Canadian Oil Sands: Development and Future Outlook

IV International Workshop on Oil and Gas Depletion

May 19 – 20, 2005

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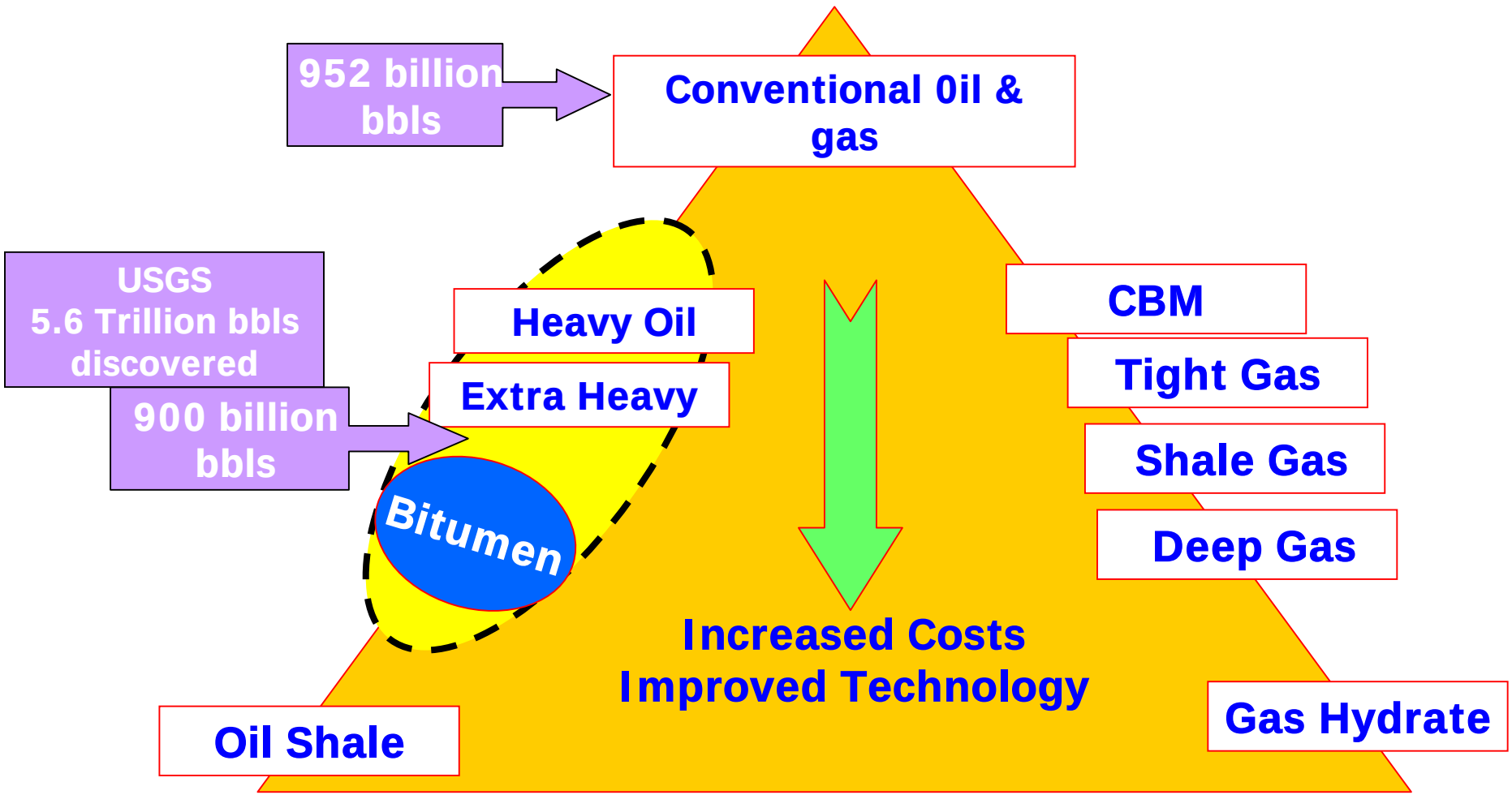
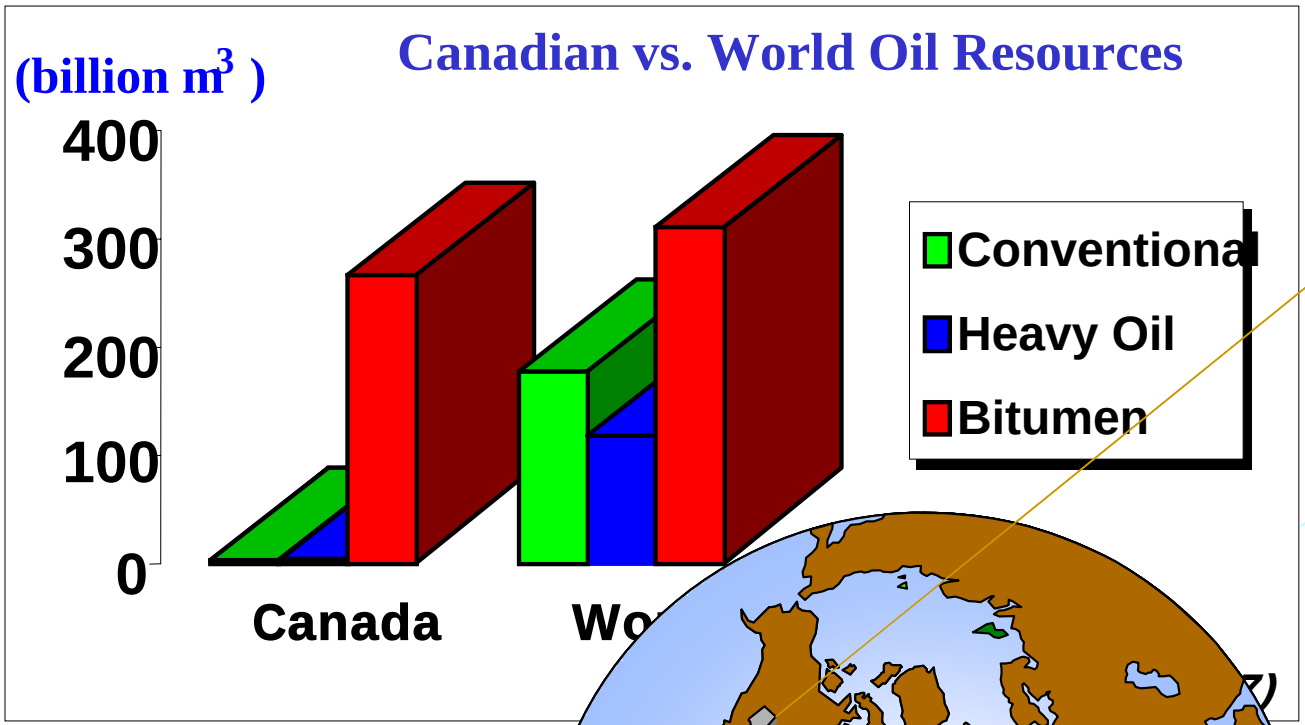
Conventional vs. Unconventional Resources

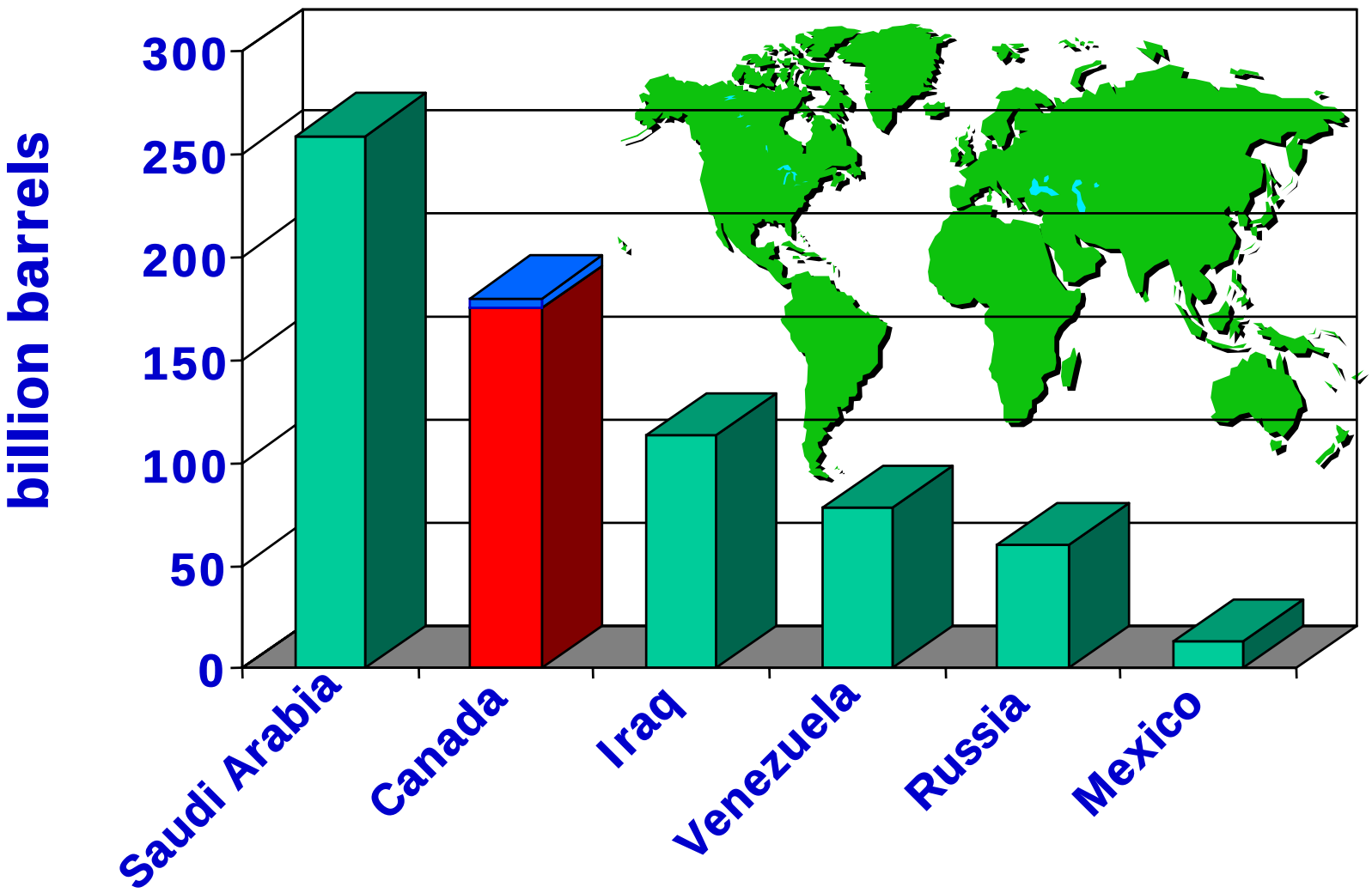


Modified from Holditch (2002) & Etherington (2005)

Canadian Oil Sands – Huge Resources

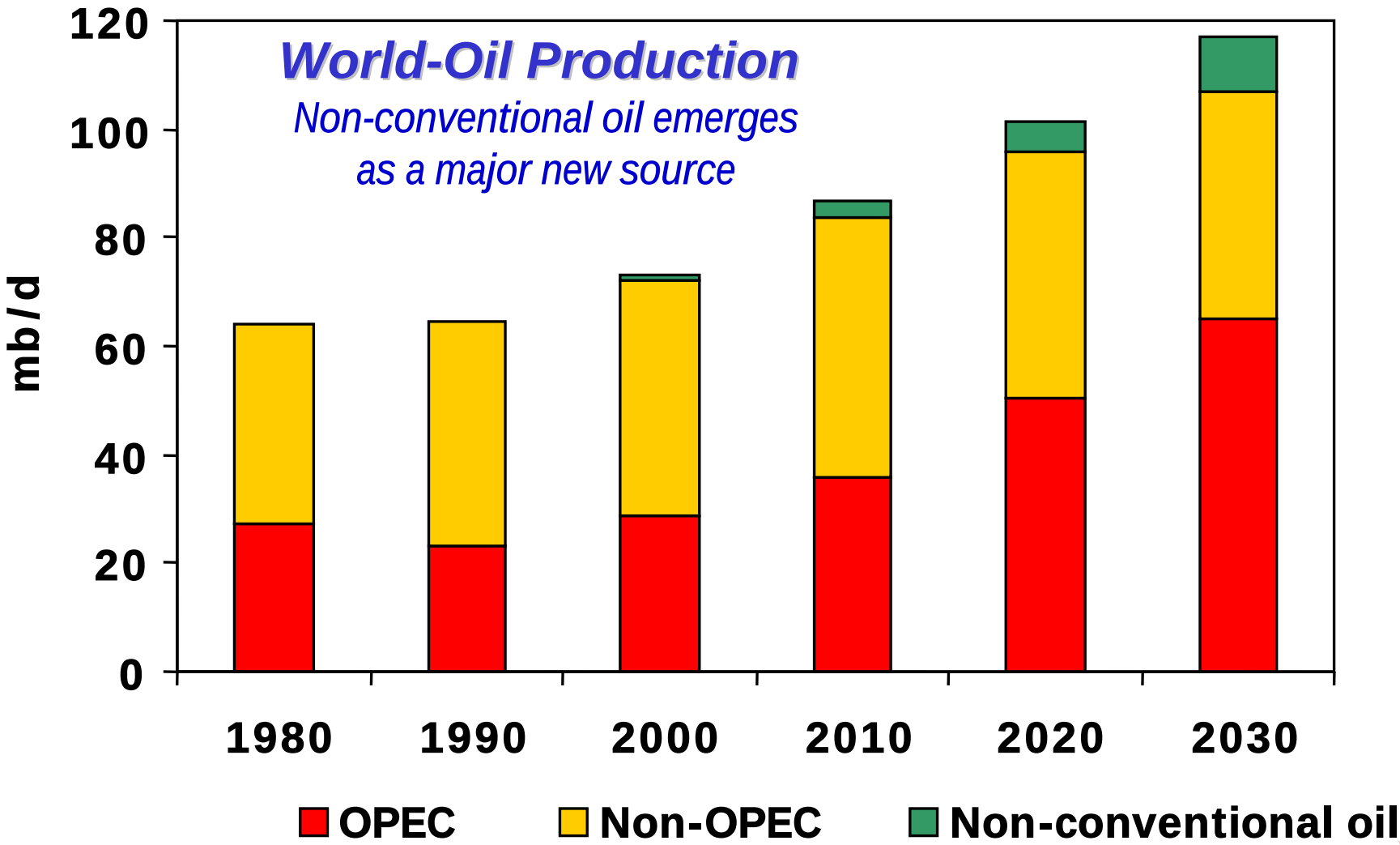


Proven World Reserves



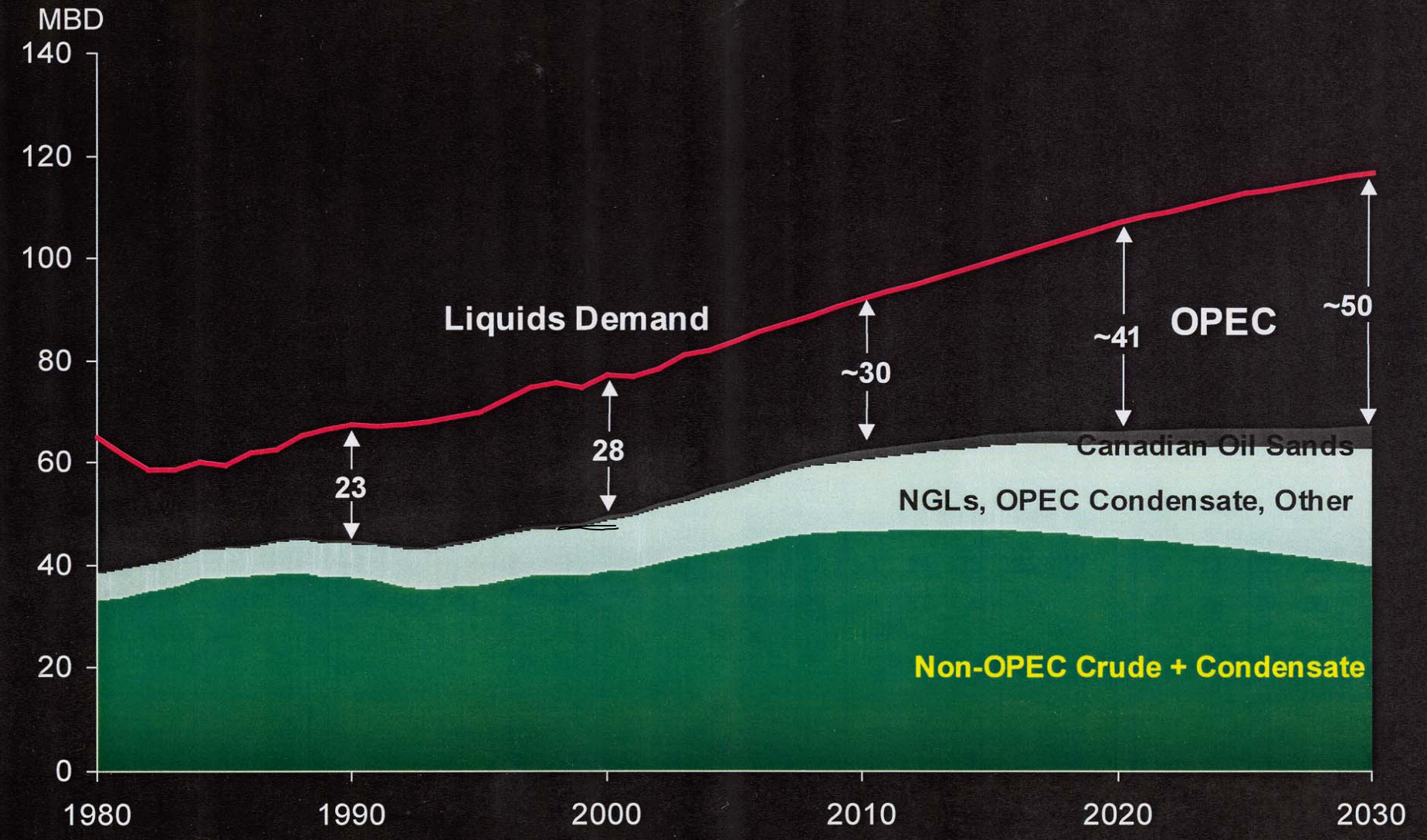
Sources: Oil and Gas Journal – Dec 2002, AEUB

How Much will Non-conventional Oil Contribute?



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

World Liquids Production Outlook

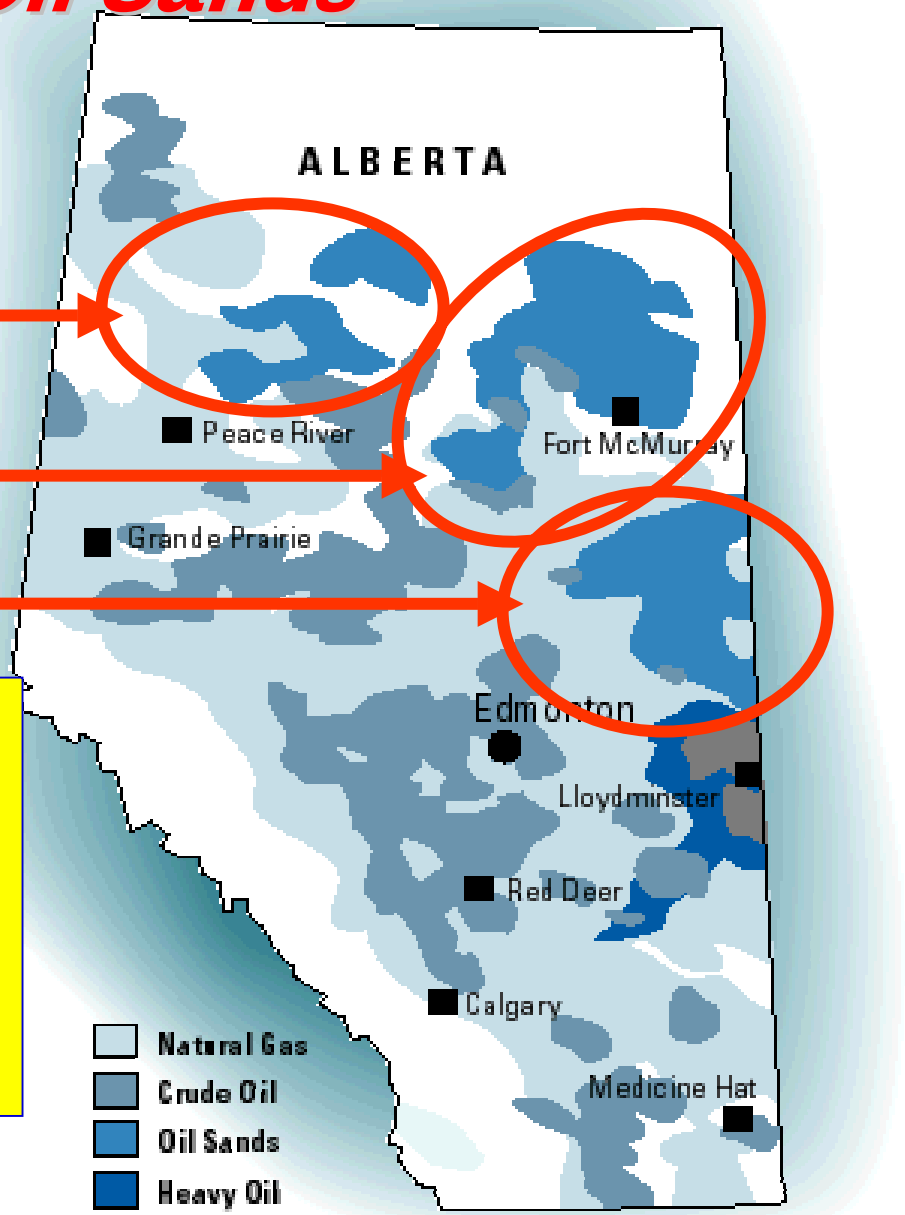


ExxonMobil

Canada's Oil Sands

Three locations:

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

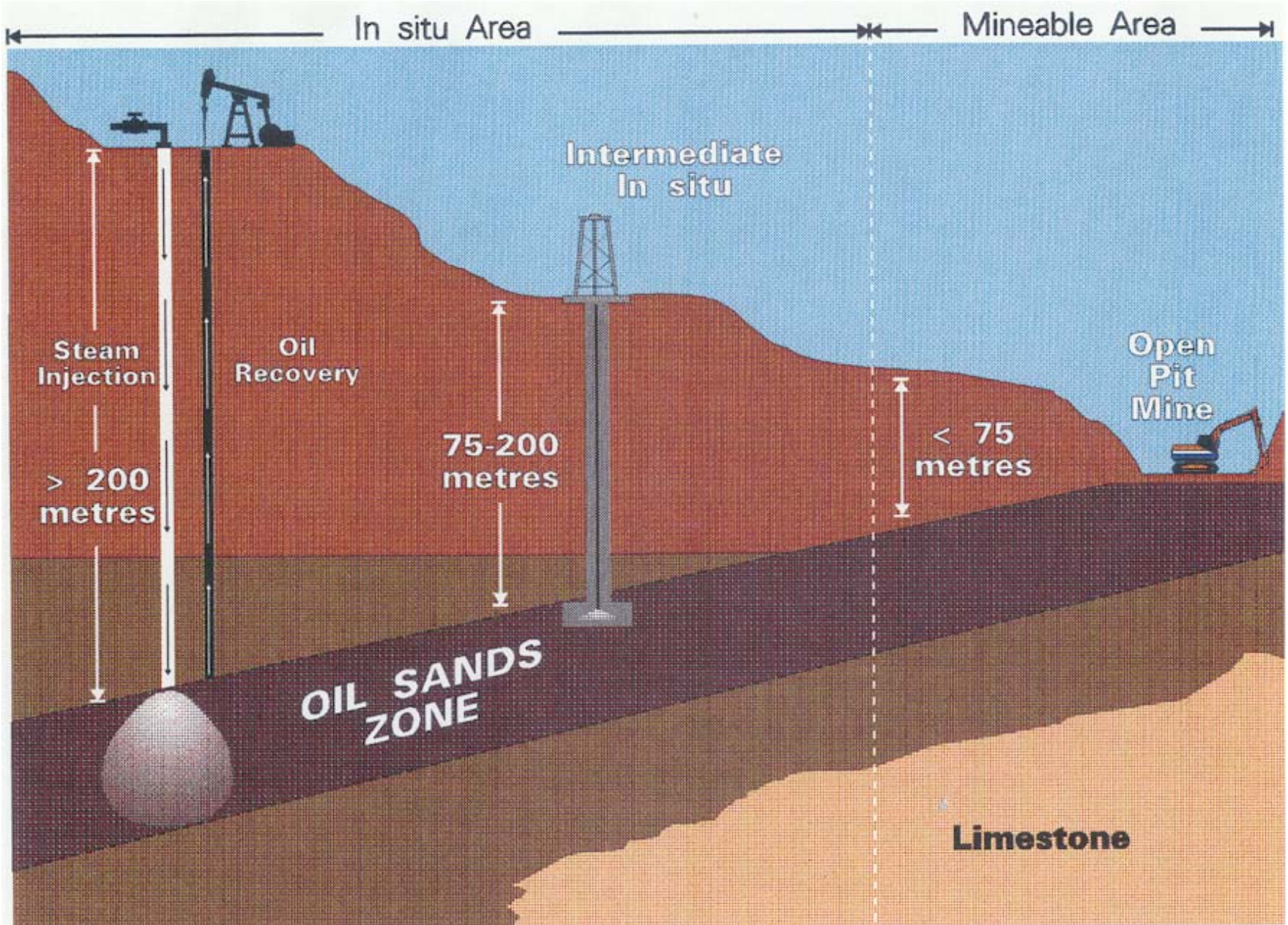


Reserves (2003 - EUB)

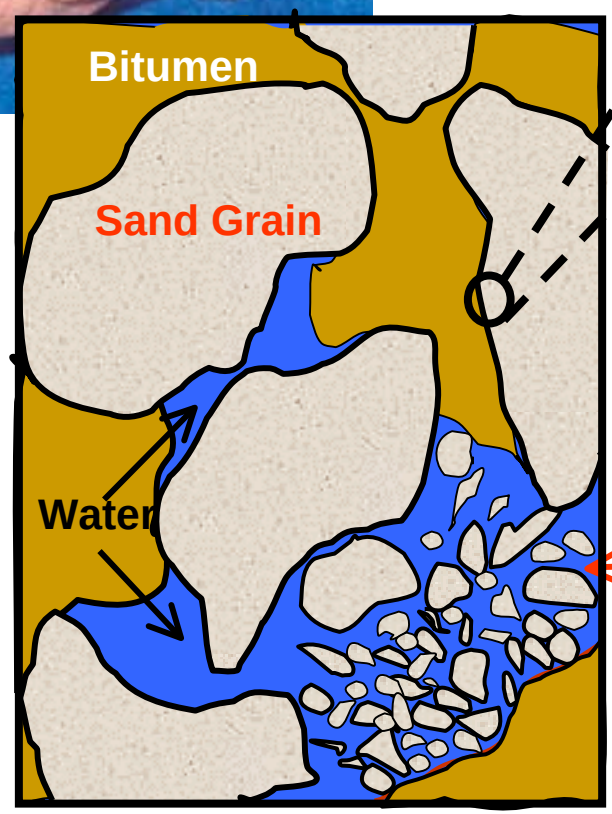
(Billion Barrels)

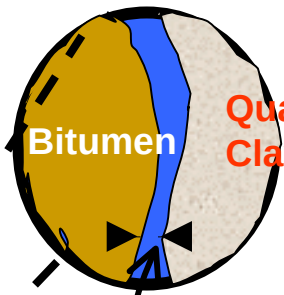
	Oil Sands	Conv.
In Place	1,629	62
Remaining Est.	175	2
Rem. Ult. Pot'l	310	5

The Nature of the Oil Sands Resource



Oil Sands
What is special?





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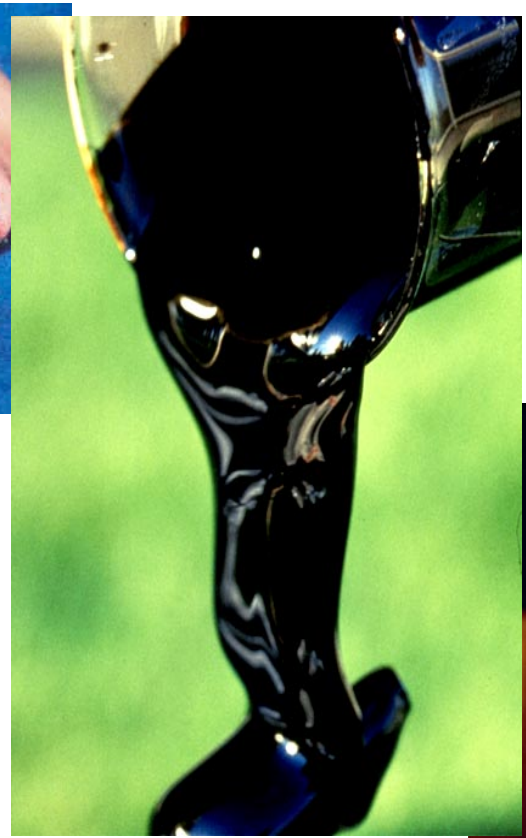
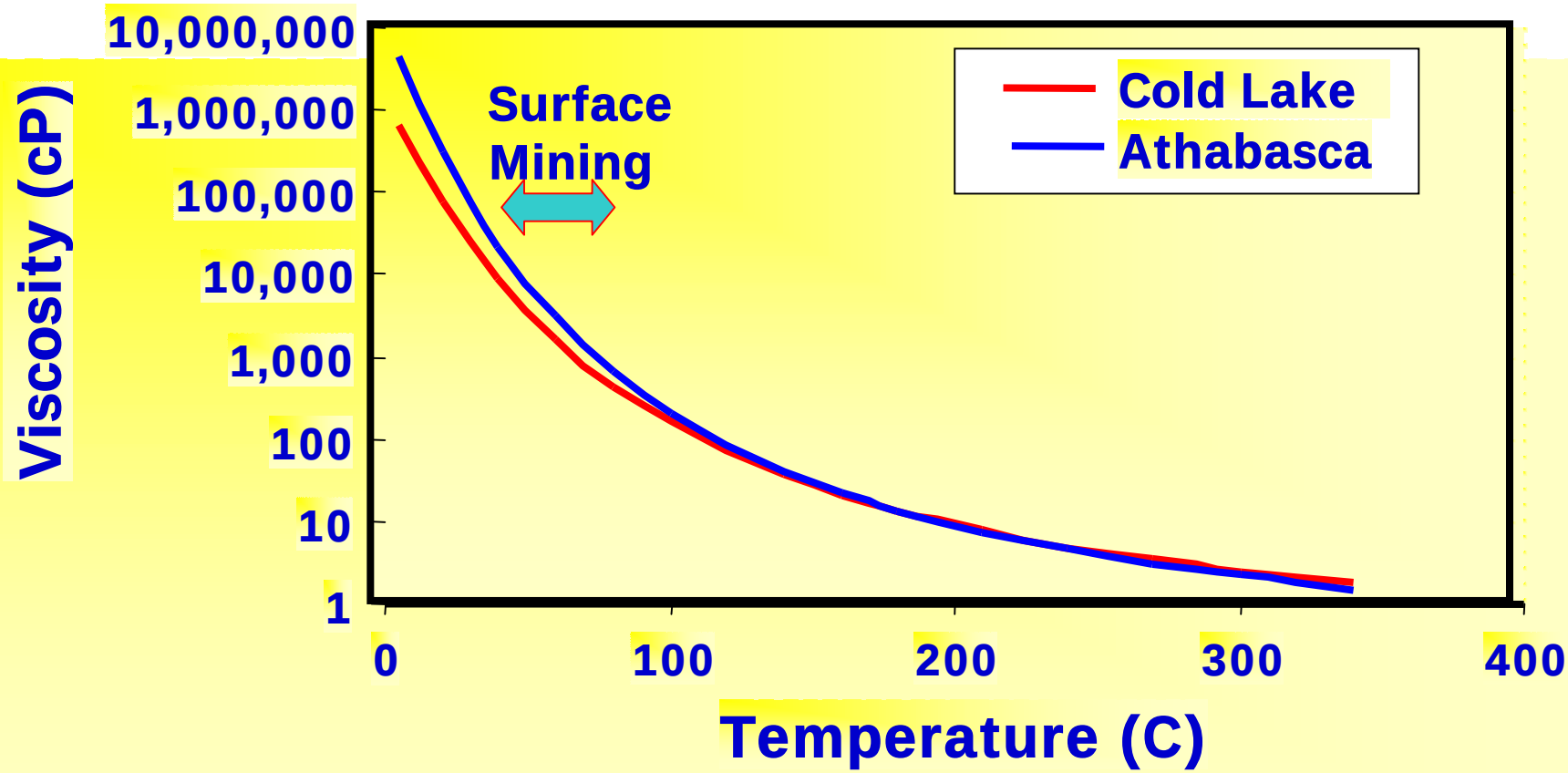
"Technology Oil "
Continuous Innovation Since the 1930's



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

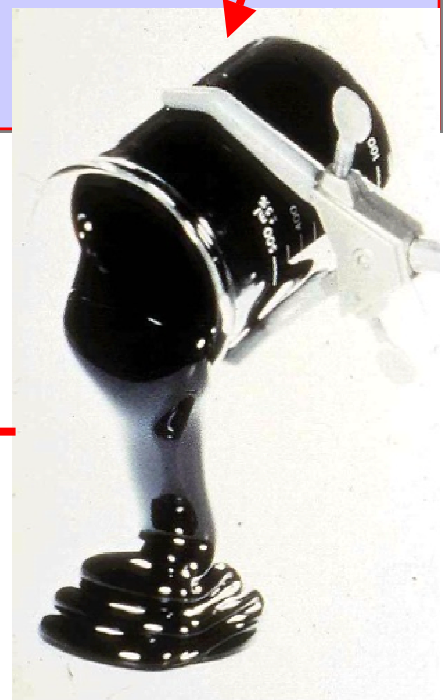
- Draglines, Bucketwheels & Conveyor Systems
- Truck & Shovel Feed System
- Hydrotransport System

Oil Sand

Oil Sand Slurry

Extraction

Tumblers → Primary Separation Vessel → Froth Treatment



Upgrading

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

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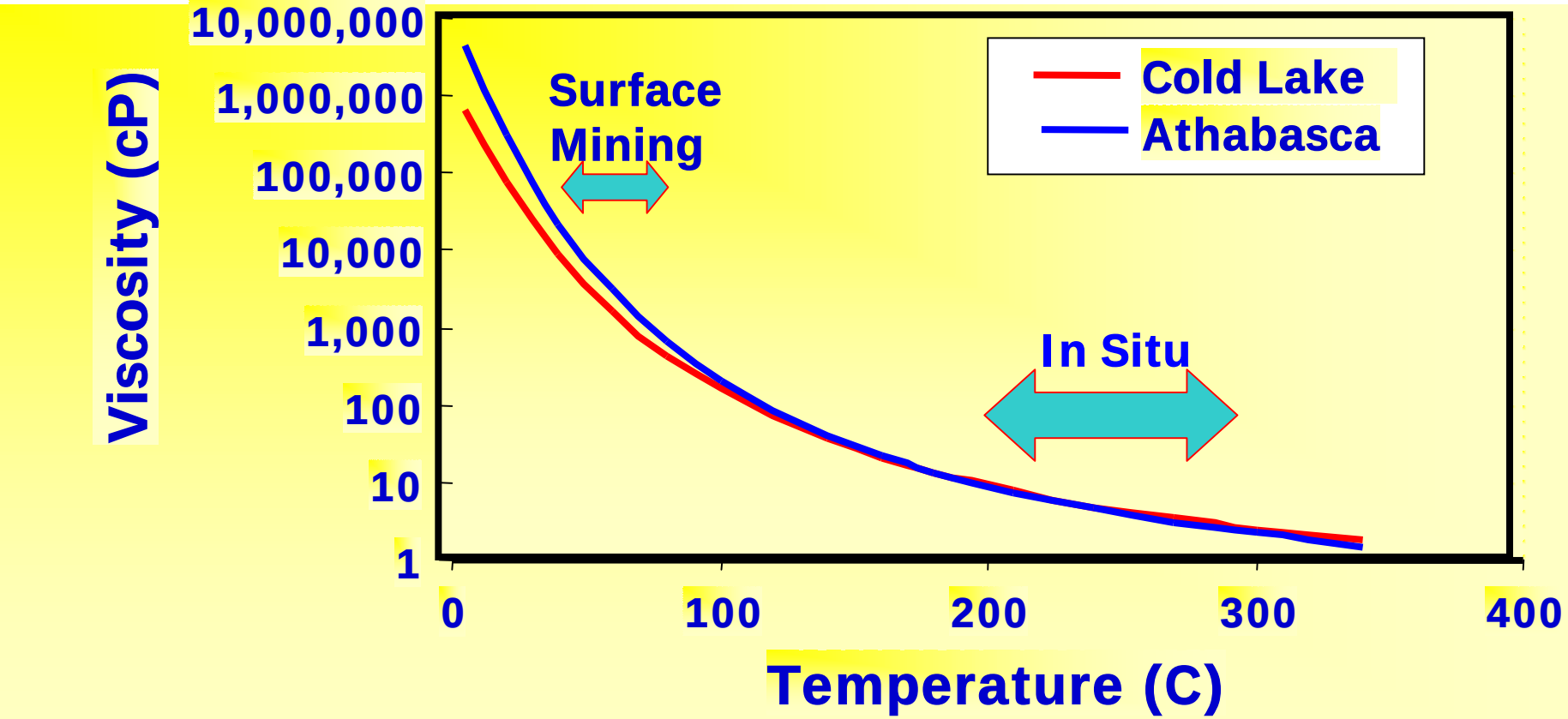
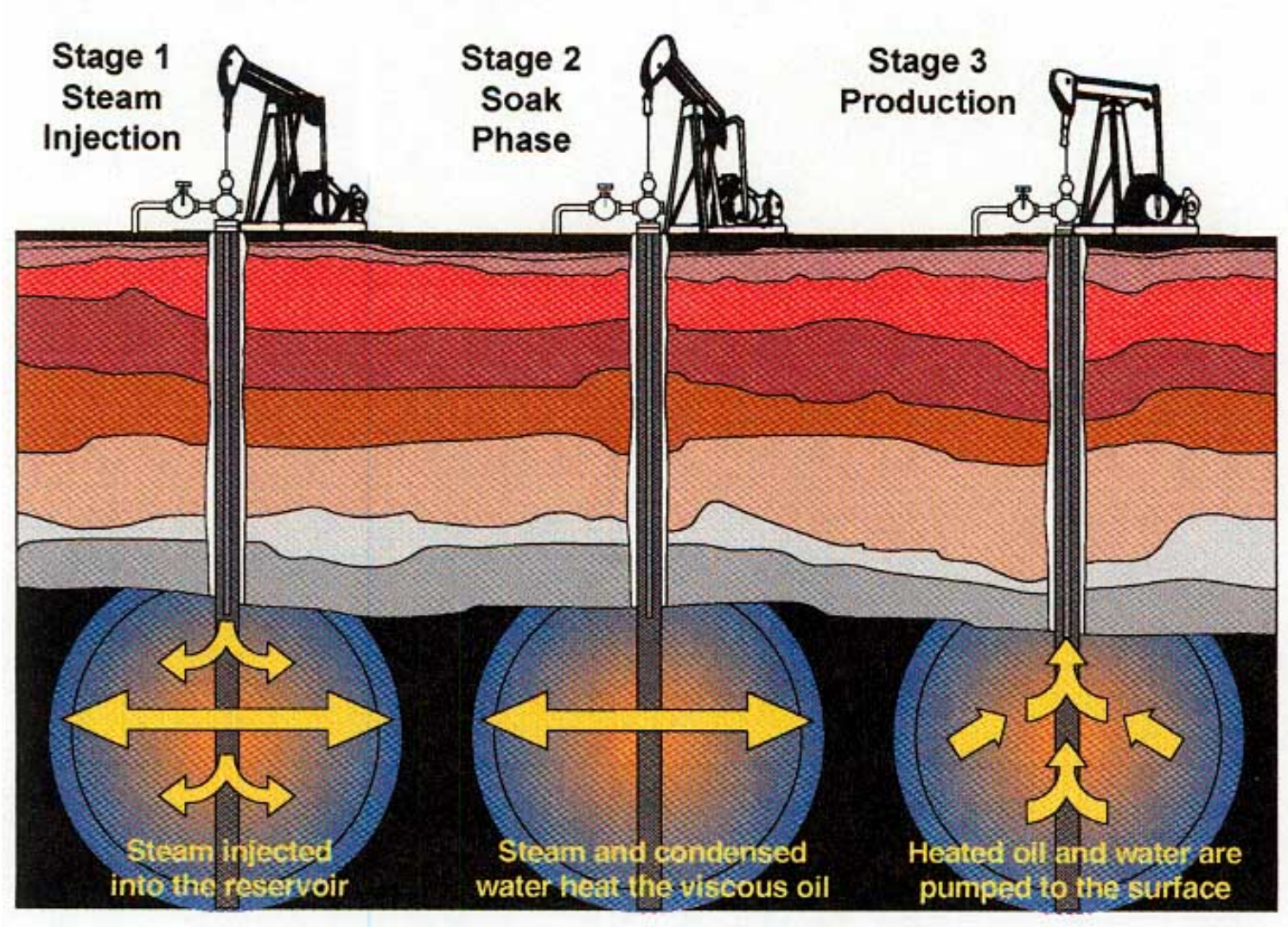
Producing Bitumen – In Situ



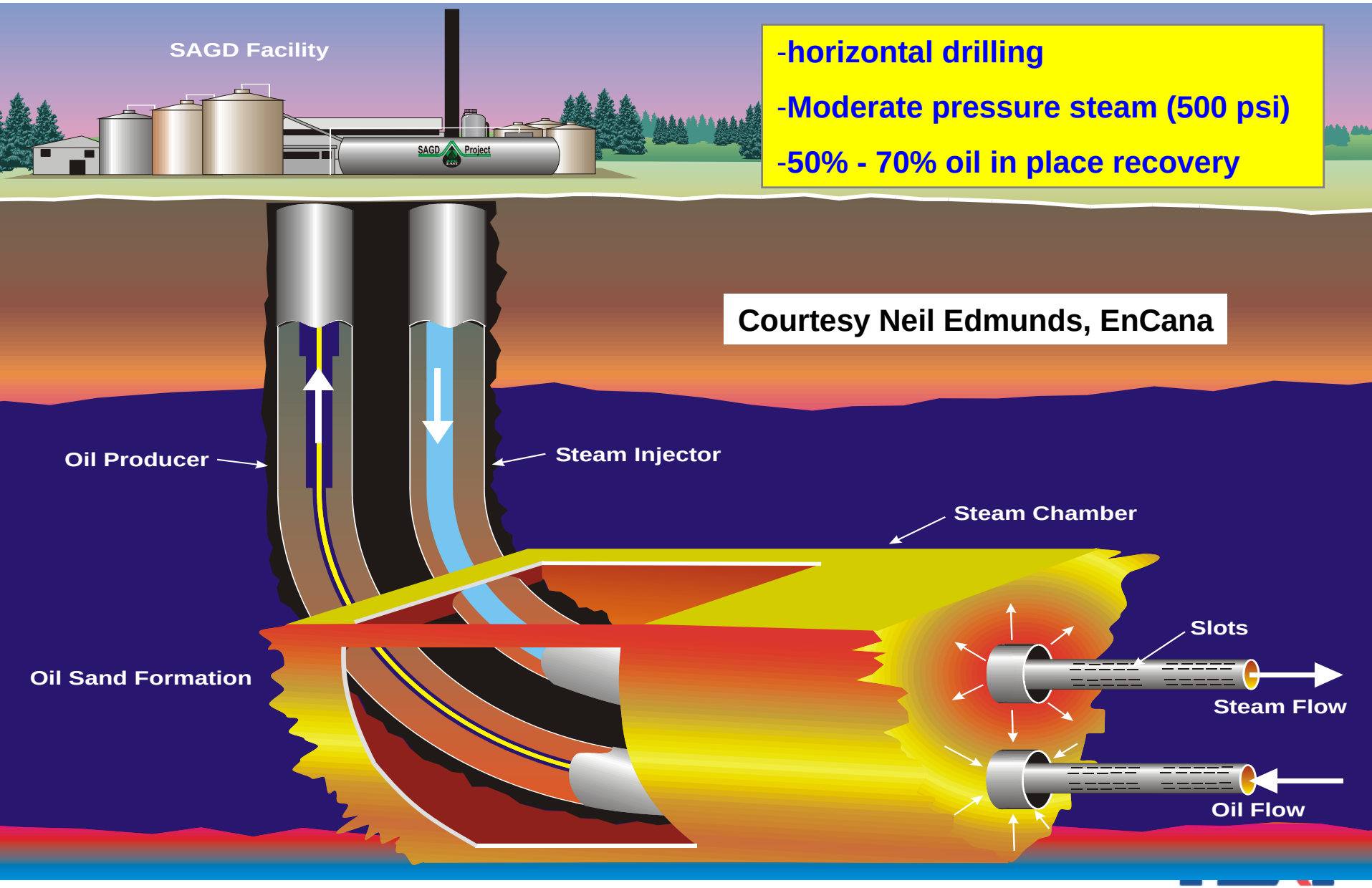
In Situ Production Technology
Cyclic Steam Stimulation Process



Drilling Technology Minimizes Land Disturbance

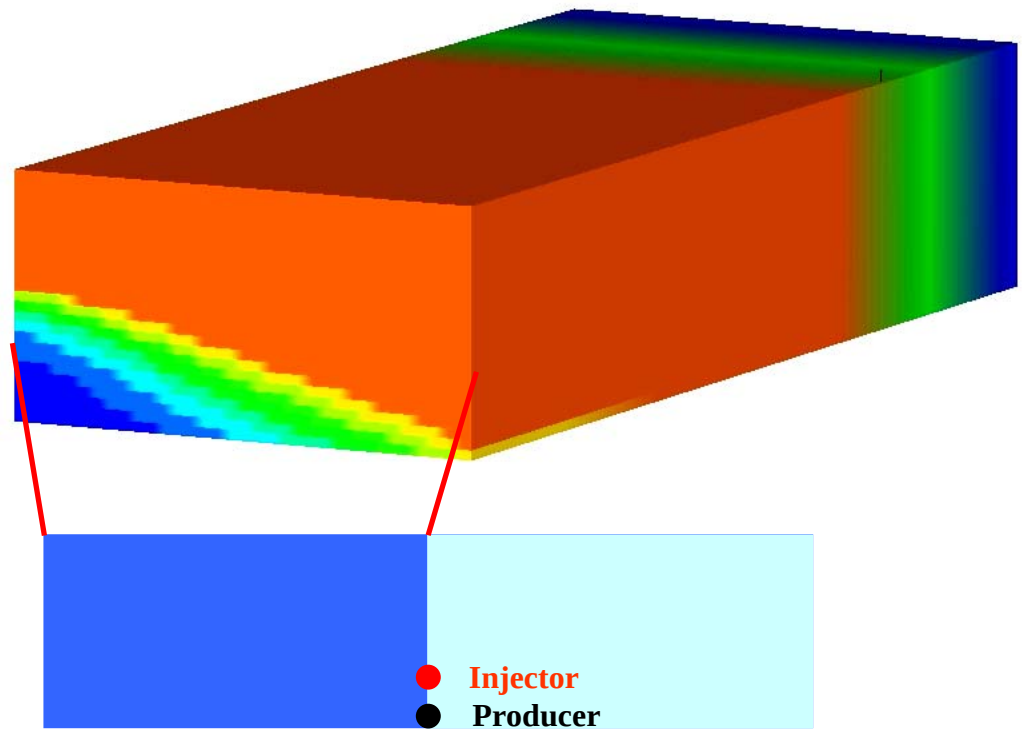
Imperial Oil Cold Lake - Cyclic Steam Project 125,000 bbl/day

Steam Assisted Gravity Drainage (SAGD)- Schematic

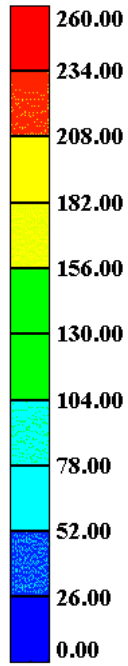


Gravity Drainage Concept
(SAGD Process)

Steam Chamber Development



Temperature
(°C)



Courtesy: David Law, Alberta Research Council

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	Petrovera	Total
	Murphy	Devon	

Not an all inclusive list

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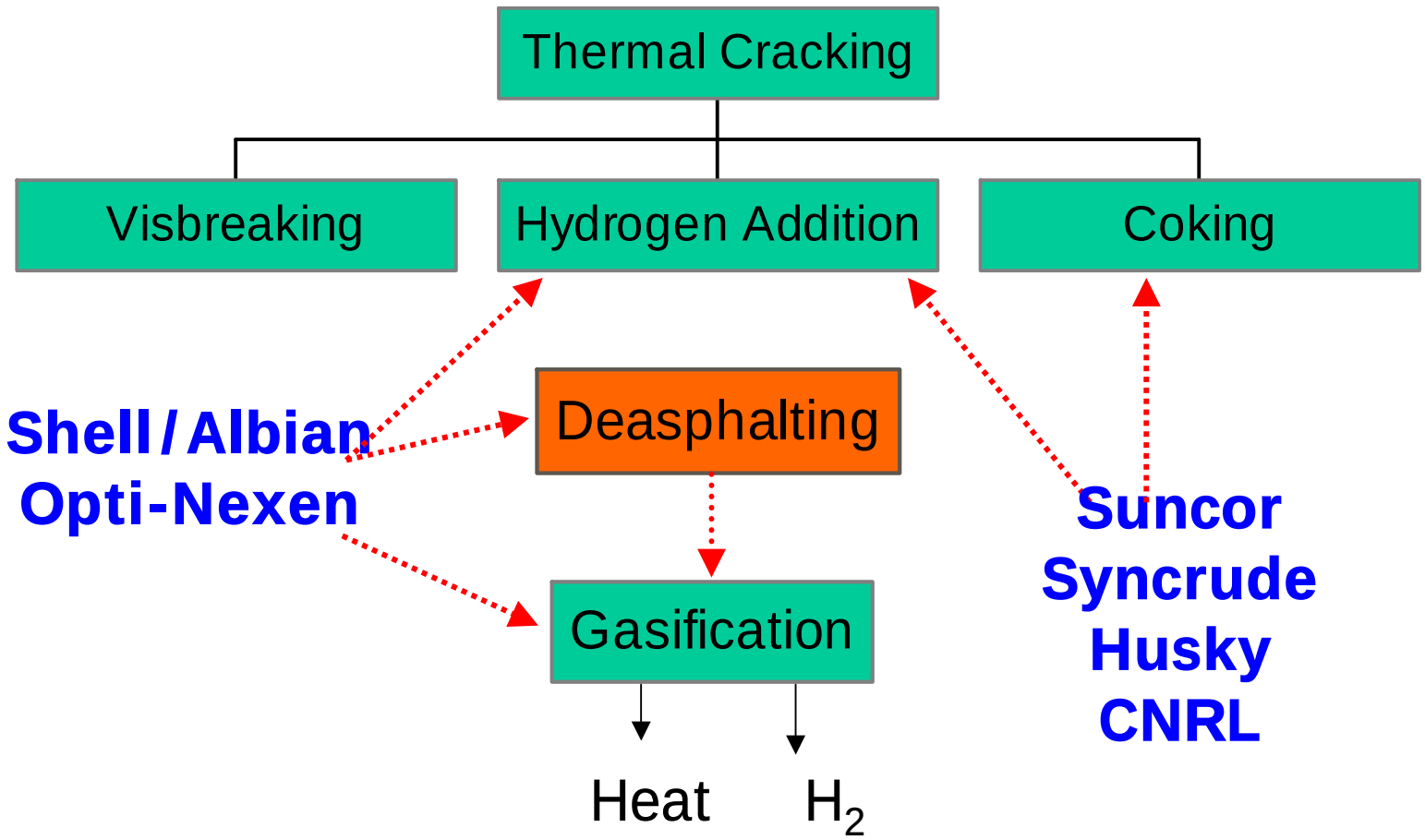
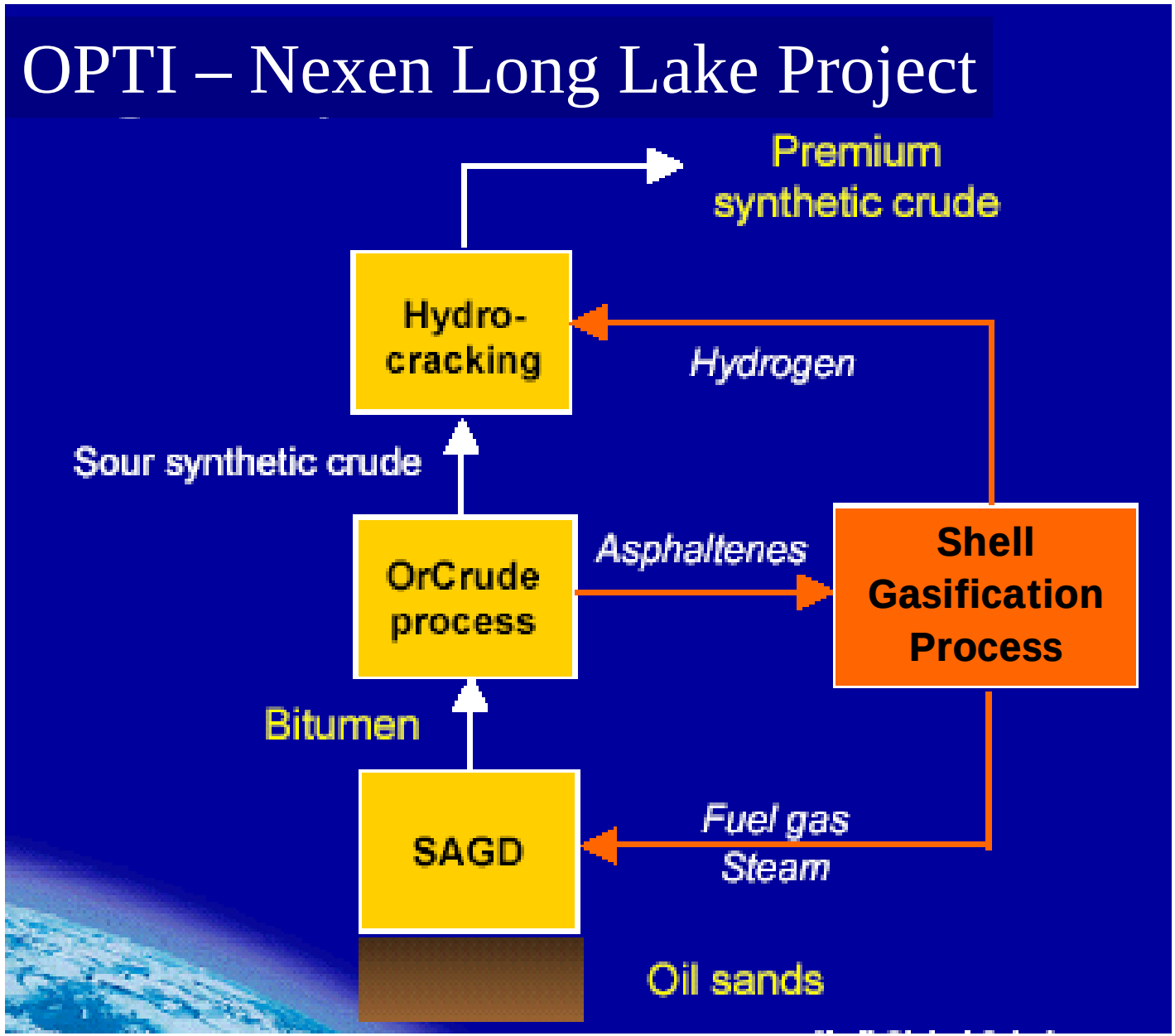
Upgrading Technology – 1940 - Today

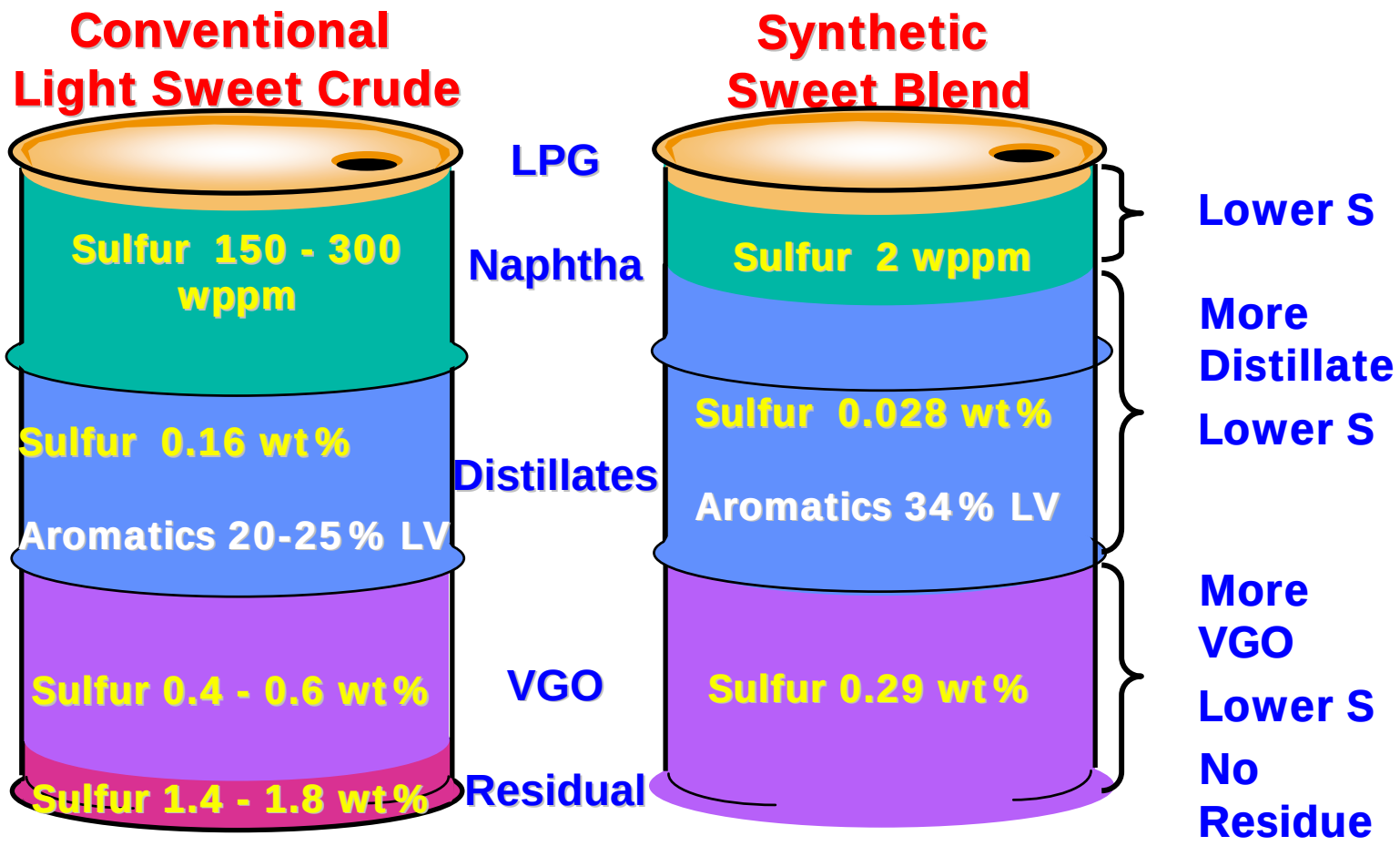


After Murray Gray, University of Alberta

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



Synthetic Crude Oil – desirable features



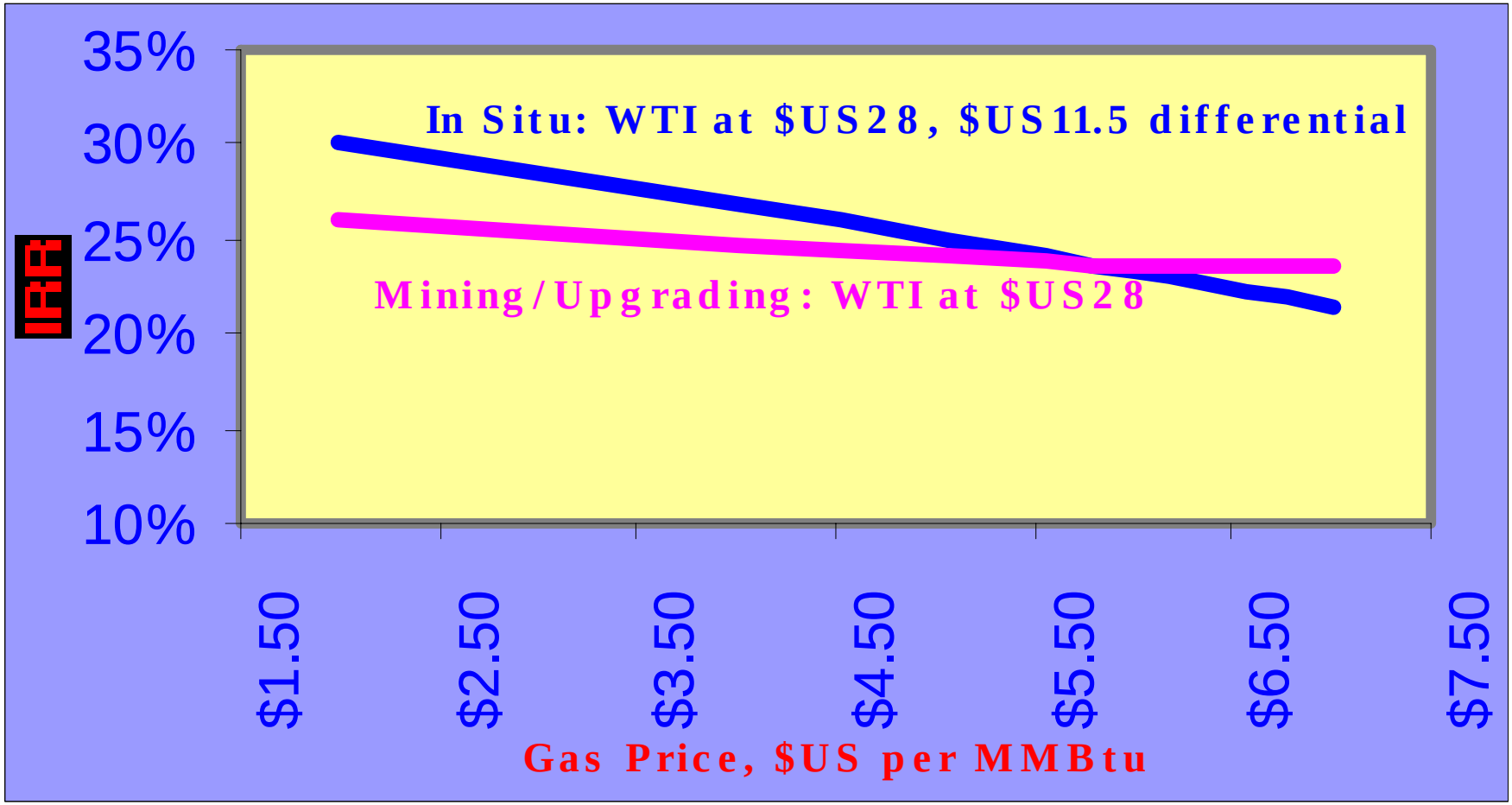
Current Production Costs

Production Method	Crude Type	Cost per barrel (US$, 2003)	
		Operating	Supply
Mining / Extraction	Bitumen	5 to 8	10 to 13
Cold Production	Heavy Oil	5 to 7	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

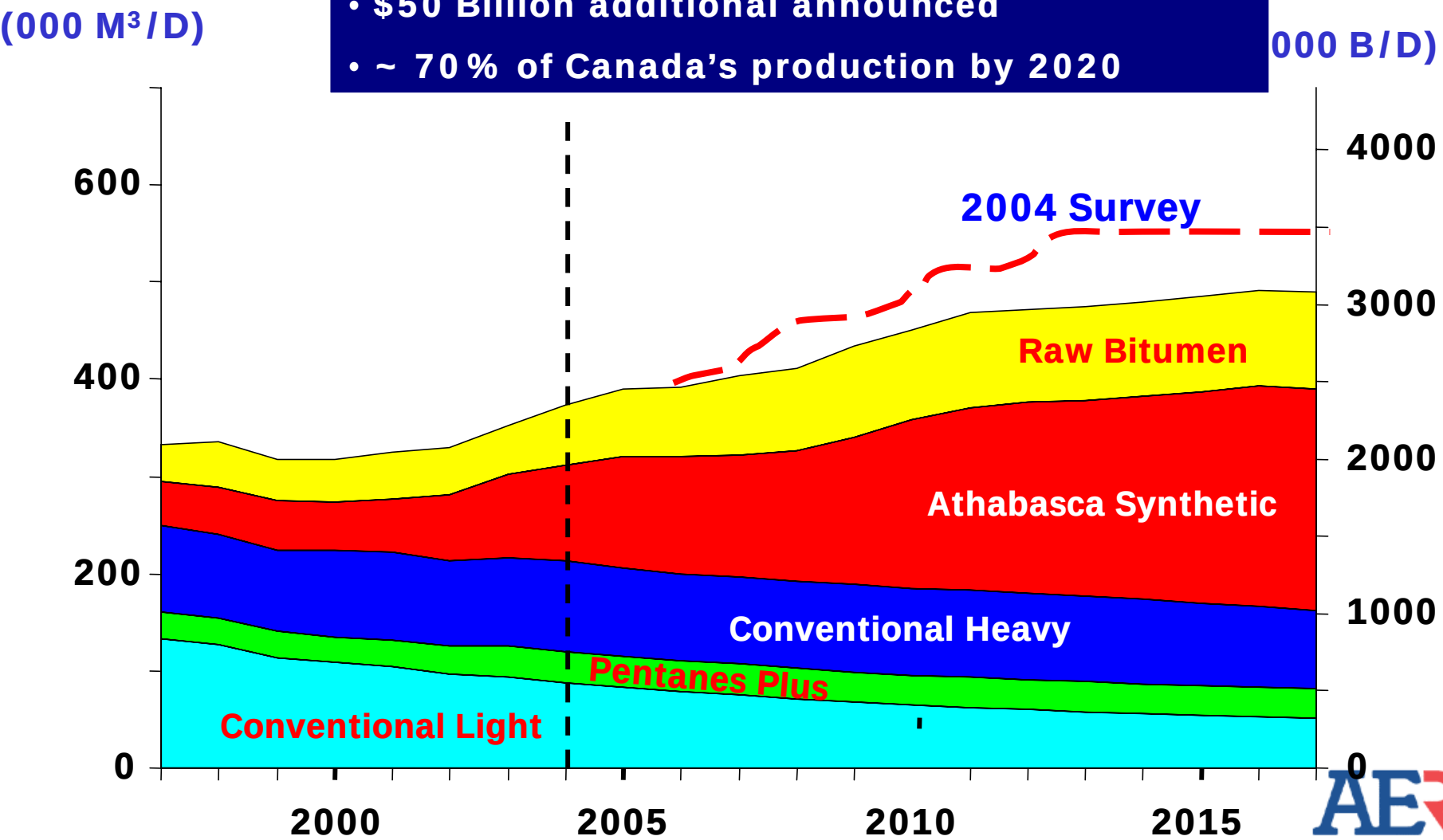
Source: National Energy Board of Canada

Economic Returns – In Situ and Mining Projects



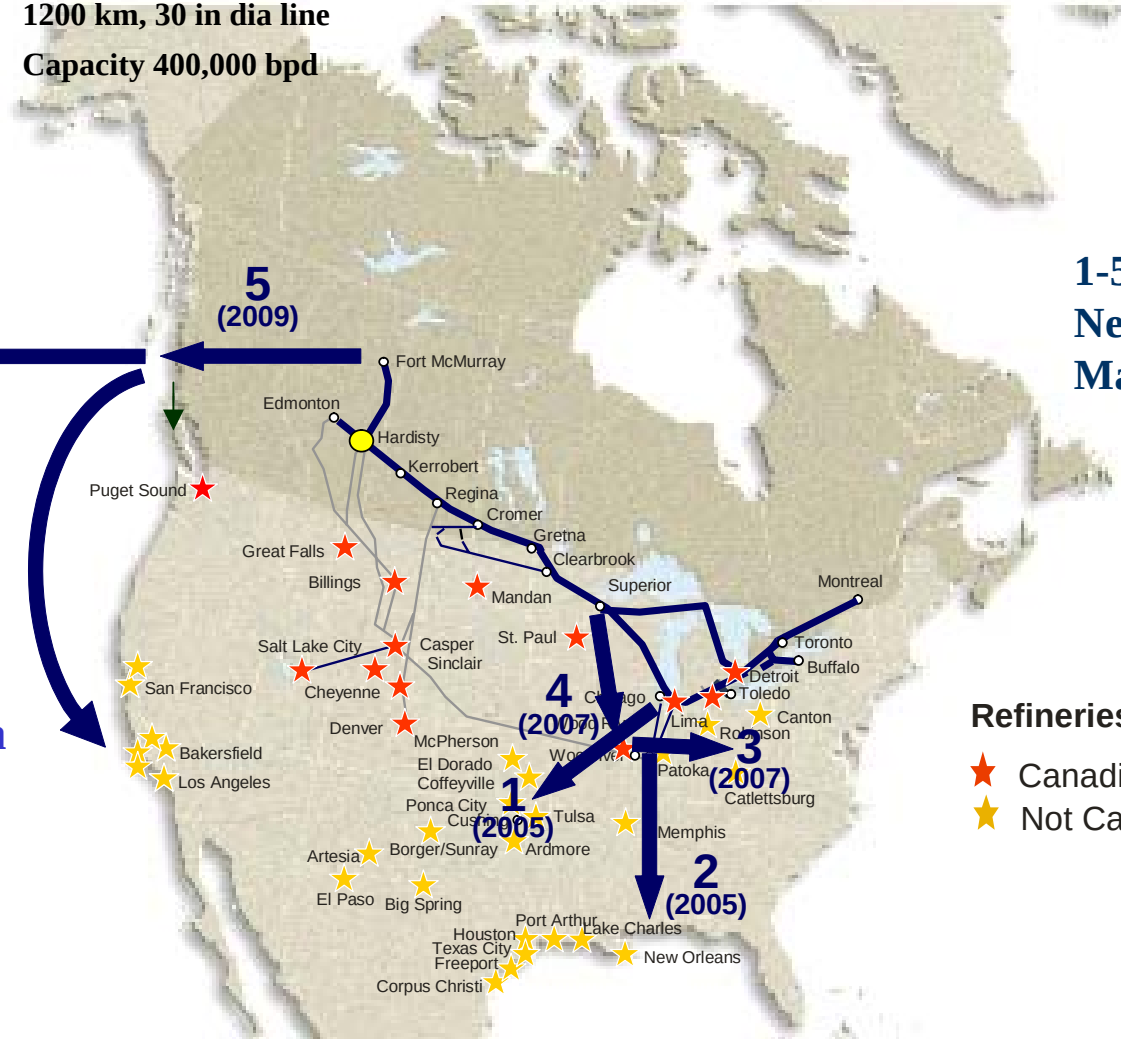
Western Canada Sedimentary Basin Crude Oil Production Potential

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

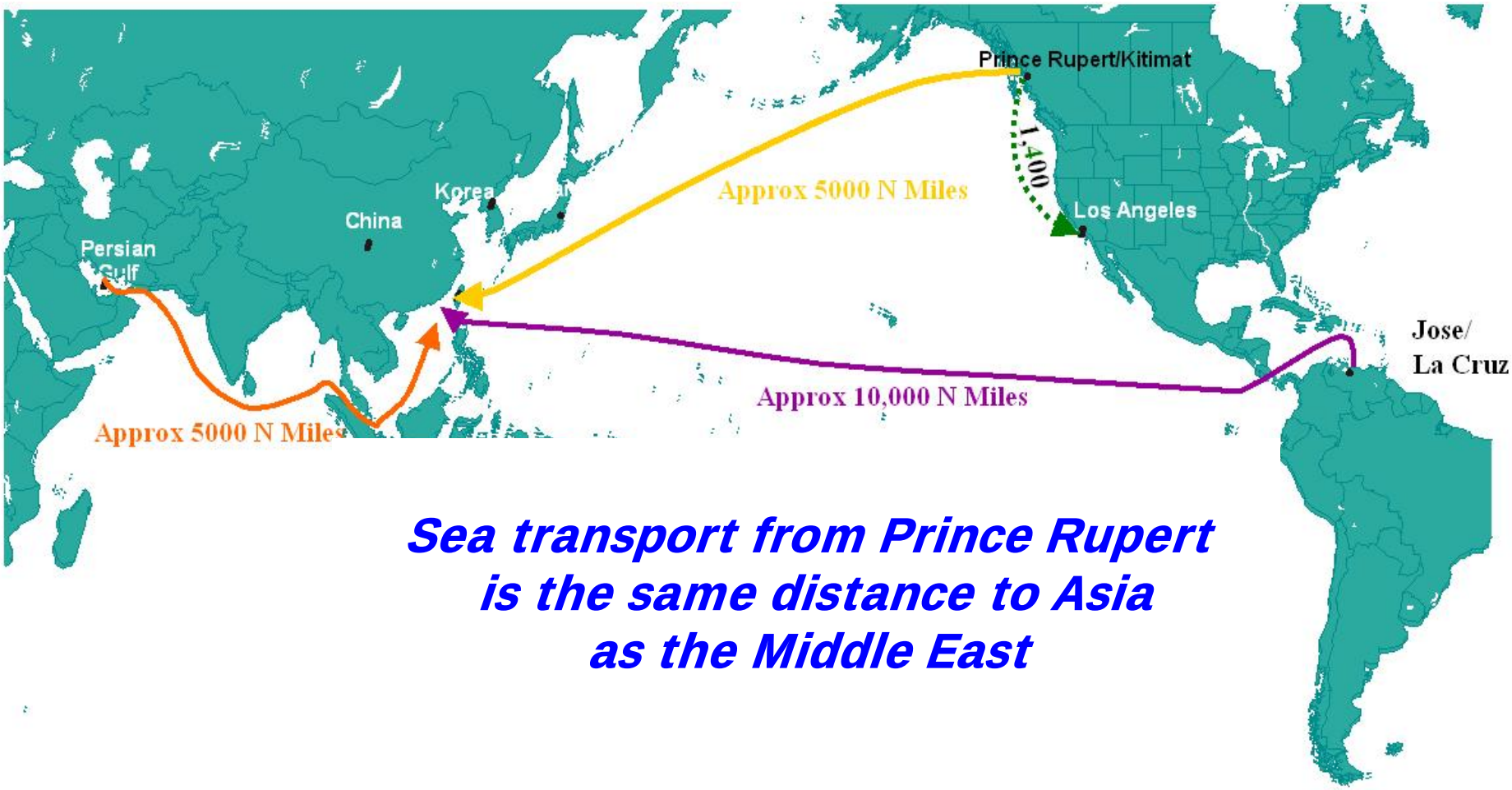


Existing and Expanded Markets

Gateway Project
1200 km, 30 in dia line
Capacity 400,000 bpd



Potential Markets - US West Coast & Far East



Sea transport from Prince Rupert is the same distance to Asia as the Middle East

Major Challenges
Need for Technological Innovation

- Natural gas substitution
  - Rising cost and future availability of natural gas
    - Steam generation
    - Hydrogen for upgrading
- Improved recovery processes
  - Significant portion of resource not currently economic
- Improved refinery conversion technologies
  - Future fuel requirements & refinery fit
- Air emissions, land access and water management
  - Land disturbance / reclamation costs
  - Manage water demands
- High GHG emissions add significant risks

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Summary

- Canadian oil sands resources are immense
- Serious challenges remain
  - technical, environmental, human resource, infrastructure, costs and required investments
- 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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Summary

- "Integrated Energy Economy" is key to a secure energy future
  - Significant opportunities emerge when we consider the energy sector as an interconnected whole
- The Energy Innovation Network (www.EnergyINet.com) designed to take advantage of the shift in energy systems
  - From conventional to unconventional oil & gas
  - From coal burning to advances in near-emission free clean coal technology
  - From a relatively low to significantly high mix of renewable and hydrogen energy options
  - From a focus on separate energy sources to an integrated energy system

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