



# BITUMEN PROCESSING INTEGRATION STUDY

by

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for

National Energy Board

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# Presentation Outline

- Alberta's Oil Sands Resource
- Hydrocarbon Upgrading Task Force
- Value-Added Strategy & Vision 2020
- Export Markets For Alberta Refined Products
- Integration Study Objective
- Process Design
- Product & Co-product Volumes
- Capital Investment & Economics
- Eco-Industrial Site Model





# The Size of the Resource

Alberta's oil reserves contribute to 16% of total global reserves, 2<sup>nd</sup> only to Saudi Arabia



<u>Reserves (2004)</u> (Billion Barrels)		
	<u>Oil Sands</u>	<u>Conv.</u>
<i>In Place</i>	1,699	62.9
<i>Remaining Est.</i>	174	1.6

Production is expected to reach 50% of Canada's crude oil output and 10% of North America's by 2010





# Hydrocarbon Upgrading Task Force (HUTF)

- Decision in Oct/03 to develop strategies for \$20B investment to upgrade bitumen to high value products:
  - Senior Industry & Government membership
  - Commissioned Purvin & Gertz for Bitumen to Refined Products/Petrochemicals Study
- Hydrocarbon Upgrading Task Force (HUFT) 1st meeting Feb/04
- Developed Vision 2020
- Initiated follow-on studies jointly funded by government & industry to develop business case for upgrading:
  - Current membership about 60 private companies & 20 Gov't Departments & Agencies

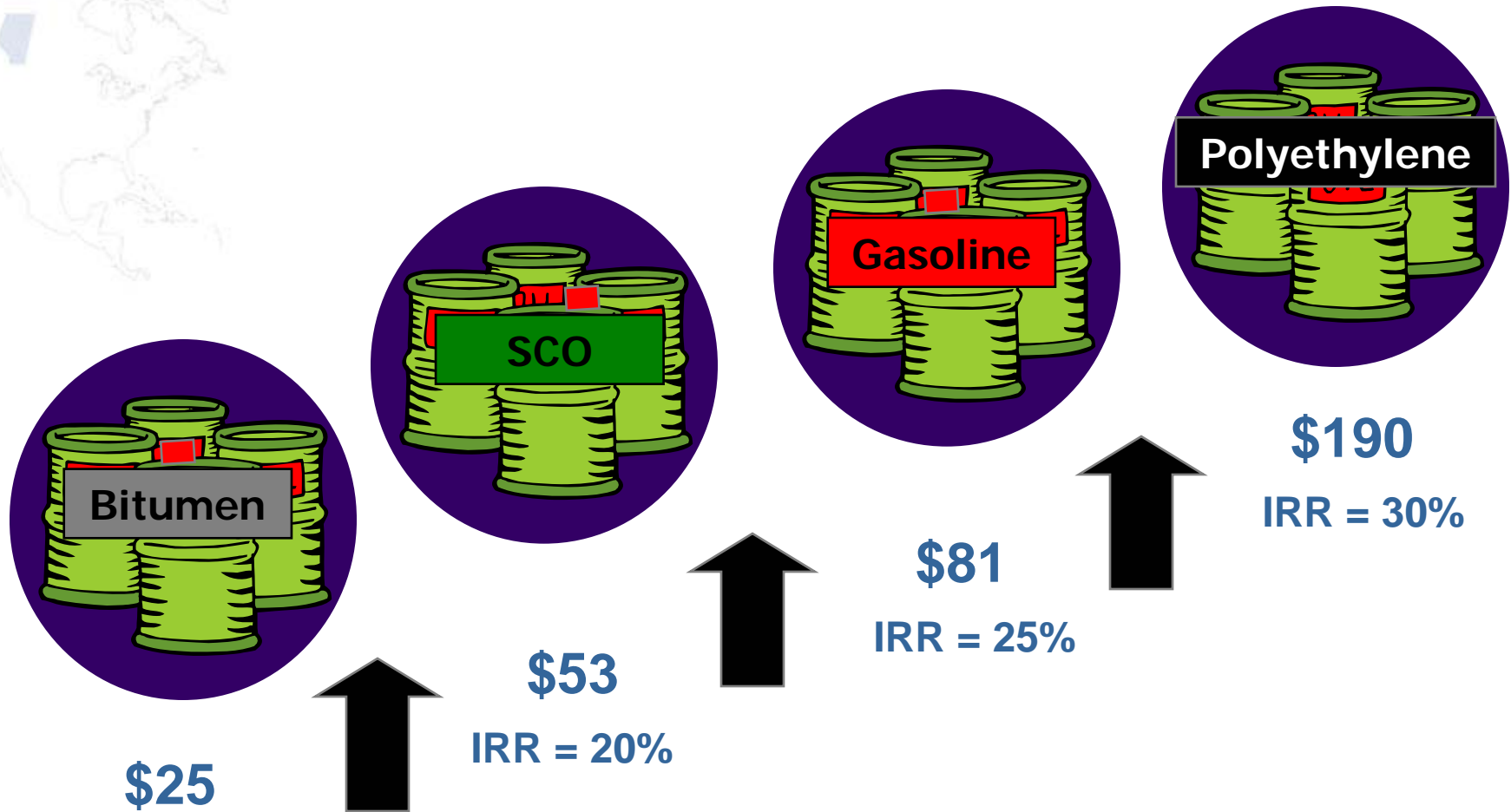


***“Alberta will achieve a competitive hydrocarbon upgrading industry that expands the market for Alberta’s bitumen resource by producing higher value finished products in Alberta”***

- 3 million barrels per day production by 2020
  - 1 million barrels/day upgraded to finished products
- 5 million barrels per day production by 2030
  - 2 million barrels/day upgraded to finished products
- Urgent to capture “window of opportunity” or risk losing value-added investment to other locations



# The Value Chain Incentive (2004 C\$/barrel)



IRR = 15%

\$53  
IRR = 20%

\$81  
IRR = 25%

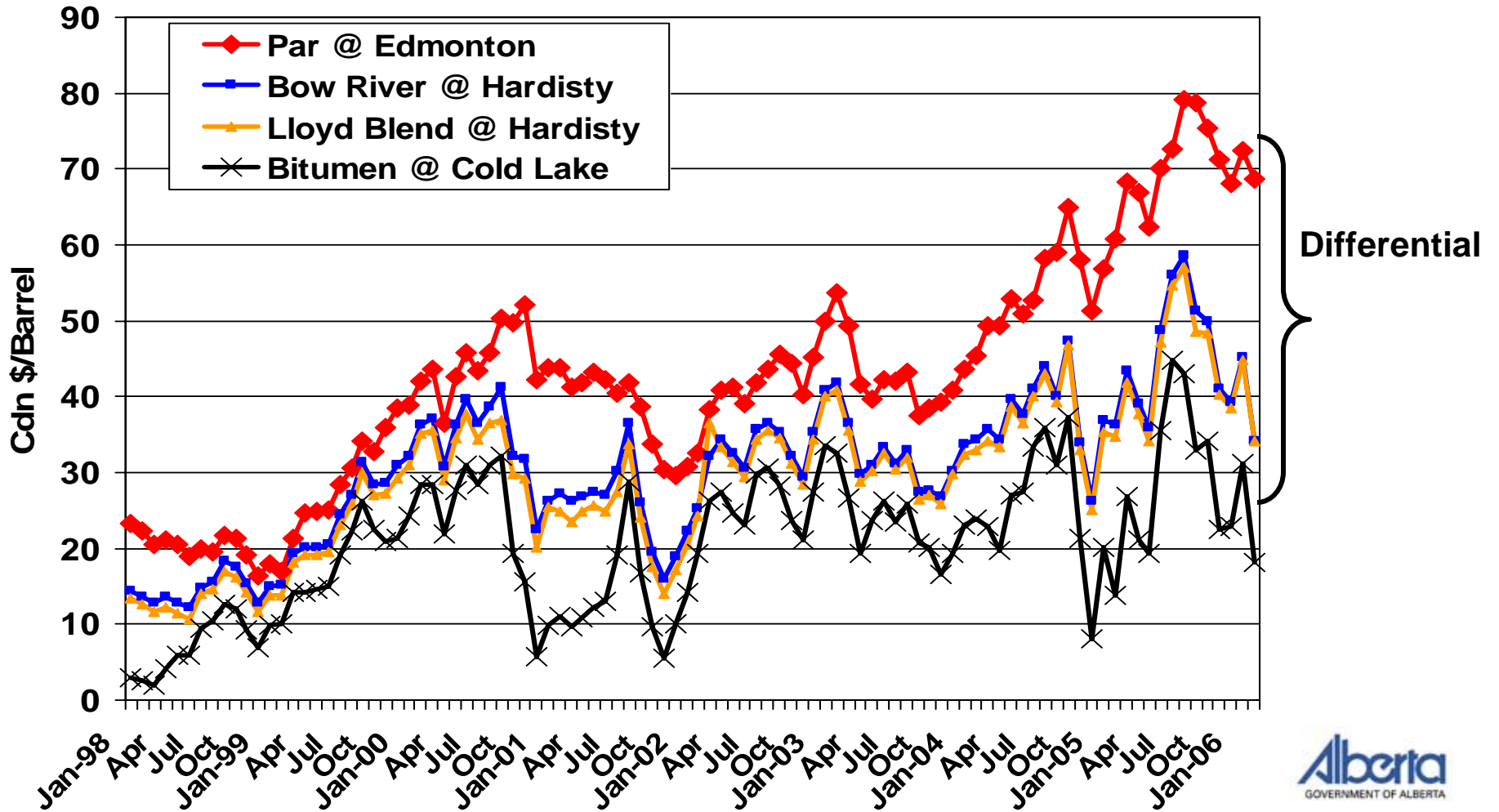
\$190  
IRR = 30%





# Light/Heavy Differentials - (C\$/barrel)

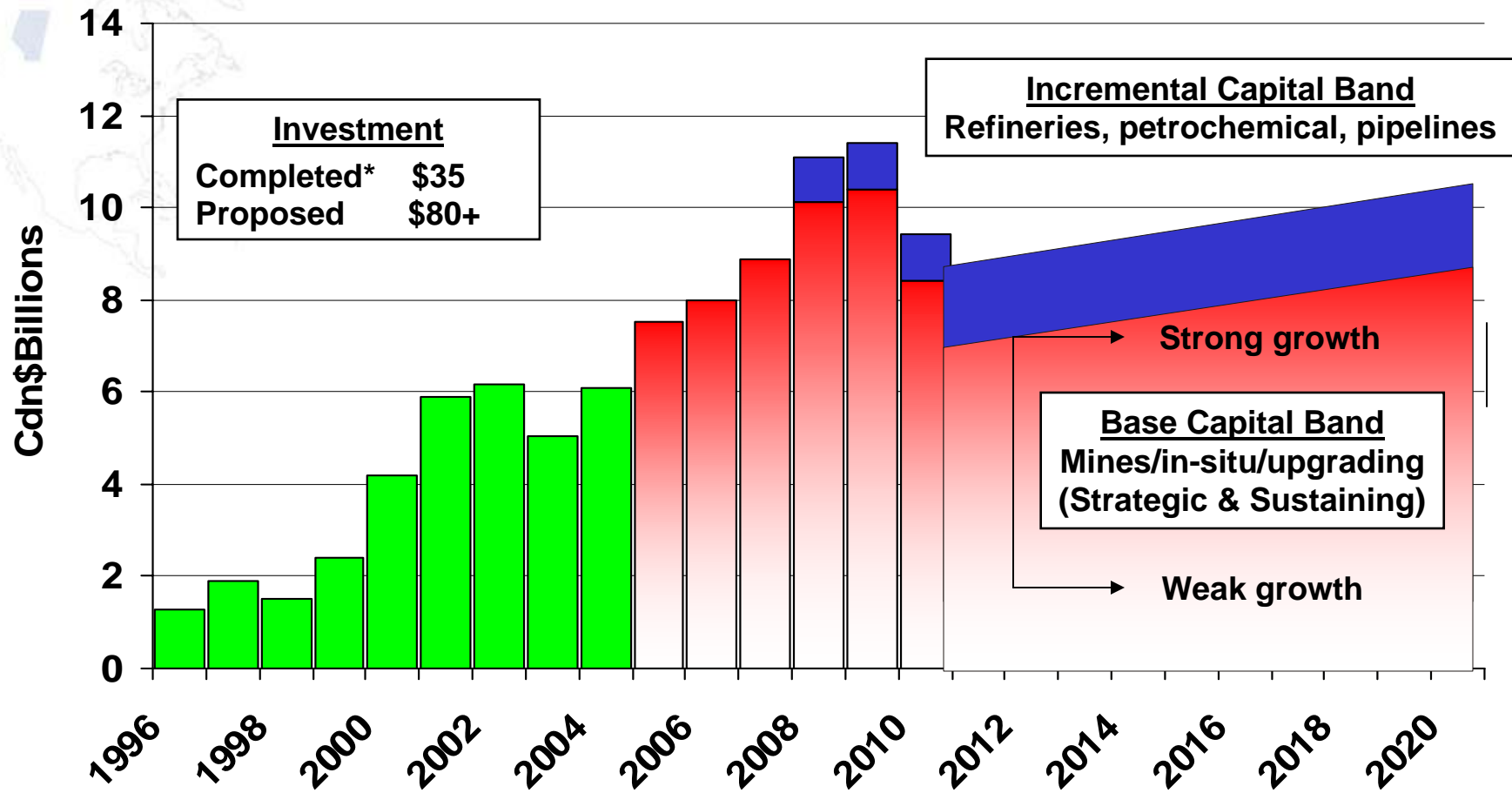
January 1998 to January 2006





# Oil Sands Investment

*Trends are illustrative*



\*Completed – 1996 to 2004

Source: CAPP, Media





# Economic Impact Of Oil Sands

\$100 Billion Investment from 2000 to 2020 @ US \$32/B

	Alberta	Ontario	Quebec	Rest of Canada	Total Canada	Outside Canada	<b>Grand Total</b>
GDP–Billion 2004\$	633.9	101.5	8.4	45.3	789.1	95.7	<b>884.9</b>
Cum. Employ. – k Person Yrs	3649	1039	125	612	5425	1130	<b>6556</b>
	Federal	Alberta	Other Prov.	Municip.	Total Canada	Outside Canada	<b>Grand Total</b>
Govt. Tax Rev. - Billion 2004\$	51.1	43.8	11.5	16.9	123.3	13.5	<b>136.8</b>

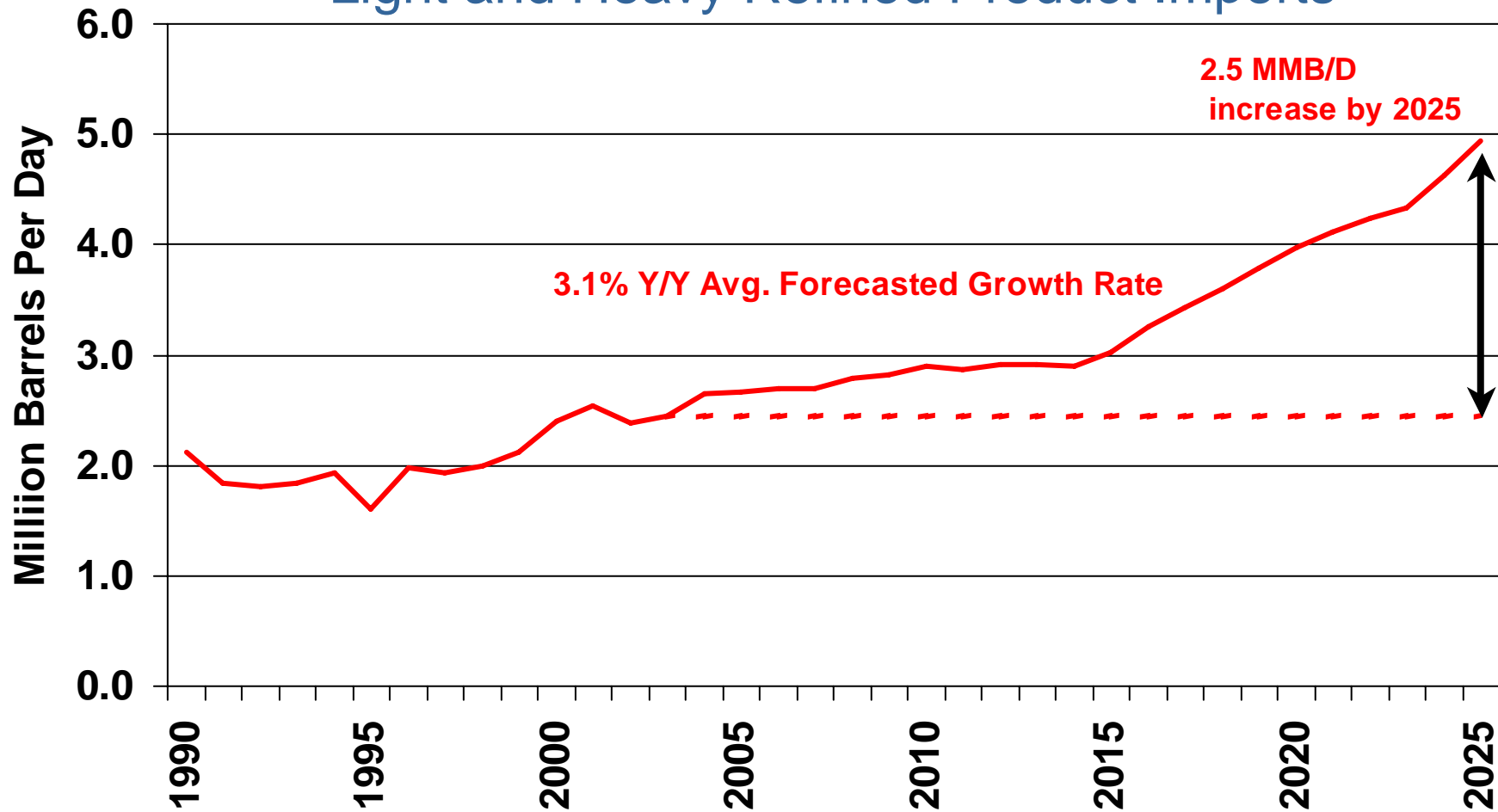
Source: CERI Report – Oct. 2005





# Growing US Product Imports

## Light and Heavy Refined Product Imports



Source: EIA 2004 Annual Energy Outlook





# Purvin & Gertz US Market Study

## **PADD II (Midwest) Marketing Conclusions**

- Alberta Product Exports will compete with product transfers from PADD III (Gulf Coast). Such transfers about nine times Alberta's export volume, so should be readily absorbed.
- Chicago is preferred point of delivery, allowing physical deliveries into northern Illinois, northwestern Indiana, eastern Wisconsin, and most of Michigan.
- Specific regional marketers could be potential contract purchasers and distributors of Alberta products to reduce marketing risk.





# General Concept of Integration Study

- Most beneficial (value-added) use of Alberta's resources
- Combined bitumen upgrader, export refinery & petrochemical complex
- Maximize high valued finished products while minimizing capital and operating costs:
  - Avoid high severity & recycling in conversion processes
- Lower valued materials from upgrading & refining provide petrochem & ammonia feedstocks or consumed as fuel





# Plant Design Basis

- Nominal bitumen capacity of 300,000 bpsd
- Capacity sufficient to incorporate world scale units for downstream processing units
- Central power & steam plant
- The bitumen upgrading rejects carbon as coke:
  - Rejected carbon is FULLY utilized for hydrogen & ammonia production
  - Unconverted carbon burned in power plant
- Utilize current technology & ensure an operable plant
- Satisfy Colt Engineering Due Diligence review



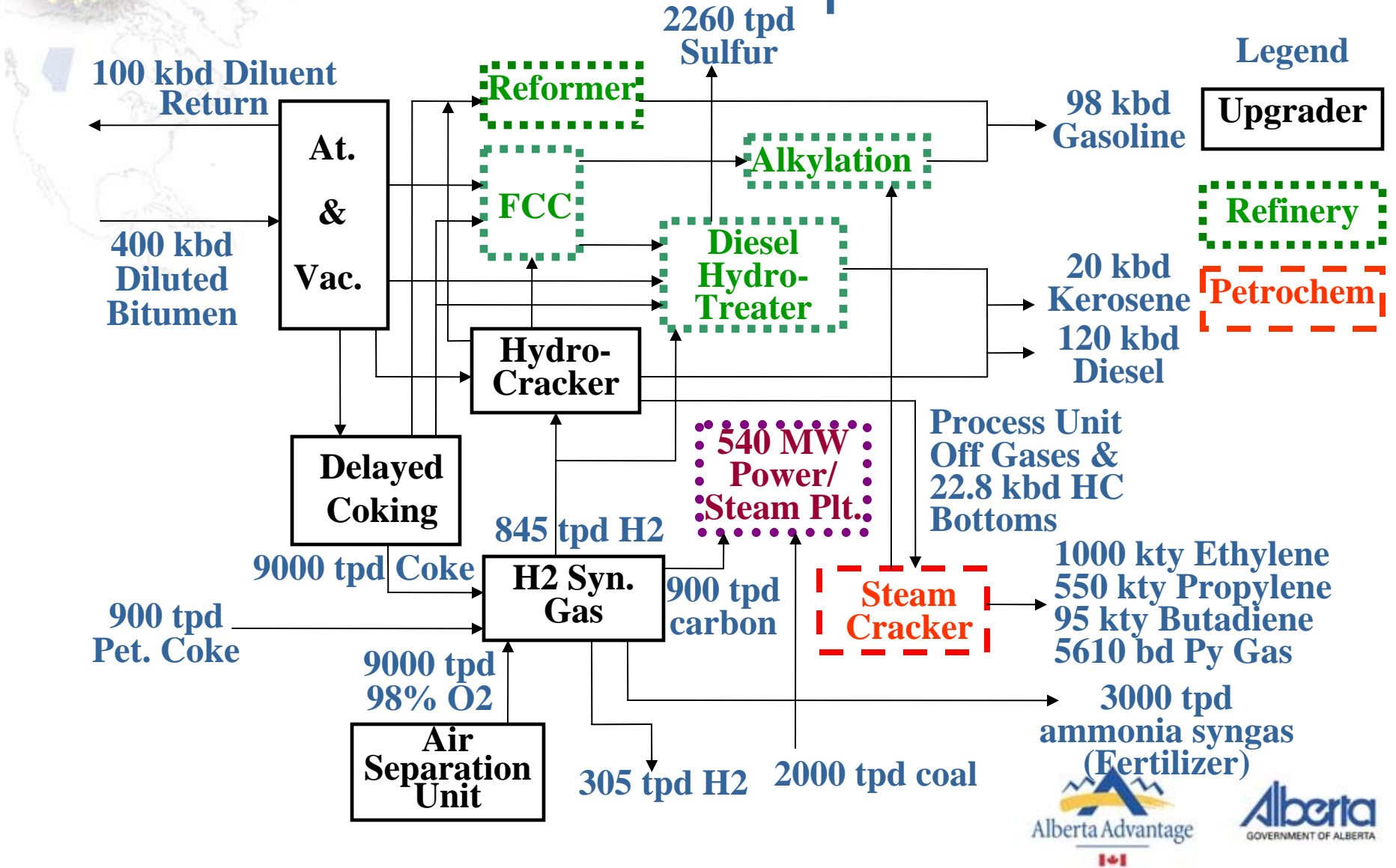


# Electric Power Generation

- The facility will generate 540 MW power (gross) mostly for large compressors
- Production of power onsite synergistic with operations & more economical than grid:
  - Fluidized bed boilers consume low value unconverted carbon from gasification & offsite coal
- The rotating equipment in the facility is driven exclusively by electric motors:
  - Reduces plant cost compared to winterized steam distribution system



# Integrated Bitumen Processing Plant – Simplified Flow Plan





# Project Product Volumes

- Diesel @ 119,000 bpsd ultra low sulfur, low aromatic, Cetane index 48
- Reformulated gasoline @ 98,500 bpsd, 90 Octane R+M/2 , 7.1 RVP
- Kerosene @ 21,000 bpsd
- Ethylene @ 1,000 KT/Y
- Propylene @ 550 KT/Y
- Butadiene @ 95 KT/Y
- Ammonia syngas @ 3,000 tpd
- Hydrogen @ 130 MM scfd





# Petrochemical Production

- The study focused on petrochemical products now produced in Alberta, primarily ethylene:
  - Ethylene is the core petrochemical product @ 4,500 KT/Y
  - Ethylene is the largest global petrochemical commodity @ 110,000 KT/Y
- As a fall out of ethylene production, the following products will also be produced:
  - Propylene, Butadiene & Pyrolysis gasoline





# Fertilizer Production

- In order to fully utilize rejected carbon, H<sub>2</sub>/N<sub>2</sub> for ammonia and pure CO<sub>2</sub> for urea are produced
- The province of Alberta is a huge producer of ammonia and urea:
  - The soil is alkaline and sulfur deficient
  - There are consumers for ammonium sulfate
- Production of ammonium sulfate will reduce capital investment by reducing cost of emission controls



# Sources Of Co-Products

- About 90% of ethylene production from low value heavy liquid & light ends feedstocks
- Production of hydrogen and ammonia syngas based on zero value coke.
- Producing ammonium sulfate is based on negative value SO<sub>2</sub> from sulphur plant tail gas
- Producing electric power based on low cost, local coal and waste carbon from the H<sub>2</sub> Syngas plant
- Elemental sulfur production could be synergistic with sulfuric acid production





# Capital Cost Estimate

- 300 kbd upgrader/refinery/petrochem plant facilities - US Gulf Coast US\$4700M
- Add contingency @40% (Class V) 1900M
- Subtotal facilities (instantaneous) US\$6600M
- Adjust to Edmonton location US\$7400M
- Convert to Canadian \$ Cdn\$8500M
- Escalation during construction 1680M
- Facility License Fees 100M
- Working Capital & Owner's Cost 1020M
- TOTAL Edmonton (as spent) CDN\$11300M





# Edmonton Location Economic Cases

- Economic Model cases:
  - Reference case – GLJ WTI @ \$40/B 19.5%
  - +\$10/barrel crude price 23.0%
  - + 10% in capital cost 18.1%
  - - 10% in capital cost 21.0%
  - \$3/barrel transportation cost 19.1%
  - Edmonton location factor of 1.25 18.0%
  - 2004-2005 product to crude price ratio 19.9%





# Integration Study Conclusions

- General advantages of integration:
  1. Efficient centralized power generation/steam plant
  2. Utilization of low cost or negative value materials
  3. Smaller environmental footprint
- Design concept advantages:
  1. Lower severity process operations
  2. Light ends and heavy ends by-pass refinery & converted to high value petrochemicals
  3. H<sub>2</sub> & Ammonia syngas consume all coke
- Requires extensive engineering studies to finalize design & cost estimate





# Eco-Industrial Sites

- “An integrated network of raw material suppliers, upgraders, manufacturers, support and infrastructure providers (including logistics) that collaborate for mutual commercial advantage in an environmentally acceptable manner.”
  - Synergies provide improved operations/costs while reducing the environmental footprint.
  - End goal is development of globally competitive facilities within their respective areas of focus and geography





# Eco-Industrial Site Best Practices Study

- Significant differences between the sites studied:
  - ChemSite & ValuePark, Germany; Rotterdam, Holland; Deer Park, TX; Singapore; Sarnia, ON; Wilton-Teesside, UK
- No one formula nor any specific predictor for success
- Through collaboration between government, the site operator and individual participants, there can be a win-win-win outcome





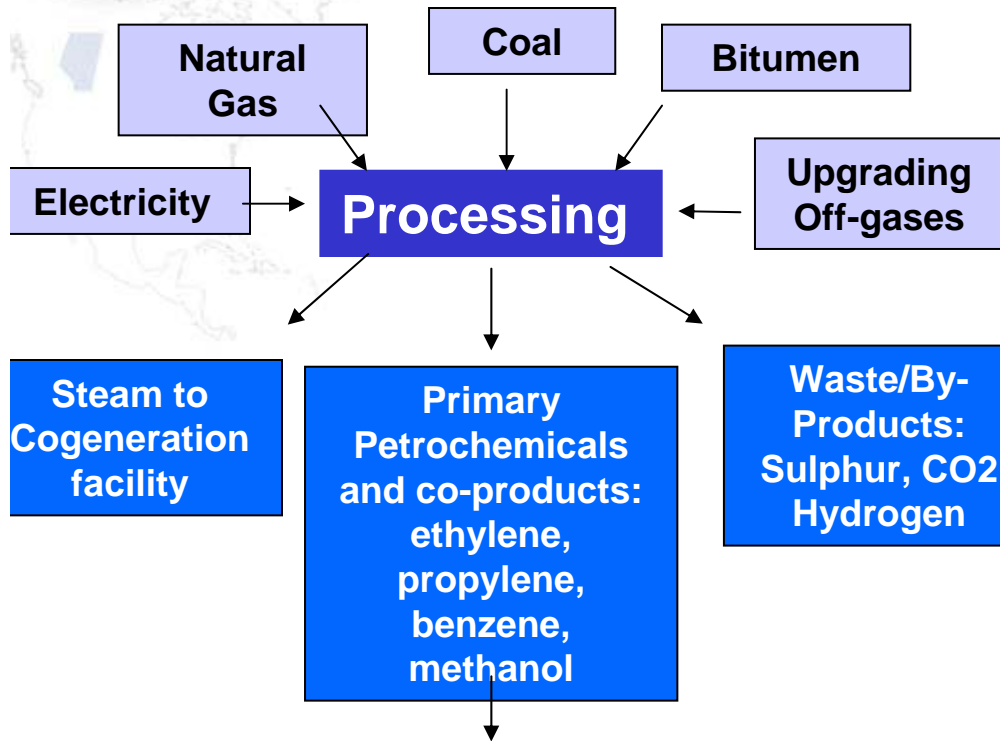
# Eco-Industrial Study Conclusions

Basic attributes required for success include the following:

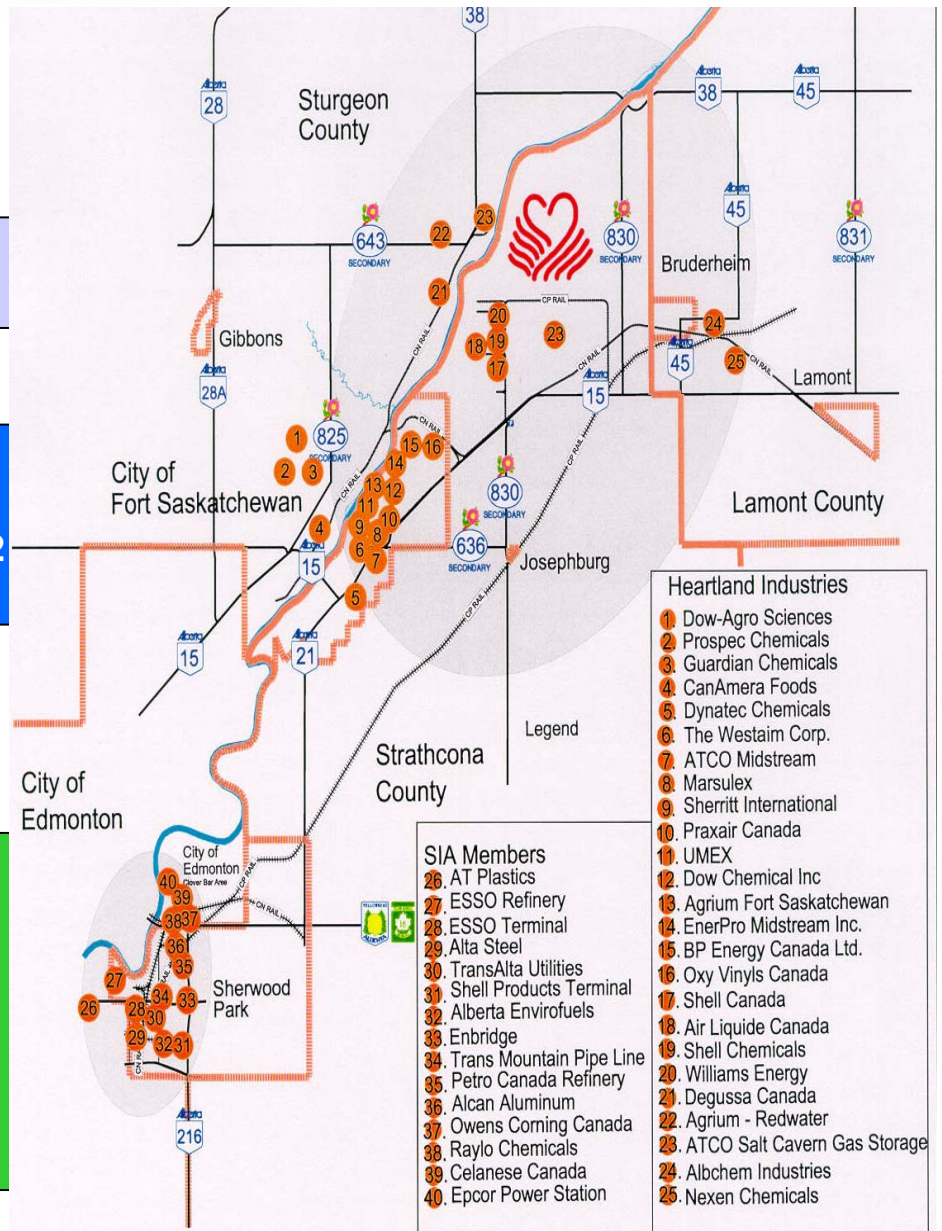
1. Excellent logistical systems – ideally with competing suppliers to assure cost effectiveness,
2. Economies of scale that promote cost competitiveness,
3. Easy access to significant markets,
4. Reliable supplies of hydrocarbons and other raw materials that provide cost competitiveness and security,
5. Good infrastructure and support services, including R & D,
6. A defined system of management/governance,
7. Government/public support that allows continuity of operations and fiscal certainty to support future growth,
8. Both vertically and horizontally integrated supply chains that add value to inputs.



# An Alberta Energy Hub



<b>Markets</b>	
- Alberta Electricity Grid	- Fertilizers
- Industrial Gases Recovery	- Enhanced Oil
- Secondary Petrochemicals:	- Natural Gas in Coal
- Polyethylene	- Plastics
- Polypropylene	- Pharmaceuticals





Thank you

I will be pleased to take your questions

Bitumen Processing Integration Study

Posted on Website:

<http://www.energy.gov.ab.ca/docs/petrochemicals/pdfs/AlbertaIntegrationReport.pdf>

