

NCUT

National Centre for Upgrading Technology

'a Canada–Alberta alliance for bitumen and heavy oil research'

Canadian Bitumen to Ultra Clean Fuels: Climate Change Challenges and Opportunities

Presented to:

Climate Change Technologies for Fossil Fuels Workshop

North American Energy Working Group

Monday, June 16, 2003

Calgary, AB



Natural Resources
Canada

Ressources naturelles
Canada



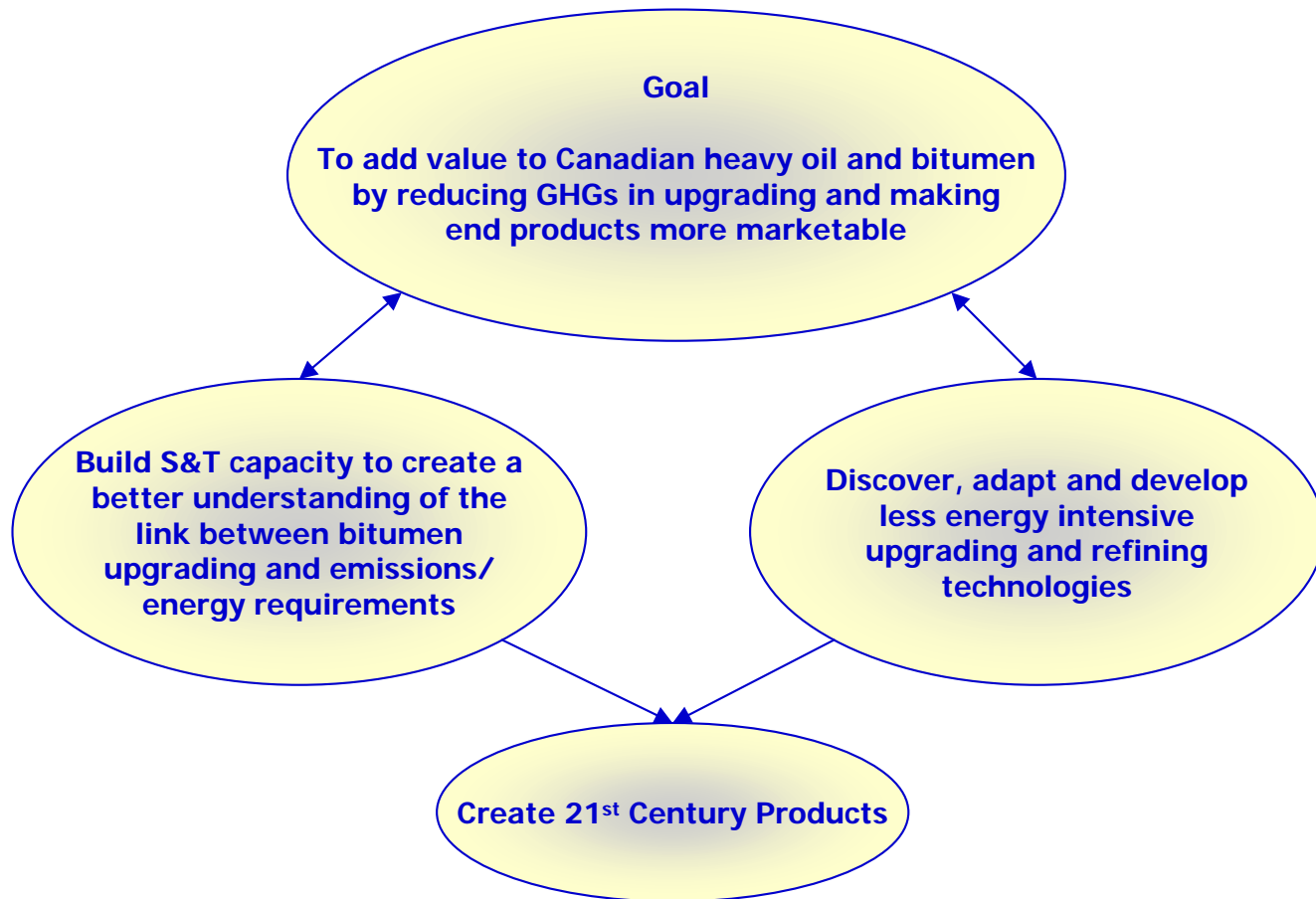
Outline

1. The sources of GHG emissions in oils sands bitumen upgrading.
The technology being applied to deal with GHG emissions.
A 2015 scenario for upgrader GHG emissions.
2. Challenges to manufacturing ultra clean fuels from bitumen.
Will the U.S.A. market accept 3M bpd of Canadian SCO?
3. From a technology perspective, climate change issues are driving the various fossil fuel industry sectors onto common ground. The distinctions between coal and oil sands processing will be obscure by 2015.



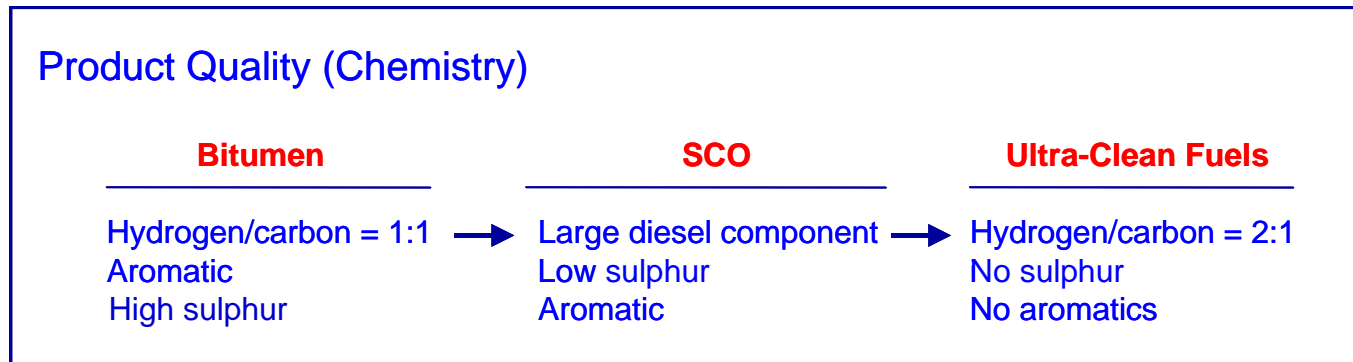
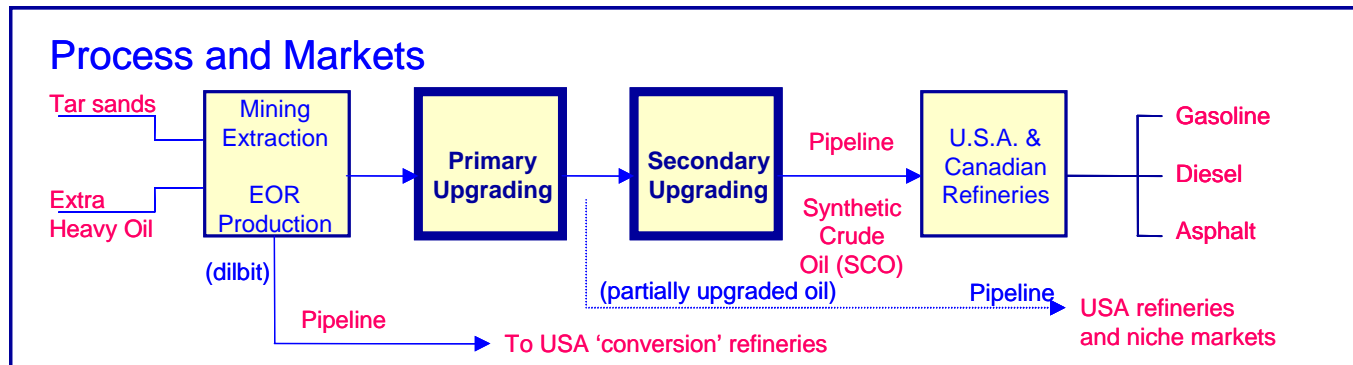
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Upgrading Bitumen to Synthetic Crude Oil followed by Refining to Clean Fuels

- Upgrading is the process of chemically and physically converting bitumen into a synthetic crude oil. Generally a 2-step process – primary and secondary upgrading



GHG Emission From Bitumen Upgrading

Two sources account for about 90% of upgrader GHG emissions and energy consumption, and in roughly equal contributions:

The Furnaces:

The upgrading is done at high temperature. The preferred furnace fuels are natural gas and waste process gases.

Hydrogen Production:

Upgrading requires adding hydrogen. It is generally produced at the upgrader by reforming natural gas. Emissions are almost equally split between

- SMR CO₂ products @ 1500 psi and high purity
- heater combustion products

The remaining emissions:

- Sulphur Recovery and other units and utilities



Dealing with Furnace Emissions:

Two general approaches:

Reduce the size of the furnaces by:

- Process improvements that reduce the upgrader's need for heat. Such as lower temperature reactions.
- More efficient furnaces.
- Process integration for optimal energy use and heat balancing.

AND/OR

Capture and Sequester the Emissions

- Among the variety of upgrading technologies, and furnace designs, are there some that are more amendable to capture?

Additional Furnace issues that must be considered in any new furnace design are:

- Furnace fouling – this is a multi-million dollar annual headache for operators
- Process integration - internal and with mining (e.g. SAGD)
- Decouple the dependence on natural gas
 - Gasification or combustion of bitumen or its asphalt components.
 - Reform the off gases for hydrogen production (they represent 25% of the hydrogen in bitumen)



Example of Improvements Possible

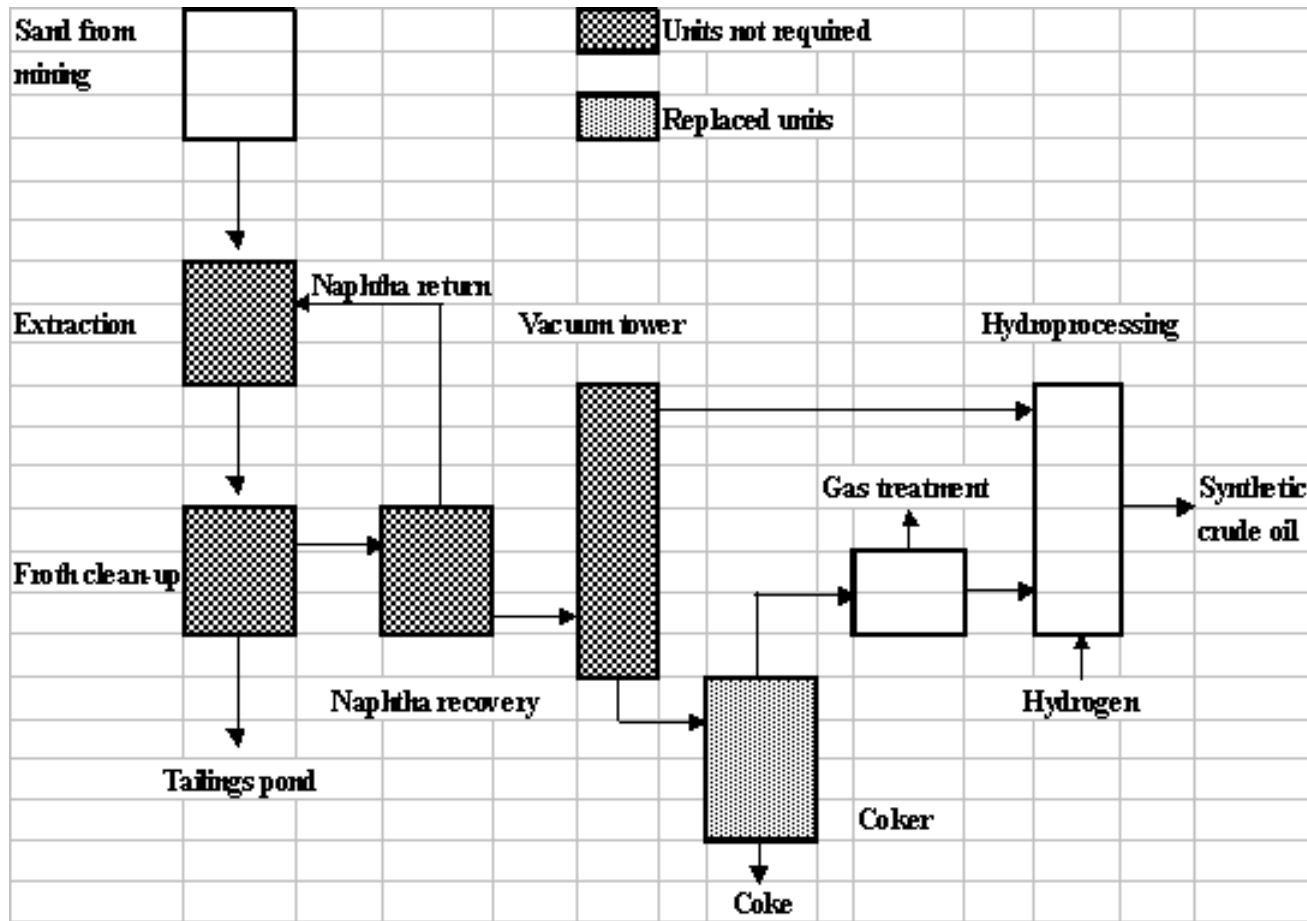
The Chattanooga Oil Sands Extraction/Upgrading Process

- 'A novel breakthrough process than promises
 - a 50% reduction in GHG emission of CO₂;
 - elimination of SO₂, NO_x, NH₃ and hydrocarbon gases;
 - greater efficiency;
 - lower capital and operating costs and;
 - complete elimination of tailings ponds and ground water contamination'



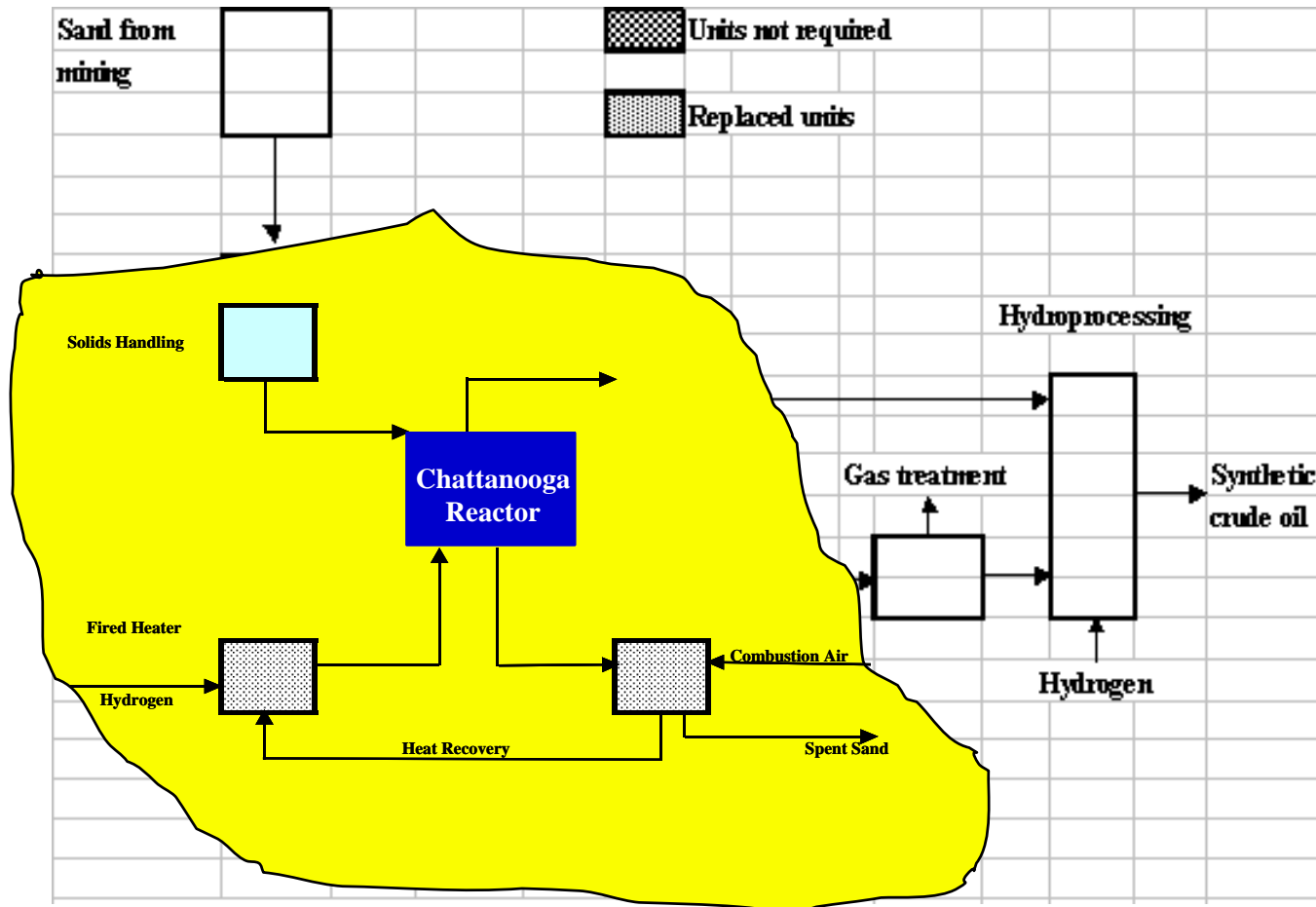
Example of Improvements Possible

Current Oil Sands Upgrader

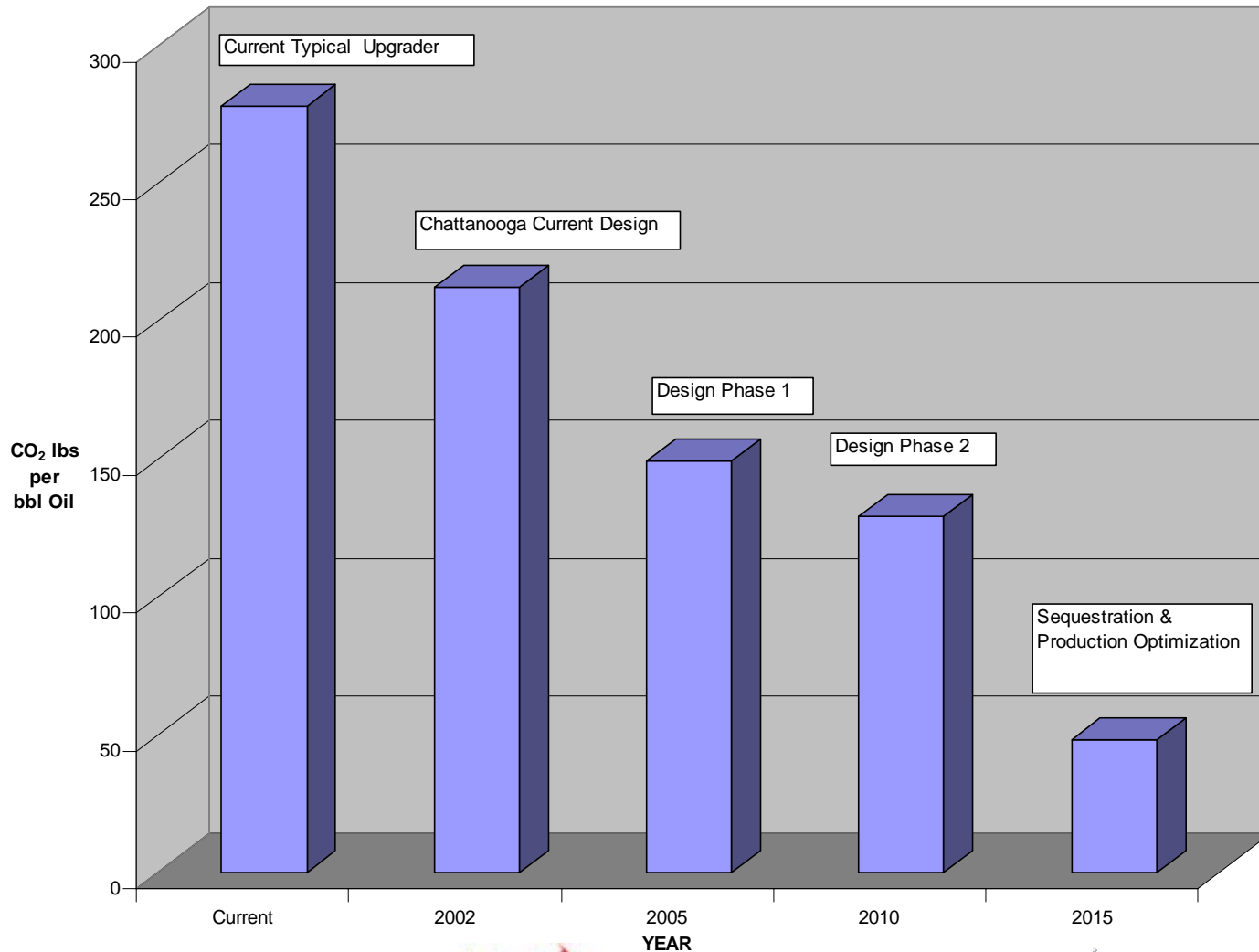


Example of Improvements Possible

Current Oil Sands Upgrader



Chattanooga Oil Sands Extraction/Upgrading Process: Commercialization Phases



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Ultra Clean Fuels From Bitumen

Find ways to adjust the properties of bitumen-derived crude (BDC) so that it is an ideal refinery feedstock

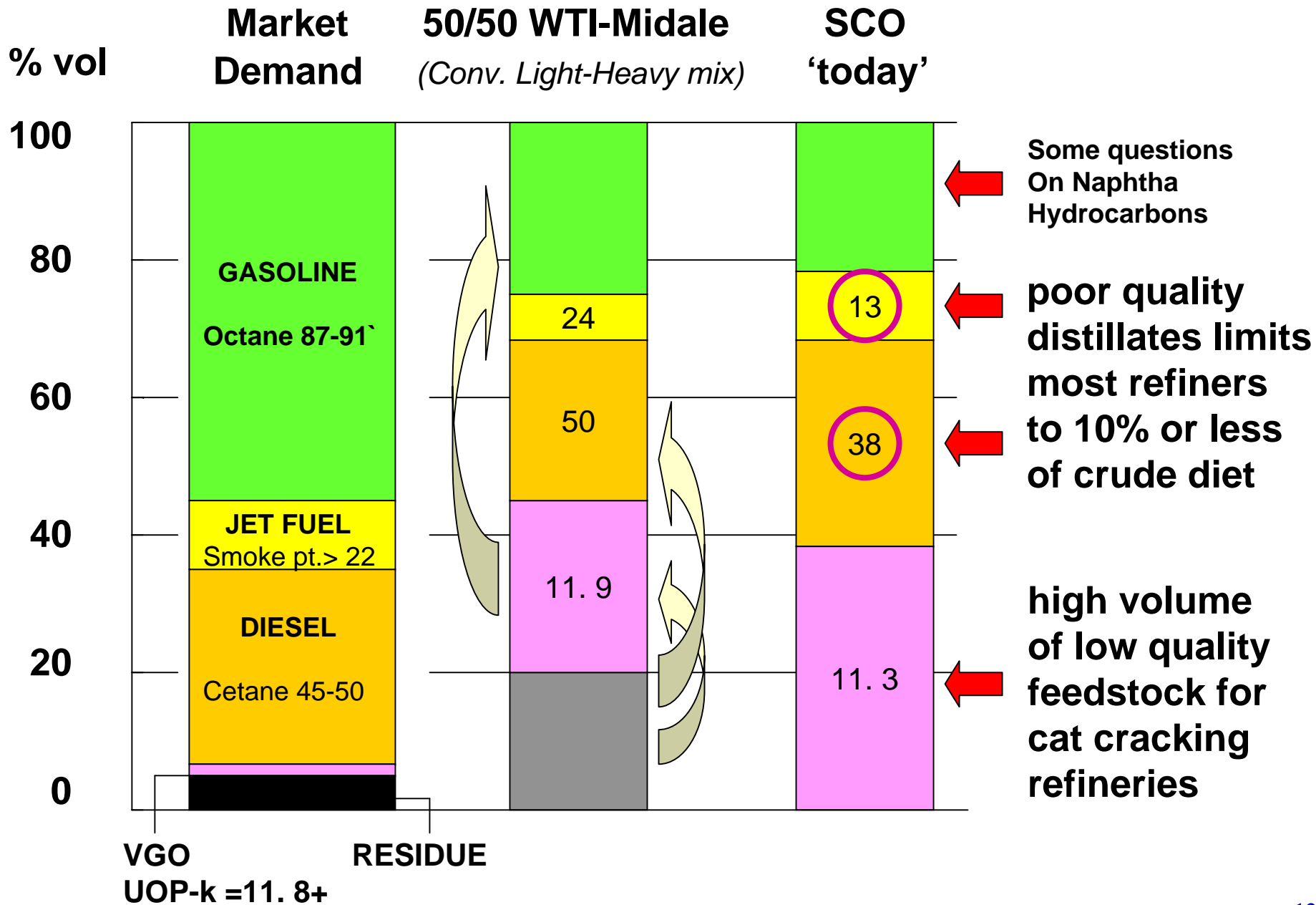
TODAY'S QUALITY BDC (limited market access)



FUTURE QUALITY BDC (unlimited market access)

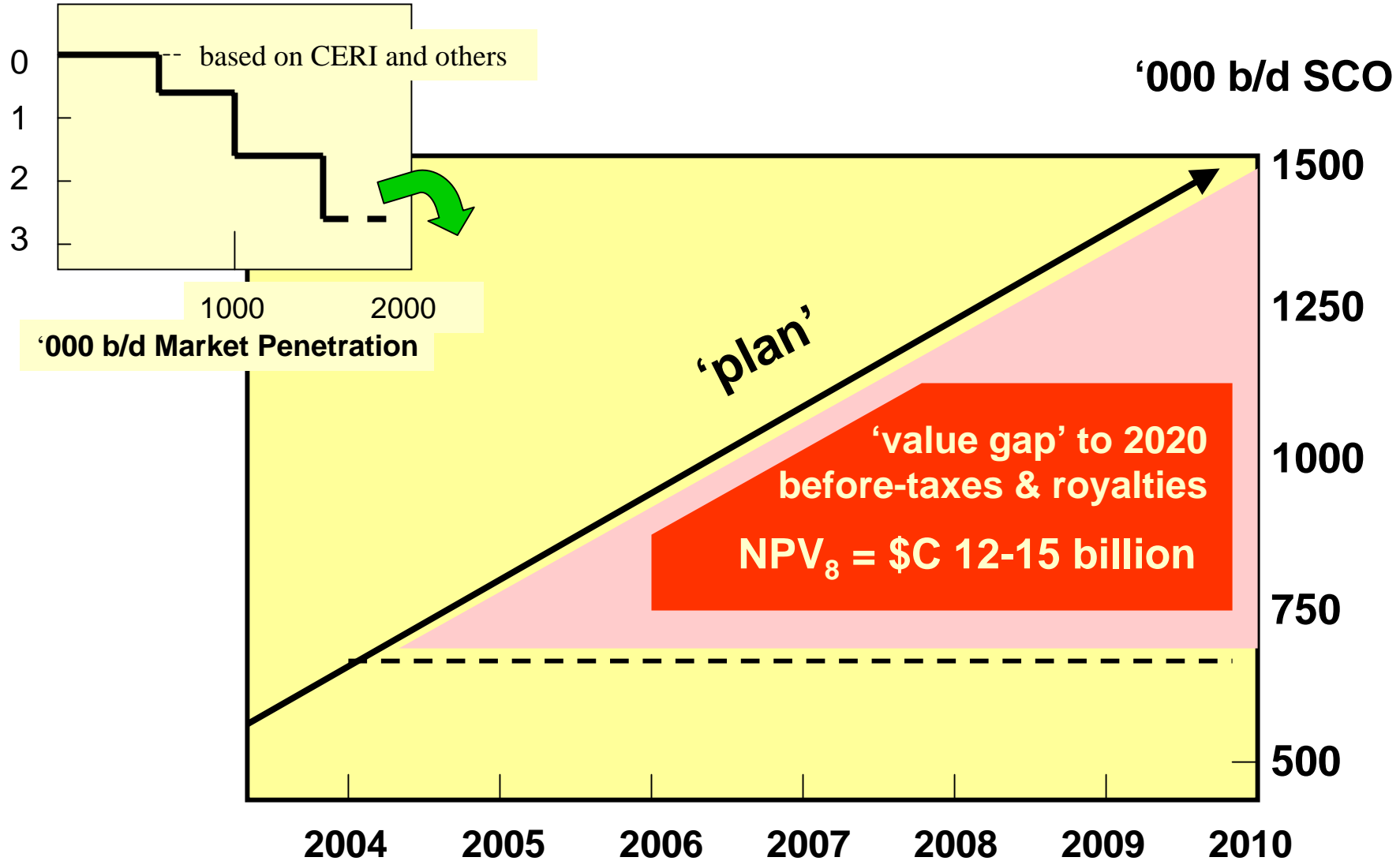


A Dose of Reality ...

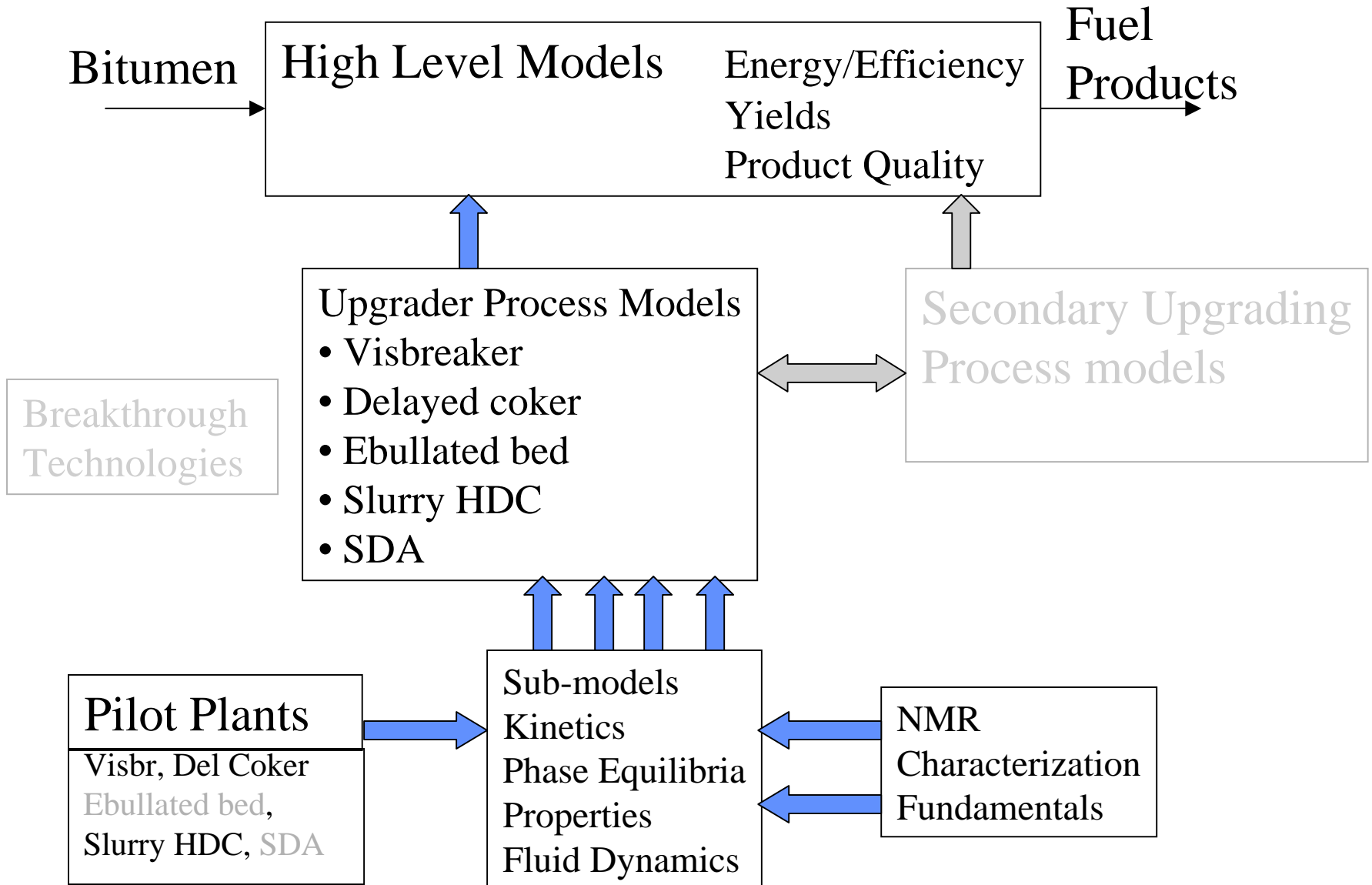


The Potential Value Gap

US\$ below WTI

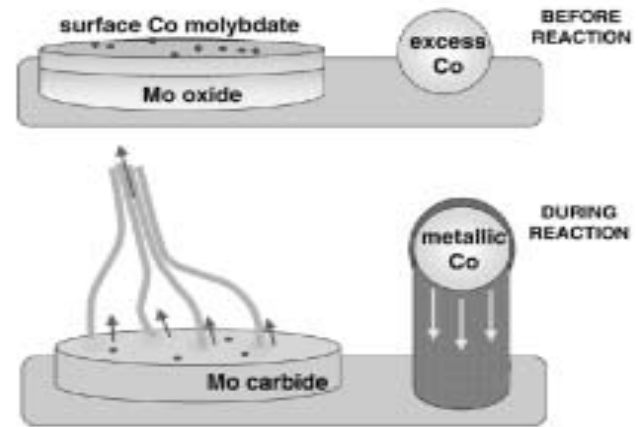
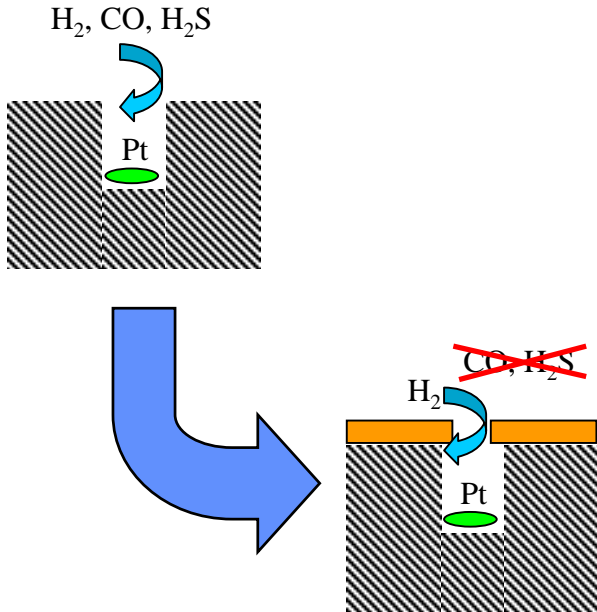


Virtual Upgrader



Intense Research Effort in Catalysts for Secondary Upgrading and Refining

1. Carbon nano-tube or nano-fiber catalysts



2. Sulphur-resistant hydroprocessing catalysts

Summary

Probable Improvements by 2015

- A. Hydrogen production** – currently almost 50% of upgrader GHG (one-half is SMR product; one-half is combustion from process furnaces)
 - Alternate sources, including nacent generation
 - Over-the-fence (co-production synergies) (petrochemicals in Edmonton)
 - Improve processing (SMR)
- B. Furnaces** – currently almost 50% of upgrader GHG
 - More efficient furnaces
 - Process integrations (heat balancing)
- C. Unit processing**
 - Lower temperature reactions
 - Process integrations along the value chain (mining, extraction, refining)
 - Alternative chemistry (biochemistry, ring opening catalysts)
- D. Capture and storage**
 - SMR offers the least expensive point source of GHG capture
 - Capture GHG from furnaces
- E. Ultra Clean Fuels**
 - Intense research effort in catalysis is paving the way to high quality SCO
 - Petrochemicals is an emerging business area

Areas for Collaboration

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* **NCUT research areas shown in 'red' color**