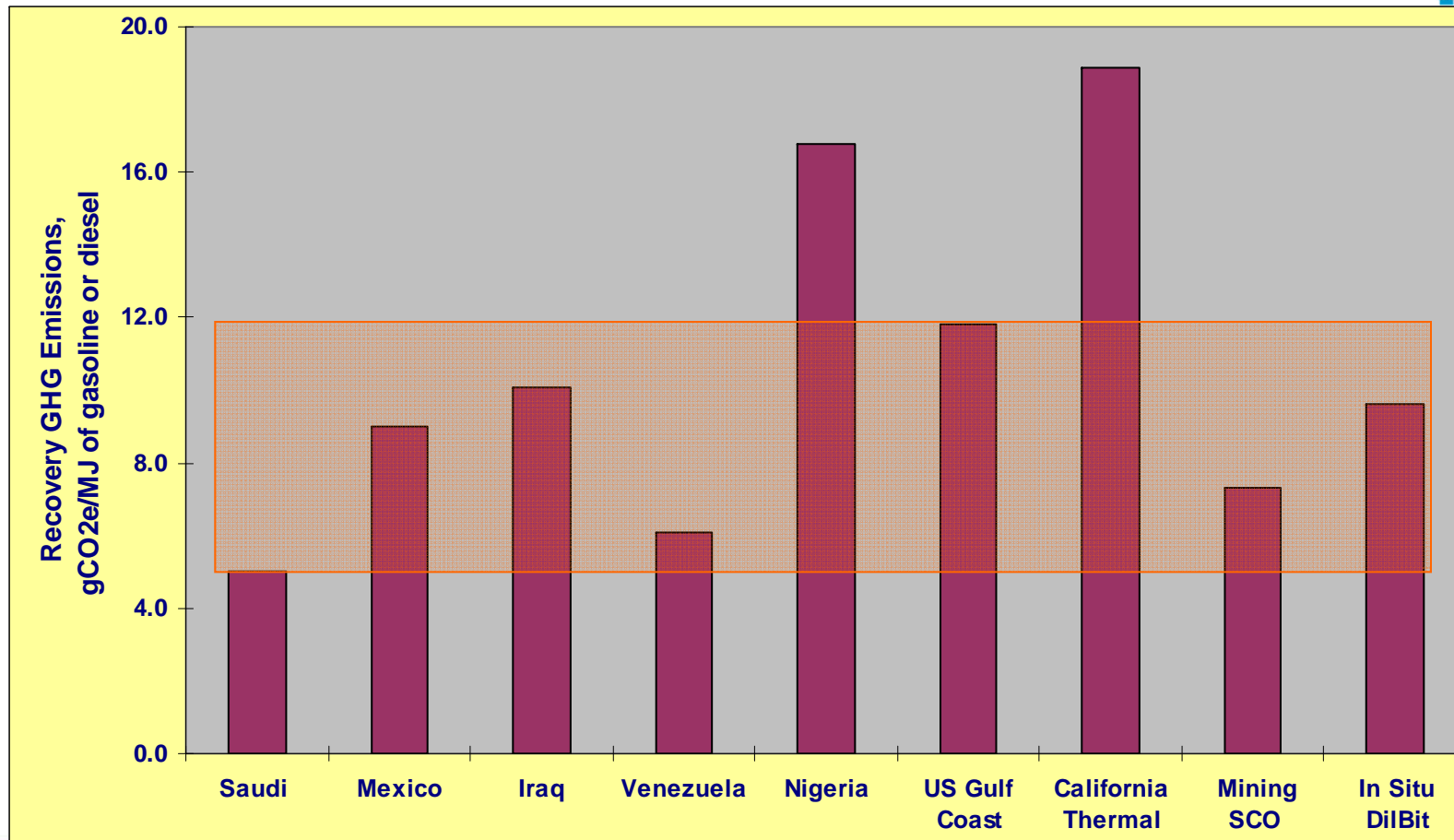
GHG Emissions – Production Factors

- *Variation in GHG Emissions:*
 - *Depth*
 - *Pressure*
 - *Water-oil ratio*
 - *Gas-oil ratio*
 - *Venting*
 - *Flaring*
 - *Offshore production*
 - *Transportation*
 - *Steam-oil-ratio*

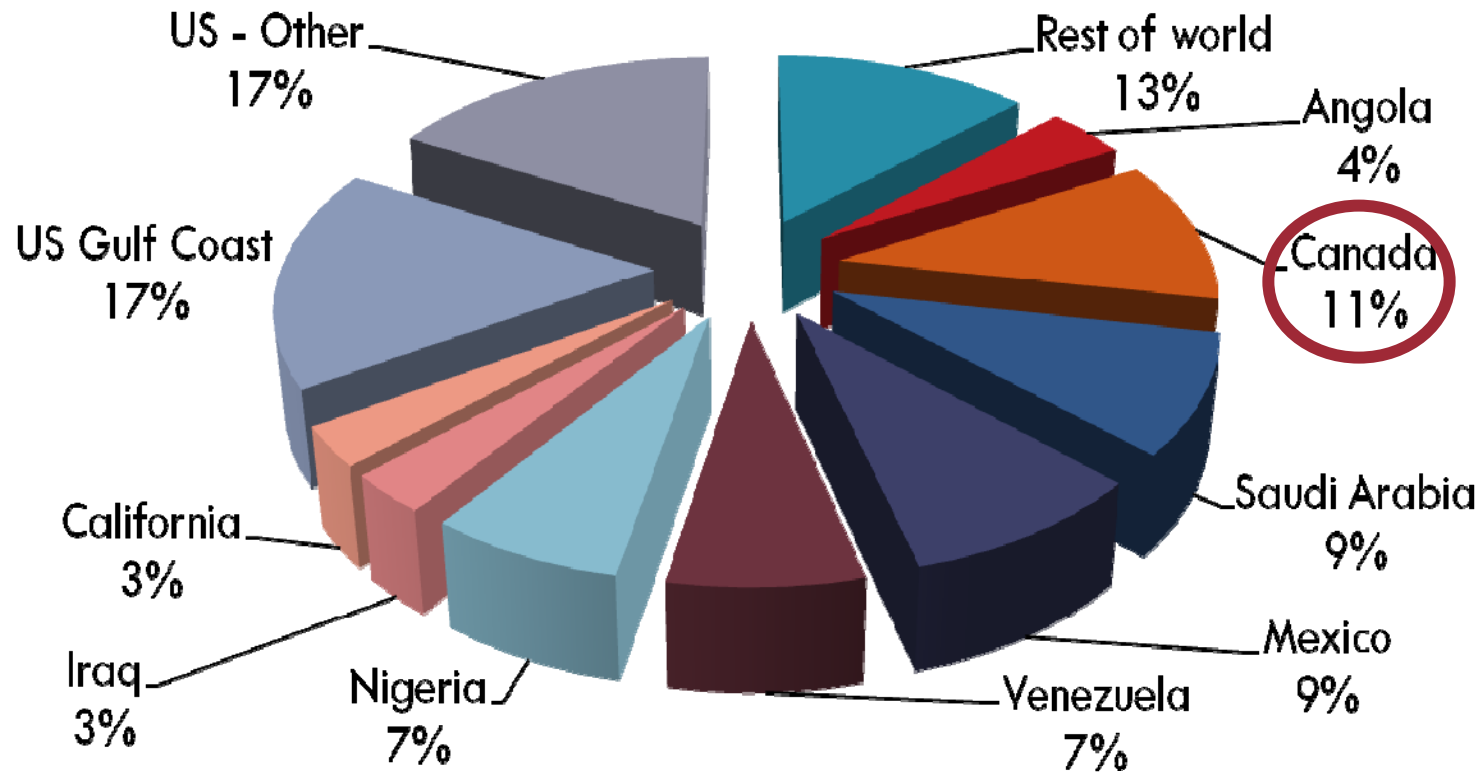
Modelling Crude Production



Comparison of Oil Production GHG Emissions – Jacobs Study



Sources of Crude Oil in US Refineries - 2007

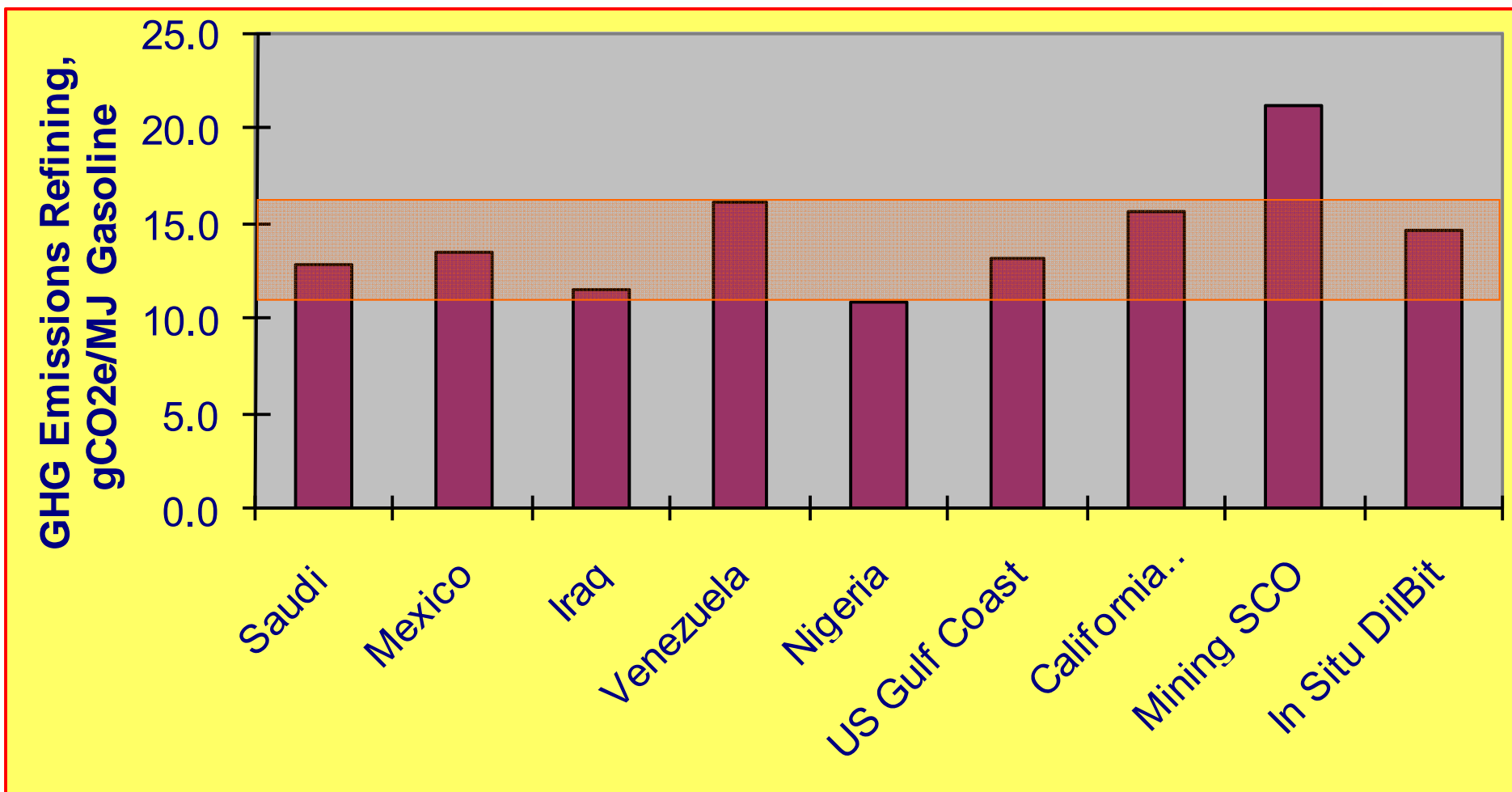


GHG Emissions

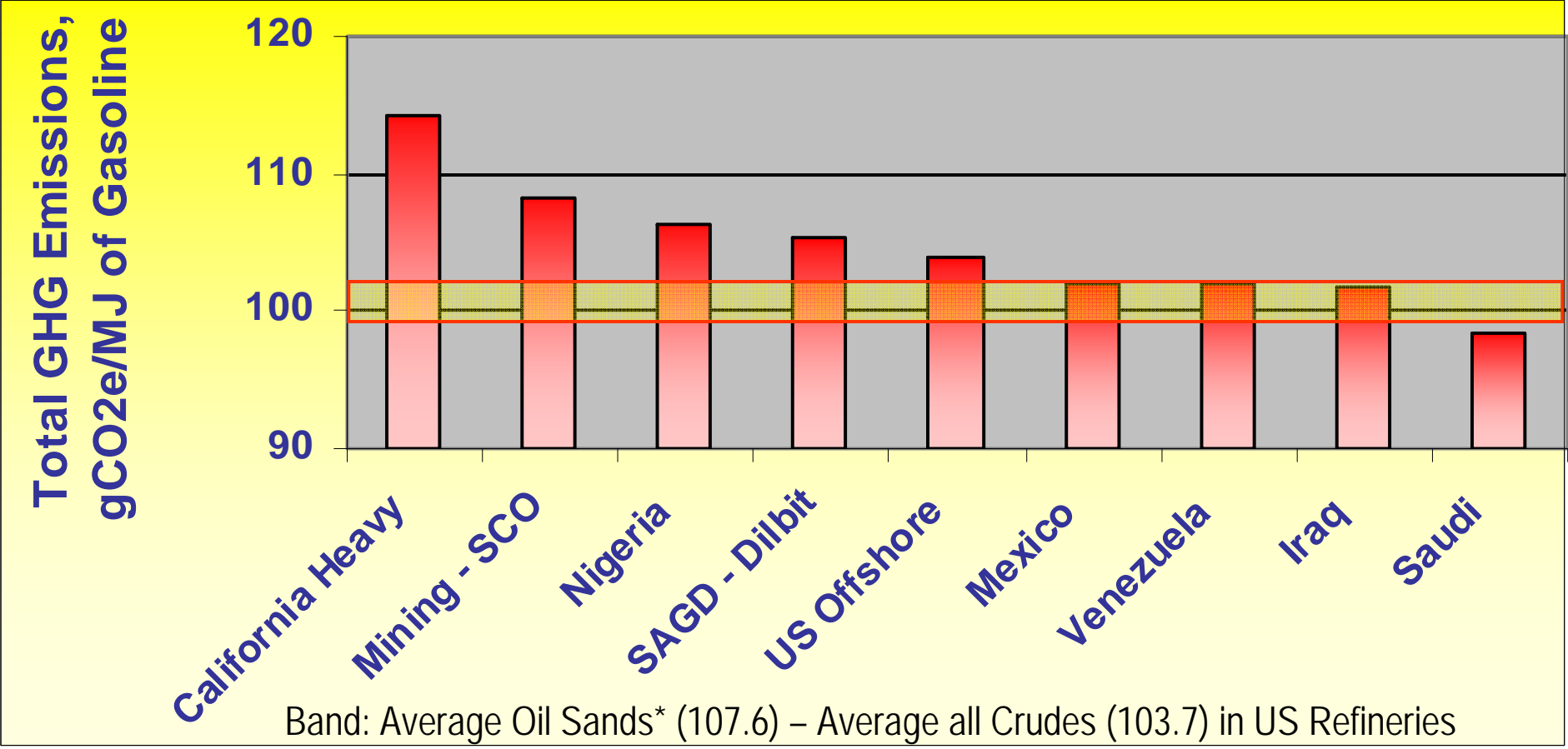
– Upgrading and Refining Factors

- Crude quality and product requirements:
 - Processing complexity
 - Hydrogen addition
 - Energy consumption
 - Product yield and consistency
 - Handling co-products such as coke
- Refinery configuration and technology:
 - Level of conversion
 - Product slate (gasoline, diesel etc.)

Comparison of Refining (Upgrading) GHG Emissions for Gasoline – Jacobs Study

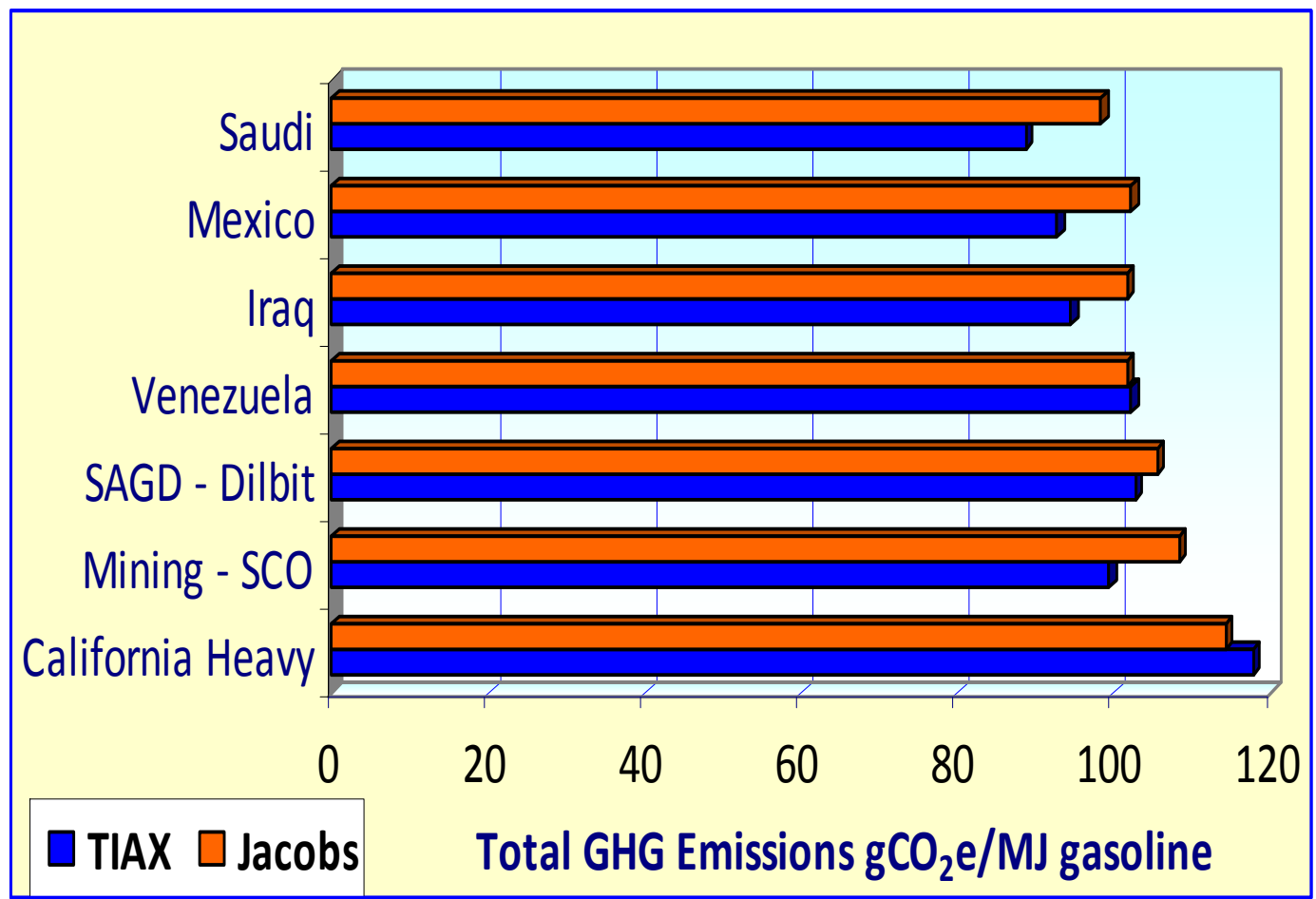


Comparison of Total GHG Emissions of US Domestic and Imported Crudes – Jacobs Study



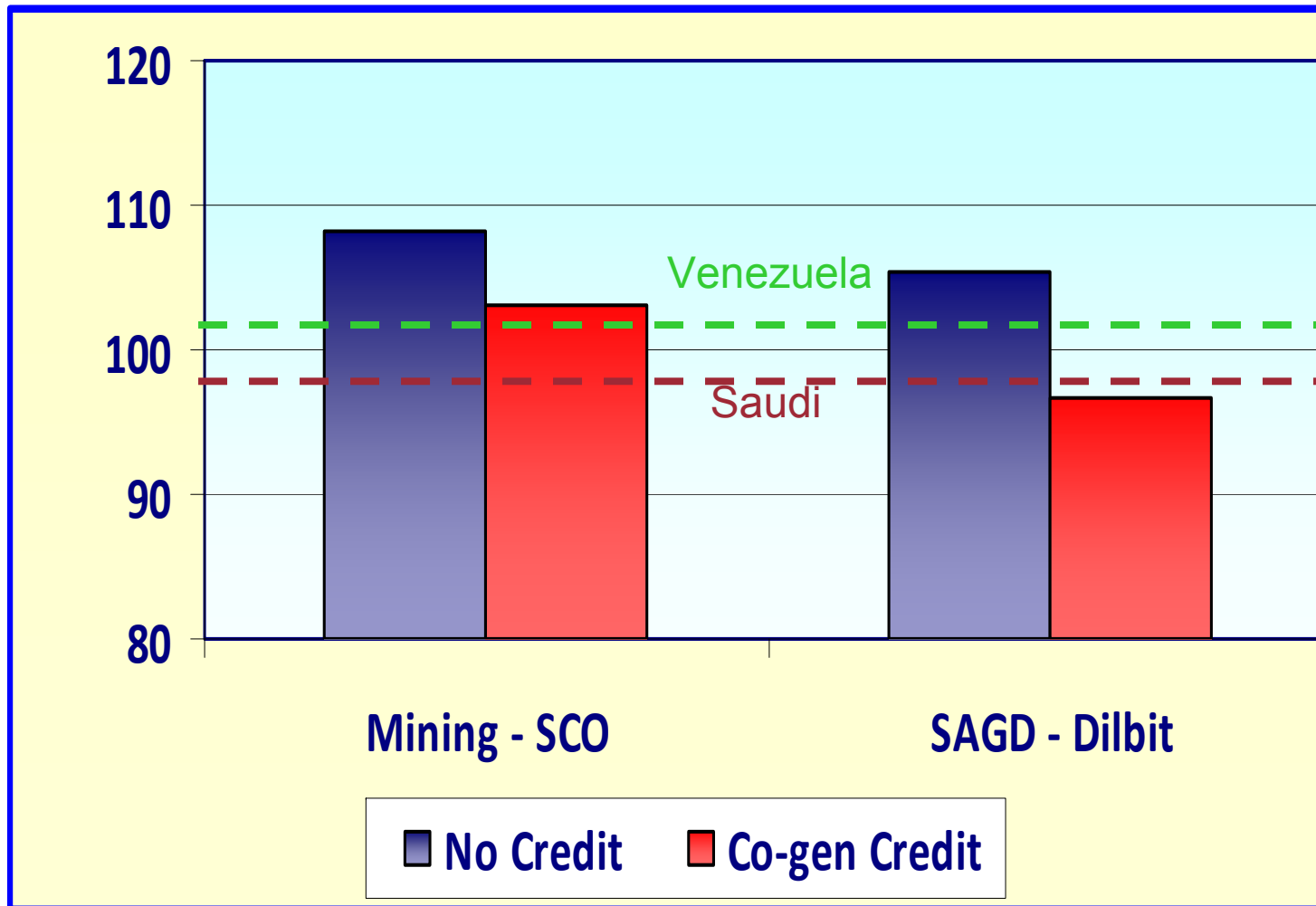
*Oil Sands: 55% mining/SCO, 40% SAGD-Dilbit, 5% SAGD-SCO

LCA Comparison TIAX vs. Jacobs – Total GHG Emissions Reformulated Gasoline



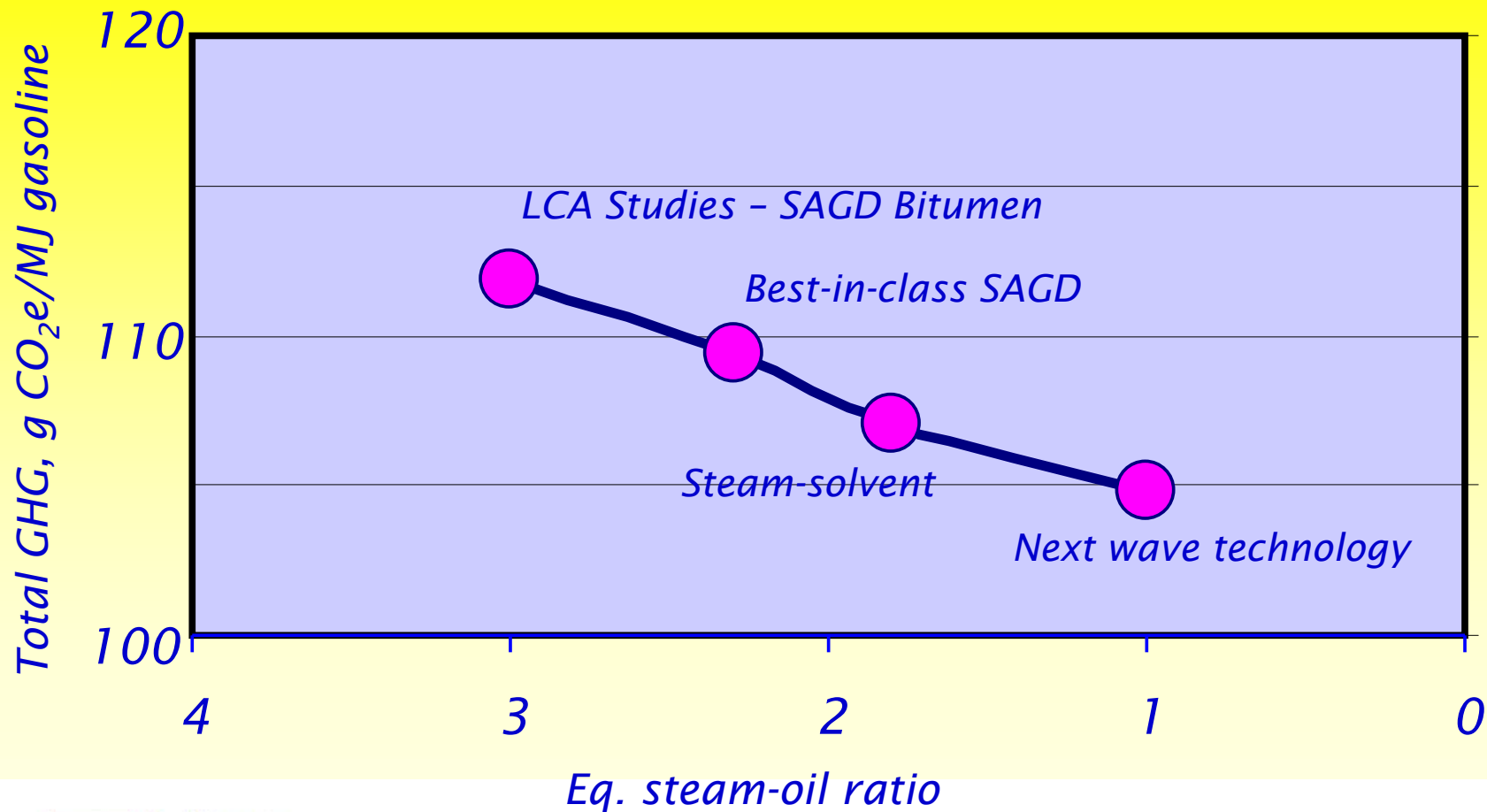
SAGD-Dilbit
(SOR = 3; adjusted)
No electricity credits

Jacobs Consultancy - 50% Credit for Co-generation



- Emissions from oil sands are comparable to conventional crudes entering US refineries
- Methodology for cogen credits is uncertain

Impact of Technology Advances - SAGD Bitumen (Estimate)



Summary Drawn from Life Cycle Analysis Reports

- A wide range of GHG emissions for crude oils in North American refineries
- Imported and U.S. domestic heavy oil crudes
 - have similar emissions to the oil sands pathways
- With some overlap, oil sands pathways generally have 10% higher emissions than conventional crudes
- GHG emissions from oil sands crudes are comparable to conventional crudes when potential cogeneration credits are considered
- Technological advances will further decrease GHG emissions for oil sands crudes

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