Canadian Oil Sands: Development and Future Outlook

National Academies Workshop on Trends in Oil Supply/Demand and Peaking of Conventional Oil Production

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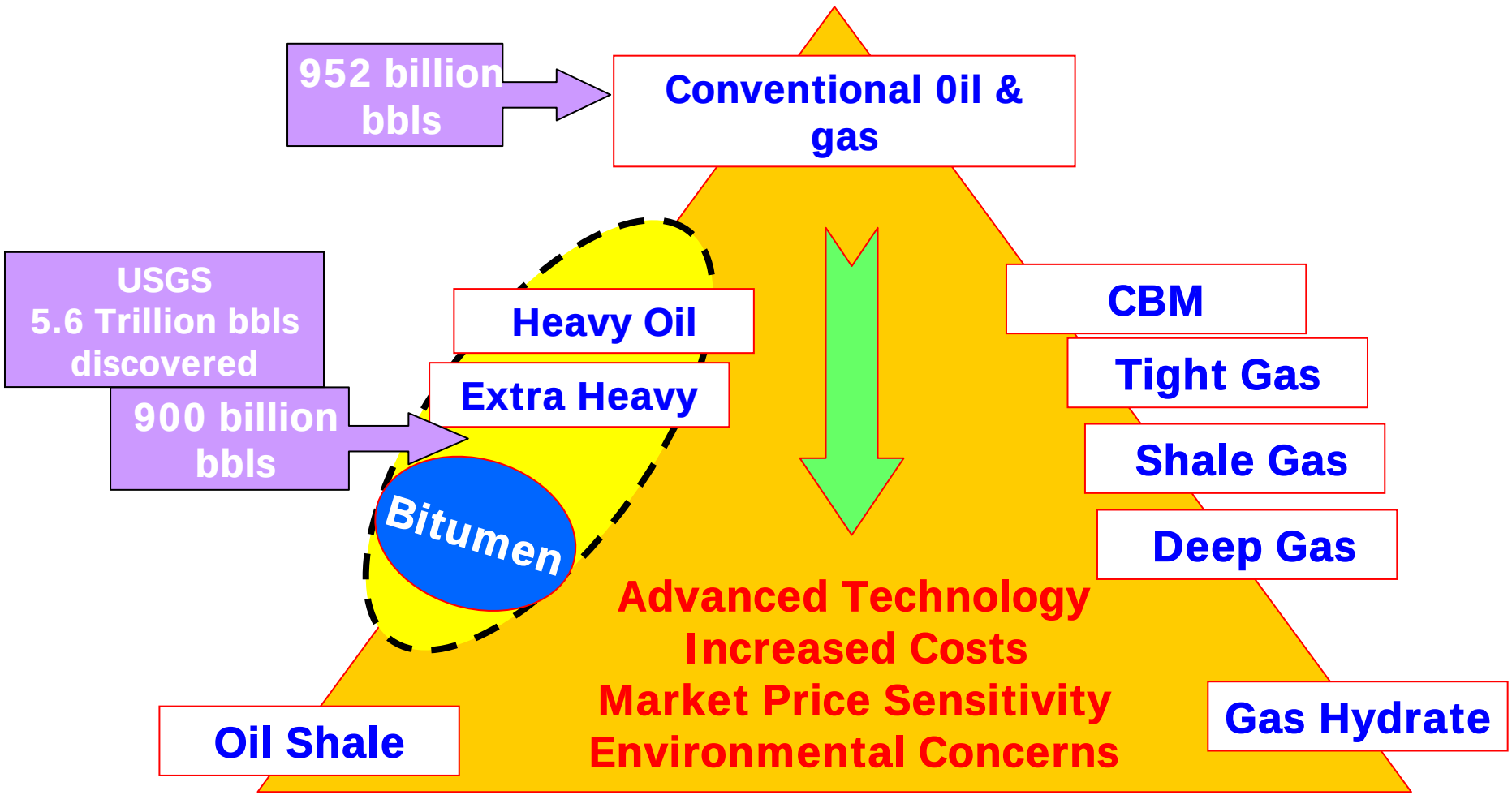
Conventional vs. Unconventional Resources



Modified from Holditch (2002) & Etherington (2005)

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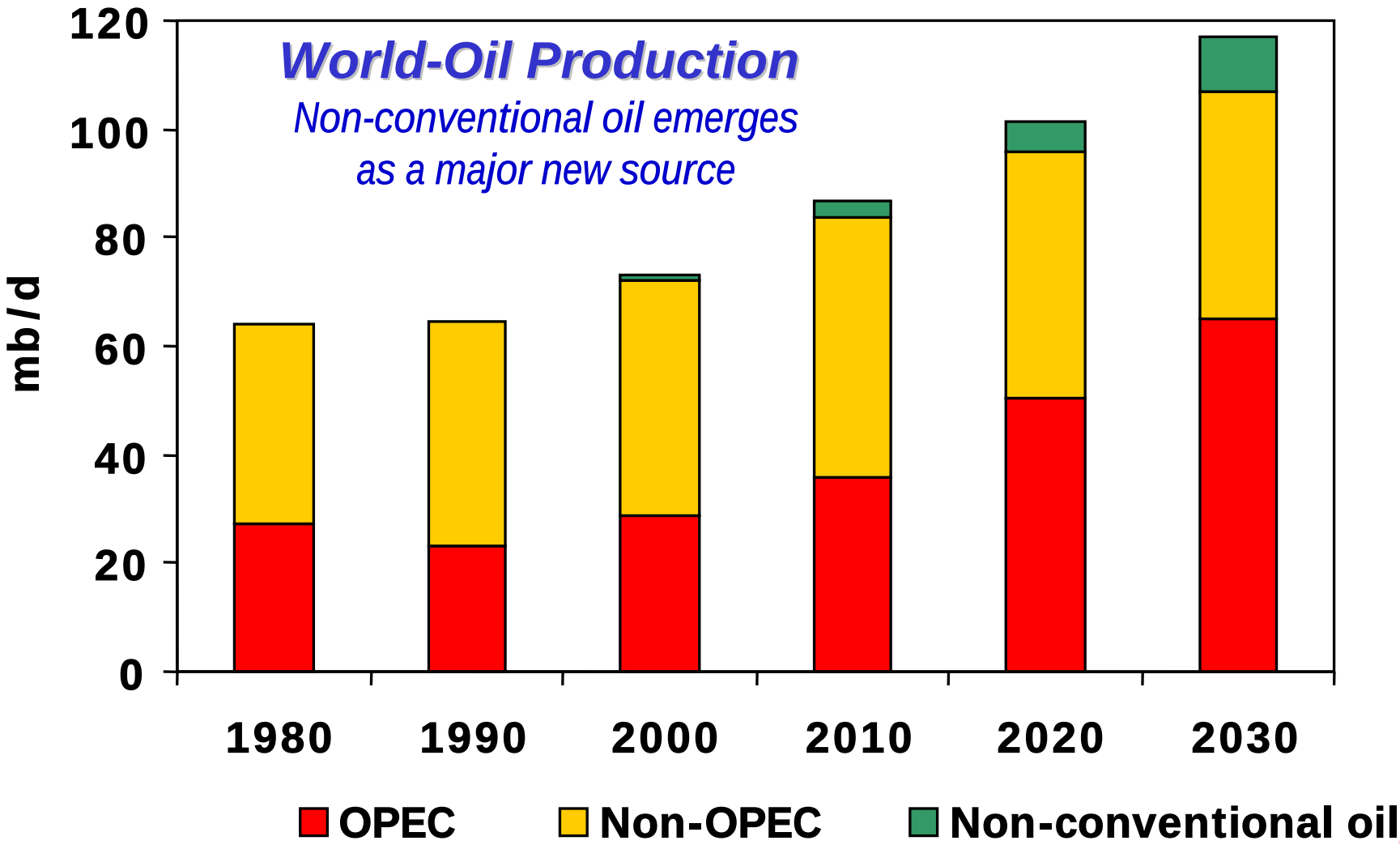
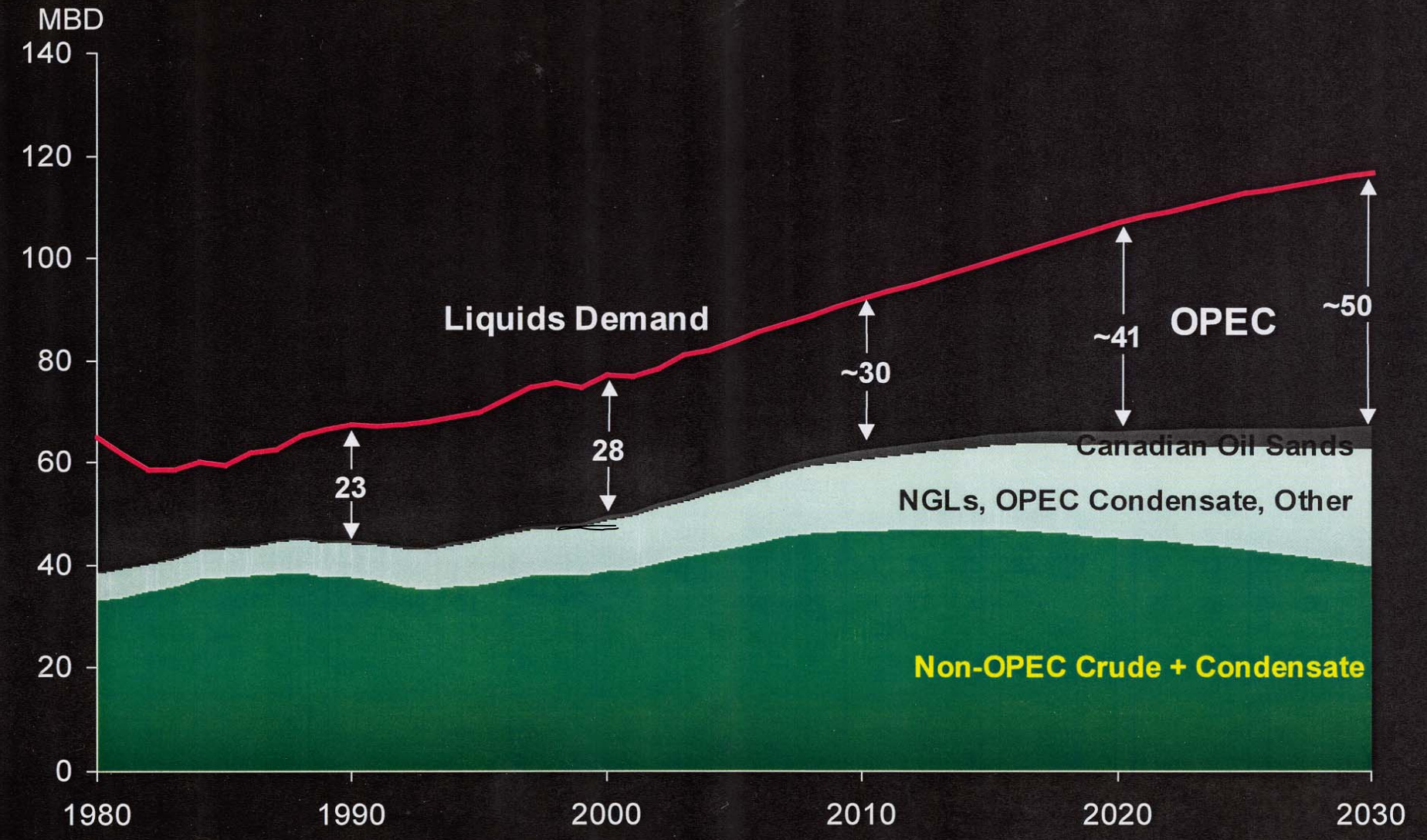
How Much will Non-conventional Oil Contribute?



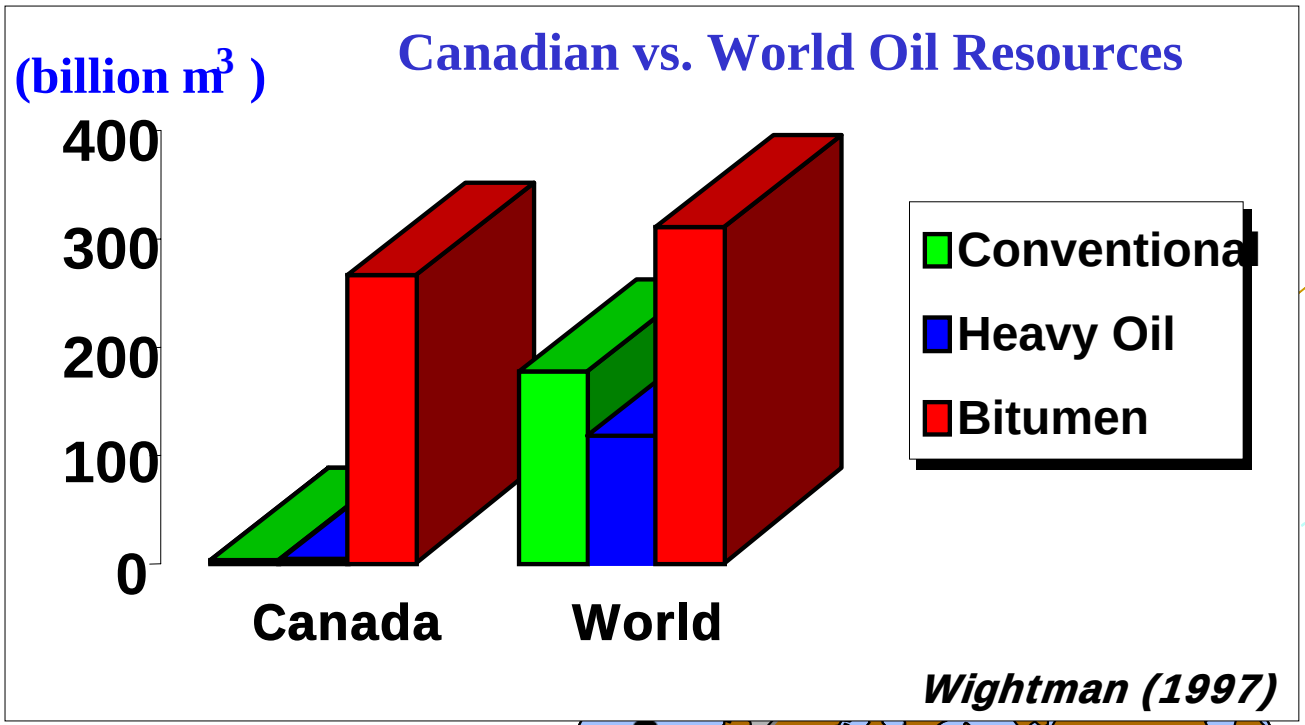
Courtesy: International Energy Agency, World Energy Outlook (2002)

World Liquids Production Outlook



ExxonMobil

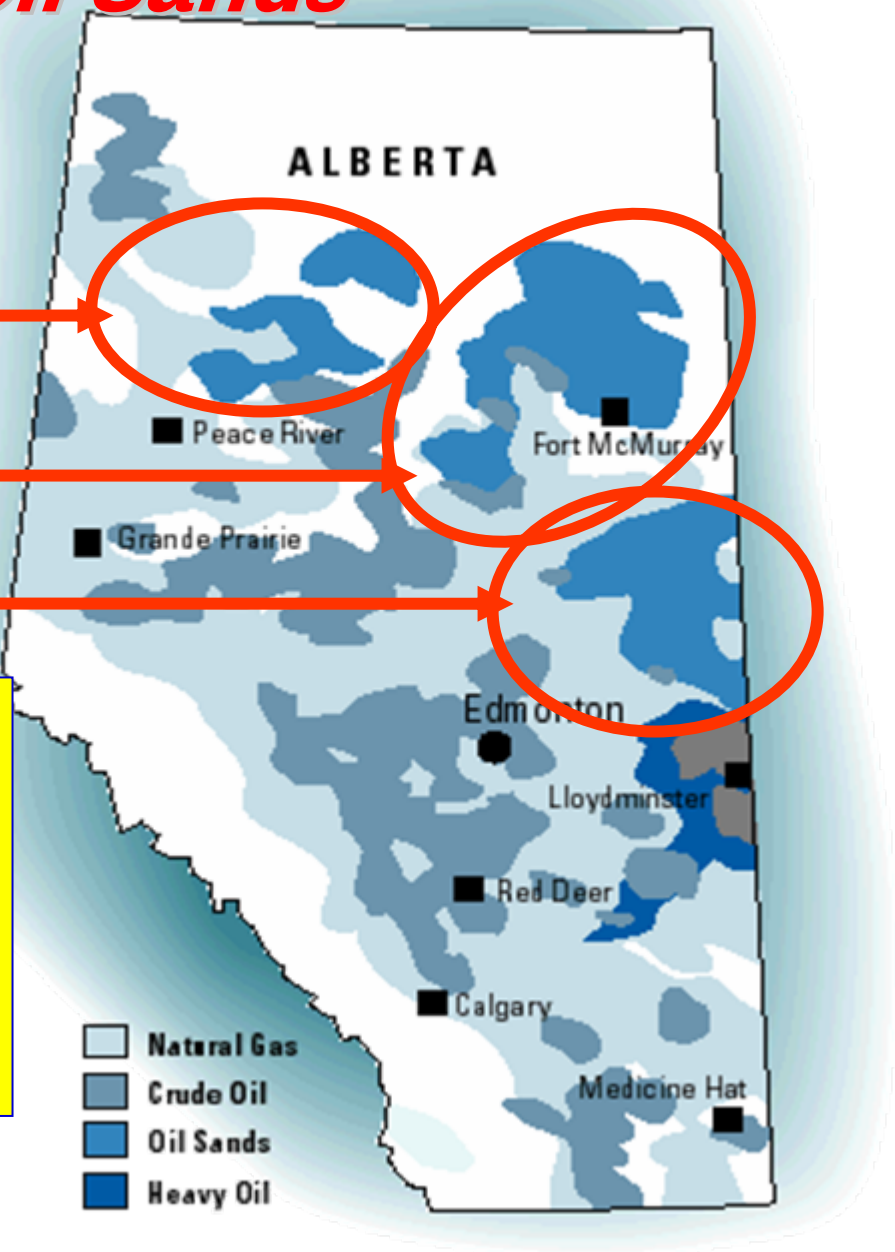
Canadian Oil Sands – Huge Resources



Canada's Oil Sands

Three locations:

- **Peace River**
- **Athabasca**
- **Cold Lake**

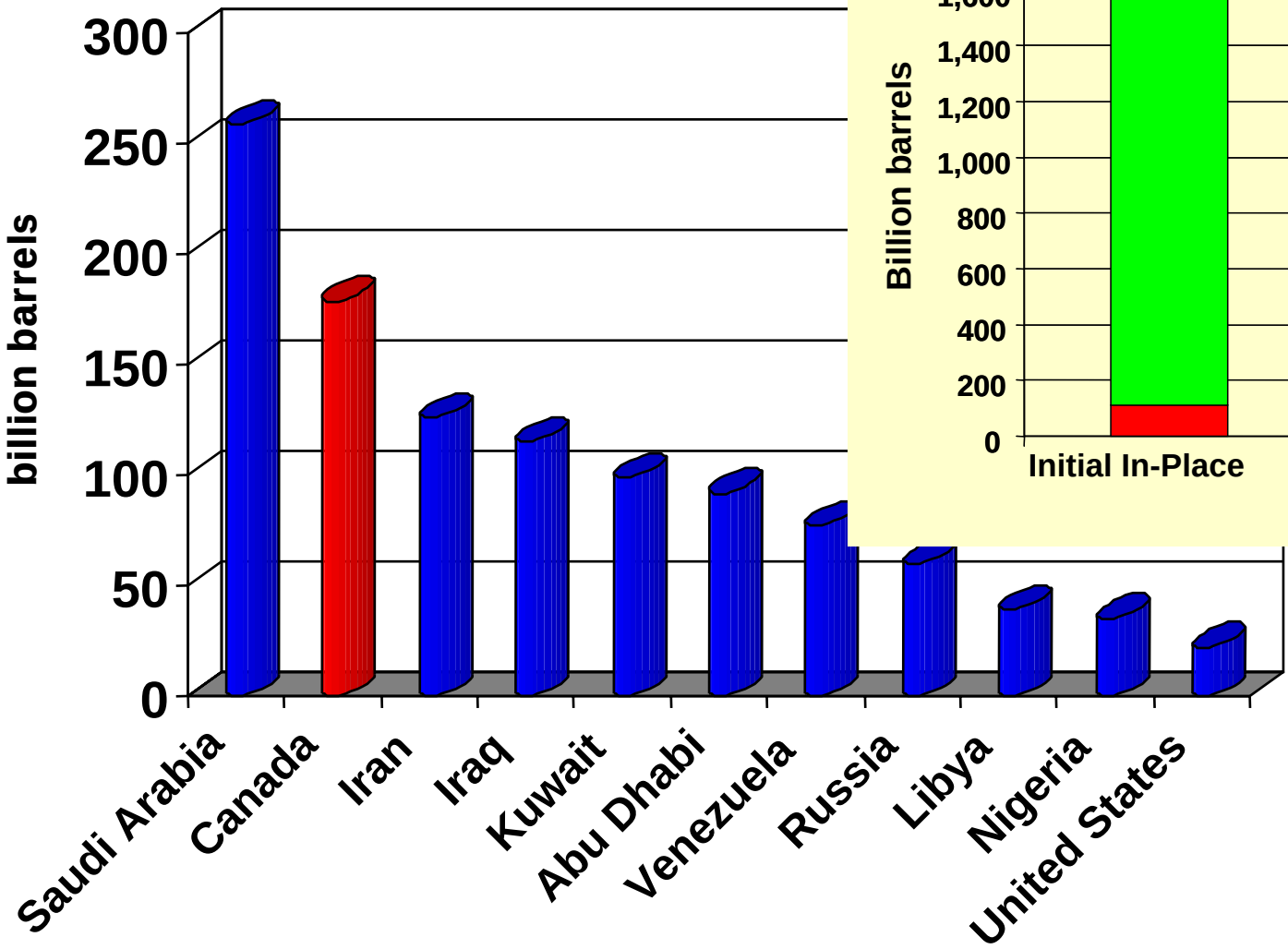


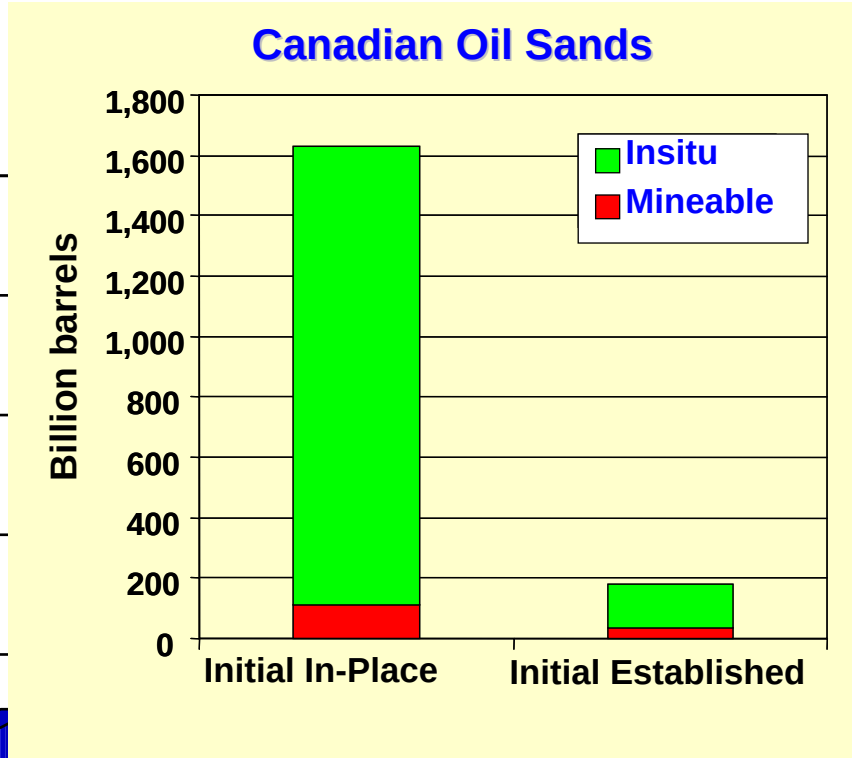
Reserves (2003 - EUB)

(Billion Barrels)

	Oil Sands	Conv.
Oil-in-place	1,629	62
Est. Reserves	175	2
Rem. Ult. Pot'l	310	5

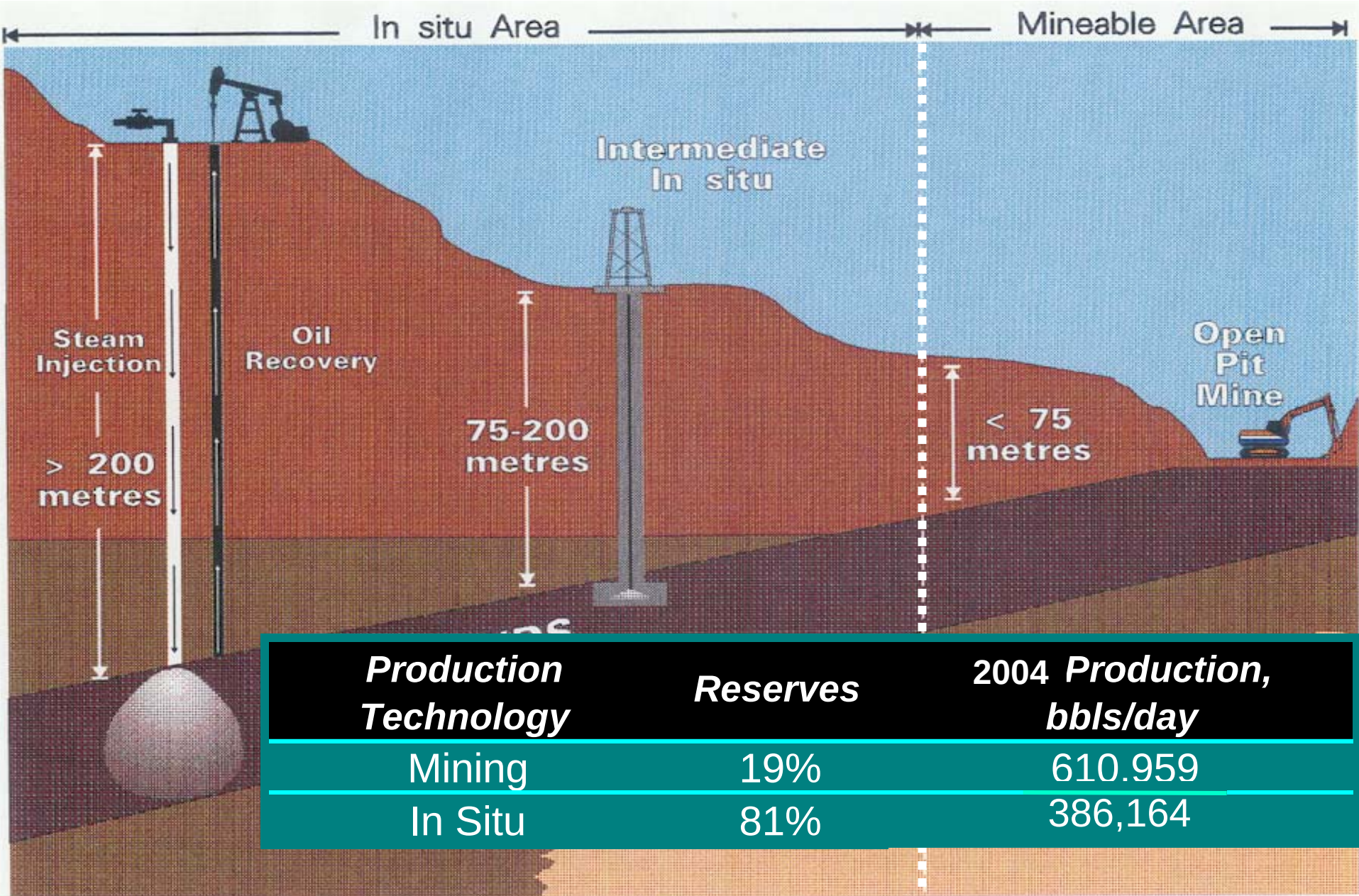
Proven World Oil Reserves





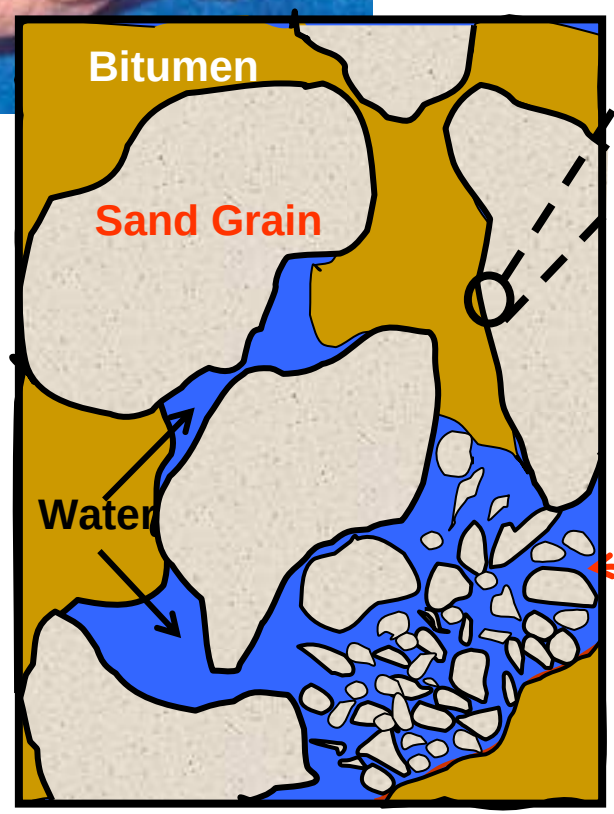
Source: Oil & Gas J, December 2004

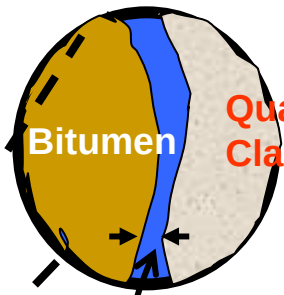
The Nature of the Oil Sands Resource



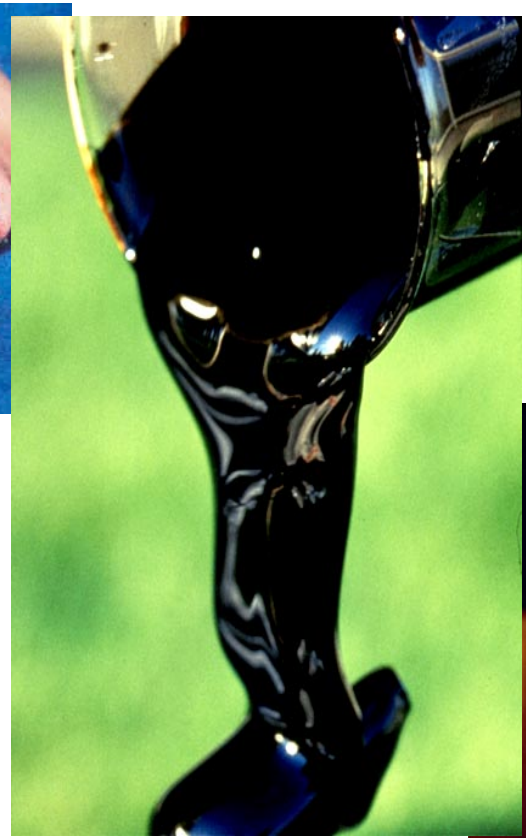
Production Technology	Reserves	2004 Production, bbls/day
Mining	19%	610.959
In Situ	81%	386,164

Oil Sands - What is special?



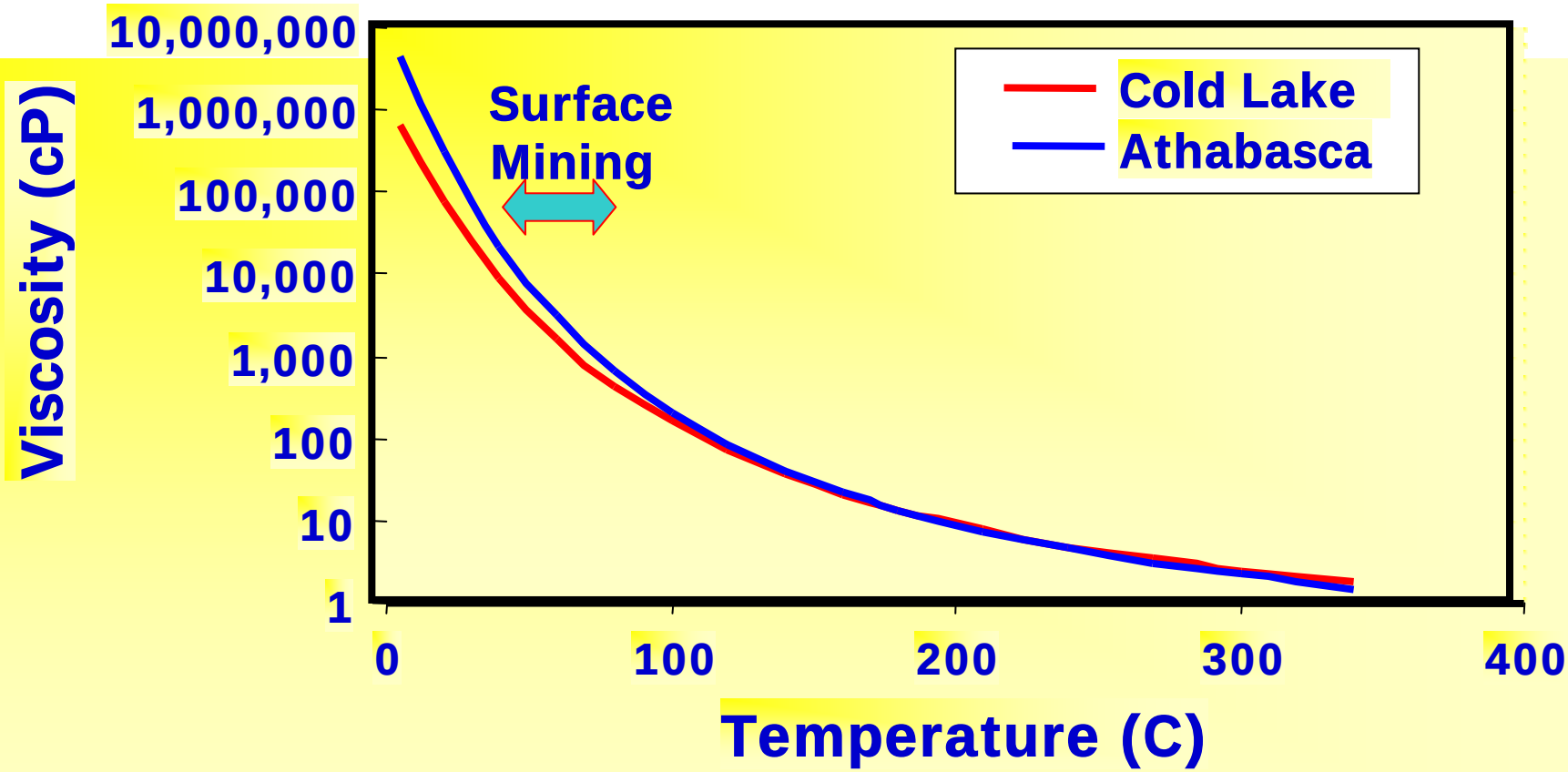


"Technology Oil "
Continuous Innovation Since the 1930's



From Oil Sands → To Bitumen → to Synthetic Crude Oil

Producing Bitumen – Surface Mining



Innovation in Mining Technology

From Draglines to Shovel & Truck Operations

1970

2000

400 tonne Ore Trucks

Slurry Hydrotransport – Remote Mine (Separation during flow)

Mining Extraction to Produce Bitumen

Mining

- Draglines, Bucketwheels & Conveyor Systems
- Truck & Shovel Feed System
- Hydrotransport System

Oil Sand

Oil Sand Slurry

Extraction

Tumblers → Primary Separation Vessel → Froth Treatment

Upgrading

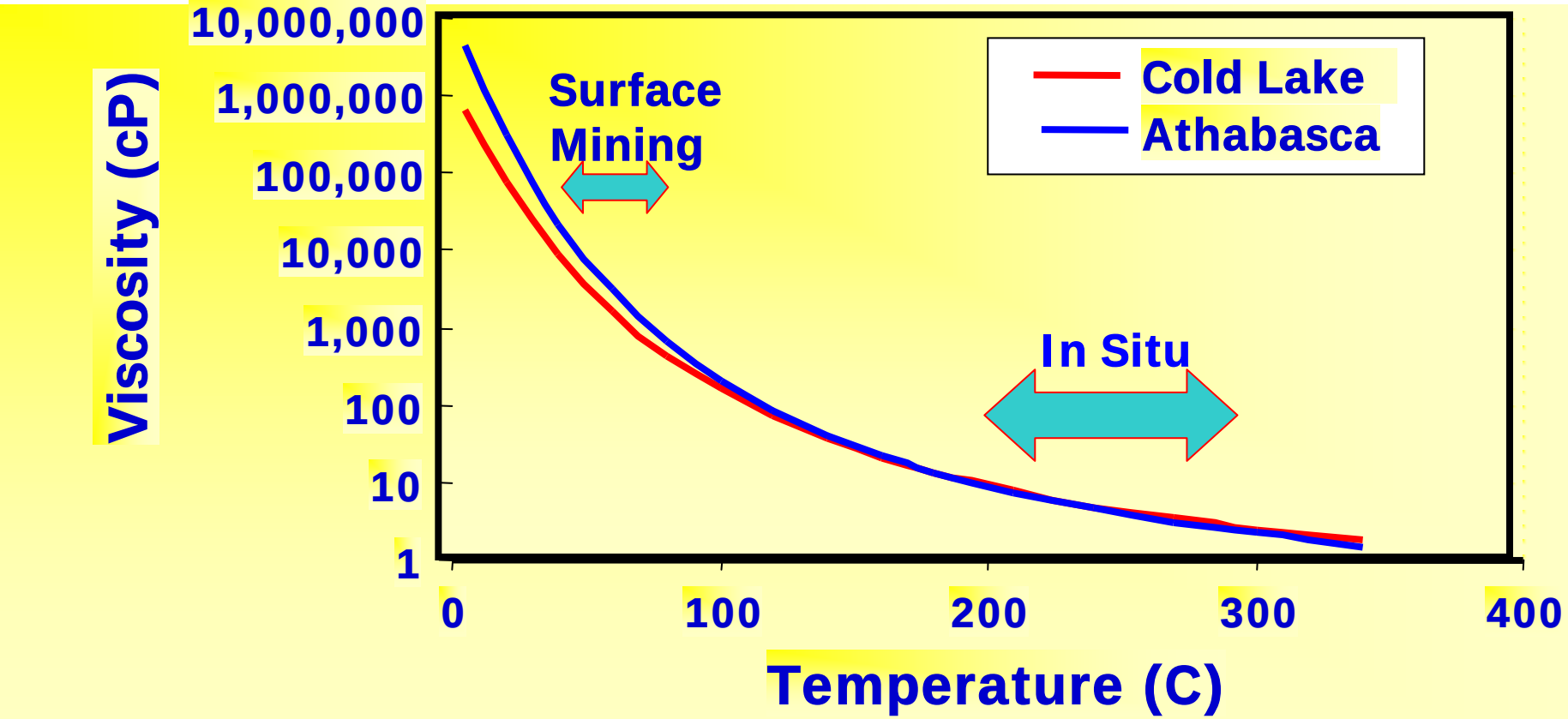
(lots of H_2)

Mining *Projects – Who is playing the game?*

1980	2000	2005+
Suncor	Suncor	Suncor
Syncrude	Syncrude	Syncrude
		Albian / Shell
		CNRL
		Imperial
		Synenco
		Fort Hills

Not an all inclusive list

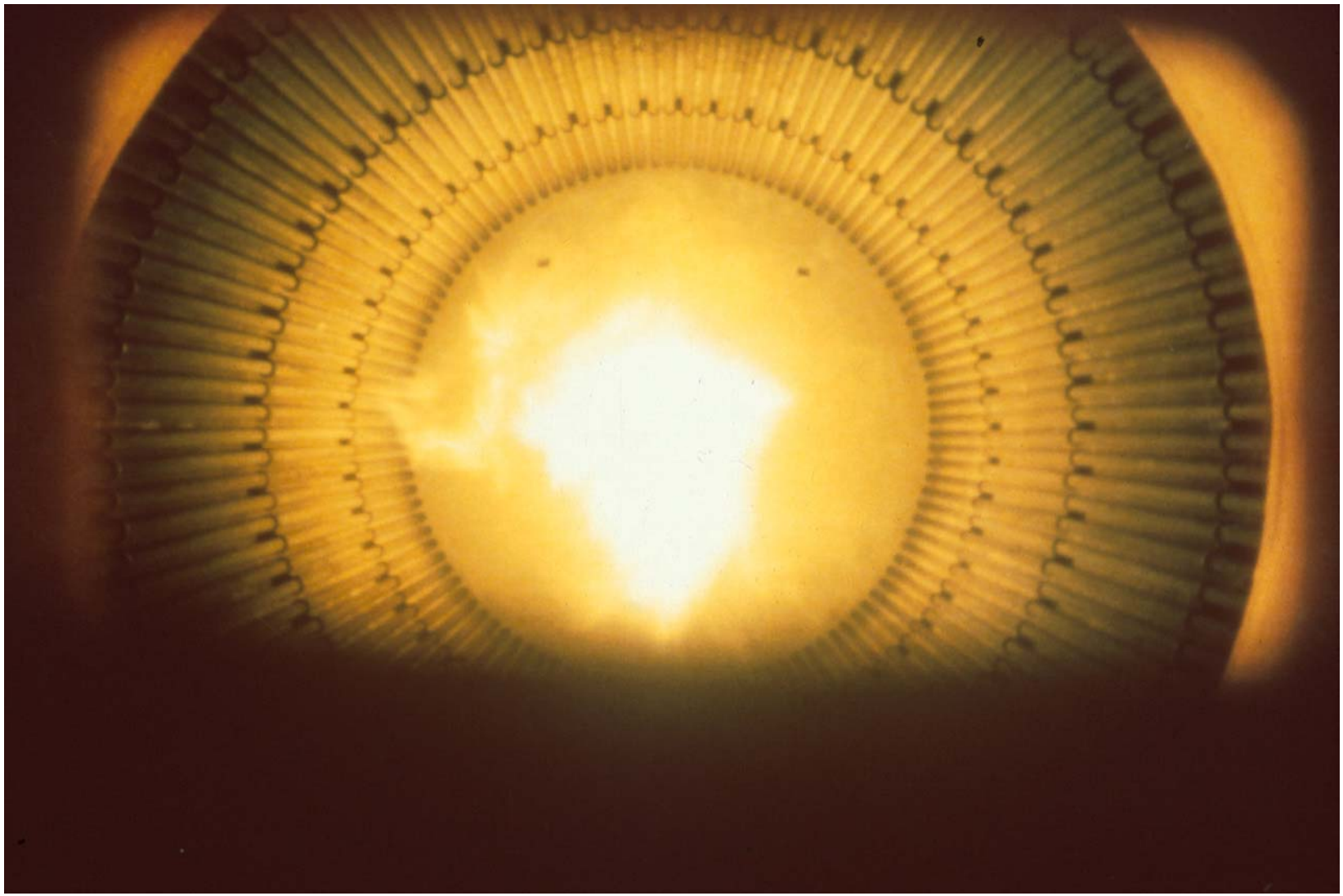
Producing Bitumen – In Situ



Transporting Steam Generators – Radiant Section

Courtesy of Mark E. Doig

Steam Generator – Burner Flame



Courtesy of Mark E. Doig

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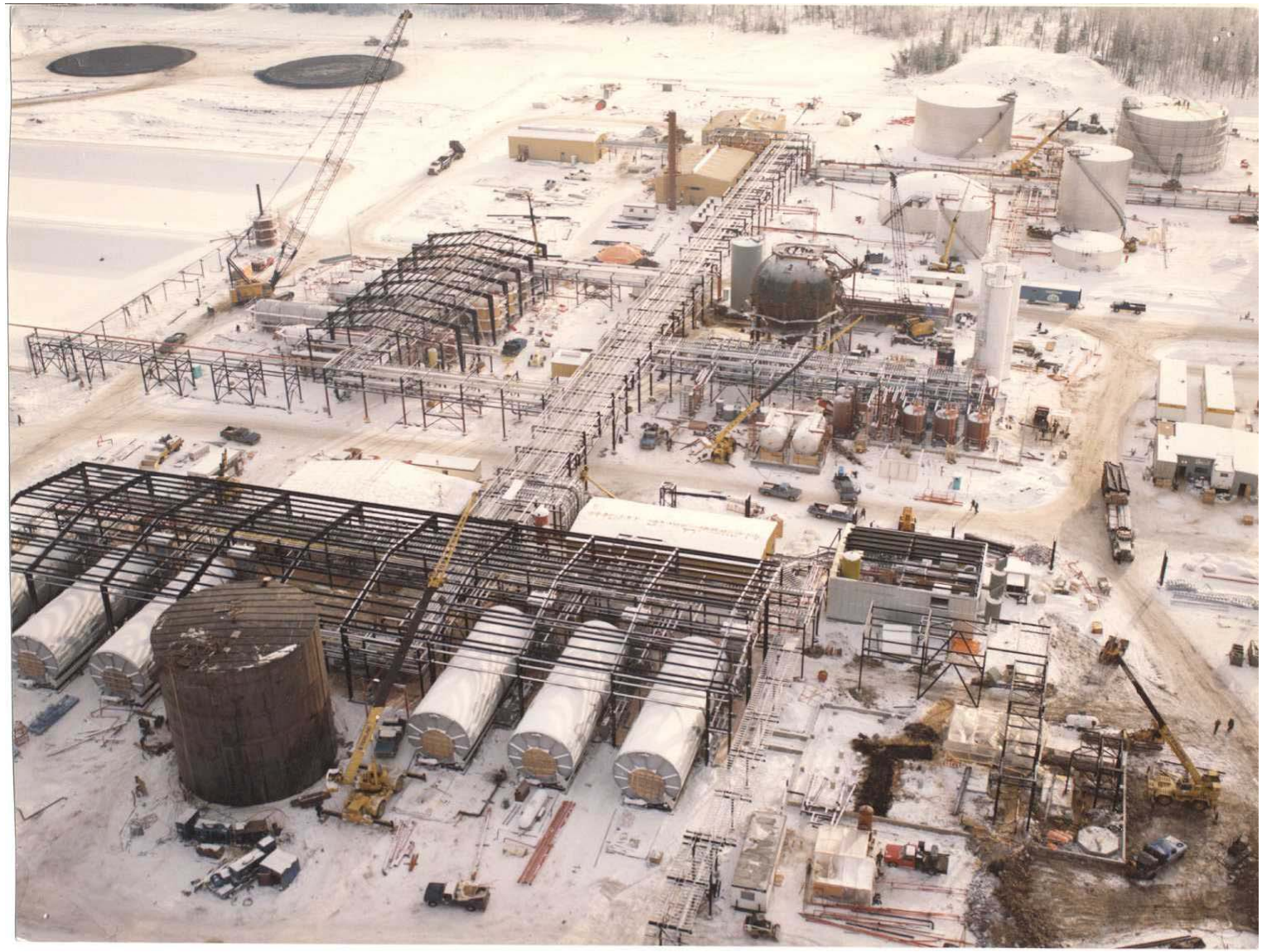
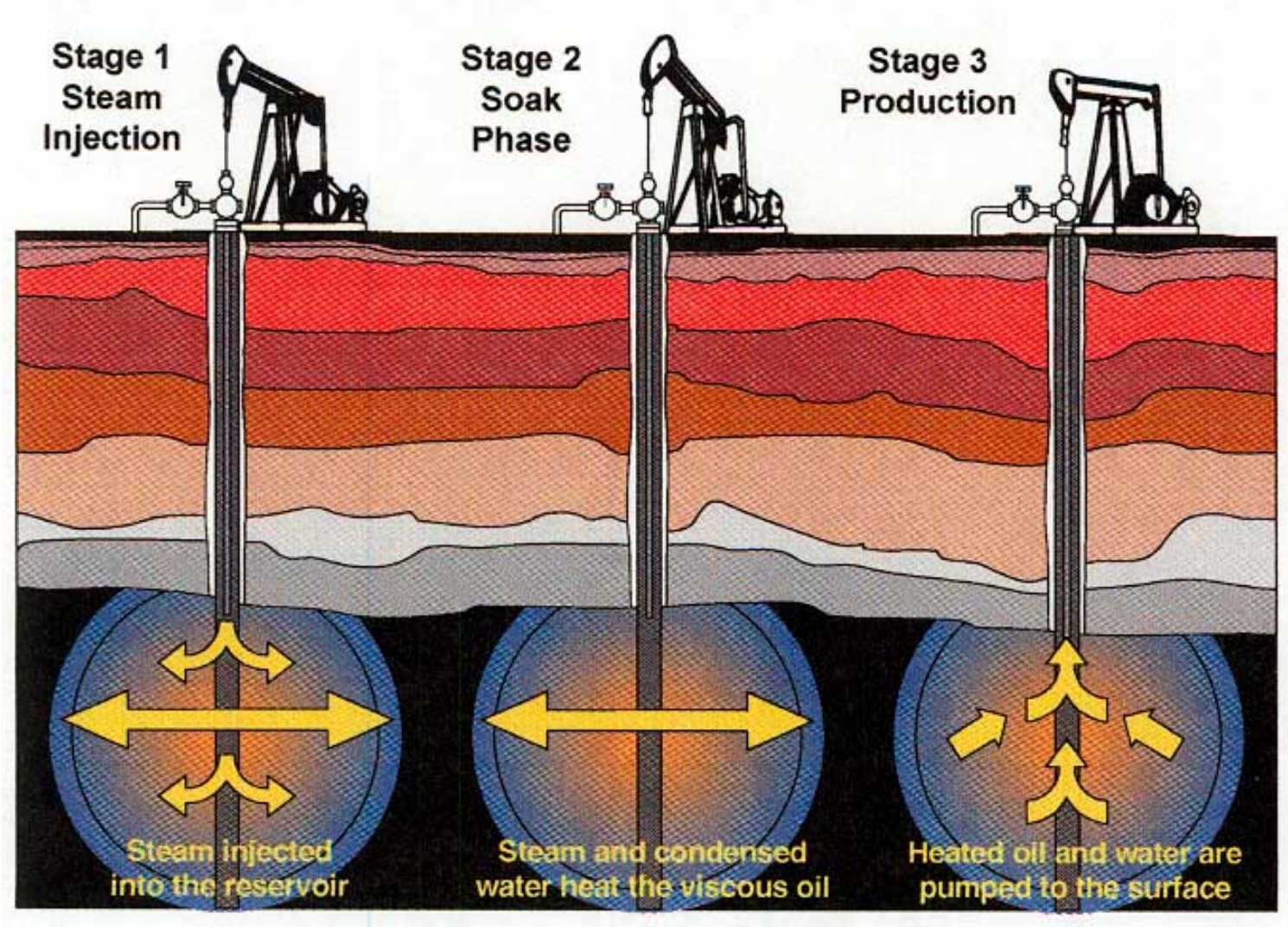
Central Plant Under Construction



Courtesy of Mark E. Doig

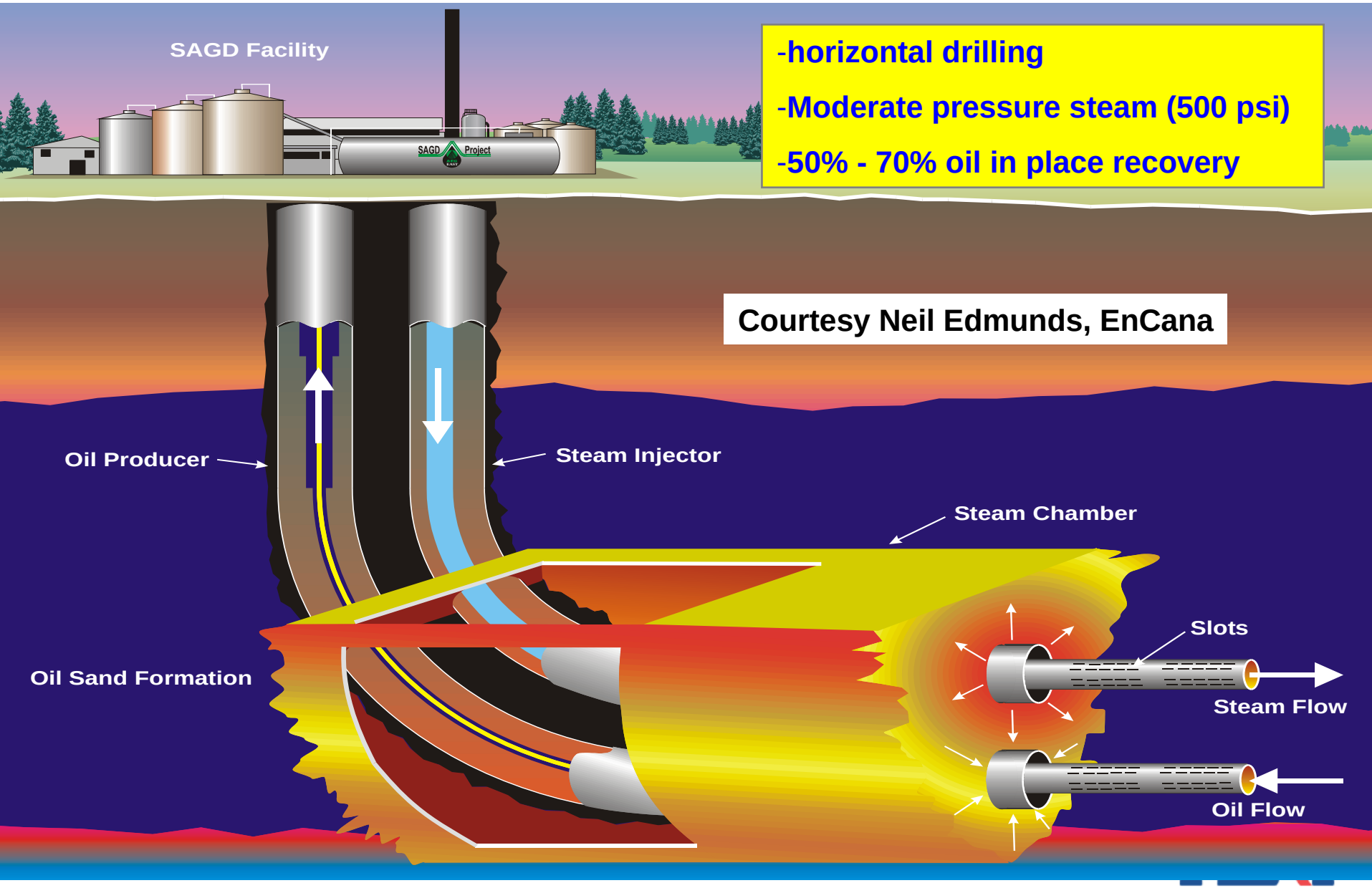
In Situ Production Technology
Cyclic Steam Stimulation Process



Drilling Technology Minimizes Land Disturbance

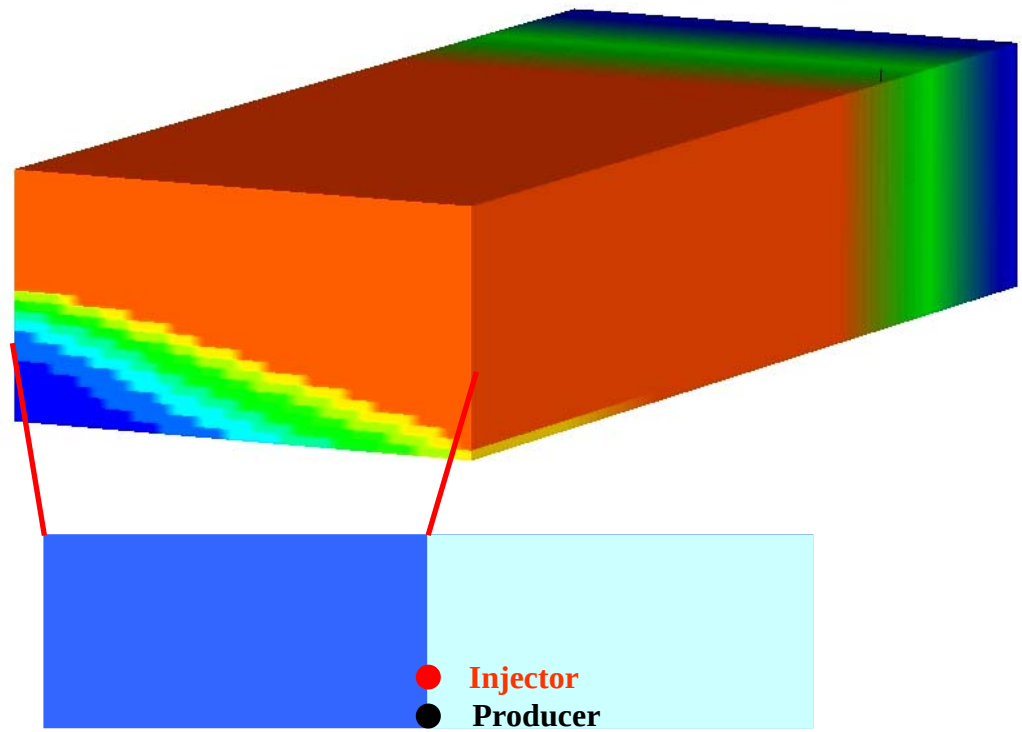
Imperial Oil Cold Lake - Cyclic Steam Project 125,000 bbl/day

Steam Assisted Gravity Drainage (SAGD)- Schematic

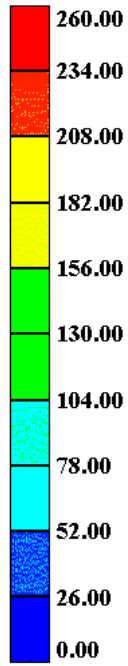


Gravity Drainage Concept
(SAGD Process)

Steam Chamber Development



Temperature
(°C)



Courtesy: David Law, Alberta Research Council

Steam Assisted Gravity Drainage Wells

Source: Suncor

In Situ *Projects – Who is playing the game?*

1980	2000	2005+	
Imperial	Imperial	Imperial	JACOS
	AEC	EnCana	Deer Creek
Numerous	CNRL	CNRL	OPTI/Nexen
Experimental	Shell	Shell	BlackRock
Projects	PanCdn	Suncor	ConocoPhillips
	Numac	PetroCanada	Husky
	Northstar	MEG/CNPC	Devon
	Murphy	Total	

Not an all inclusive list

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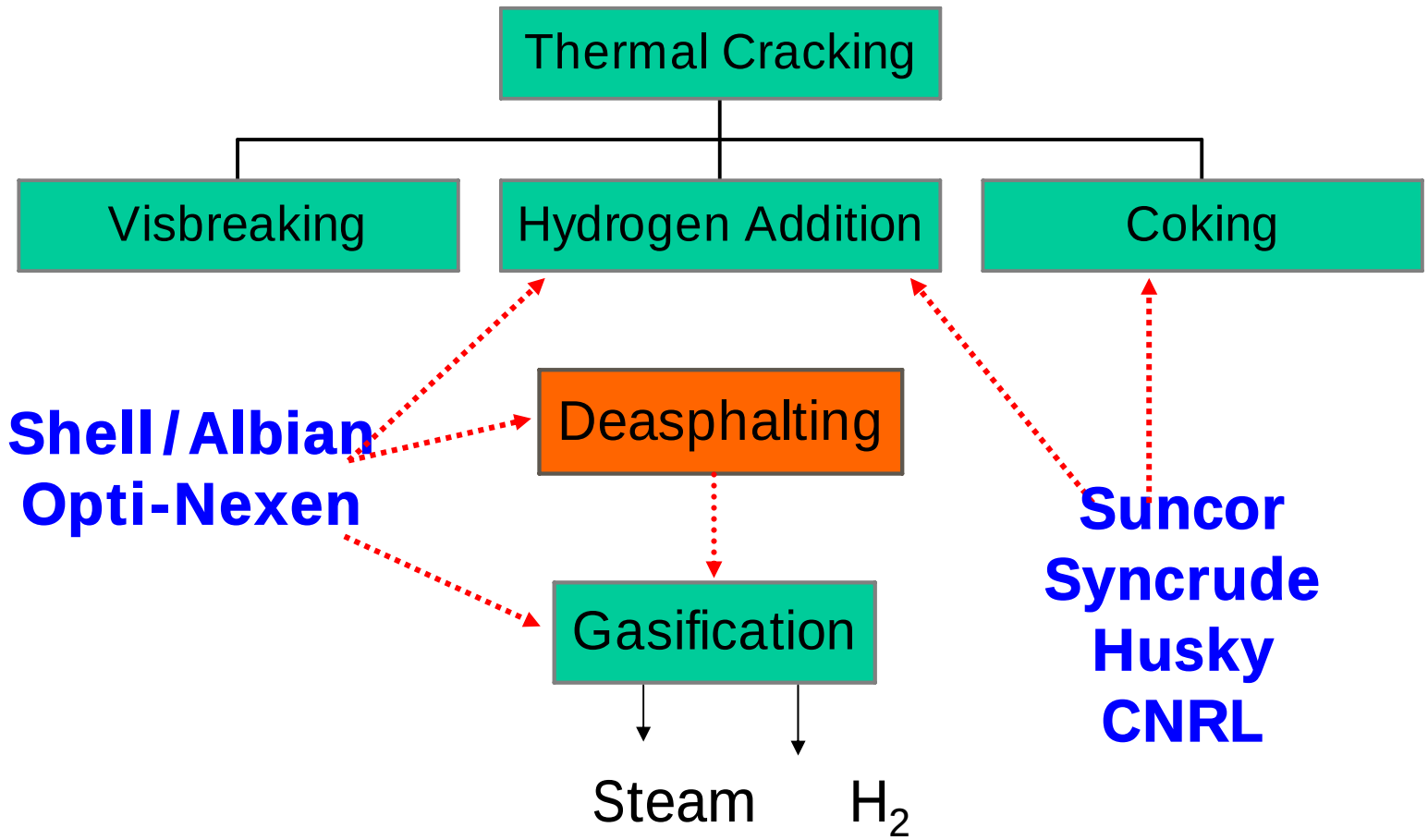
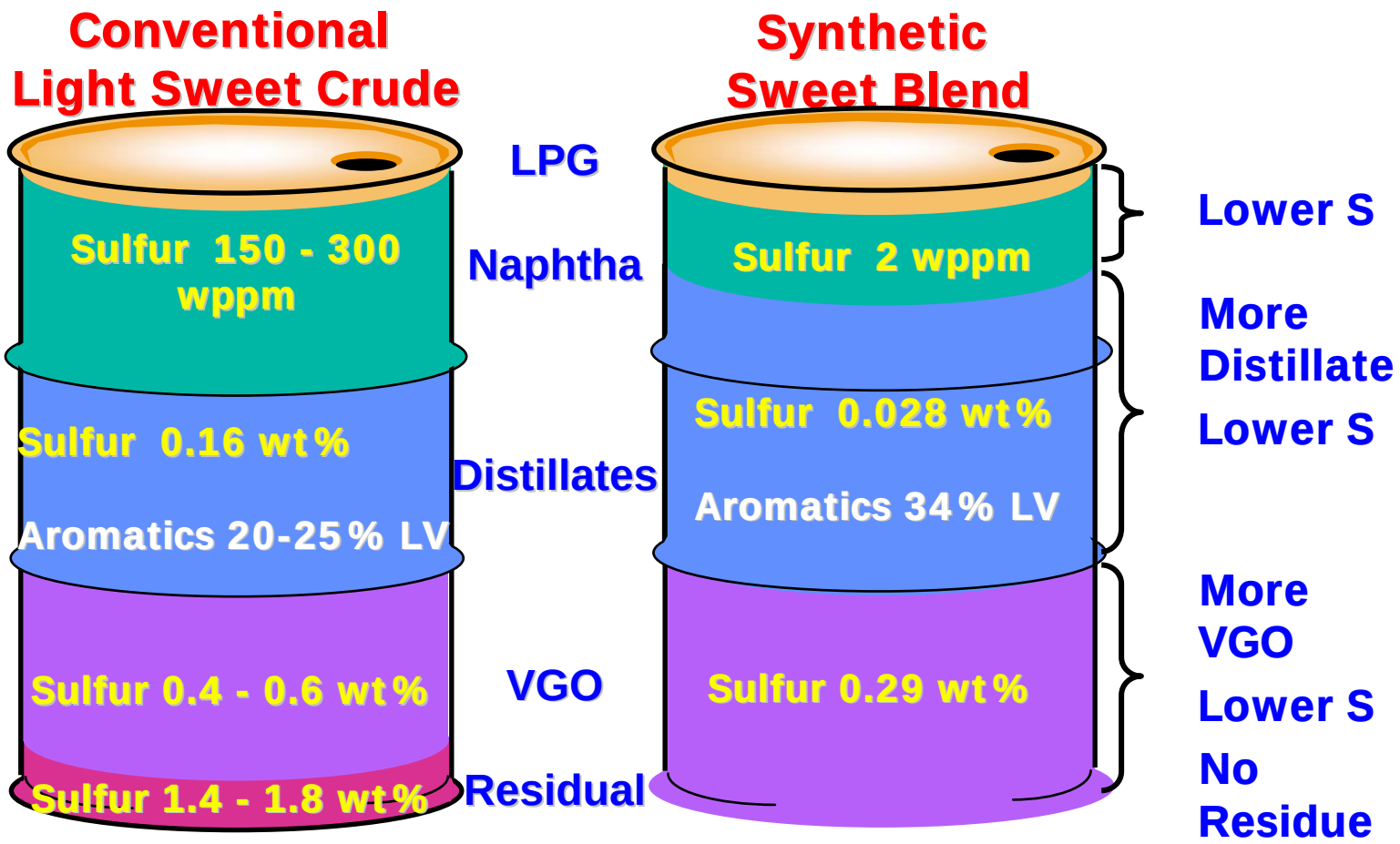
Upgrading Technology – 1940 - Today

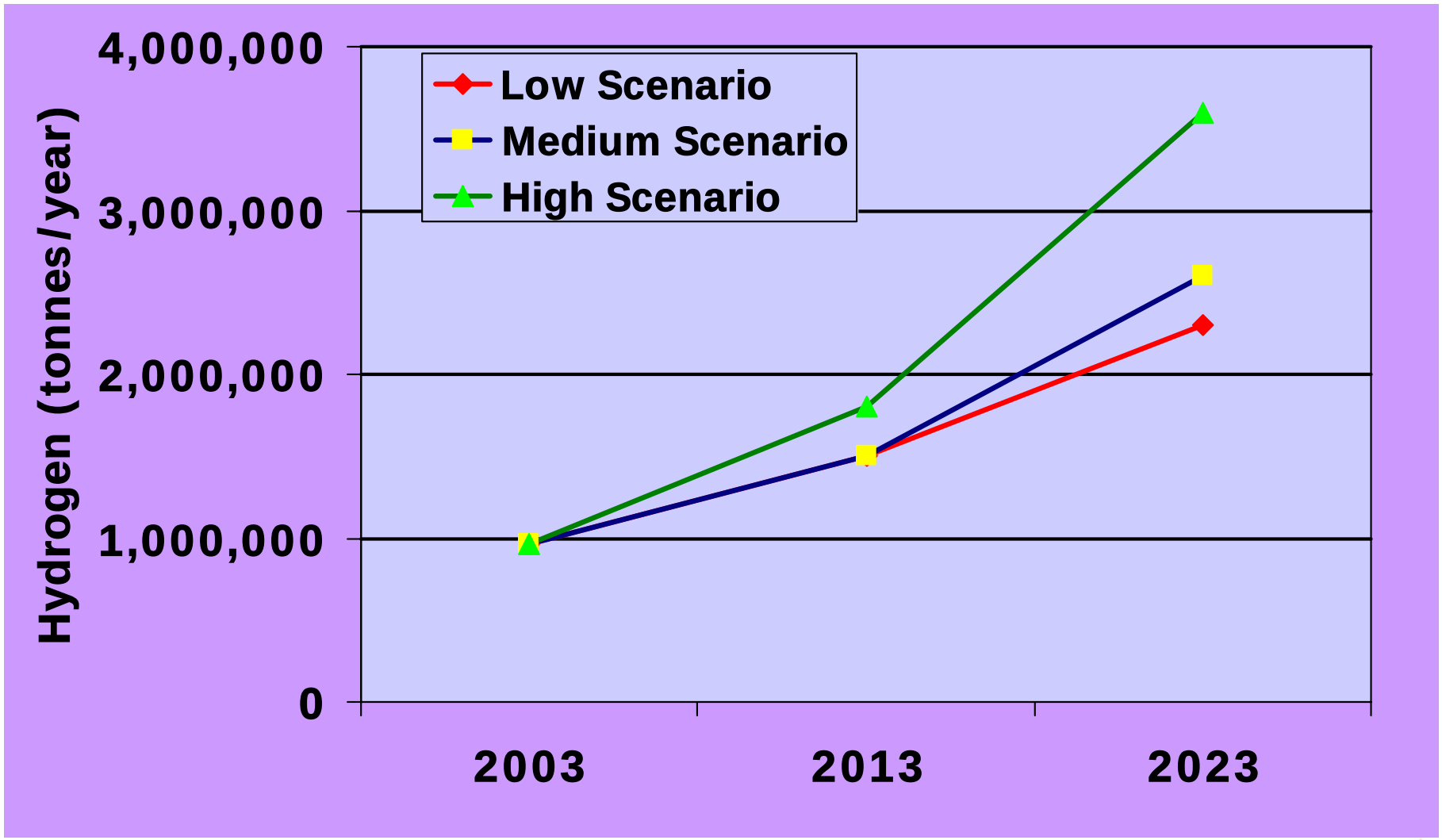


After Murray Gray, University of Alberta

Synthetic Crude Oil – desirable features



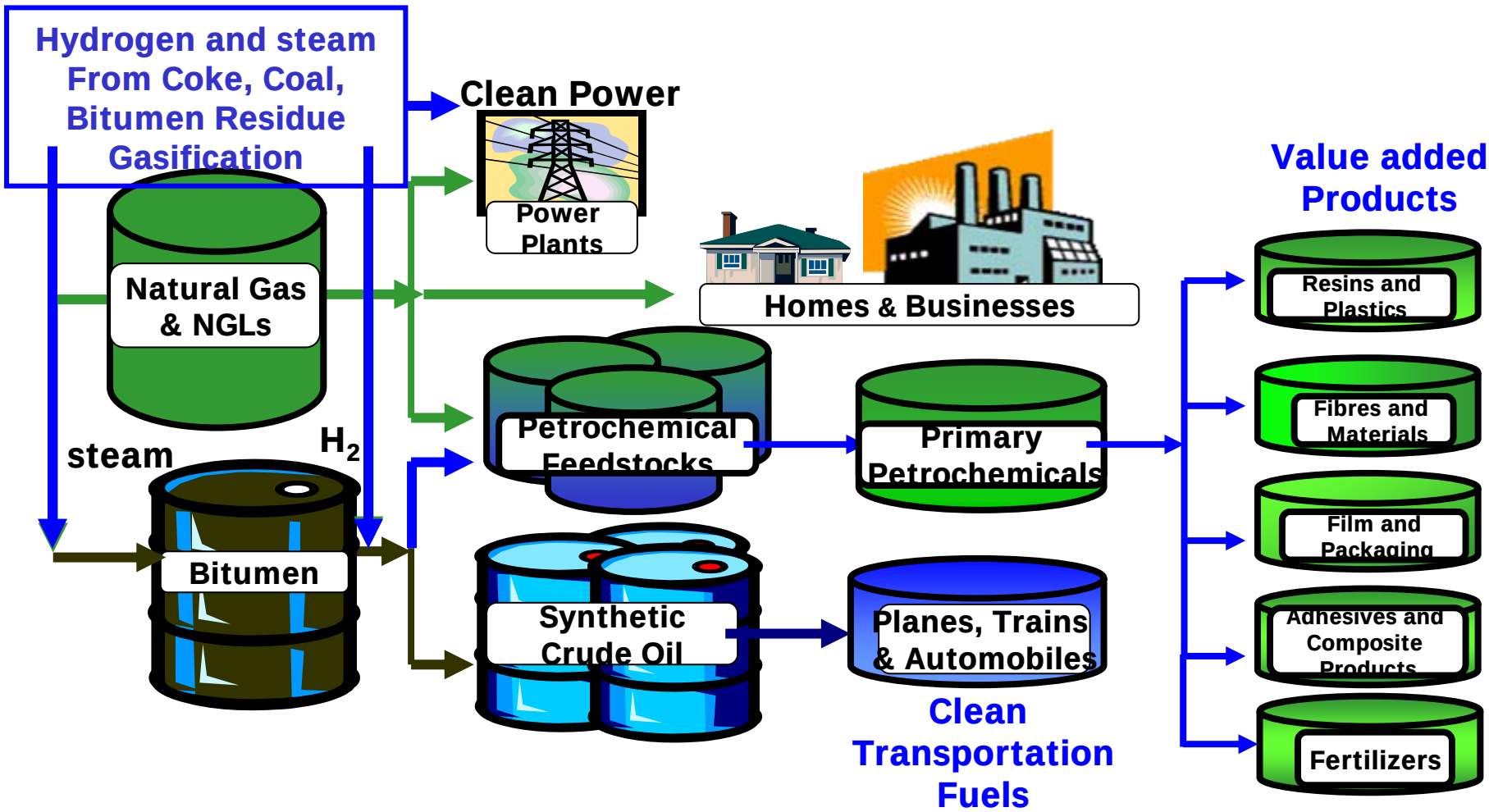
Oil Sands Hydrogen Demand Scenarios



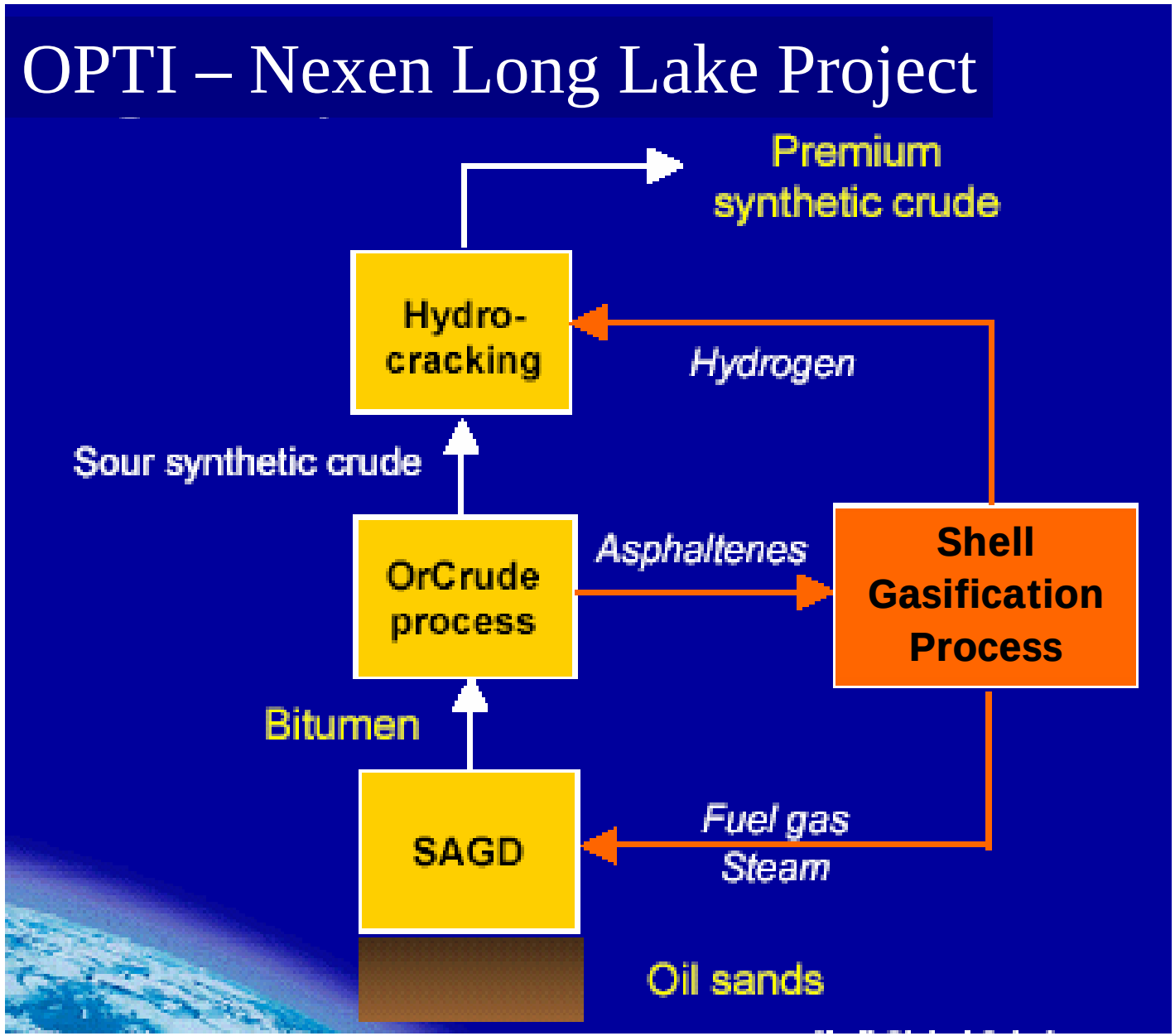
Source: Canadian Hydrogen. Current Status and Future Prospects, Dalcor Consultants & Intuit Strategies, August 2004

What the Future may look like

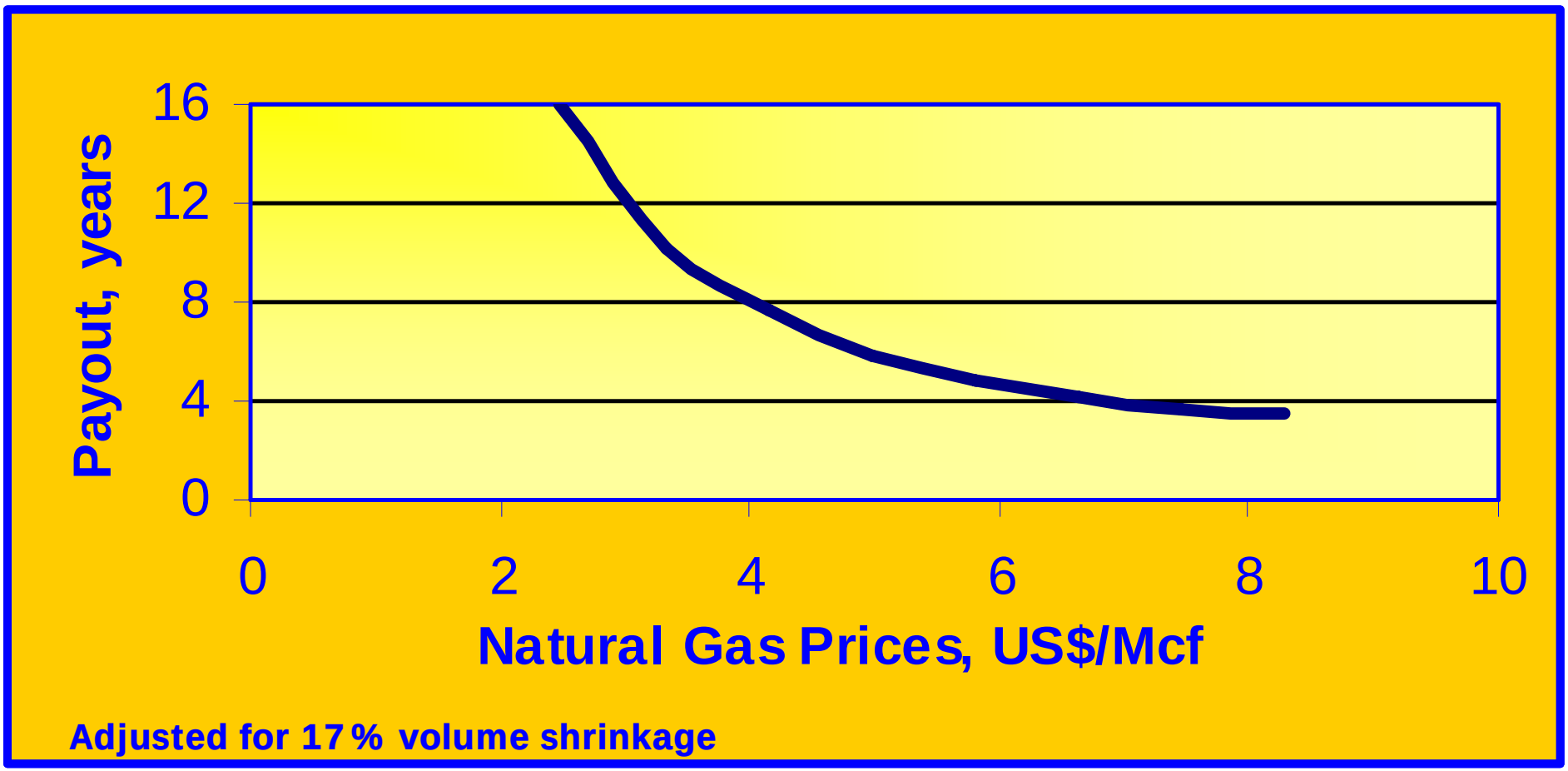
Integrated Energy Industry, Diversified Products,Broad Markets



Integrating In-Situ Oil Sands Production and Upgrading to Reduce Cost and Increase Product Value



Gasification Capital Cost Payout – SAGD with an upgrader project



Source: FirstEnergy Capital

Oil Sands Production Costs

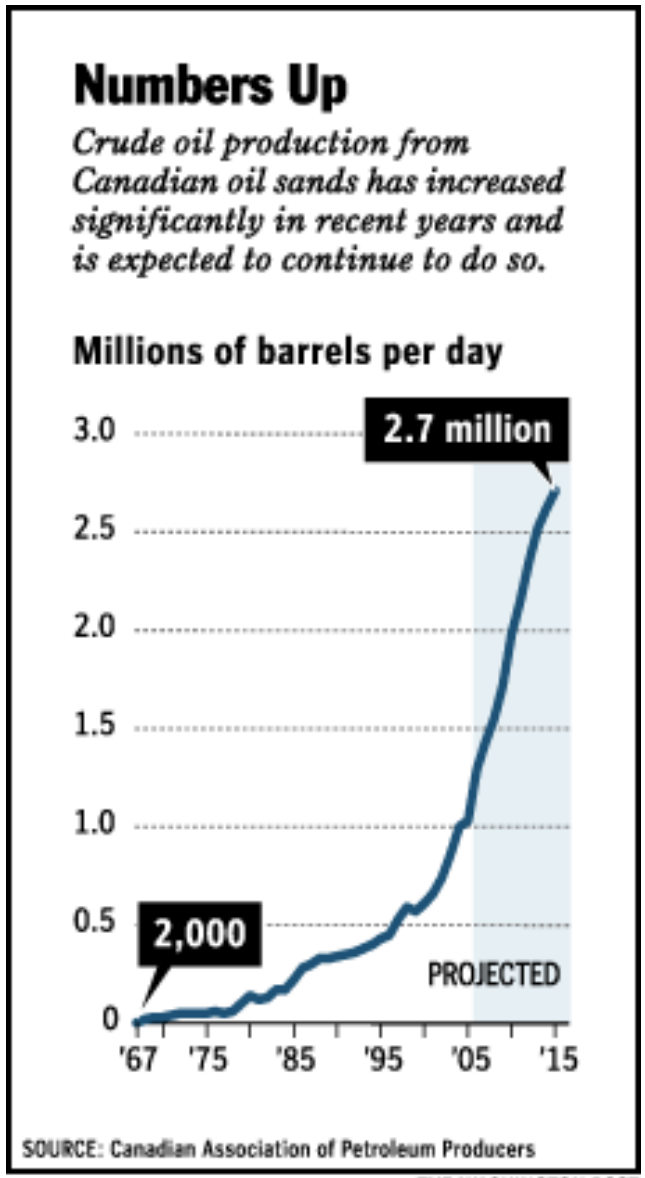
Production Method	Crude Type	Cost per barrel (US$, 2003)	
		Operating	Supply
Mining / Extraction	Bitumen	5 to 8	10 to 13
Cyclic Steam Stimulation (CSS)	Bitumen	6 to 11	10 to 15
Steam Assisted Gravity Drainage (SAGD)	Bitumen	6 to 12	9 to 14

Production Method	Crude Type	Cost per barrel (US$, 2003)	
		Operating	Supply
Mining / Upgrading	Synthetic	10 to 14	18 to 23

Source: National Energy Board of Canada

Oil Sands Production Potential

- $US2O Billion under construction or approved
- $50 Billion additional announced
- ~ 70% of Canada's production by 2020



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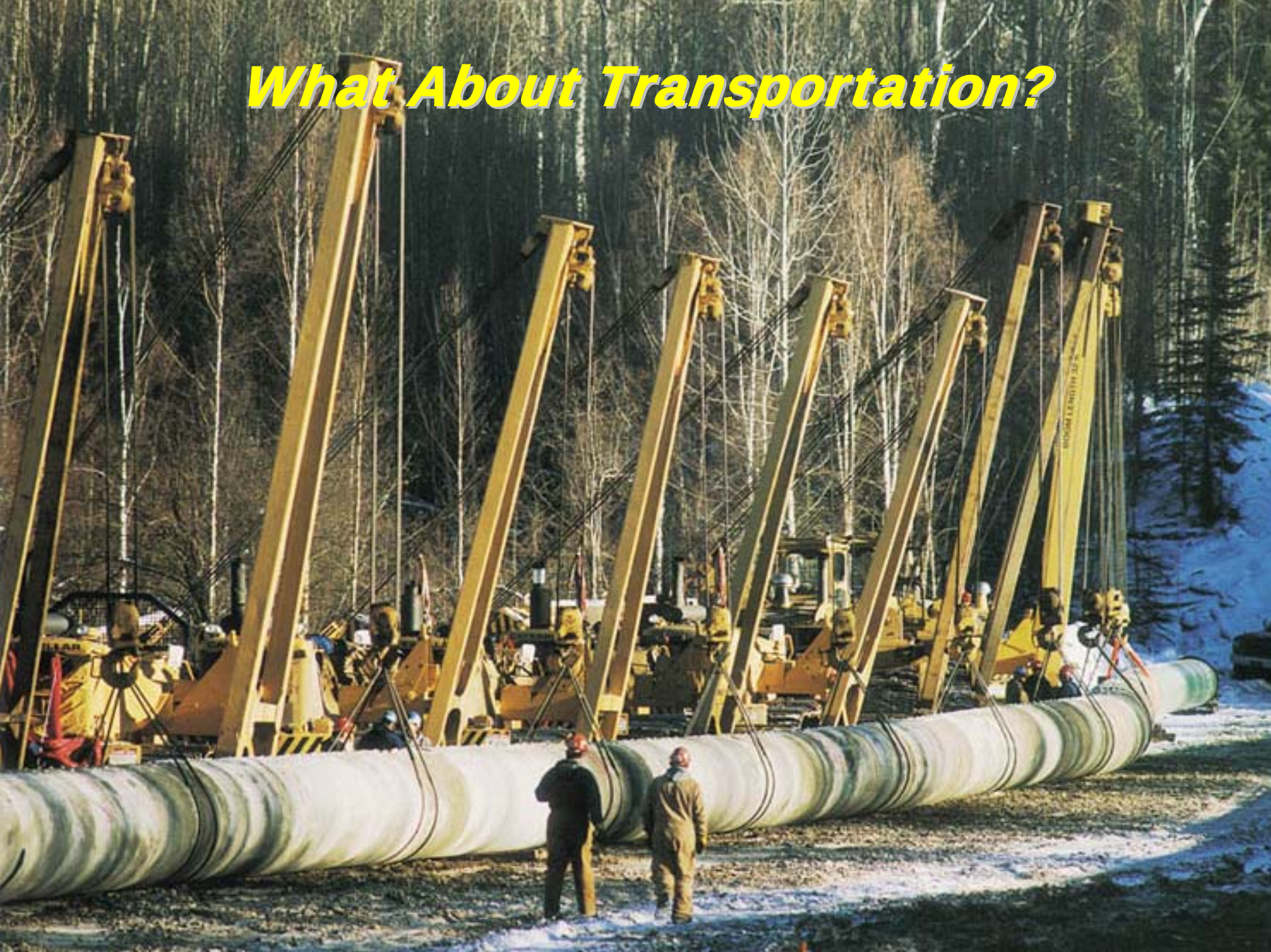
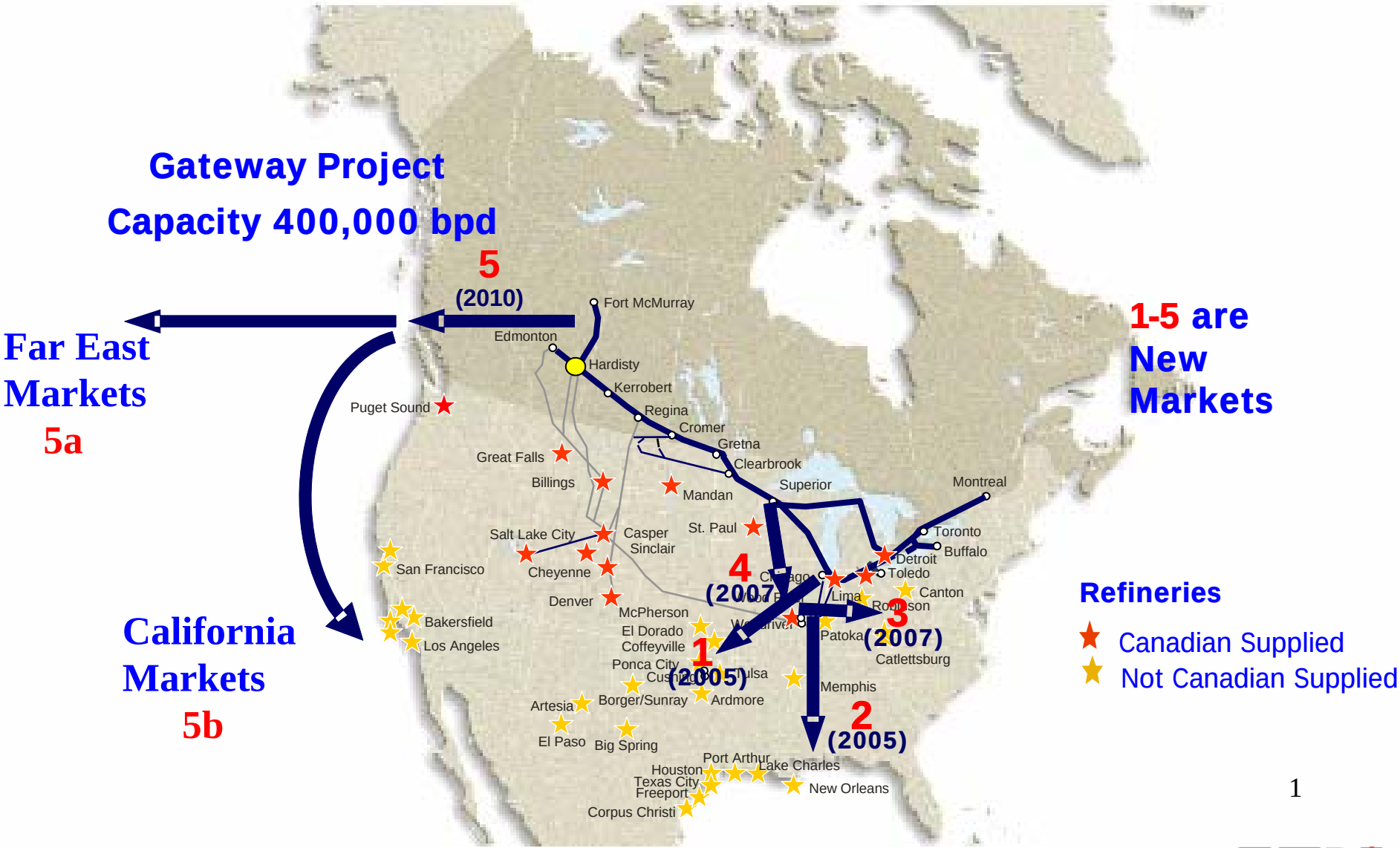
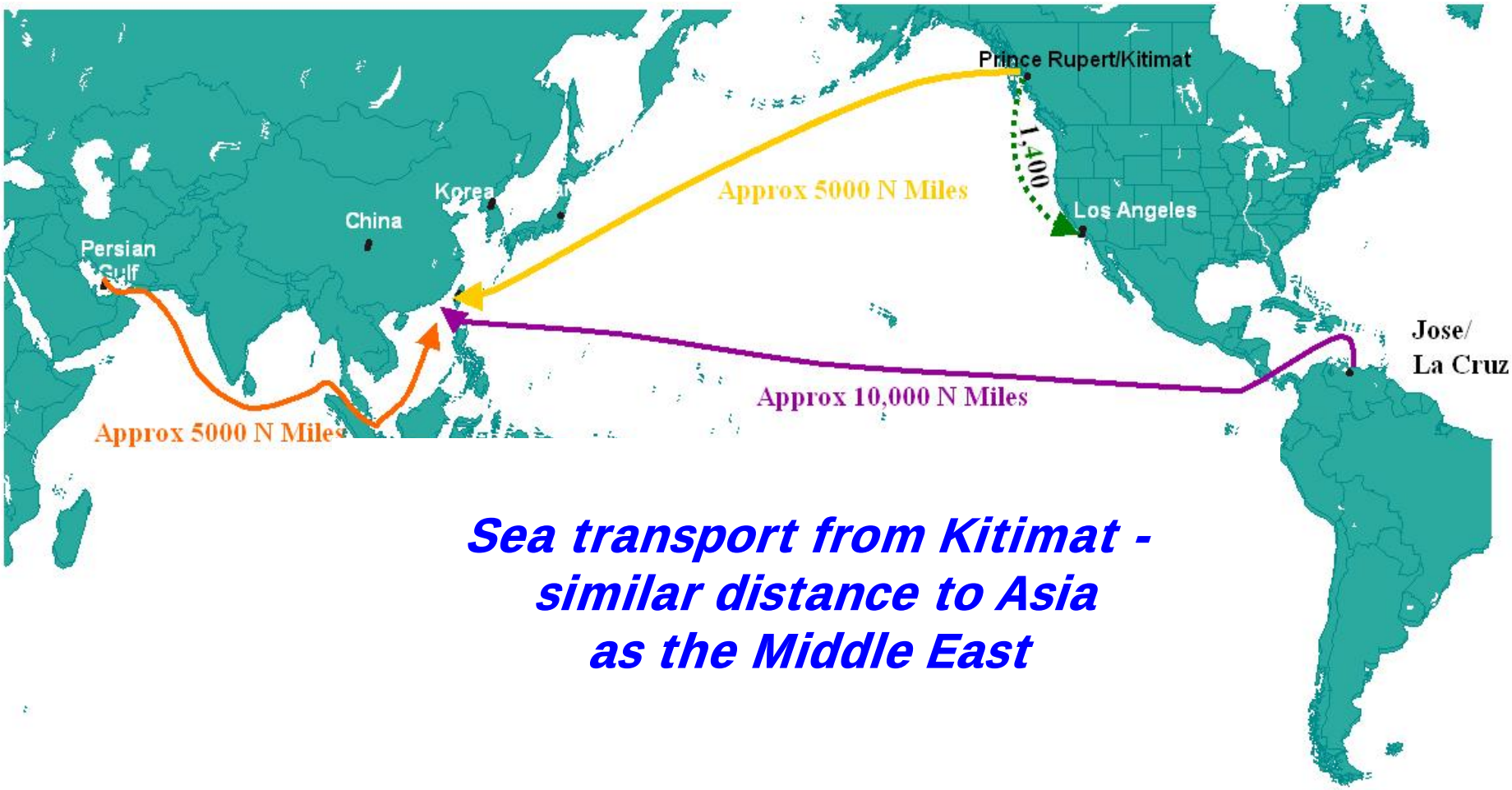
What About Transportation?



Expanded Markets to Sustain Growth



Potential Markets - US West Coast & Far East



Sea transport from Kitimat - similar distance to Asia as the Middle East

Summary

- Canadian oil sands resources are immense
- Serious challenges remain
  - Technical – hard to extract and sensitive to market and input costs
  - Environmental – land, water, emissions (including CO_2)
  - Social – community growth, native population
  - Human resource – maintaining a skilled labor force
- Innovation is key to "technology oil"
  - Production is expected to reach 3 MM bbls/d before 2020 (currently 1 MM bbls/d)
  - As production increases, more upgrading will be required to meet refinery specifications and increase value
  - Future co-production of clean fuels and Petrochemicals - technically and economically feasible
- Even this aggressive development can supply only some 10 - 15% of the required new global oil demand

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