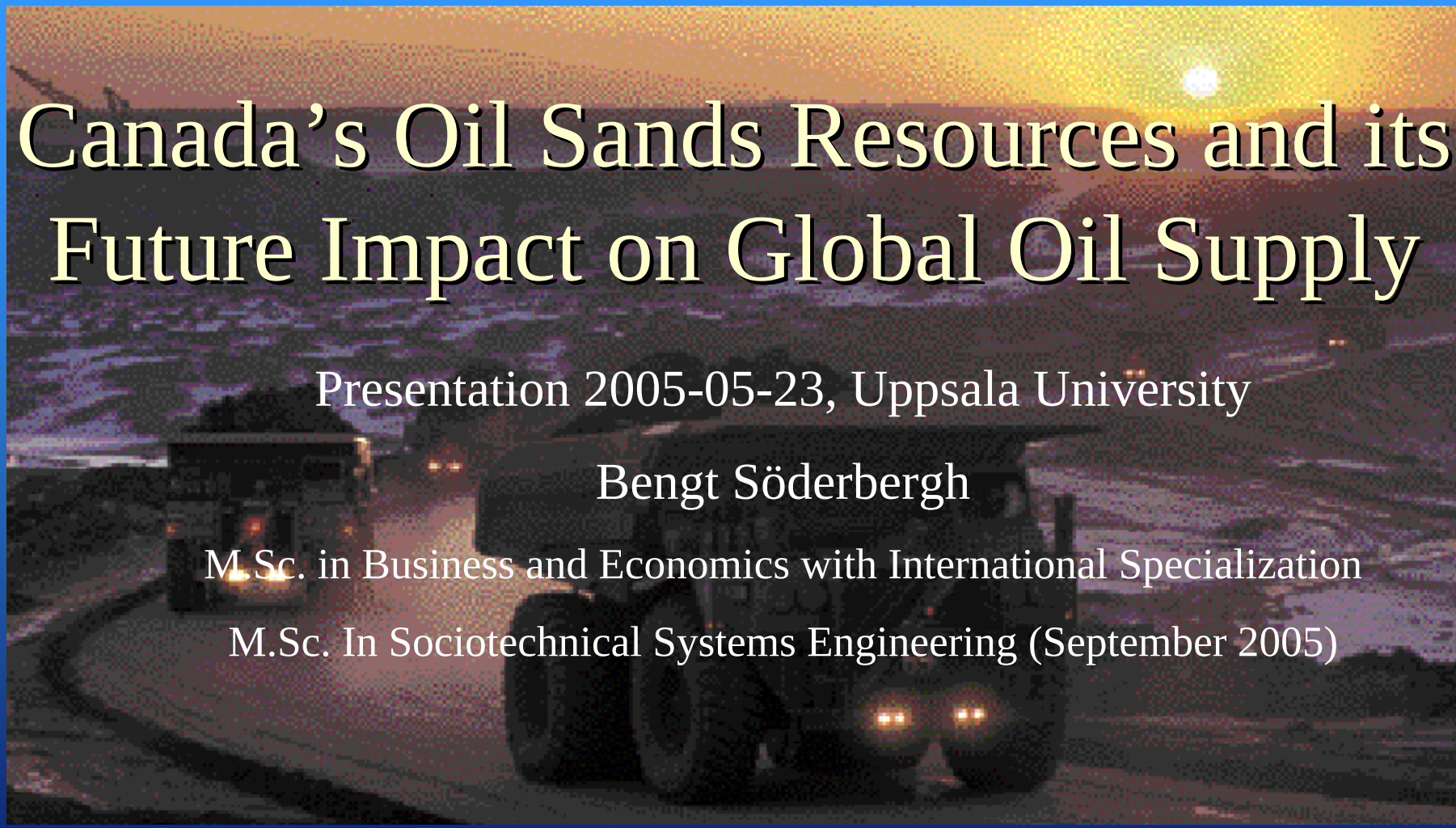


Canada's Oil Sands Resources and its Future Impact on Global Oil Supply

Presentation 2005-05-23, Uppsala University

Bengt Söderbergh

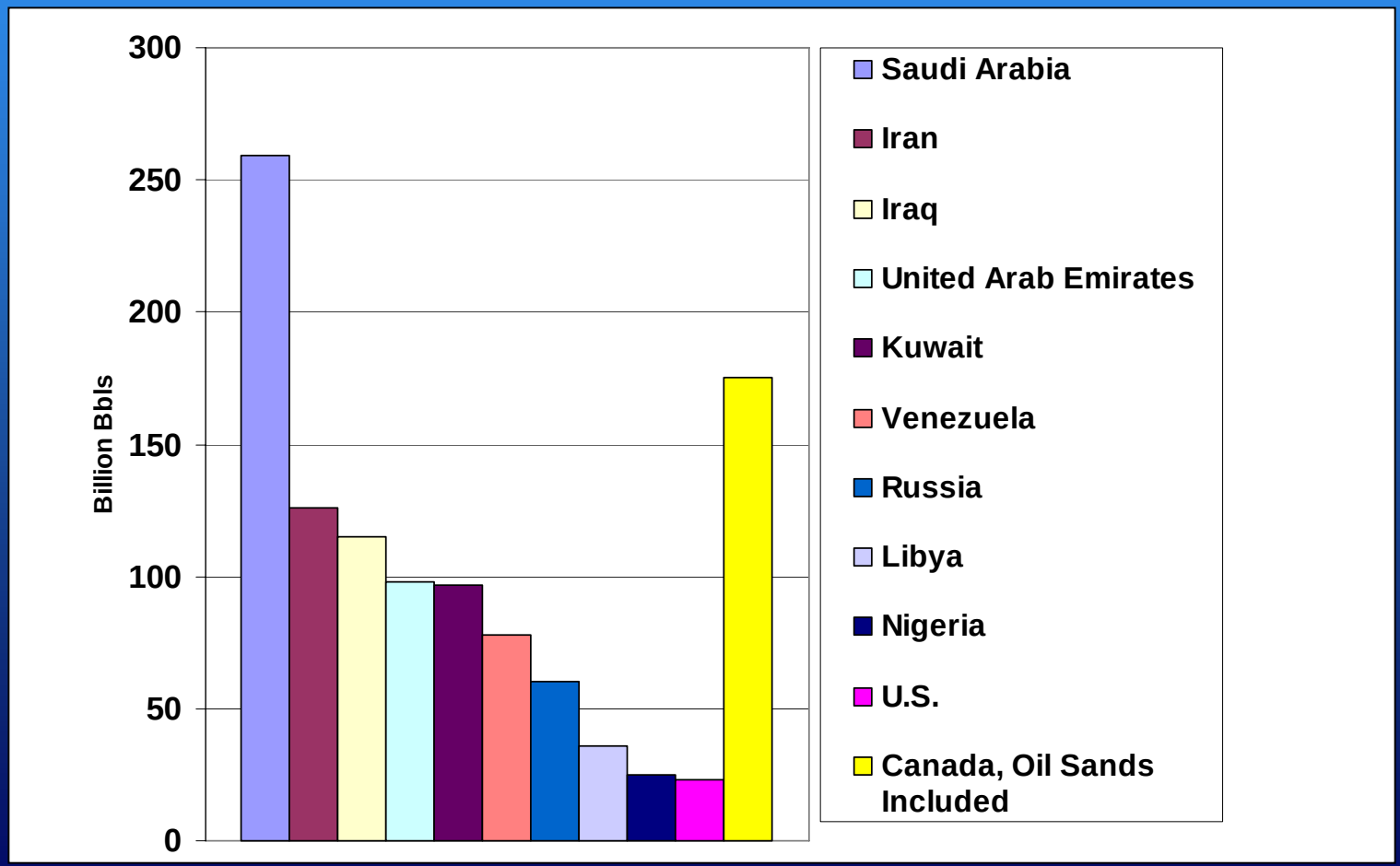
M.Sc. in Business and Economics with International Specialization

M.Sc. In Sociotechnical Systems Engineering (September 2005)

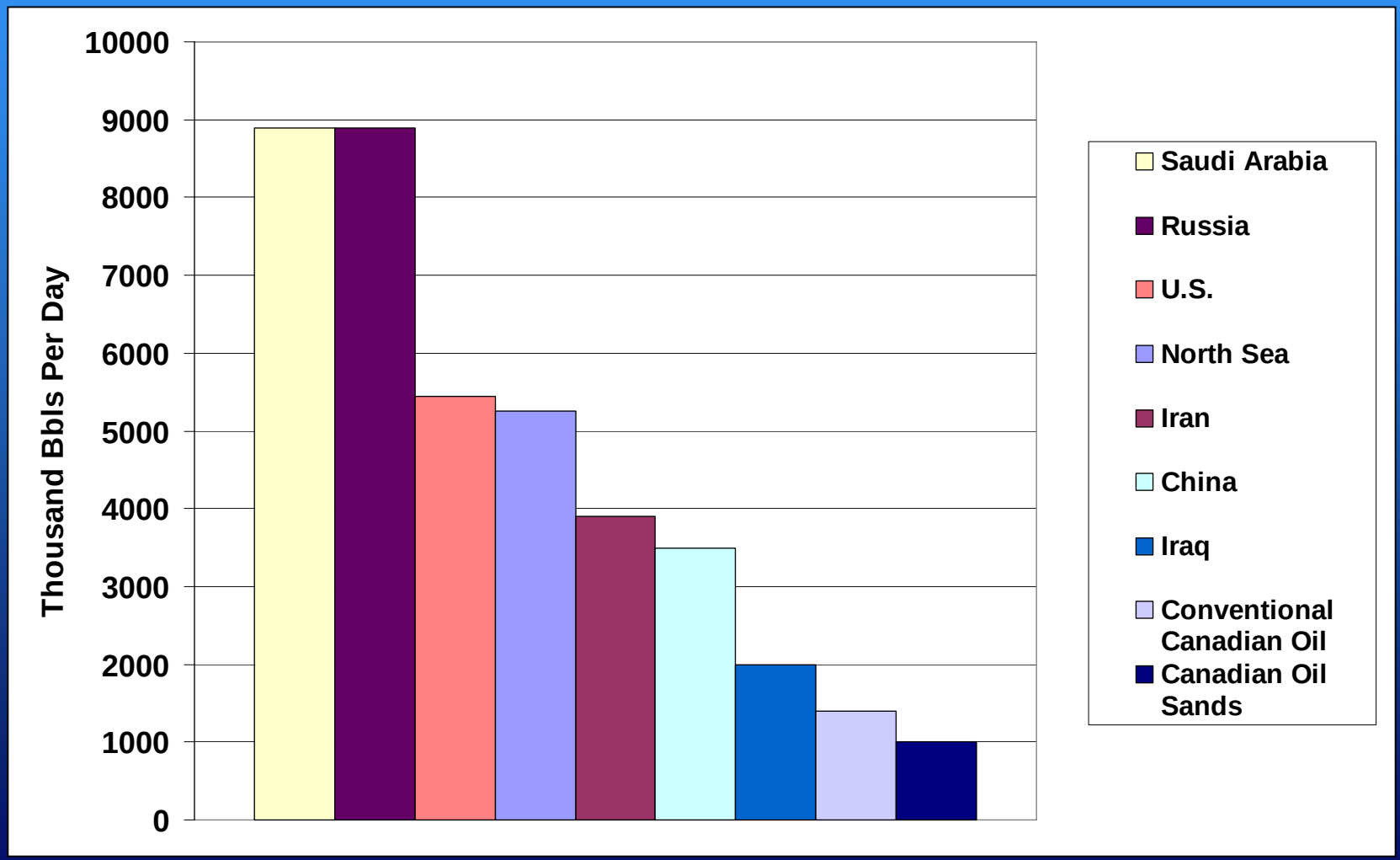
Comparison Between Different Countries' Proven Conventional Oil Reserves

In January 2003, Canada's proven oil reserves increased from 5 to 180 billion barrels.

Why? Canada's reserves of non-conventional oil became included.



Comparison Between Different Regions' Oil Production



Unconventional Oil Production is Supposed to Bridge the Coming Gap!

Low Resource Case

Remaining ultimately recoverable resources base for conventional oil, as of 1/1/1996 (billion barrels)	1700
Peak period of conventional oil production	2013-2017
Global demand at peak of conventional oil (mb/d)	96
Non-conventional oil production in 2030 (mb/d)	37

Source: World Energy Outlook 2004

Definitions of Oil Sands and Heavy Oils

Oil Sands

Quartz sand, silt and clay, water and bitumen. Also, minor amounts of mineral, titanium, zirconium, tourmaline and pyrite

Typical composition:

75 – 80% inorganic material (90% quartz sand)
3 – 5% water
10 – 12% bitumen

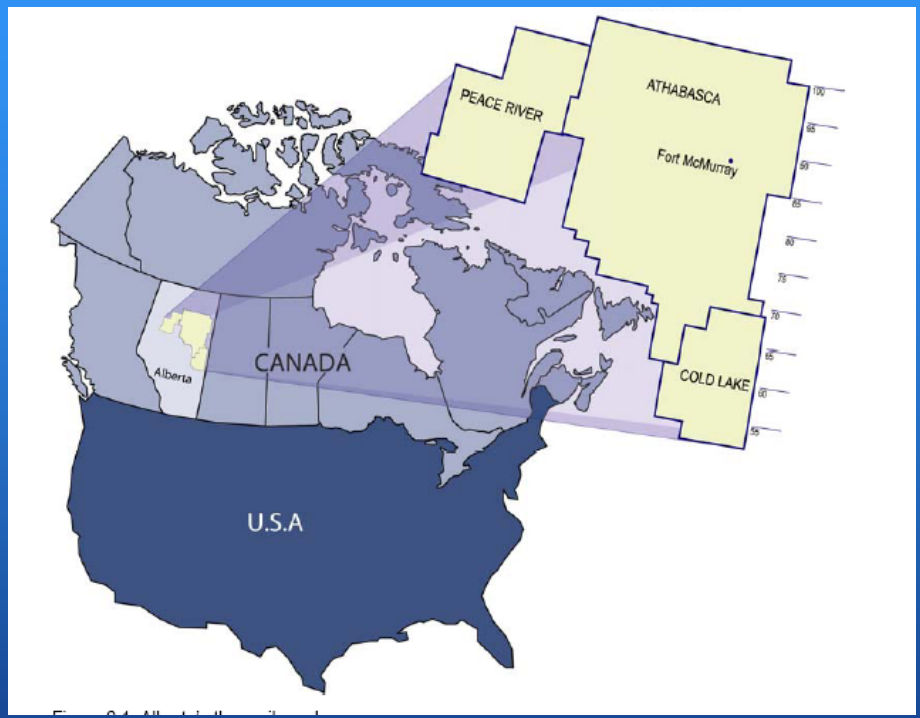
Bitumen/Heavy Oil

Thick black, tar like substance that pours extremely slowly.

7 – 14° API

Bitumen > 10.000 cPo

The Canadian Oil Sands Deposits



Production Technologies

Mining and In situ thermal recovery

In situ, extraction accomplished by drilling wells and thereafter injecting hot steam.

Mining production 2004, about 600.000 bbls/d

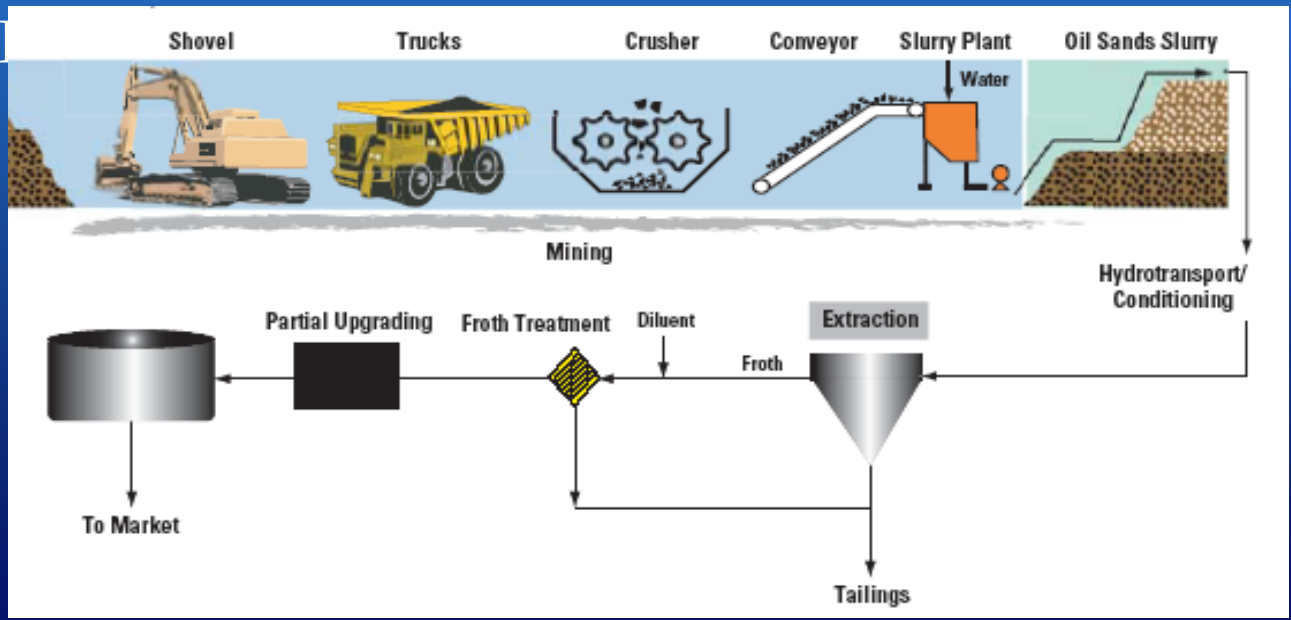
In situ production 2004, about 400.000 bbls/d

Mining Extraction

About 20 % of established reserves

Mining, huge open-pit mines combined with large extraction facilities to separate the bitumen from the sand.

Less than 75 meters overburden.



In Situ Recovery

About 80 % of oil established reserves

In situ extraction removes the hydrocarbons, and leave the mineral behind.

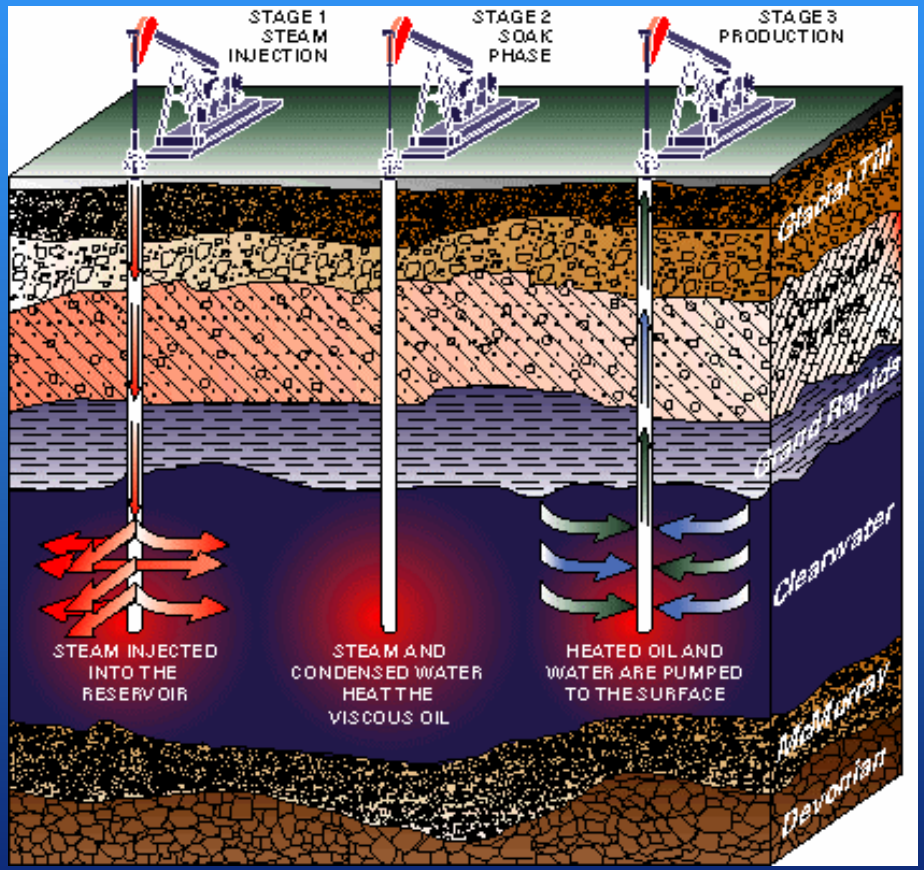
Viscosity, permeability and reservoir thickness important.

Cyclic Steam Stimulation (CSS) Steam Assisted Gravity Drainage (SAGD)

Emerging technologies, VAPEX & THAI

Cyclic Steam Simulation (CSS)

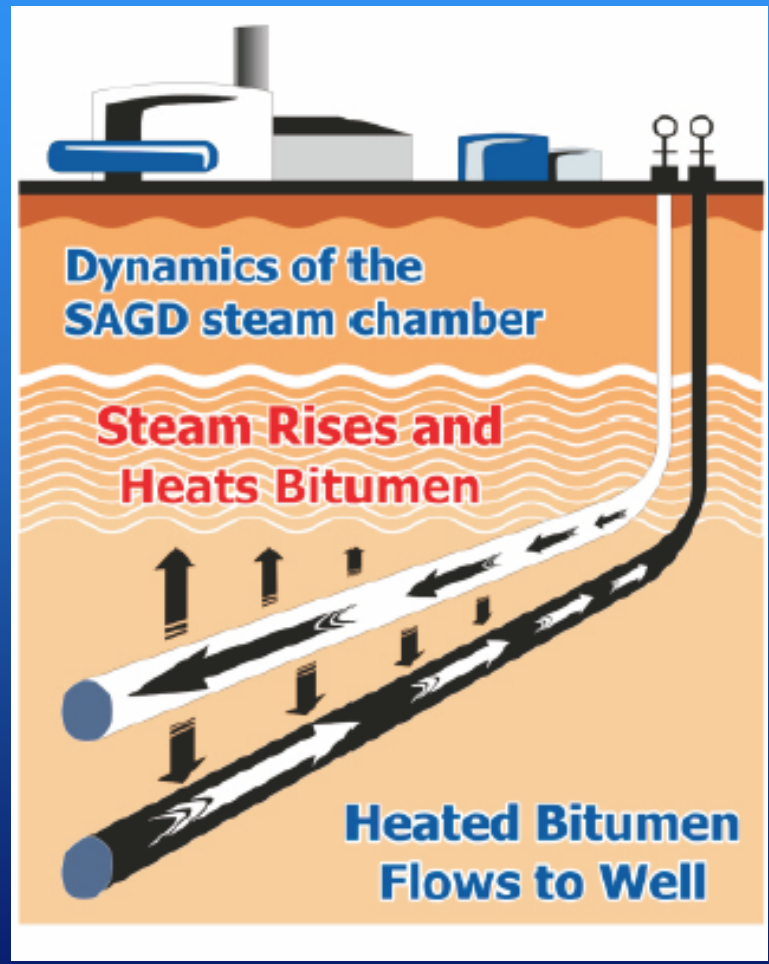
(20 – 25% recovery rate)



Source: Imperial Oil

Steam Assisted Gravity Drainage (SAGD)

(40 – 70% recovery rate)



Source: Husky Energy

Upgrading

Bitumen is deficient in hydrogen. Must be upgraded to synthetic crude oil (SCO) to acceptable feedstock for refineries

Addition of hydrogen or the rejection of carbon, or both.

Upgrading uses natural gas as a source of heat and steam for processing and also as a source of hydrogen.

Canadian Reserves of Crude Bitumen

(Billion barrels)	Ultimate Volume In Place	Initial Volume In Place	Initial Established Reserves	**Remaining Established Reserves**
Mineable				
Athabasca	138.6	113.4	35.2	**32.3**
In Situ				
Athabasca	n/a	1187	n/a	**n/a**
Cold Lake	n/a	201.3	n/a	**n/a**
Peace river	n/a	127	n/a	**n/a**
Total In Situ	2381	1515.3	143.6	**142.4**
Total	2520	1628.7	178.8	**174.7**

Environmental Impact

Large water use (2.5 – 4 units of water per bitumen unit)

Large ponds of waste material.

Greenhouse gases, mainly CO_2, but also other air emissions such as SO_2, NOx, H_2S, CO, O_3, VOCs PAH etc

Greenhouse gas emissions from the oil sands industry may exceed 130 mega-tonnes per year by 2020.

Canada has signed the Kyoto treaty!

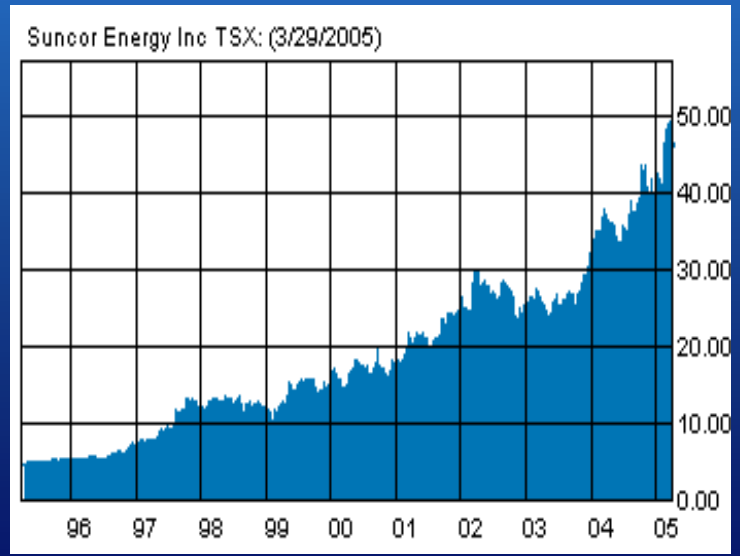
Oil Production Investment Aspects

Oil sands mining projects demand enormous capital investments.

Shell has invested more than C$6 billion in the AOSP project.

Production costs between $15 – 24!

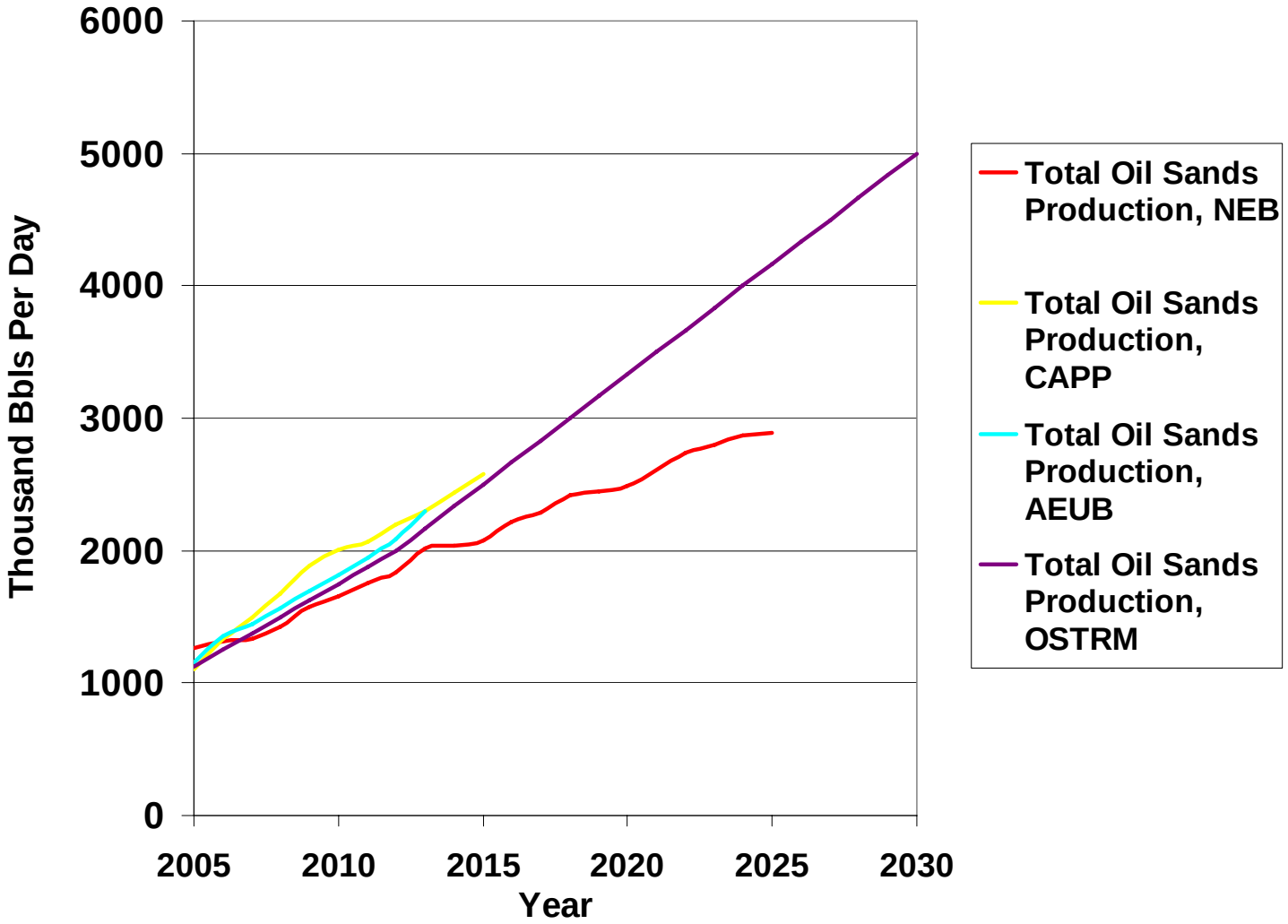
Oil Sands production - A Profitable Business Area !



Already Made And Planned Investments In Oil Sands Production

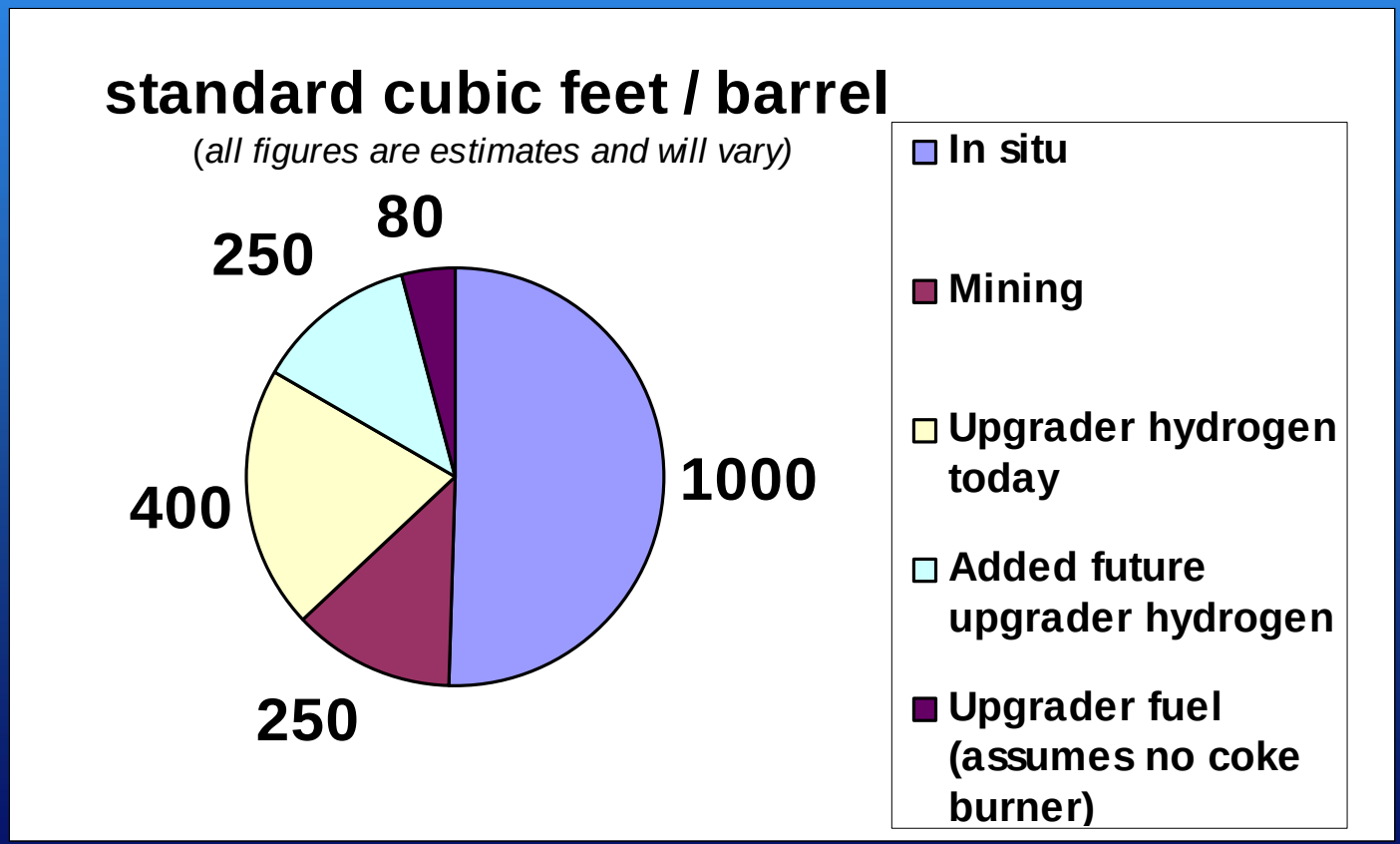
1996 – 2002 $24 billion (Can.) investment in oil sands
2002 – 2006 $7 billion (Can) under construction.
2007 - $25 (Can) billion, new oil sands projects announced and under evaluation.

Different Public Oil Sands Forecasts



Need of Natural Gas

Recovery and upgrading of bitumen from the oil sands consume large amounts of natural gas, electricity and hydrogen. Natural gas is the main source of energy and hydrogen. (historical origin)

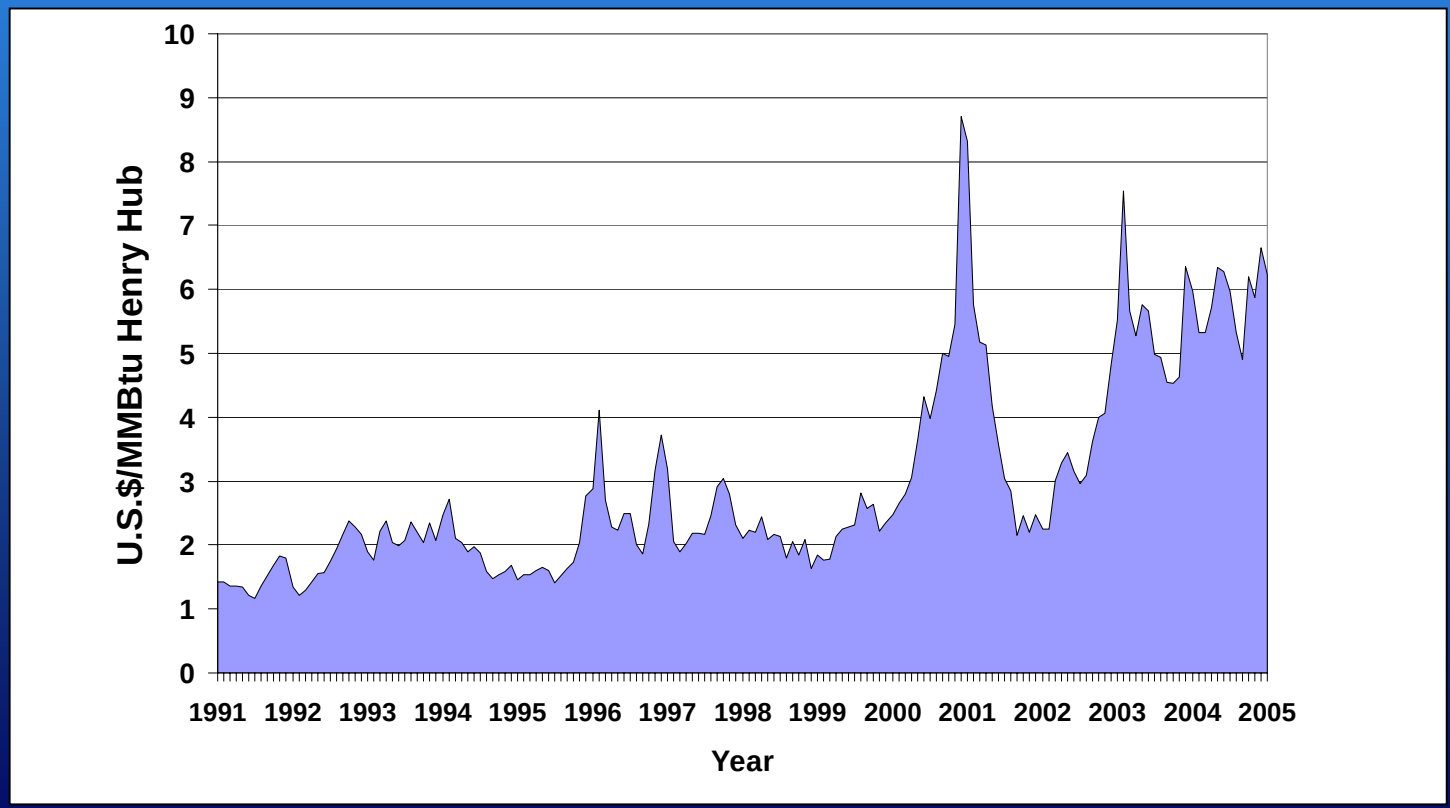


Increasing demand for Natural Gas

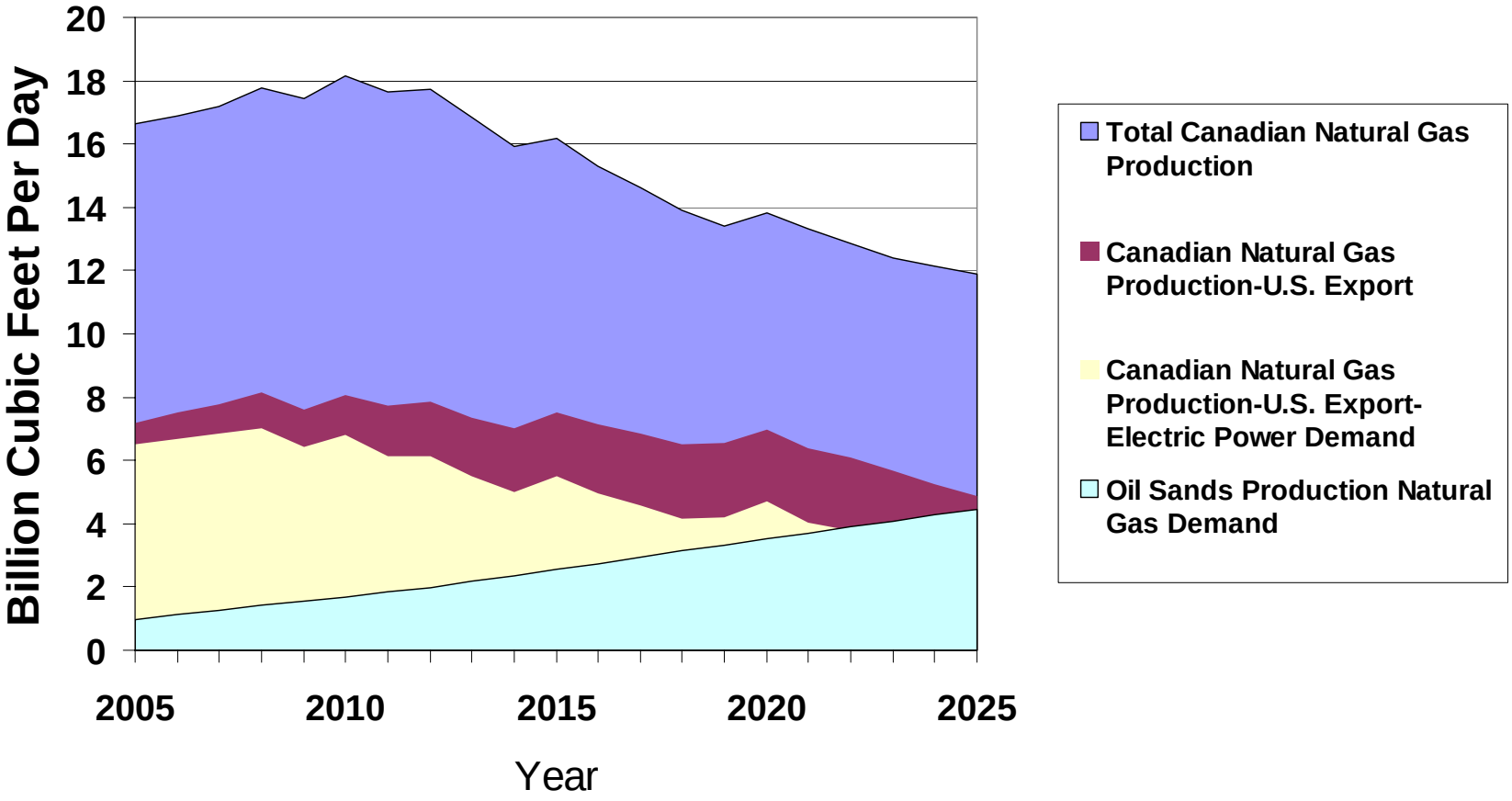
In 2003, natural gas supplied about 30% of the total energy consumption in Canada.

About 50 % of Canadian natural gas production is exported to the U.S..

U.S. gas demand will grow from today's 60 Bcf/day to more than 90 Bcf per day by 2010.

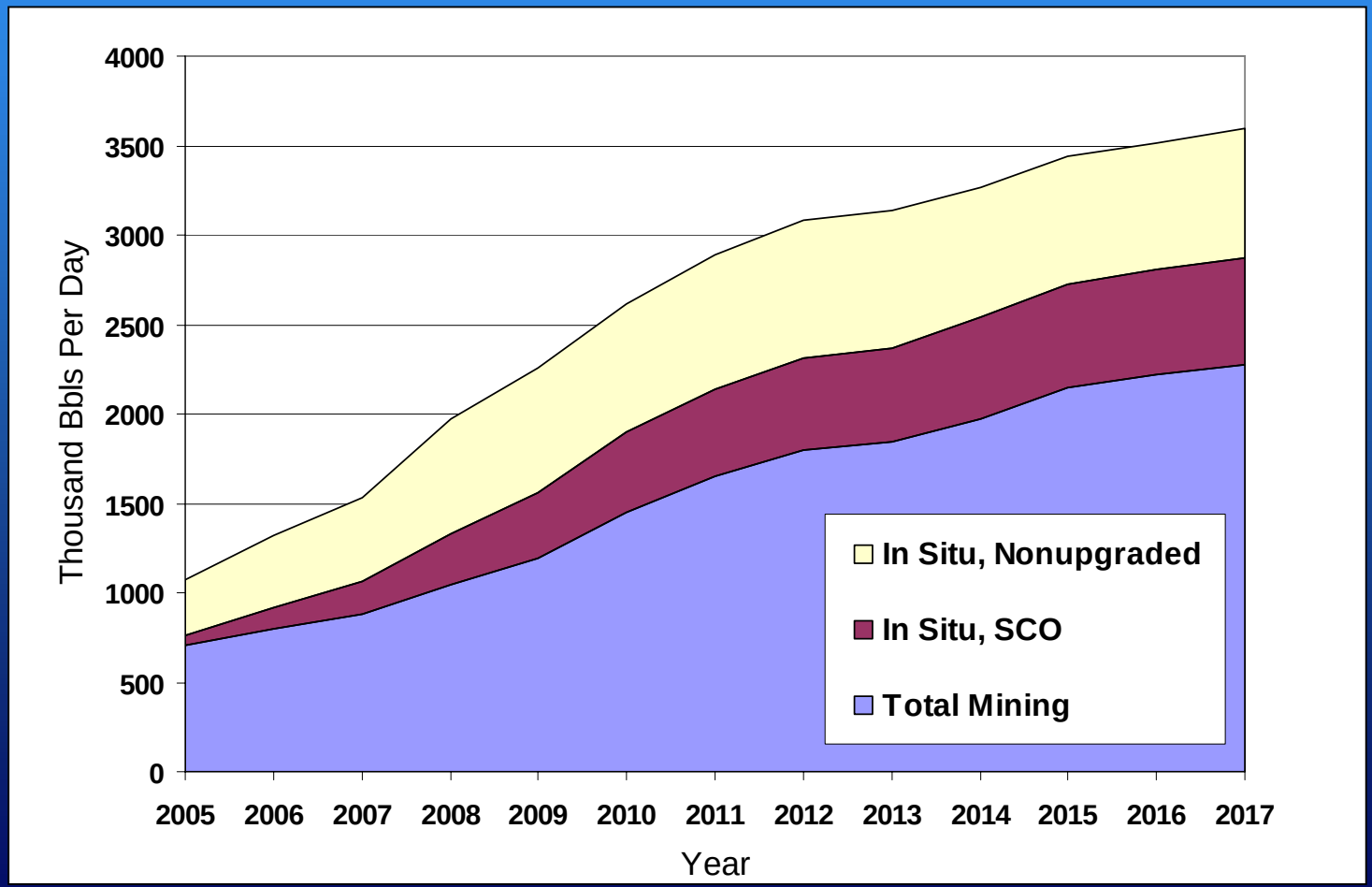


Unsustainable Reliance on Natural Gas



All Projects Oil Sands Production Forecast

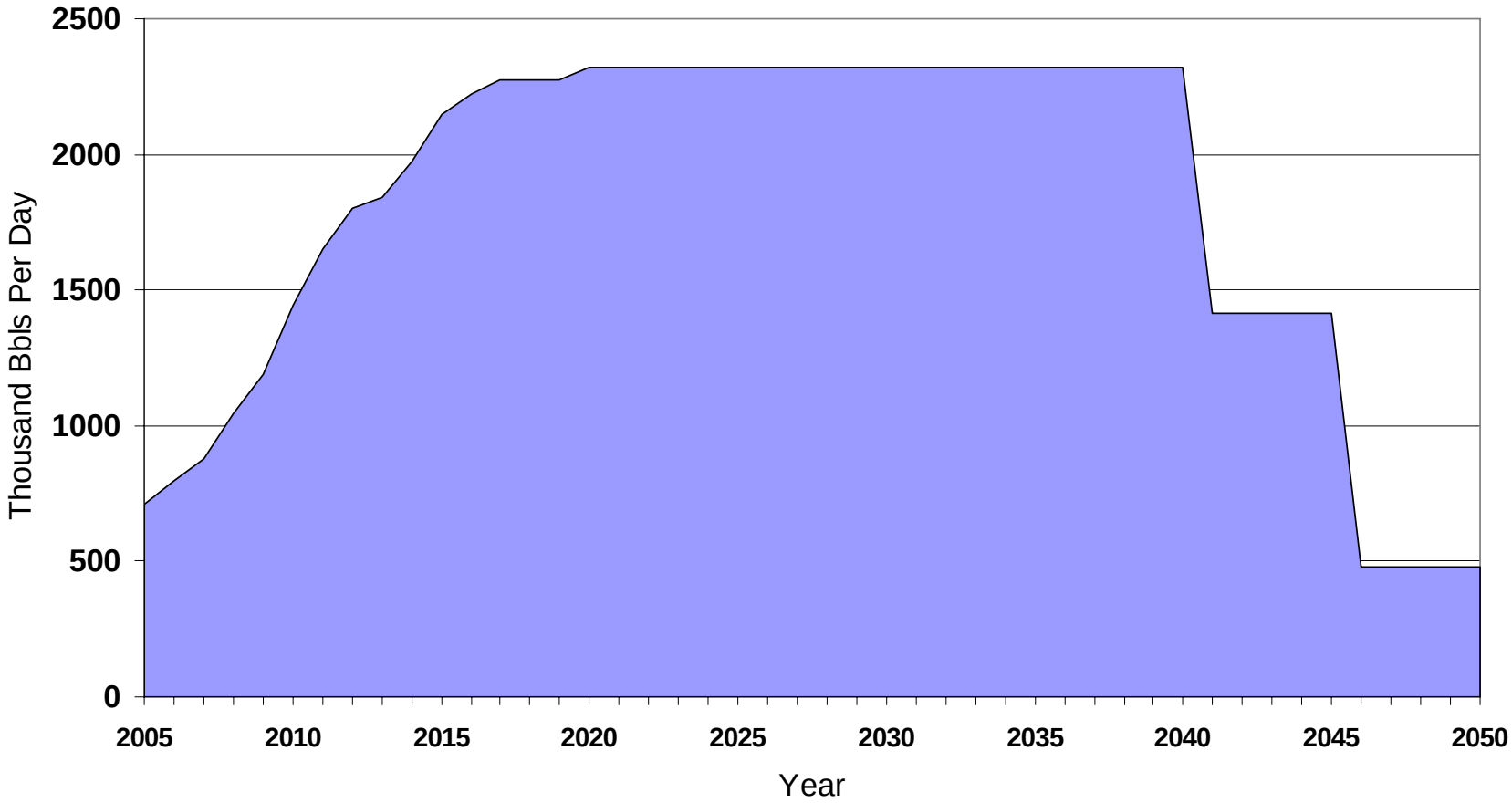
Assumes all currently planned and postponed projects completed.
– Not realistic! Assumes immediate action to increase production.



All Mining Projects Forecast

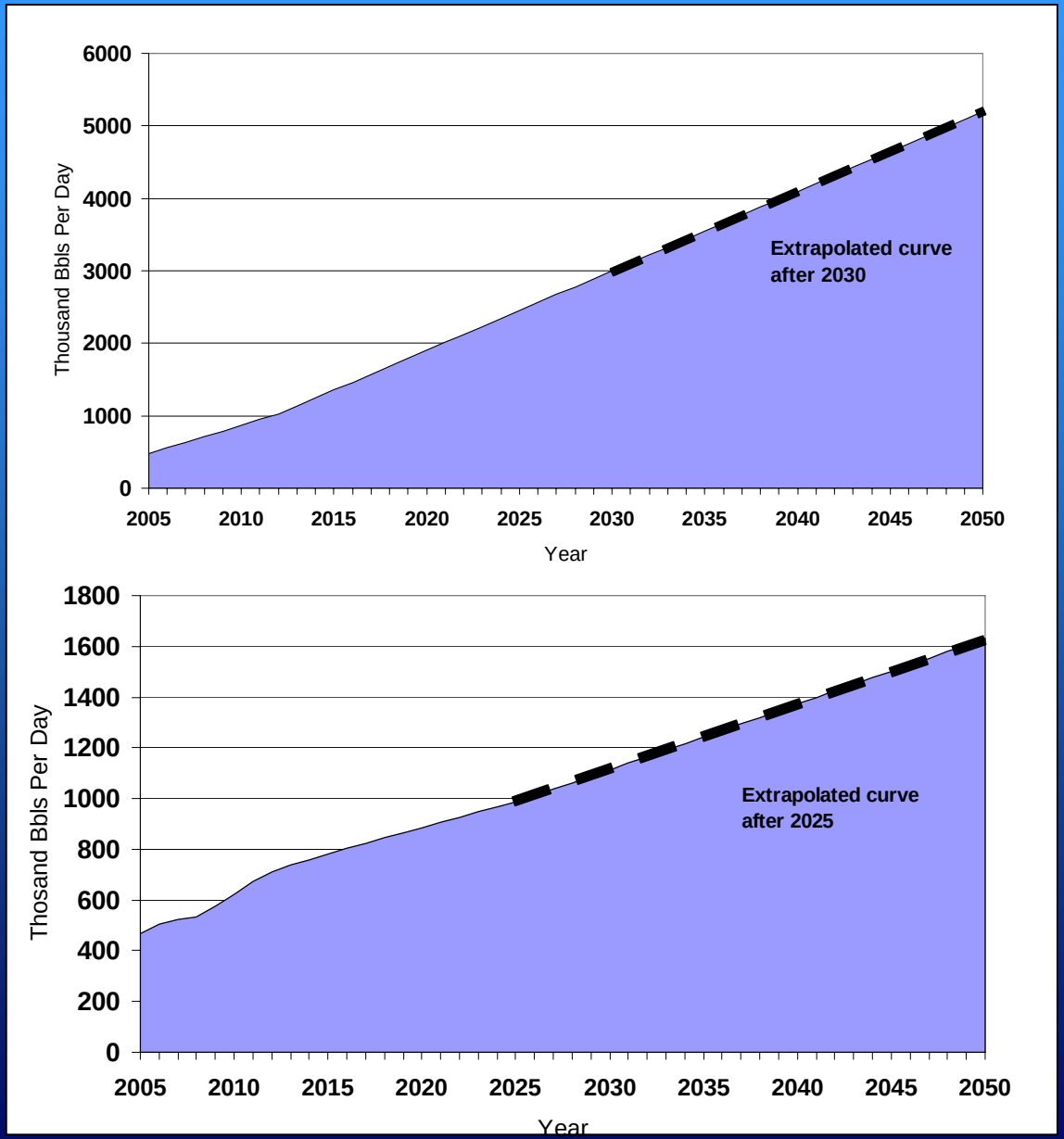
All currently planned and postponed mining projects completed.

The established mineable reserves of 32 Gb will have been produced!



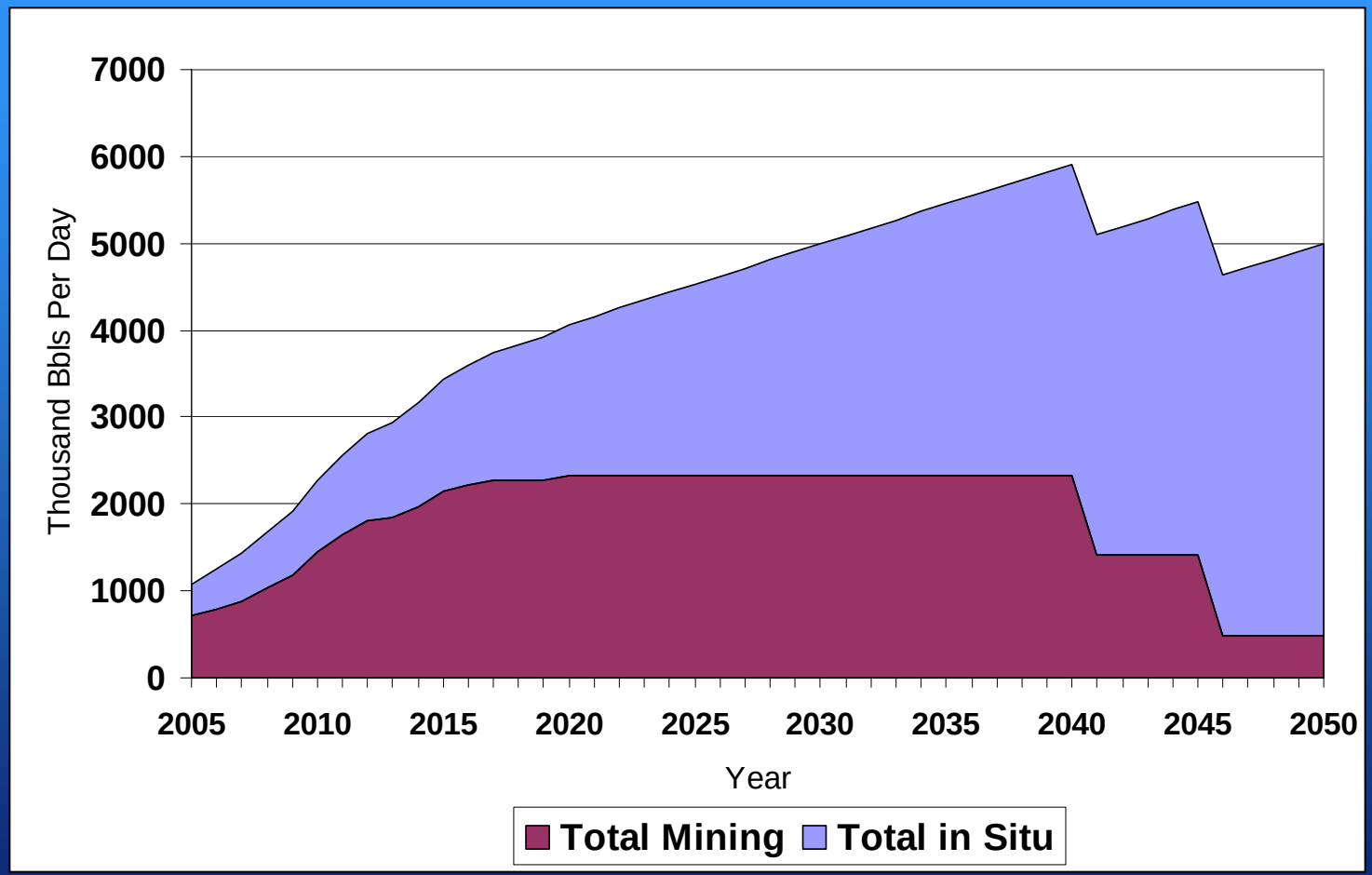
In Situ Production – the Long Term Future

OSTRM



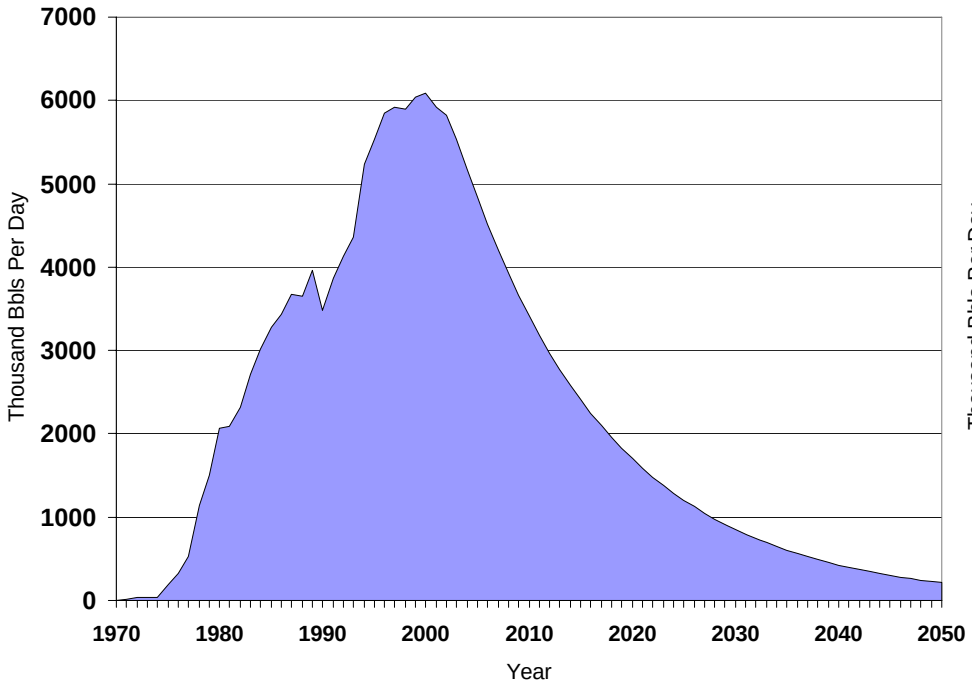
NEB

Canada's Total Oil Sands Production May Peak

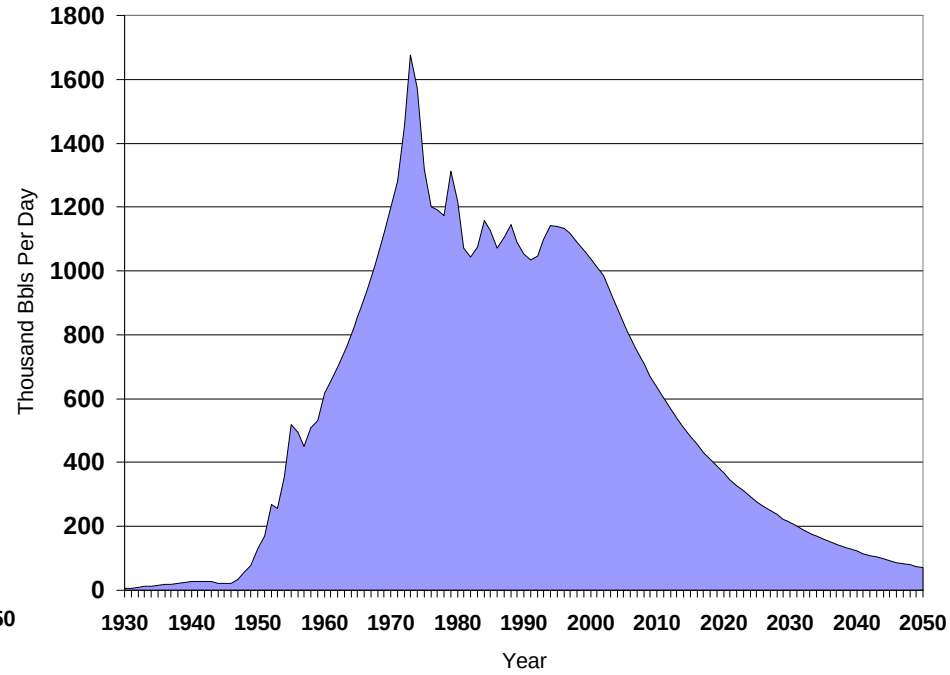


The Declining Conventional Oil Production from the North Sea and Canada

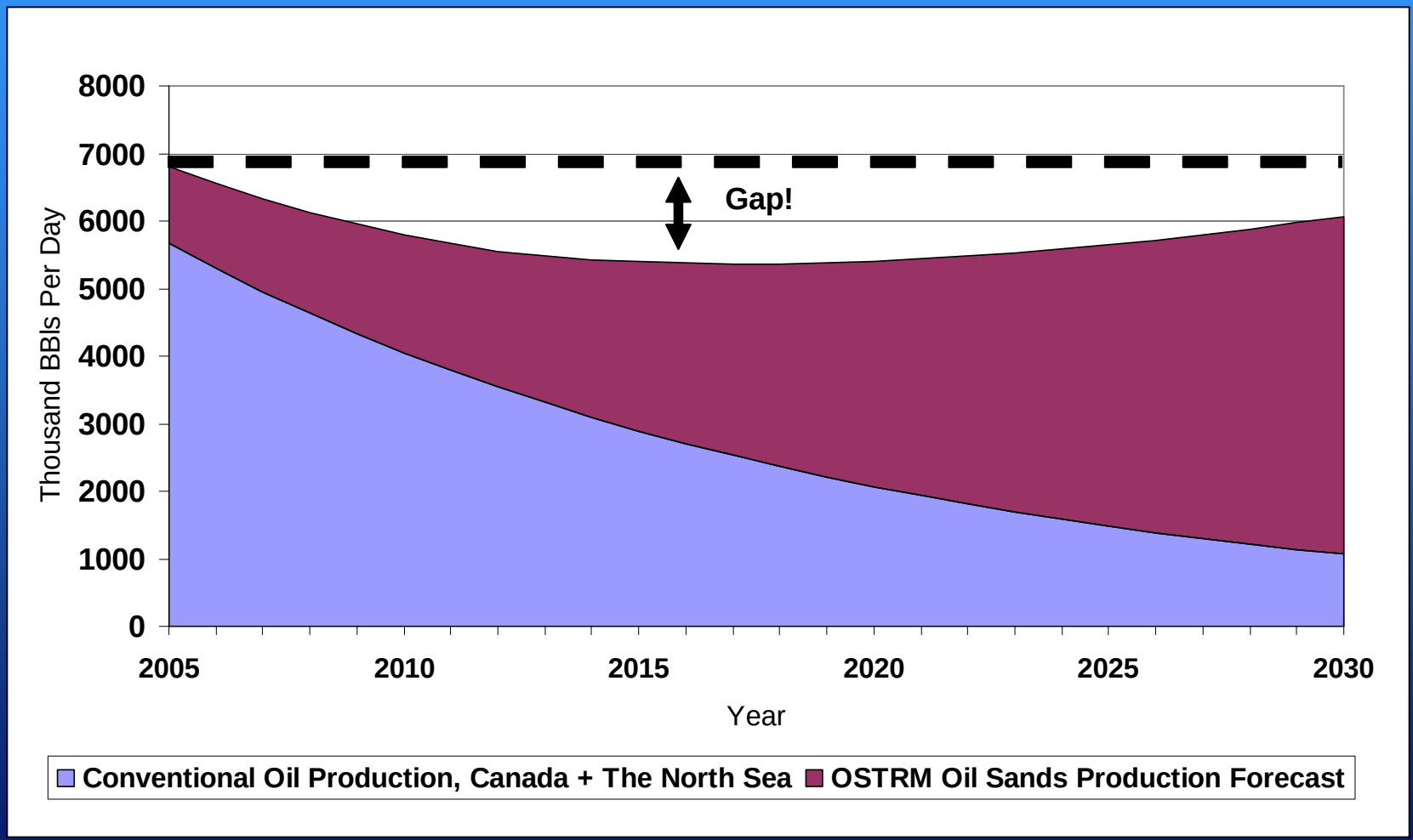
The North Sea



Canada



Resulting Oil Production from Canada's Oil Sands, Canada's Conventional oil and the North Sea



Conclusions

The natural gas supply situation and CO_2E emissions are development constraints for the oil sands industry.

??? In situ production - the big question mark ???

The Canadian oil sands industry cannot even compensate for the combined decline of conventional oil production in Canada + the North sea by 2030.

The Canadian oil sands will not prevent global peak oil!

Question to the IEA: Assuming Venezuela achieves a production of 6 million b/d of heavy oil by 2030, Canada 5 million barrels. Who will produce the remaining 26 million barrels per day of unconventional oil?

The Canadian oil sands will not prevent global peak oil, or meet future increase of demand