Expanding Unconventional Oil Production in a Carbon-Constrained World

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1. Properties of non-conventional oil

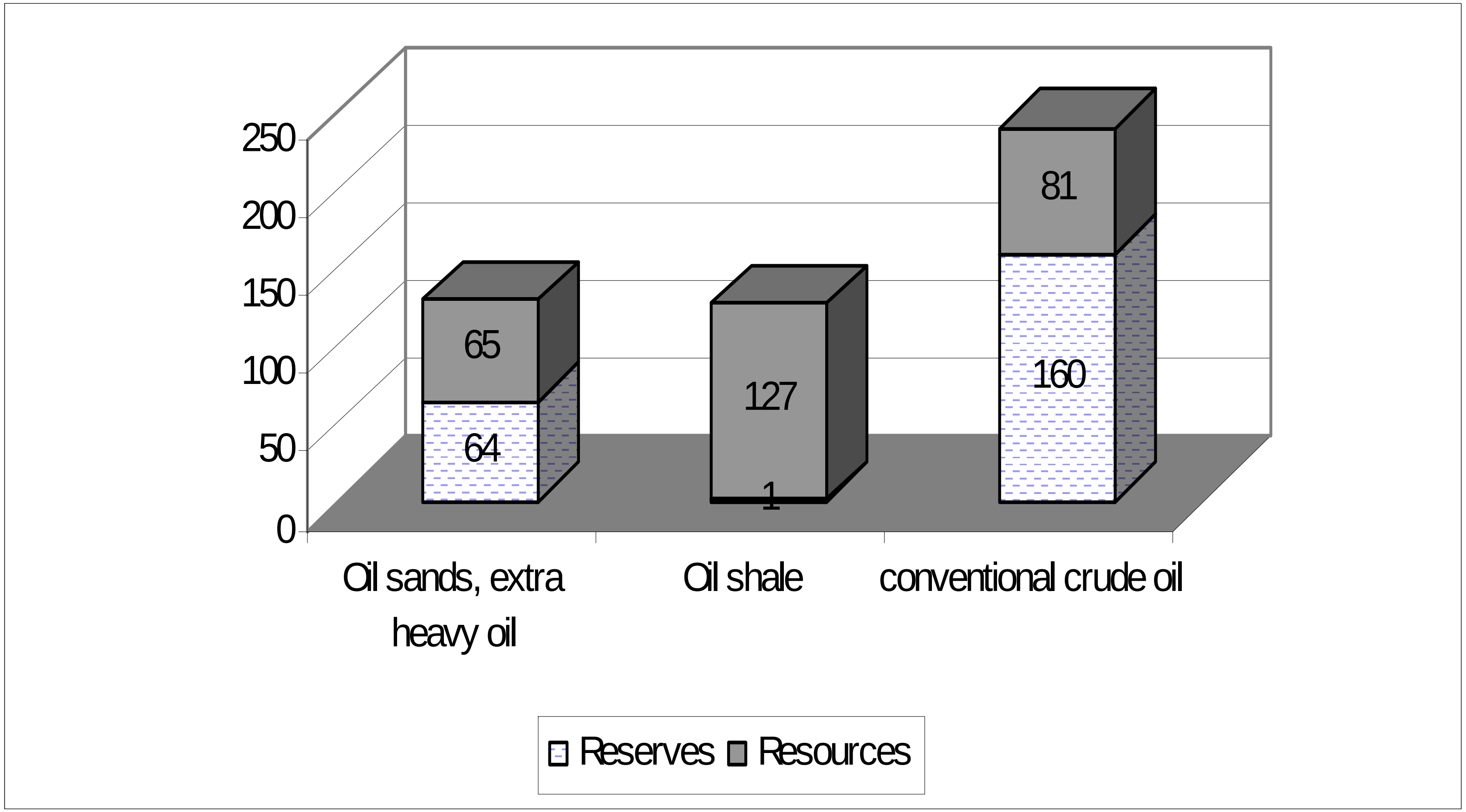
1) Non-conventional Oil cannot be lifted by means of conventional wells.
2) It has to be „upgraded“ to generate a synthetic oil, similar to crude oil (to increase the of share of hydrogen)

Non-conventional Oil: Definition World Energy Outlook 2006 (p.91)

,„Conventional Oil“ is defined as crude oil and natural gas liquids produced from underground resevoirs by means of conventional wells. This category includes oil produced from deep-water and natural bitumen.

„Non-conventional“ oil includes oil shales, oil-sands based extra heavy-oil and derivatives such as synthetic crude products, and liquids derived from coal (CTL) and natural gas (GTL).‘

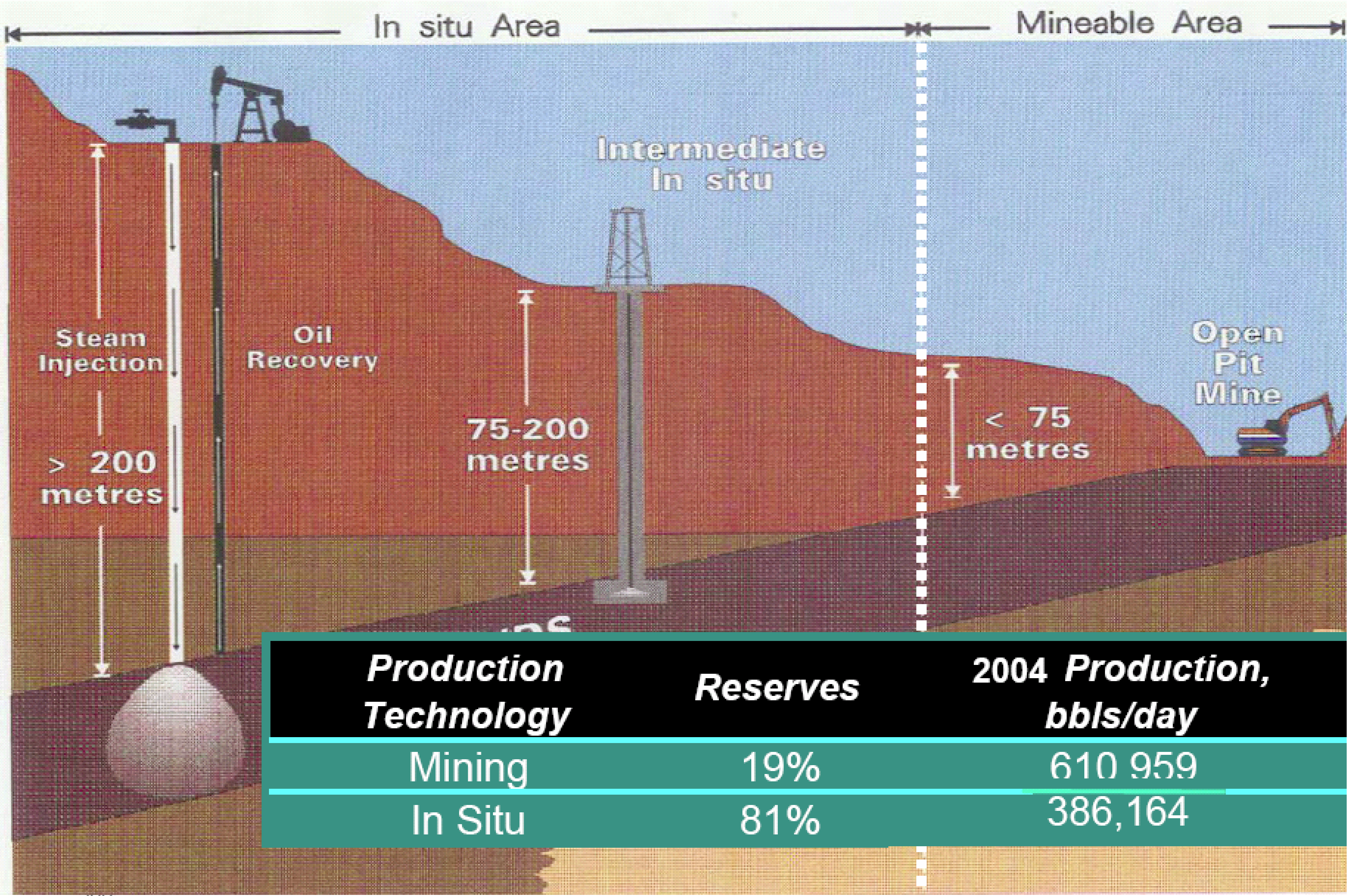
Resources and reserves of unconventional and conventional oil



Features of non-conventional oil resources

- Concentrated on non-MEMA-countries (MEMA = Middle East, North Africa)
- In each concentrated on one country (> 90% Oilsands in Canada; extra-heavy oil in Venezuela; oil-shales in USA)
- Oil sands with lowest supply cost (30-40 US$/barrel of synthetic crude oil)

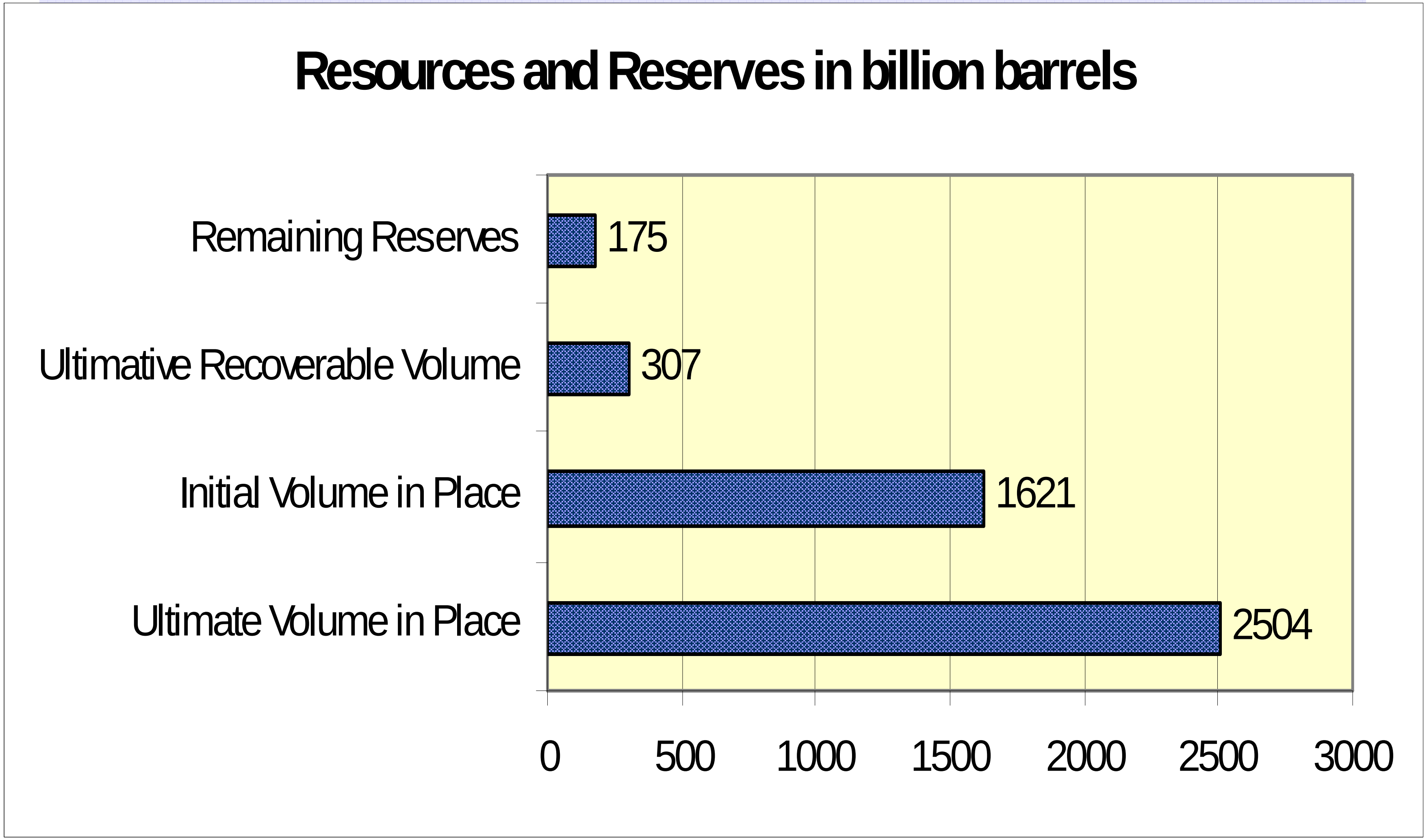
The Nature of the Oil Sands Resource



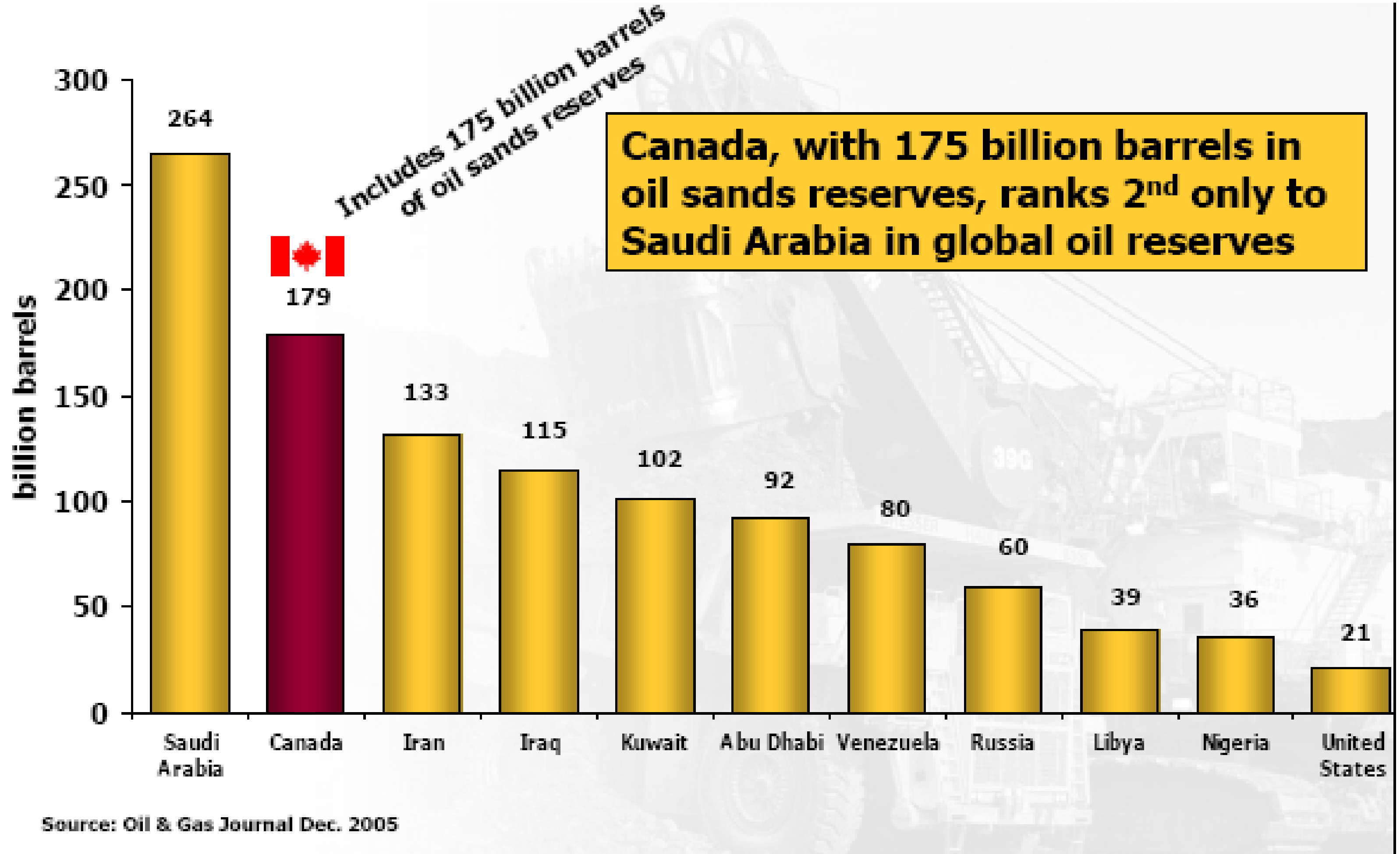
Production Technology	Reserves	2004 Production, bbls/day
Mining	19%	610,959
In Situ	81%	386,164

2. Methods to estimate oil sands resources and reserves

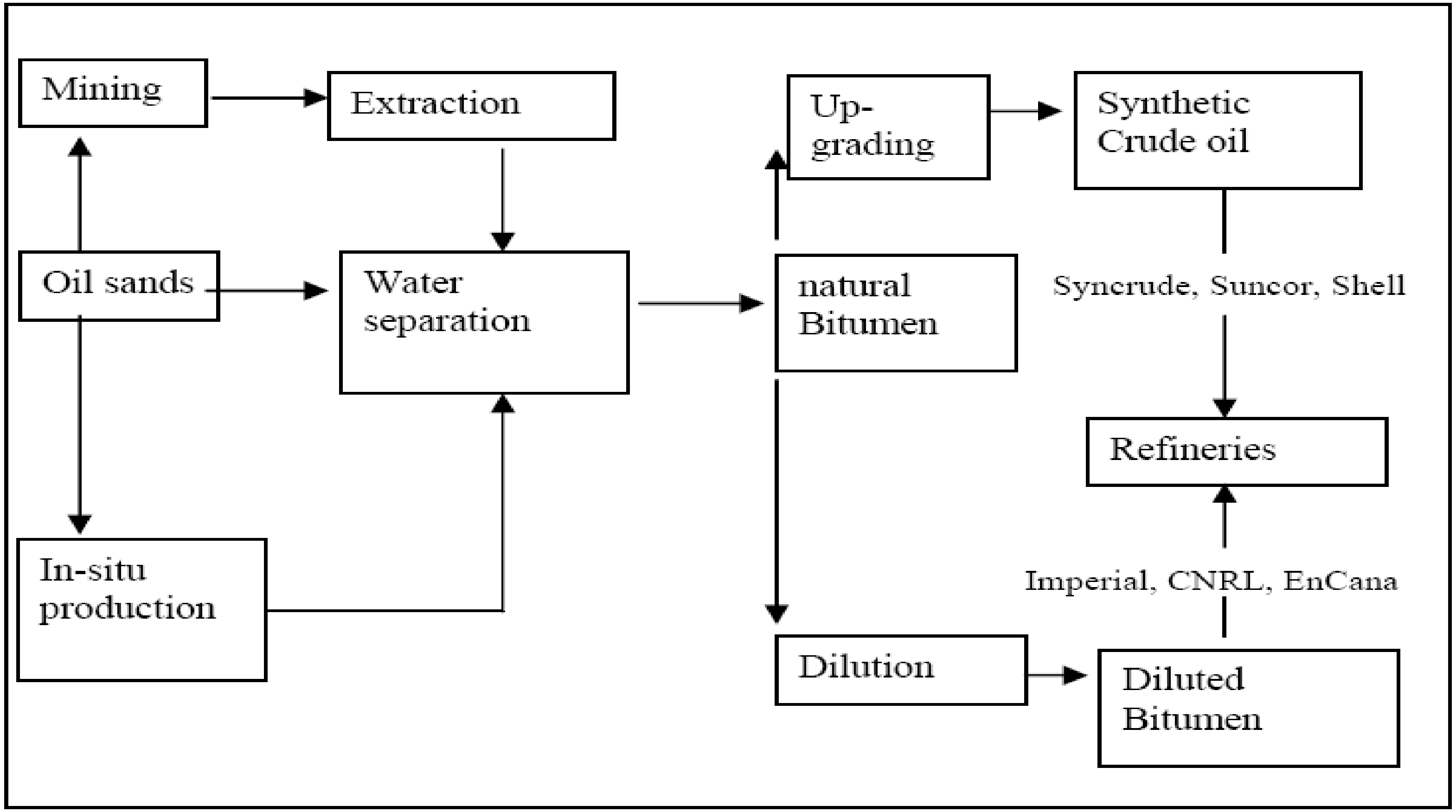
	Mining	In-situ recovery
Ultimate Volume in Place		
Initial Volume in Place (Resources)	Minimum saturation of –6 mass per cent and –zone thickness >3m	Minimum saturation of –6 mass per cent and –zone thickness >1.5m
Estimation of established reserves Step 1:	Minimum saturation of – 7 mass per cent and – zone thickness >3m	Minimum saturation of – 7 mass per cent and – zone thickness of >10m
Step 2:	Reduction factors of 10% (in each case) to take into account bitumen ore sterilized due to – environment protection corridors along rivers – small isolated ore bodies – location of surface facilities	
Step 3:	Applying a combining mining/ extraction recovery factor 82%	Applying a recovery factor of 20%


Resources and Reserves in billion barrels
Remaining Reserves
175
Ultimative Recoverable Volume
307
Initial Volume in Place
1621
Ultimate Volume in Place
2504
0
500
1000
1500
2000
2500
3000

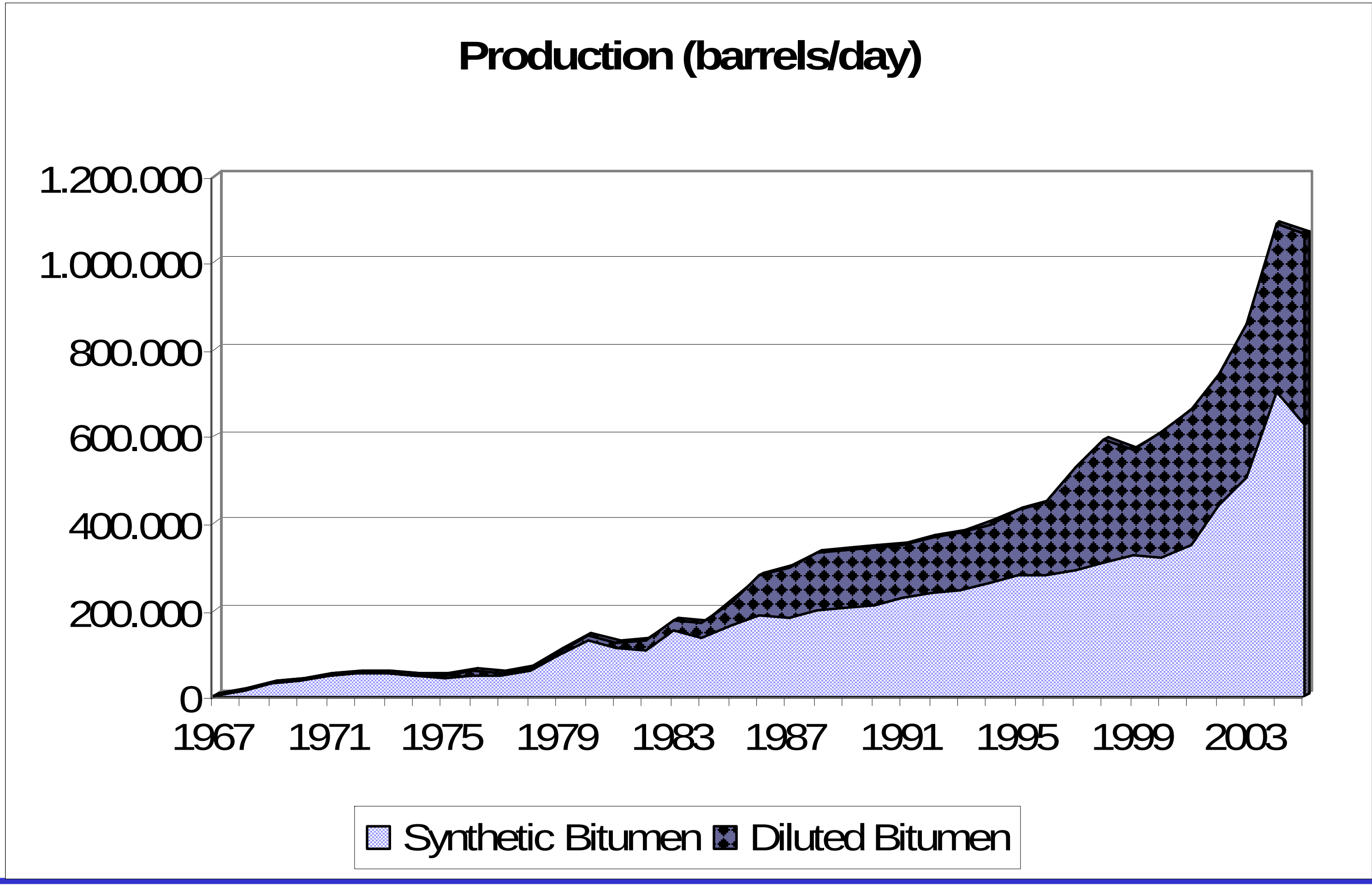
Global Crude Oil Reserves by Country

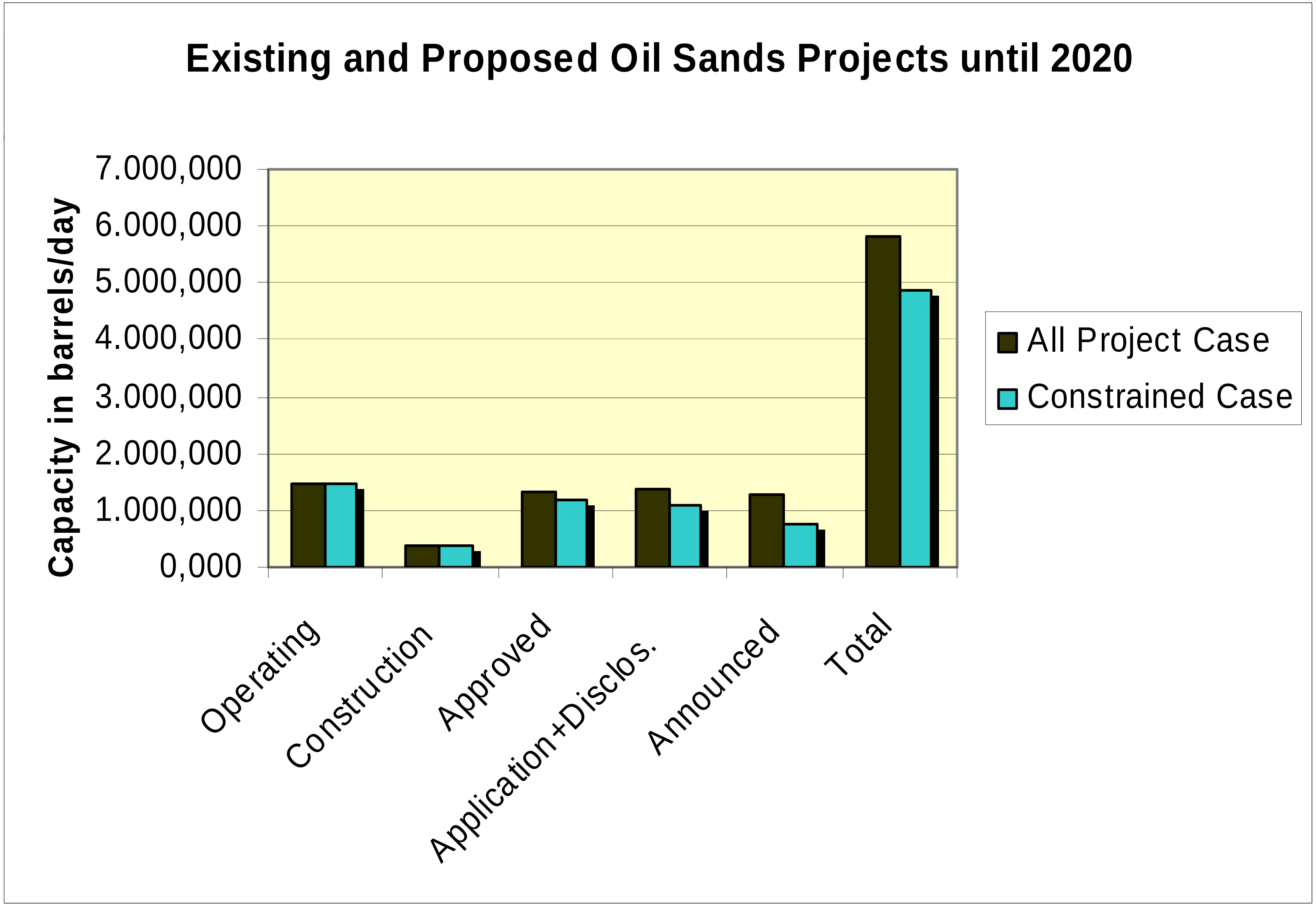


The oil sands process chain



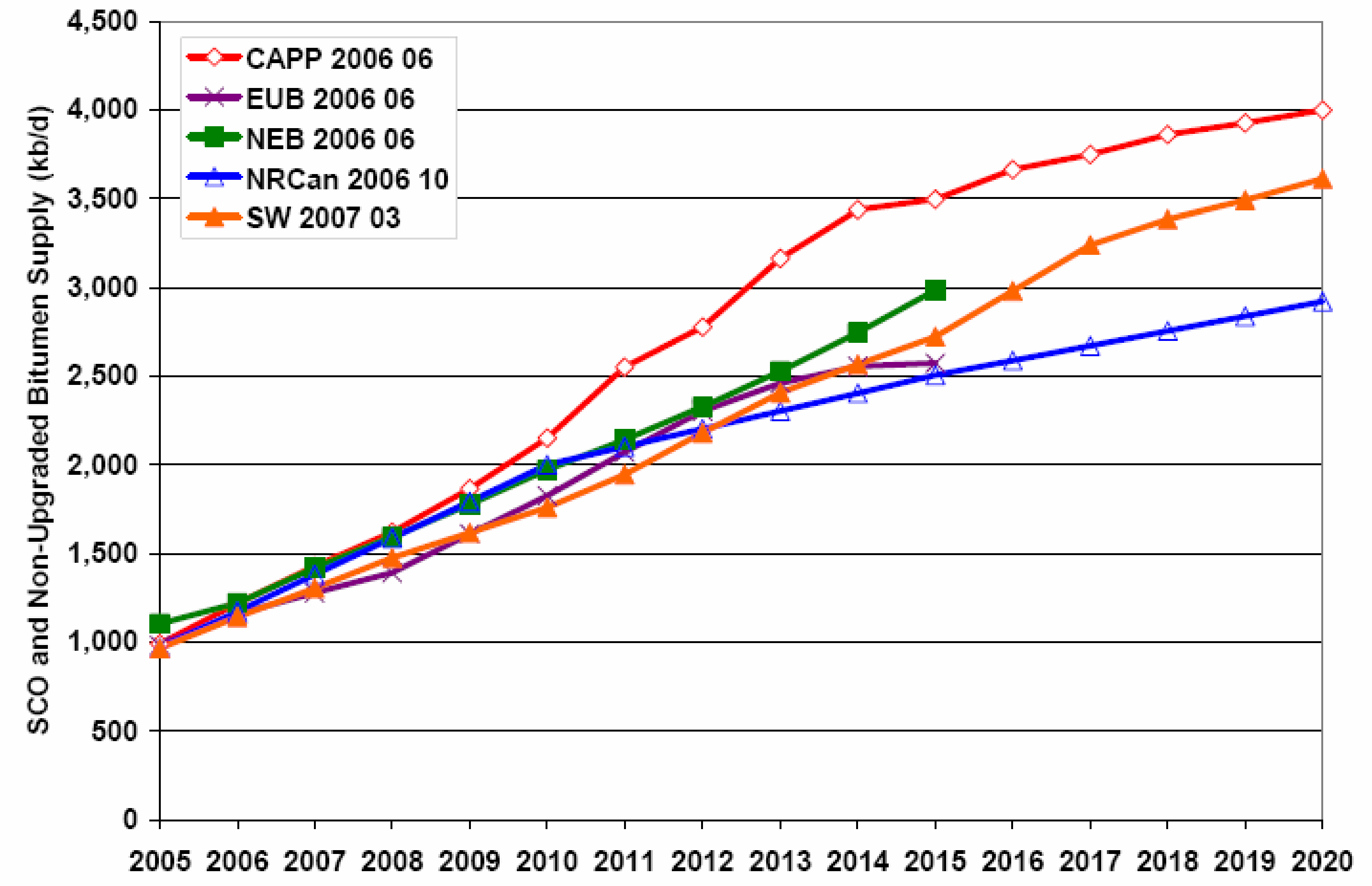
3. Production of Oil sands and Futures Projects





Existing and Proposed Oil Sands Projects until 2020
Capacity in barrels/day
7.000,000
6.000,000
5.000,000
4.000,000
3.000,000
2.000,000
1.000,000
0,000
Operating
Construction
Approved
Application+Disclos.
Announced
Total
All Project Case
Constrained Case

Projections of the oil sands production in 2015 and 2020



4. Projection of GHG-emissions of the Oil Sands Sector

Facts

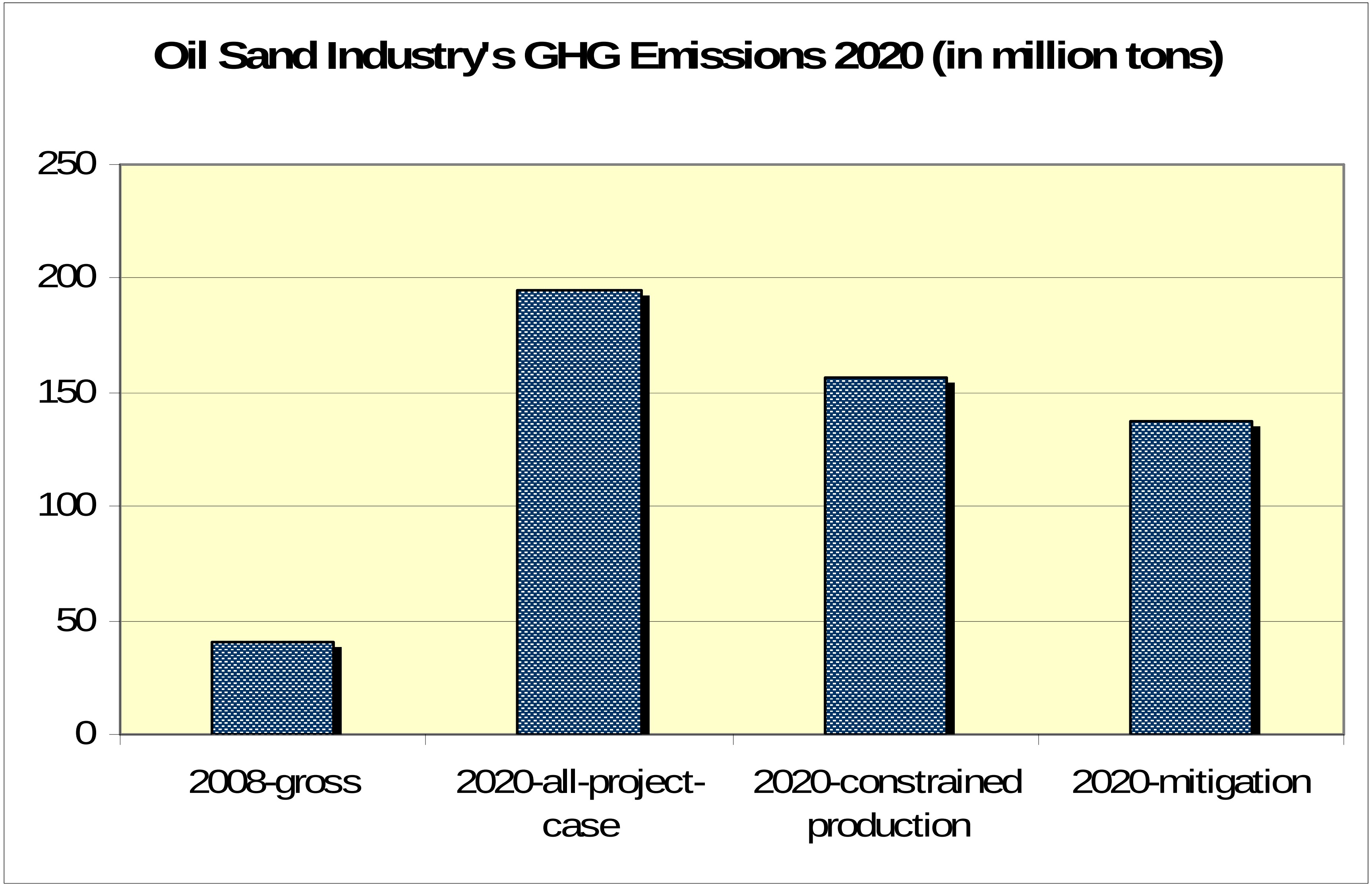
- Oil sands production is very energy-intensive (extraction, upgrading, steam generation)
- Natural gas is dominating

Estimating future GHG emissions

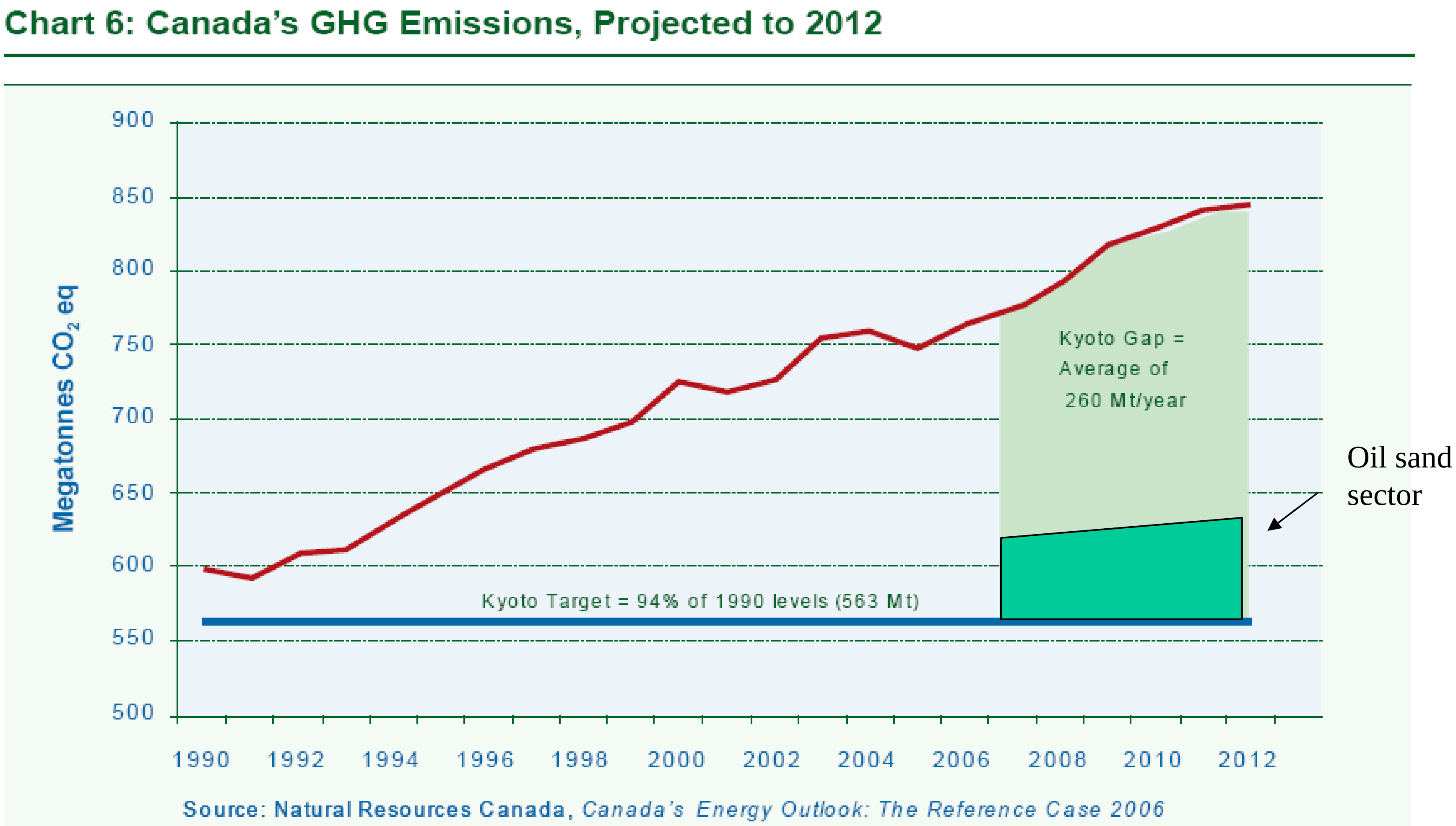
- What kind of production (share of mining and in-situ)
- What kind of in-situ (SAGD, CSS, THAI…)
- What energy (natural gas, no residues, fuel, nuclear) and how much
- Which improvement of energy efficiency
- Size of GHG-emissions from non-point sources (mining-sites, ponds…)

GHG intensity of selected oil sands production processes and upgrading (point- and non-point emissions)

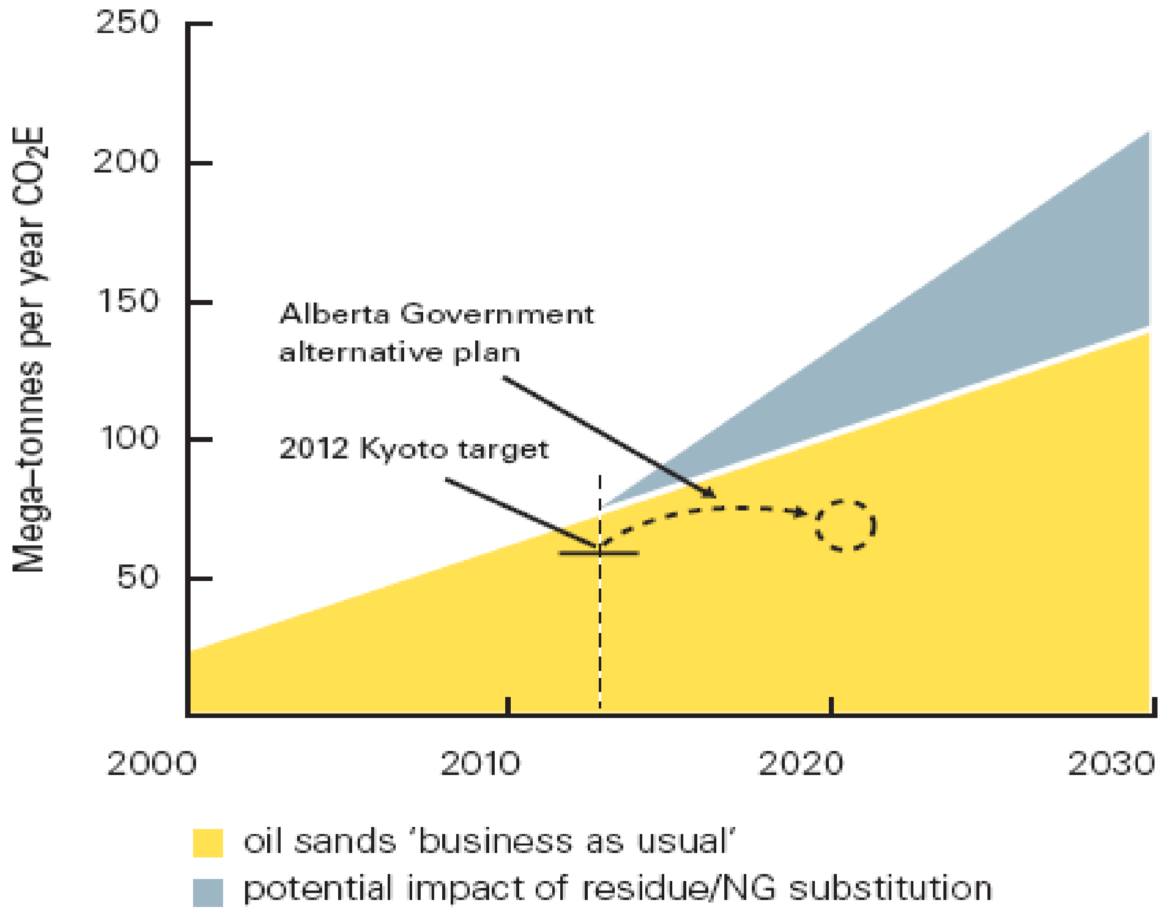
Activity	**GHG Emissions ($kgCO_2e$/ barrel)**
Mining of Bitumen	35
In situ production of bitumen by Steam Assisted Gravity Drainage (SAGD)	55
In situ production of bitumen by Cyclic-Steam-Stimulation (CSS)	90
In situ production of bitumen by Toe-Heal Air Injection (THAI)	65
Upgrading	***45***


Oil Sand Industry's GHG Emissions 2020 (in million tons)
250
200
150
100
50
0
2008-gross
2020-all-project-case
2020-constrained production
2020-mitigation

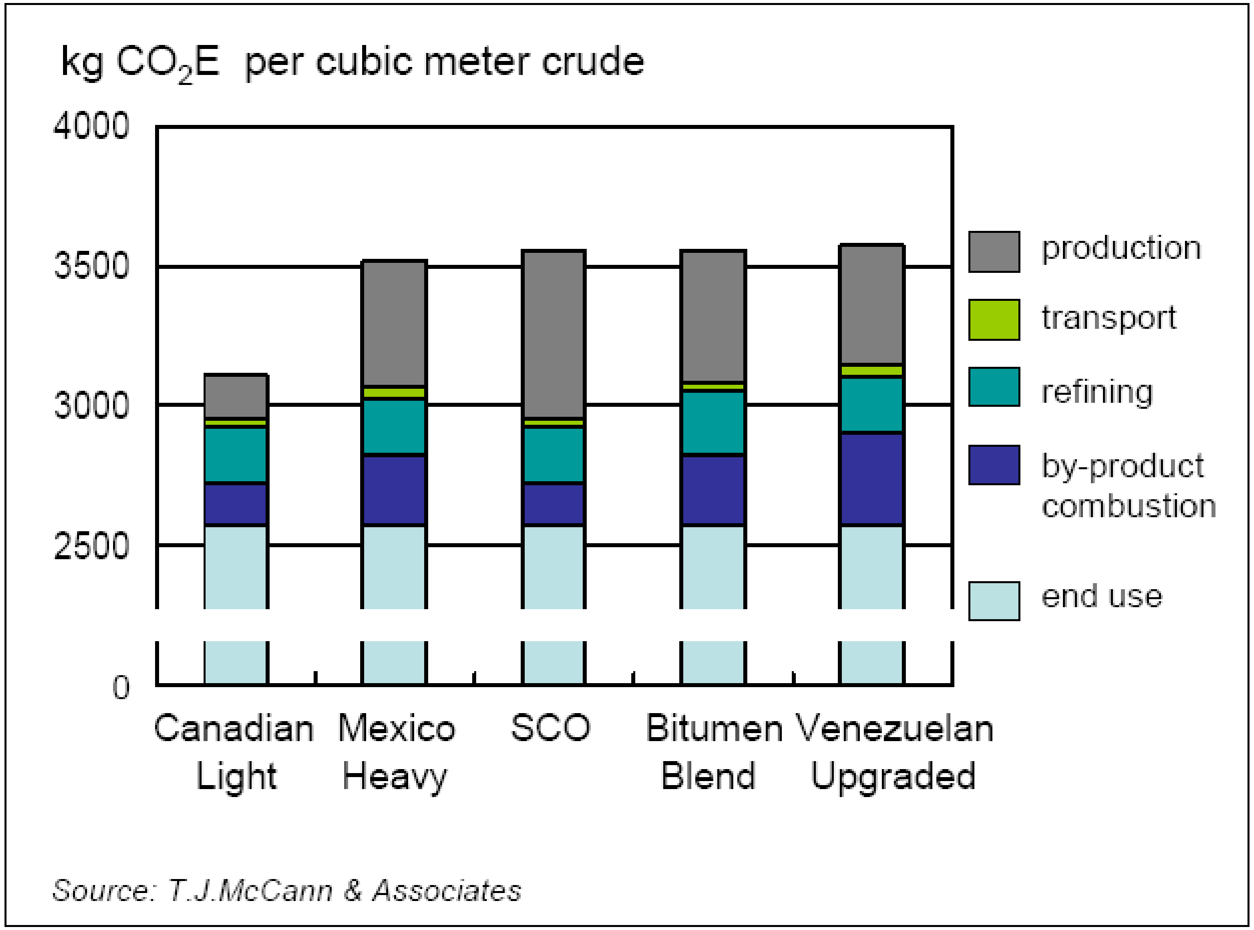
The Canadian Dilemma



Projections of GHG-emissions –with impact of use of residues



Crude Oil Life Cycle Comparison

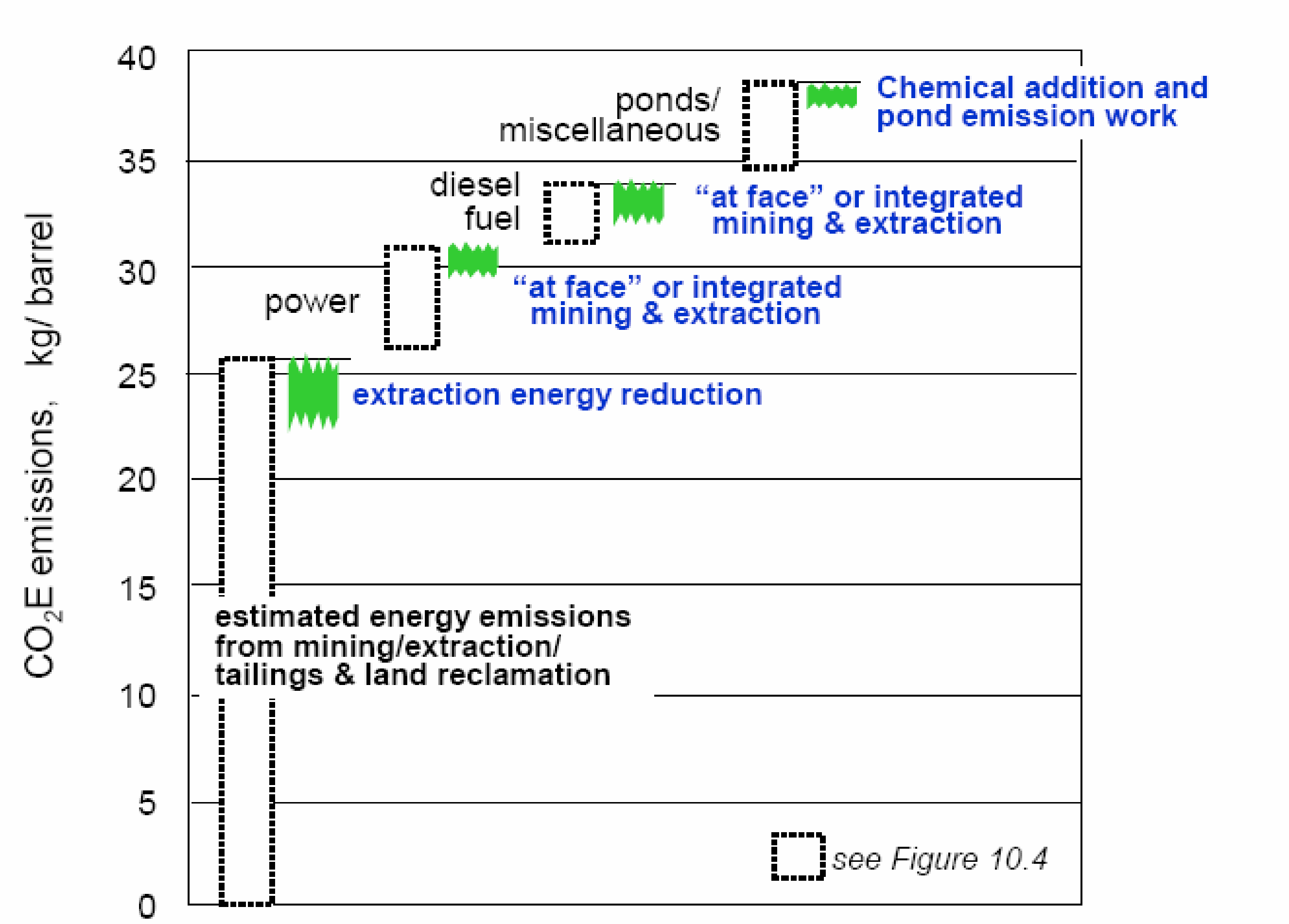


5. Technical and Political Options of Mitigating GHG-emissions of Oil Sands Sector

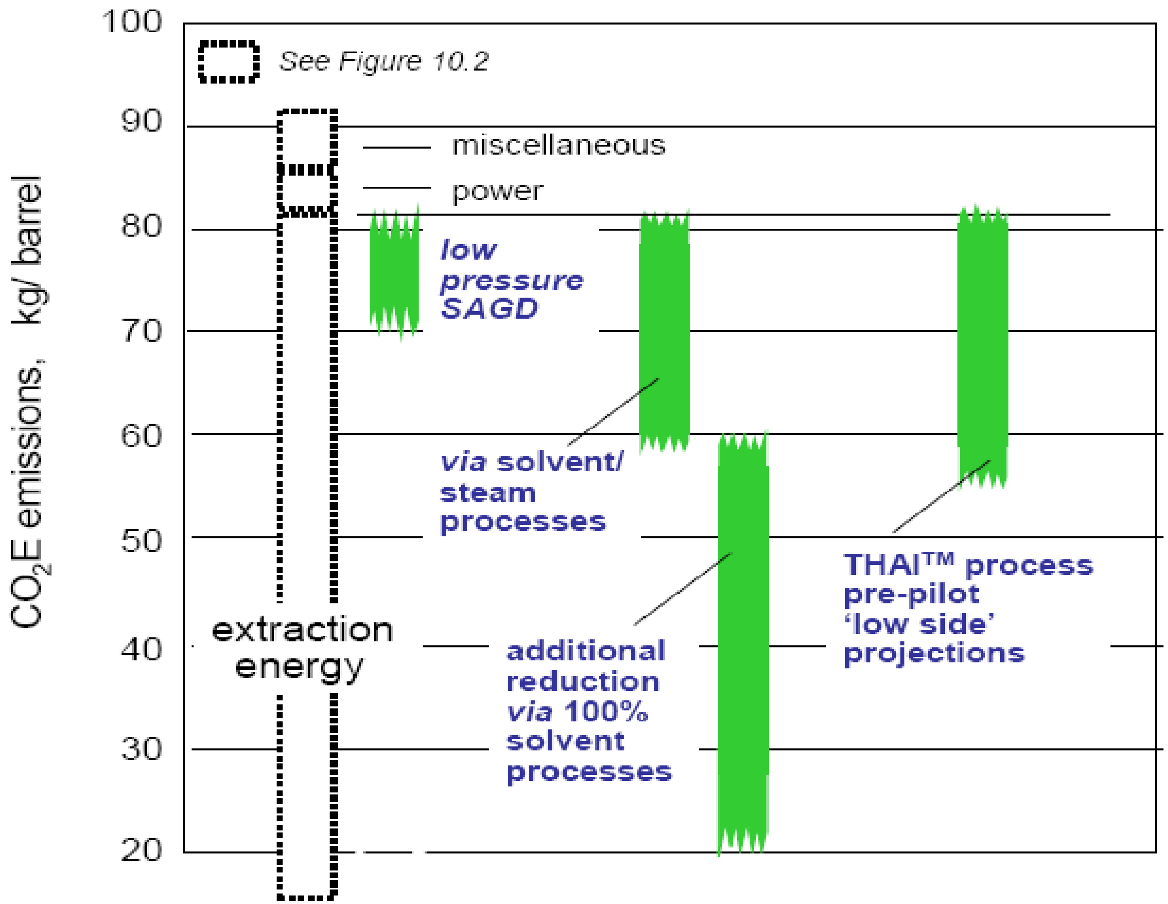
Technical options to reduce GHG emissions

- improving energy efficiency
- fuel switching
- new processes (solvents instead of steam)
- carbon capture and storage (CCS)

GHG-reductions of energy efficient technologies in oil sands mining



GHG-reductions of energy efficient technologies in oil sands in situ production



Benefits , disadvantages and cost of CCS systems in the oil sands industry

System	Description	Benefits	Disadvantages	Cost Range (US$/t$CO_2$)
Pre-combustion	Fuel is gasified into a 'syngas', after which it undergoes a shift reaction where it is converted to hydrogen and CO_2.	Low incremental energy penalty. CO_2 separation and compression is relatively efficient.	Some questions of suitability of using gasification on lower quality fuels (e.g., coke). Hot gas clean-up, issues related to pure H_2 turbines.	18–44
Post-combustion	Flue gas is captured after it has been combusted.	System can be fitted on to many of the existing conventional combustion systems in the oils sands. Most mature technology.	Captures up to 20% of available CO_2. Separation is limited to absorption technologies. Other technologies (membranes or cryogenics) are not yet considered commercially viable. High energy input for separation.	44–62
Oxy-fuel	Fuel is combusted in an oxygen-rich environment, creating a high-purity CO_2 stream.	CO_2 stream is easily captured. NO_x emissions are greatly reduced.	Producing oxygen is energy intensive. High temperature ranges can have adverse effects on materials used.	12–71

Political Options – the target

The government's national GHG-emissions **targets** 2007

	Relative to 2006	Relative to 1990	Relative to the Kyoto target
2010-12	**approx. + 3%**	approx.+ ca. 31%	approx.+ ca. 39%
2020	**– 20%**	approx.+ ca. 2%	approx.+ ca. 8%
2050	**– 60-70%**	approx.– ca. 49-62%	-

Instruments to reduce GHG emissions

The only relevant instrument:

- regulation of GHG-emissions of heavy industries. These industries are accounting for about 45% of all national emissions (2003).
- Existing facilities have to reduce their energy intensity by 6% per year during 2007-2010 (in sum 18%). After 2010 the energy intensity has to be reduced by 2% per year.
- New facilities have to meet special requirements.
- Firms that fail to reduce their energy intensity will have to make payments into the technology fund. The payment rate is set at 15$ per ton of CO_2e for 2010-12 and 20$ per ton in 2015

Targets and Instruments of the Regulatory Framework for Air Emissions 2007

Targets

Existing facilities

- 6% improvement each year from 2007 to 2010, giving an enforceable 18% reduction from 2006 emission intensity, starting in 2010
- 2% annual improvement thereafter

New facilities

- 3-year grace period
- Clean fuel standard
- 2% annual improvement

Ways to comply
(in addition to in-house reductions)

Climate change technology fund: *one fund/two components*

- Deployment & Infrastructure: access as % of total target over 2010-2017 period – 70%, 65%, 60%, 55%, 50%, 40%, 10%, 10%
- Research & Development: access over 2010-2017 period – 5 Mt annually
- Explore credit for certified project investments
- Contribution rate to funds ($/tonne over 2010-2017 period) – $15, $15, $15, $20, $20 escalating with GDP

Trading

- Domestic trading
- Access to domestic offsets
- Access to Clean Development Mechanism at 10% of total target
- Actively explore linkages to a Canada-U.S, -U.S. regional or -state-level greenhouse gas emissions trading system

Credit for early action of 15 Mt

Weaknesses of the Program

Summing up the discussion of the targets and the regulatory framework several weaknesses are obvious:

- the targets fall short of Canada's legal obligation to the Kyoto Protocol
- the regulatory framework is concentrated on the heavy industries
- regulating the emission intensity does not ensure that the targets are met

Alternate Approach

Proper alternative:

Emissions trading system including all relevant sectors.

It ensures that the reduction of GHG-emissions will take place in those sectors that show the highest marginal cost of GHG reductions.

The impacts on the oil sands industry depend on the carbon price (price of GHG emissions rights).

High prices of emission rights will let the industry revise their production plans, including the oil sands industry.

6. Conclusion

- Production of non-conventional oil is energy intensive and carbon-intensive
- Other types of heavy oil show similar properties
- The oil sands are not the reason, but part of the Canadian dilemma (energy intensive industries, high demand of energy in the housing, commercial and traffic sector and voluntary measures)
- Effective and efficient options are available

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