



North American Issues Arising from the 2050 Study

Transportation Research Board Conference -
Washington, DC

Presented by Paul Khanna

January 2003



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Outline

- **How do the 2050 scenarios and the future drivers of Innovation, Environmental Responsiveness and Market Interdependence effect ...**
 - *Natural Gas Availability*
 - *Vehicle Fuel Efficiency and Fuel Cells*
 - *Oil Sands Development*
 - *Renewable Energy Growth*



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Scenarios – Greening the Pump

- Demand management is very successful in this lower growth, environmentally conscious world
- Environmentally friendly technologies that exist or are near deployment are quickly introduced into the market
- Population and economic growth make sustainability an on-going challenge



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Scenarios – Rollin' On

- A high growth world where increasing demands are met by rapidly improving technology
- Advanced technologies make significant market penetration
- Fossil fuels still make up the bulk of the transportation fuel market



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Scenarios – Go Your Own Way

- A high growth, innovative and environmentally conscious world that aims to be both rich and clean
- Regionalized energy systems develop with alternative fuels and advanced technologies
- Growth in hydrogen, biomass and other fuels displace oil use in transportation



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Natural Gas Availability

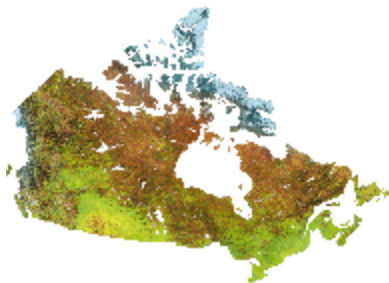
- Input from Steve



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Vehicle Fuel Efficiency

- **All 2050 Scenarios show increases in vehicle fuel efficiency.**
 - *In some cases, almost 50% improvement (including both conventional and advanced technologies)*
- **This is achieved with fleets that still primarily consist of internal combustion engines.**



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Paths to Improved Fuel Efficiency

- **Scenarios with less innovation rely on:**
 - *Changing driver habits and behaviour*
 - *significant vehicle weight reductions; and*
 - *Less emphasis on vehicle power*
- **Scenarios with more innovation rely on:**
 - *More diesel engines into light duty vehicles*
 - *improved engines and drivetrains*
 - *the adoption of hybrid technology*
 - *introduction of fuel cells & alternative fuels*



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Consumer Response

- **Will consumers pay more for more fuel efficient vehicles?**
 - *Many technologies are cost effective over vehicle life - but - they still increase the cost of the vehicle*
- **Will consumer choices change in the future?**
 - *In the U.S., light trucks hit 51% of light duty vehicle sales in 2001*
 - *In Canada, the share of new light truck sales peaked at 47% in 1997 and is now declining*





Fuel Cells in 2050

- **Market penetration varies between the scenarios:**
 - *Up to 50% of the new LDV fleet by 2050*
 - *Also in commercial transport and buildings*
- **Must compete with fossil fuels that:**
 - *are relatively cheap and energy dense*
 - *are fuel is easy to store, transport and handle*
 - *have engines which are increasingly more efficient*
 - *have a fully developed infrastructure*
- **Role of fuel cells in transportation by 2050 is varies greatly by scenario.**
 - *many benefits but also many hurdles to overcome*



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Canadian Oil Sands

- **Oil sands are mostly sand and clay with water and bitumen**
- **Bitumen**
 - *A tar like mixture of petroleum hydrocarbons with a density 20% greater than light crude*
 - *Needs to be separated from minerals/water and upgraded into light, high-grade synthetic crude oil: low-sulphur, low-nitrogen*
 - *Synthetic crude oil has sold at a premium to benchmark prices due to its high quality relative to conventional crude*





Canadian Oil Sands Statistics

- **2.5 trillion barrels in place with 315 billion barrels ultimately recoverable remaining**
- **Capital Spending (US\$):**
1999 - \$1.5 billion, 2000 - \$2.7 billion, 2001 - \$3.8 billion
- **Production cost per barrel of synthetic crude oil:**
 - *\$15-18 for surface mining*
 - *\$6-10 for cyclical steam stimulation operations*
 - *\$5-9 for steam assisted gravity drainage*
 - *Kyoto Accord may add up to 64¢ per barrel; still well below market price*



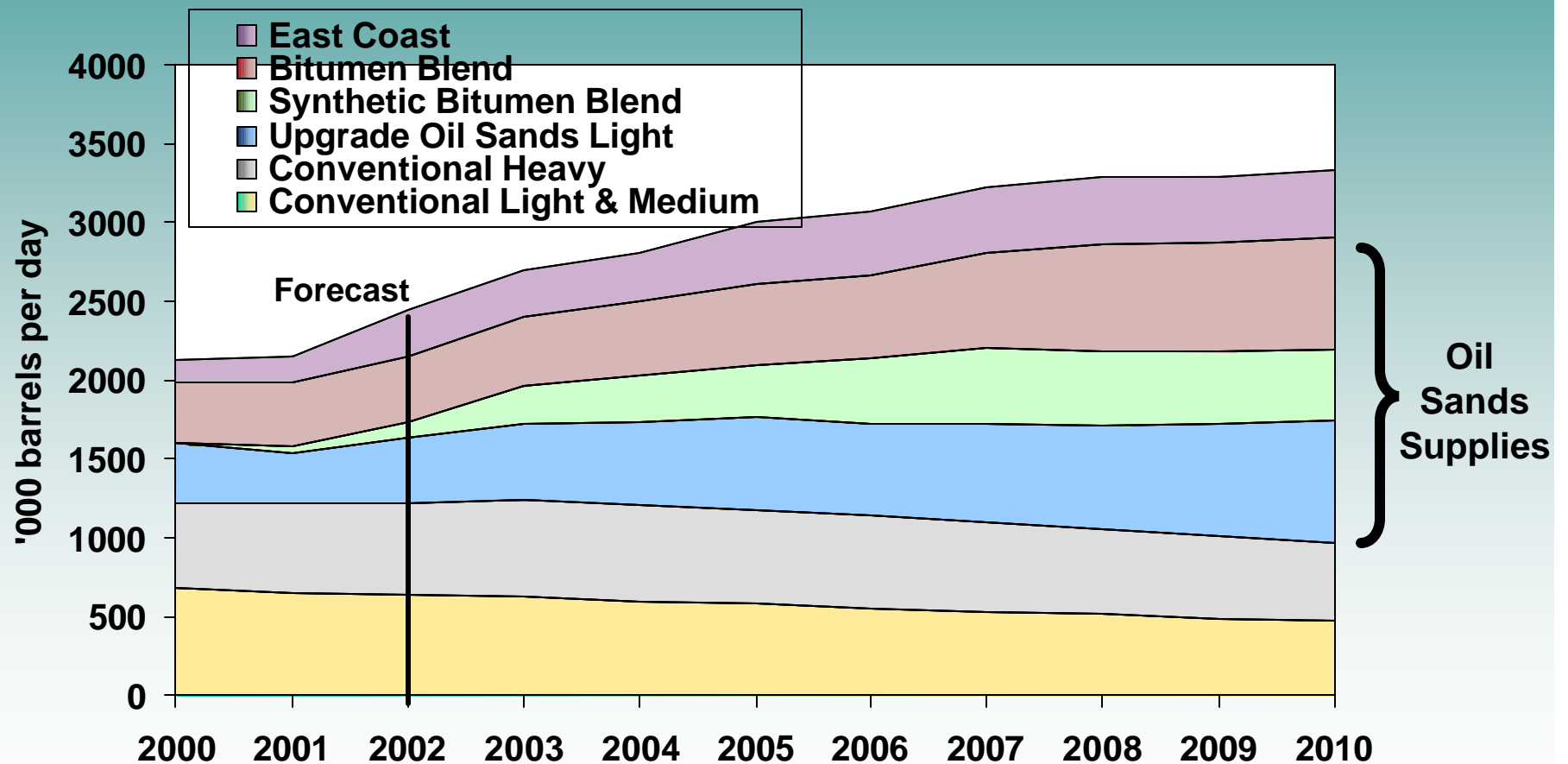
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Canadian Crude Oil Supply



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Source: Canadian Association of Petroleum Producers

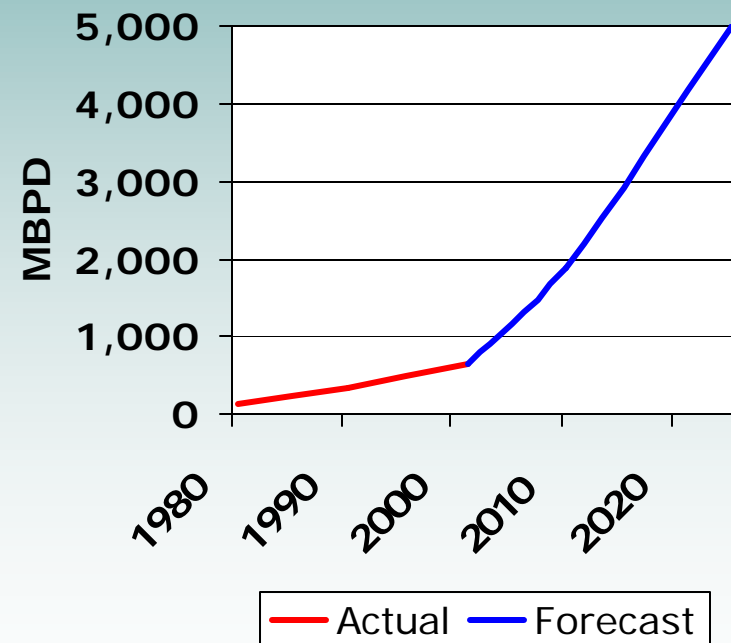
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Historical and Projected Production

- Since 1980, production has increased by 7.6% annually.
- 2001 production - 645,000 bpd
- The industry outlook assumes 8.9% per year from 2001 to 2025.

Oil Sands Production



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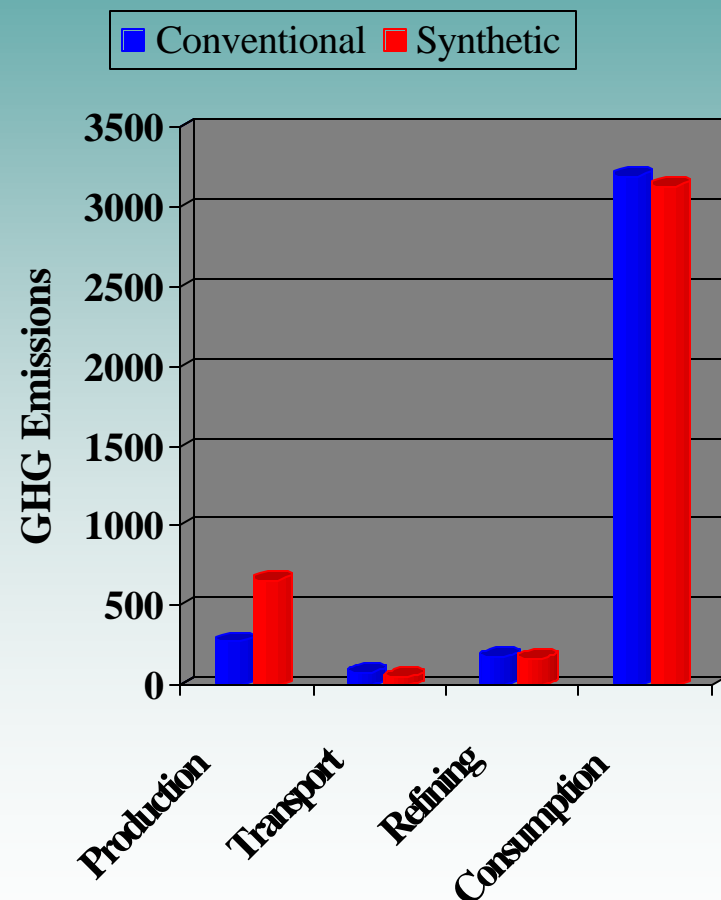
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GHG Impacts of Oil Sands

- **Currently, compared with average North American crude oil imports, oil sands synthetic crude produce:**
 - *140% more GHG emissions in production*
 - *38% less GHG emission in product shipment*
 - *4% less GHG emissions in refining*
- **Overall, total life cycle GHG emissions, including consumption, are 7.6% higher than average imported crude.**



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Source: Petroleum Communication Foundation

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Oil Sands use in the 2050 Scenarios

- **In the scenarios, North American oil production ranges from 8 to 30 million bpd by 2050.**
- **At the high end, virtually all of the production comes from oil sands**
- **Cumulative production is over half today's ultimate recoverable reserves.**
- **However, today's "ultimate" recoverable will increase over time due to better exploration and extraction technology.**



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Oil Sands & Technology

- **Technology has and will continue to play major role.**
- **New technologies for:**
 - *upgrading, & sulphur and nitrogen removal,*
 - *viscosity reduction,*
 - *water treatment and recycle,*
 - *alternatives to steam for in in-situ recovery*
 - *CO₂ for enhanced oil recovery, as a bitumen solvent or for reservoir pressurization*





Oil Sands use in the 2050 Scenarios - Conclusions

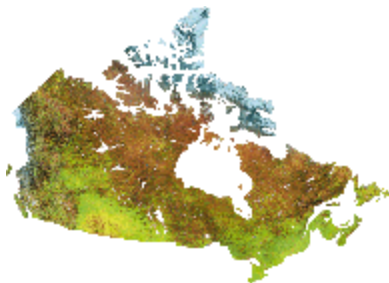
- Possible growth rates and cumulative production seem possible.
- However, oil sands may reach their peak production around 2050.
- Possible barriers:
 - *Environmental concerns*
 - *Crude oil prices*
 - *Labour and capital requirements*



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Renewables in the 2050 Scenarios

- In the scenarios, renewables are used to varying degrees – these shares are expected to grow post 2050.
- Ethanol, E-Diesel and Biodiesel play a significant role in environmental scenarios.
- To start, ethanol comes mainly from corn, then increasingly from lignocellulosic resources.
 - *Lignocellulosic technology reduces the possibility of resource constraint*



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Energy use in the Scenarios – post 2050

- **Innovation seems the most powerful and enabling driver for the future.**
- **Over time, natural gas and oil will become more scarce as technology cannot make up for depletion.**
- **These will be made up by renewables in the form of biofuels, electricity and hydrogen.**
- **Other non-renewable growth areas may include nuclear and clean coal technologies.**





Next Steps

- **Further analysis is being done on the results of the 2050 study**
- **The issues raised in this presentation will be examined in greater detail**

