
Summary - Bitumen to Refined Products and Petrochemicals

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Prepared by:



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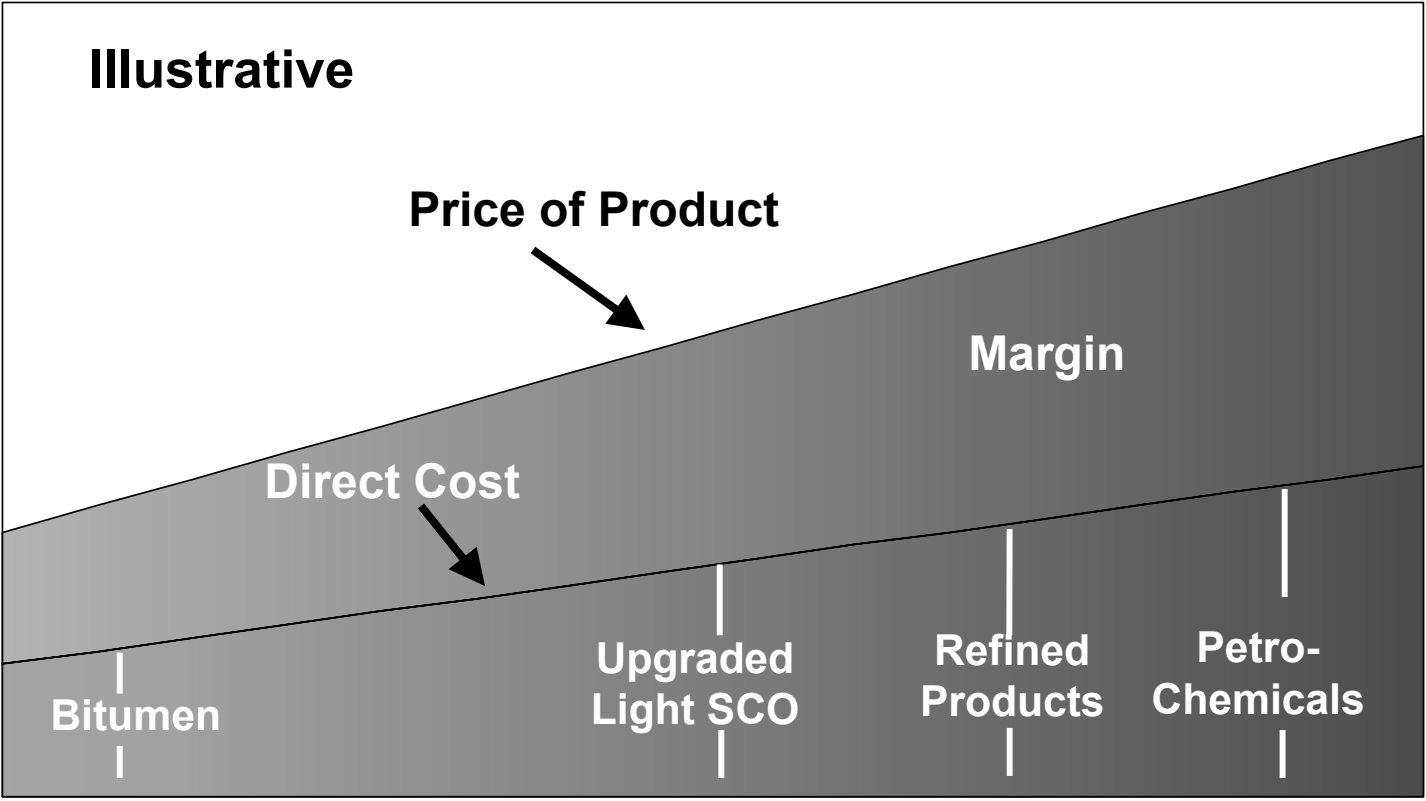
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Outline of Discussion Today

- **Introduction – Refined Products and Petrochemicals from Bitumen**
- **Purpose and Objectives**
- **Upgrading/Refining/Petrochemical Cases**
- **Summary of Results**
- **Conclusions**

How Much to Upgrade?

Dollars per Barrel



Return on Capital?

Marketability?

Degree of Upgrading (eg. API) →

Capital Cost →

Planned Phase Approach to this Study

➤ **Phase 1 – Current Focus**

- Potential for upgrading to refined products and petrochemicals
- Assess preliminary economics and potential of concept

➤ **Phase 2 – Deferred to Later**

- Assess competitive cost of supply of these options
- Strategies for implementation

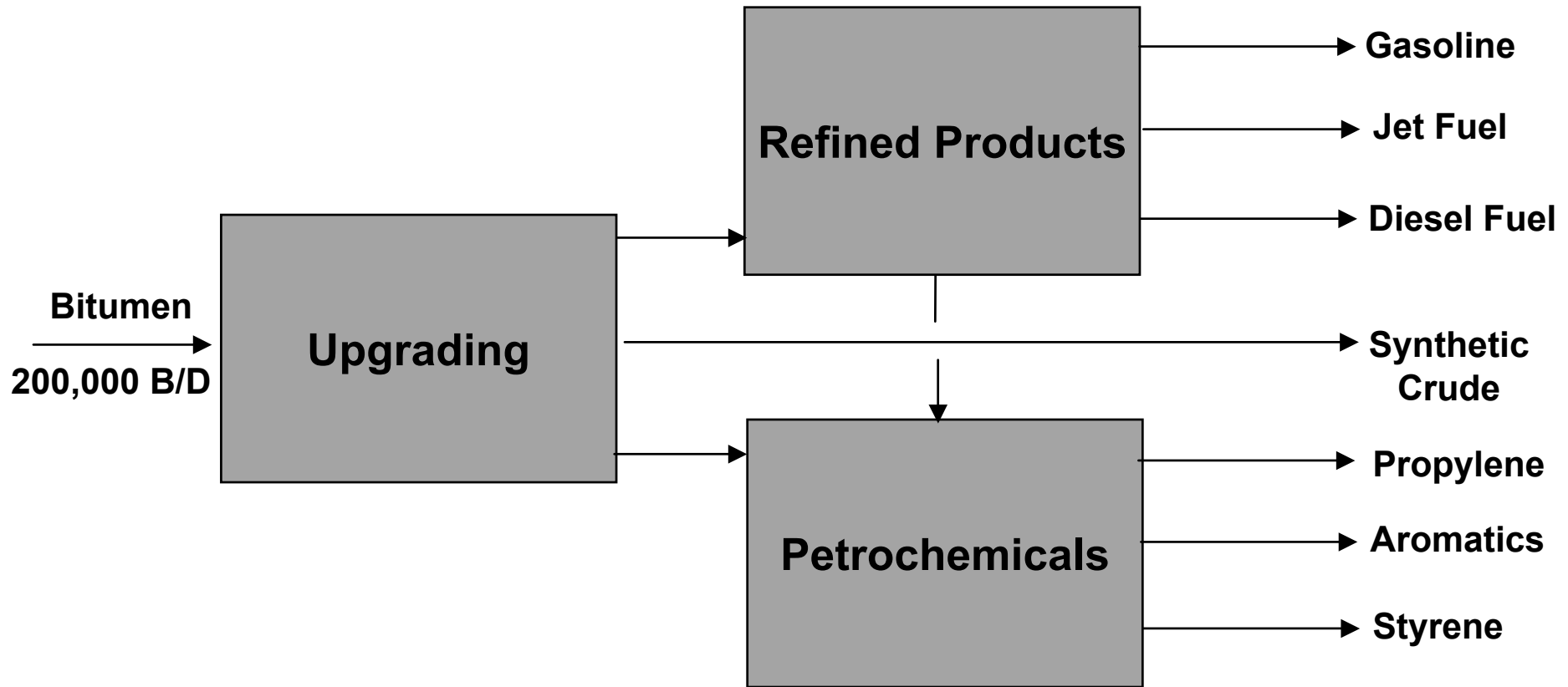
Purpose and Objectives of Study

- **To quantify the potential and benefits of increasing the upgrading step to produce refined products and petrochemicals**
- **Target preferred markets for petroleum products considering market size and accessibility (West Coast and Midwest)**
- **Develop the economic potential of refined products and petrochemicals relative to upgrading to synthetic crude**
- **Outline merits for such an Alberta development**

Scope of Study

- **Determine the potential benefit of upgrading bitumen beyond synthetic crude:**
 - To produce refined products
 - To produce some petrochemical products
- **Based on a minimum of 200,000 B/D of raw bitumen feedstock**
- **Refined products are gasoline, diesel and jet fuel, focusing on serving the Midwest and California markets. California gasoline and diesel meet CARB specifications.**
- **Petrochemical products will be priced based on export prices except if there is sufficient volumes to feed a local derivative plant.**
- **Study premise assumes the new project(s) do not impact market prices.**

Potential for Upgrading Bitumen

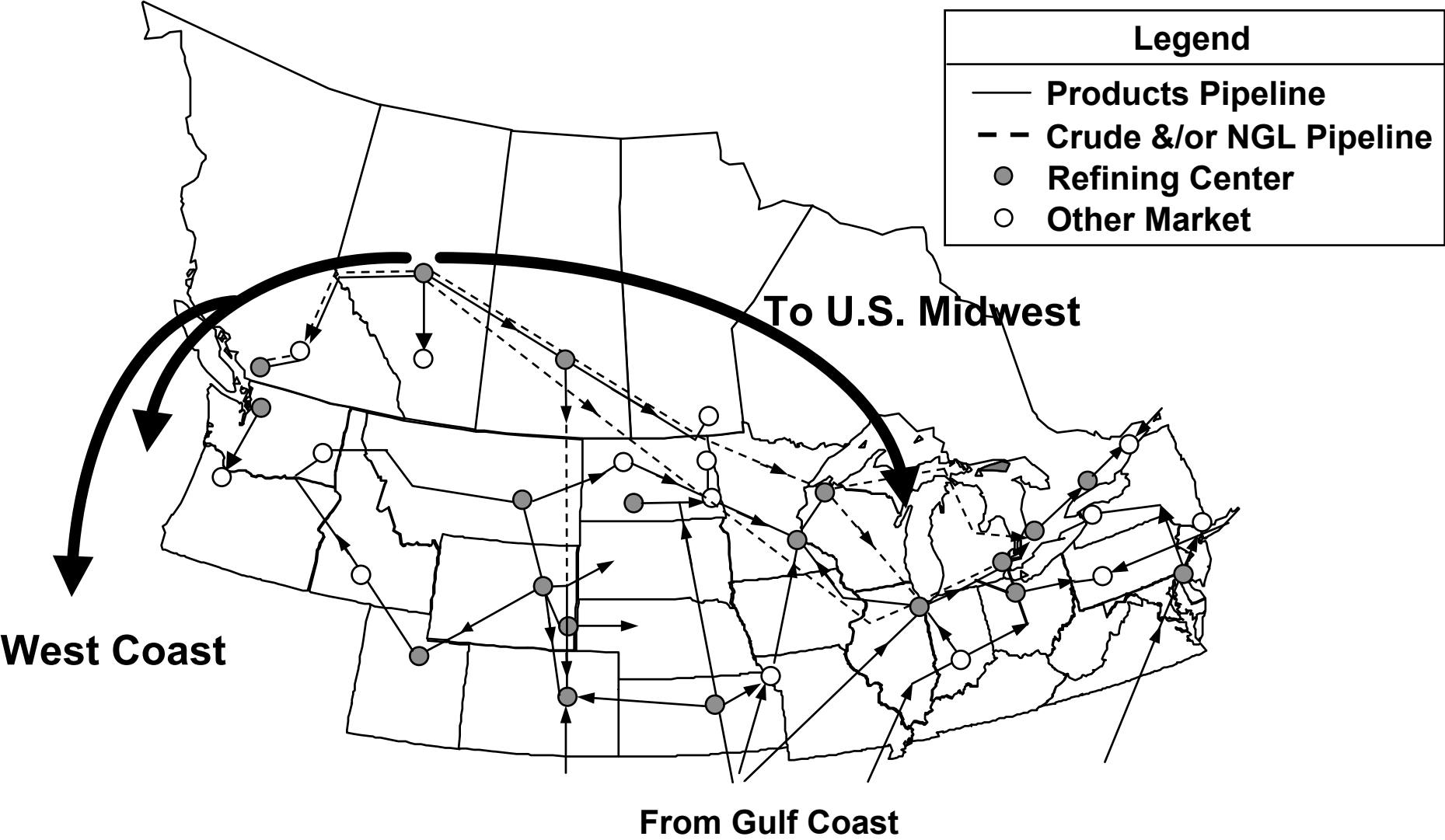


- 5 Cases were evaluated, based on combinations of the above blocks.

Proposed Upgrading/Refining/Petrochemical Cases

- Case 1** **Basic Upgrader Producing SCO**
- Case 2** **Similar to Case 1, but Recover Ethane/Ethylene**
- Case 3** **Add Hydrocracker, Producing Naphtha and Distillates**
- Case 4** **Produce Refined Products**
4a. VGO hydrocracking and catalytic reforming
4b. FCC/alkylation
- Case 5** **Produce Refined Products and Primary Petrochemicals**
5a. VGO hydrocracking and catalytic reforming, benzene and xylenes recovery with styrene
5b. DCC/alkylation and propylene recovery

Potential Refined Products Export Markets



Key Pricing Assumptions

1. Crude Oil and Natural Gas Prices

	2010 Current U.S. Dollars	2003 Constant Dollars
WTI \$/B	26.65	23.20
Natural Gas (AECO) \$/MMBtu	4.00	3.50

2. Currency at \$0.75 U.S. equals \$1.00 Cdn.

3. Product pipeline tariffs assumed equal to crude oil pipeline tariffs plus new terminalling costs for handling refined products.

Pricing of Refined Products

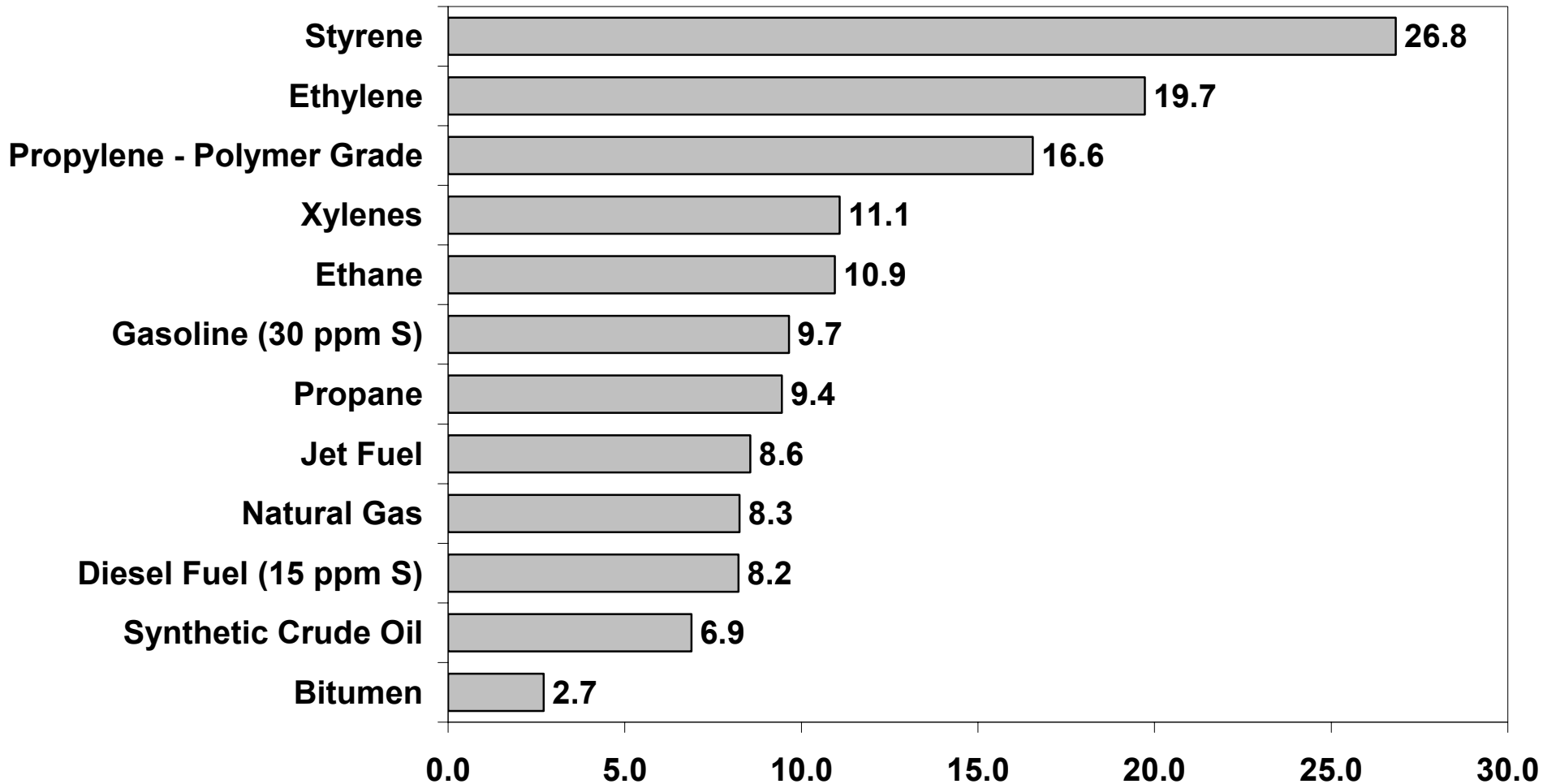
- **1. Gasoline – Detroit and Los Angeles less transportation**
 - Los Angeles based on CARB prices
- **2. Diesel and Jet Fuel – Detroit and Los Angeles less transportation**
 - Los Angeles diesel based on CARB prices.
- **3. Naphtha – Diluent price at Edmonton (adjusted relative to condensate)**
- **4. Mixed C3 – Edmonton price to a fractionator**
- **5. Mixed C4 – Edmonton price for sale to a refinery**

Pricing of Petrochemical Products

- **1. Ethylene/ethane – Both sold at ethane price**
- **2. Ethane – price based on recovery from natural gas**
- **3. Propylene – USGC less rail freight costs for small volumes, but based on feeding a polymer plant for large volumes.**
- **4. Benzene – USGC less rail freight costs**
- **5. Styrene – US Midwest less freight; equal to USGC price**
- **5. Xylenes – When not used in gasoline, equal to USGC less rail freight costs**
- **6. Cumene – uneconomic, so not considered.**

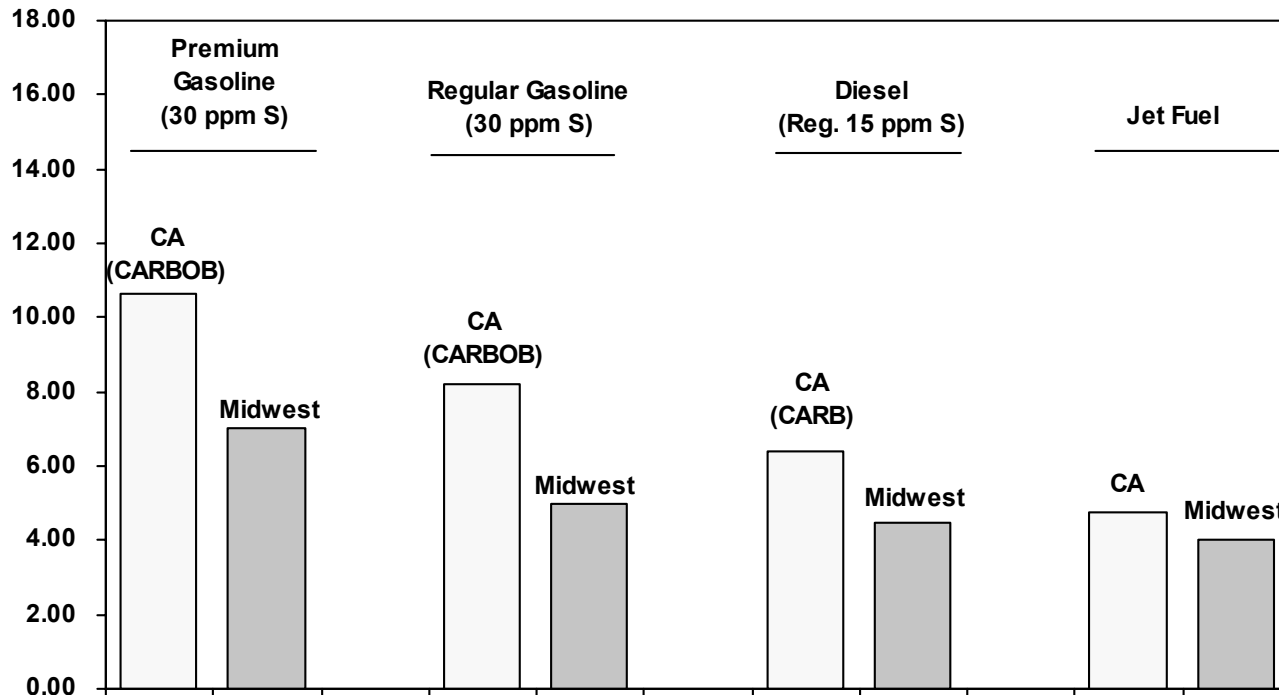
Product and Light Ends Prices in Edmonton - 2010

U.S. Cents Per Pound - Constant 2003 Dollars



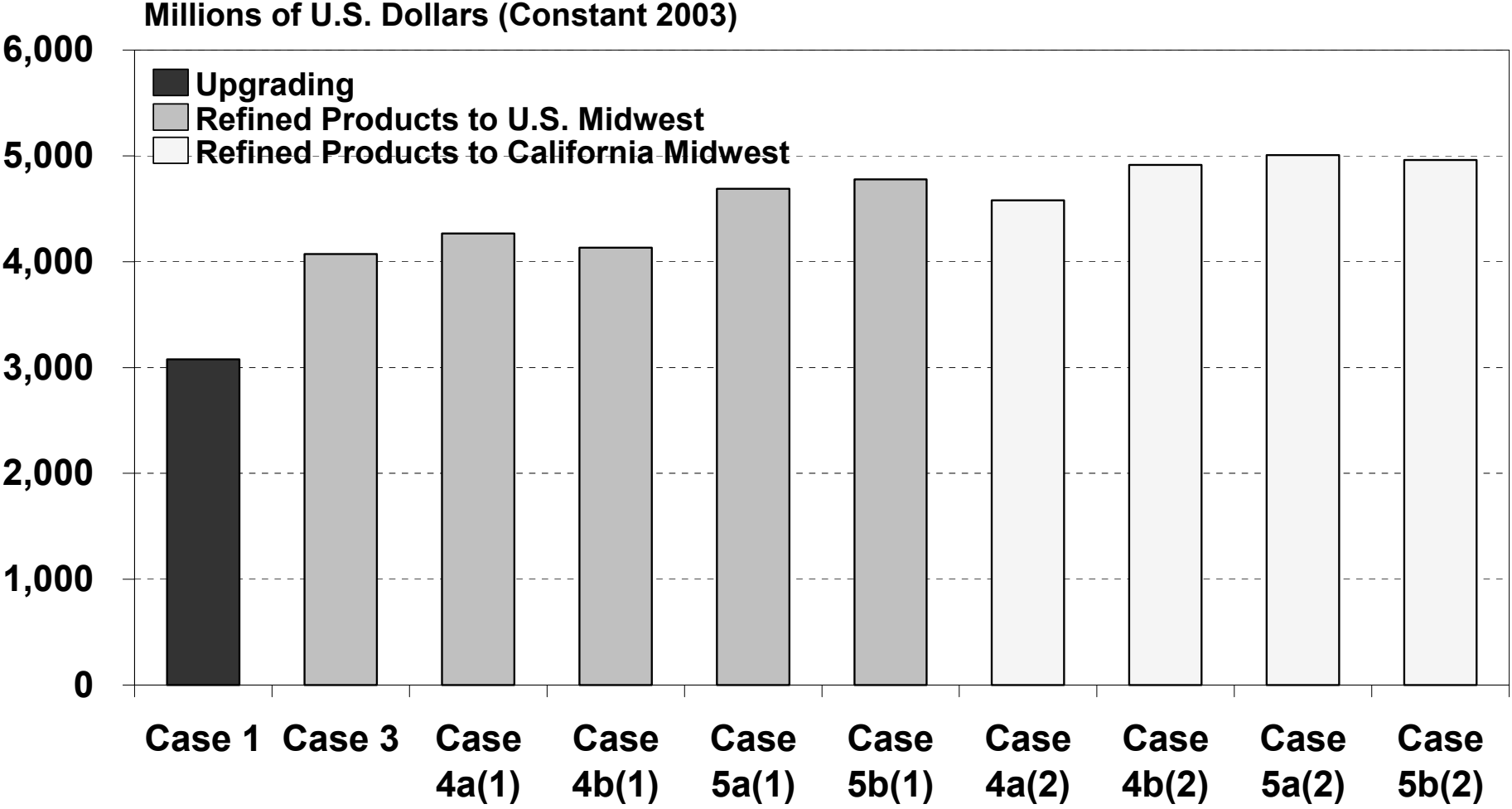
Refined Product Netback Prices Above SCO At Edmonton 2015

Constant 2003 US Dollars per Barrel



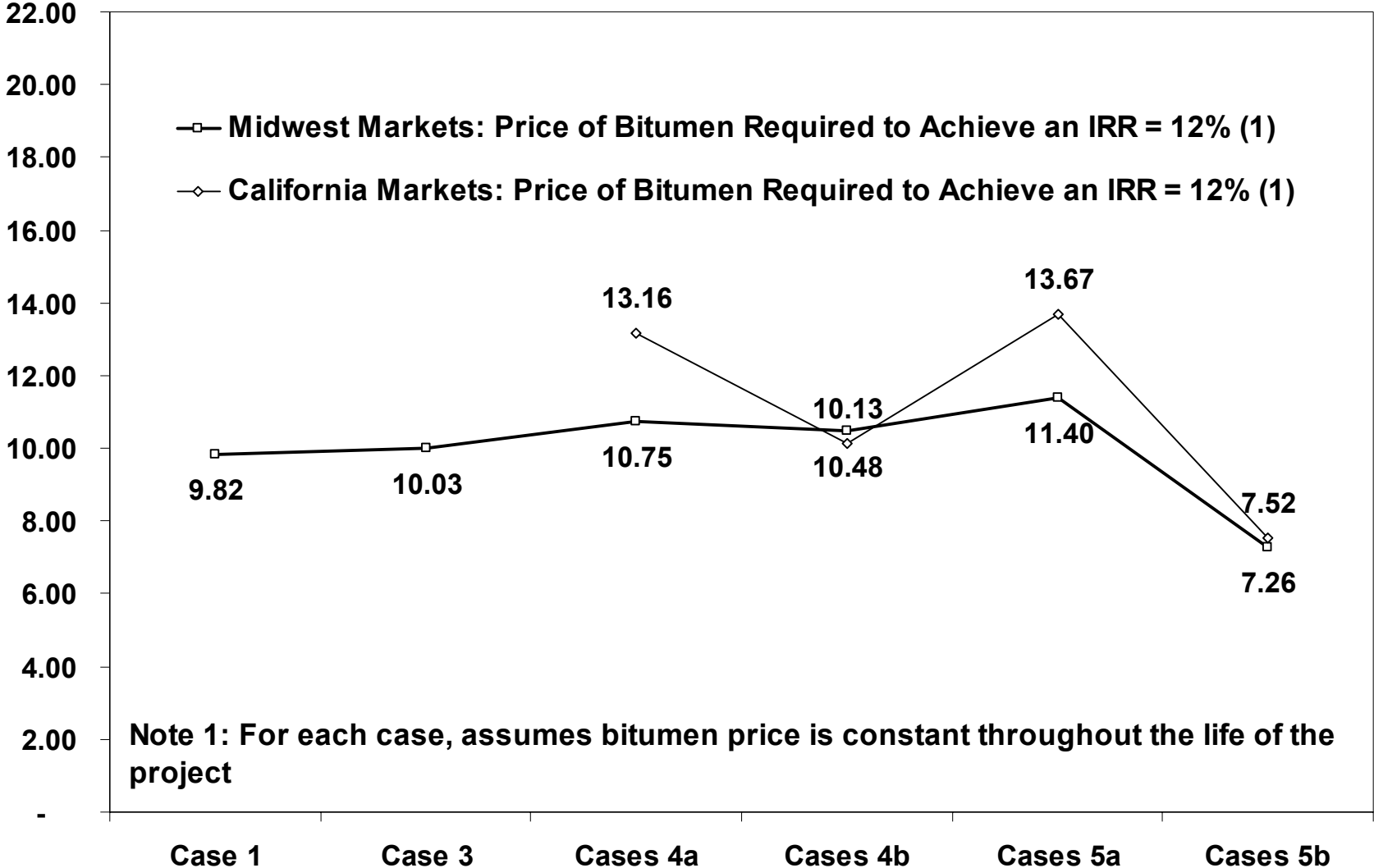
➤ **California market should yield the highest refined product netback when compared to the Midwest market**

Comparison of Capital Costs

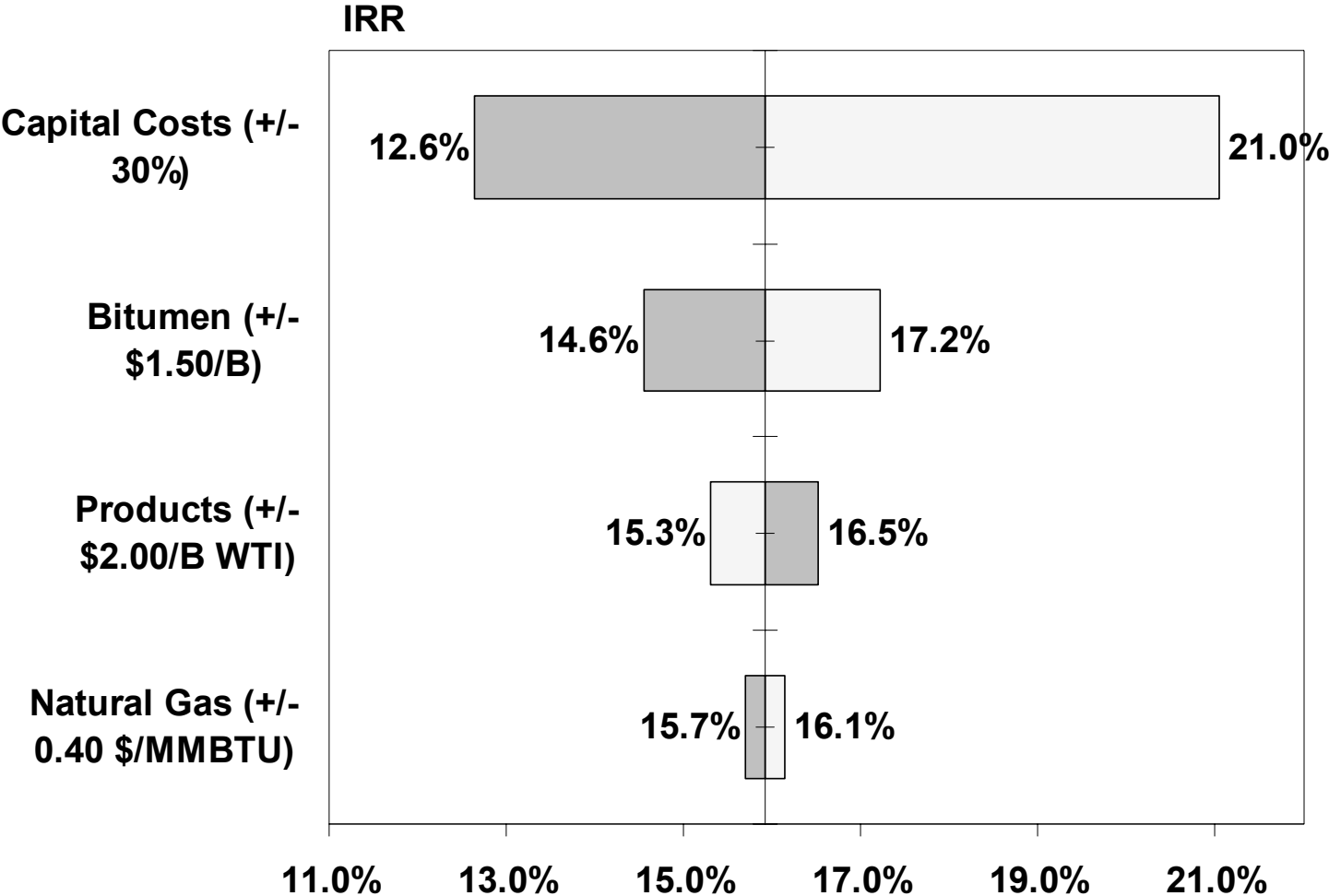


Bitumen Netback Price: Comparison Of Cases

Constant 2003 \$US per Barrel

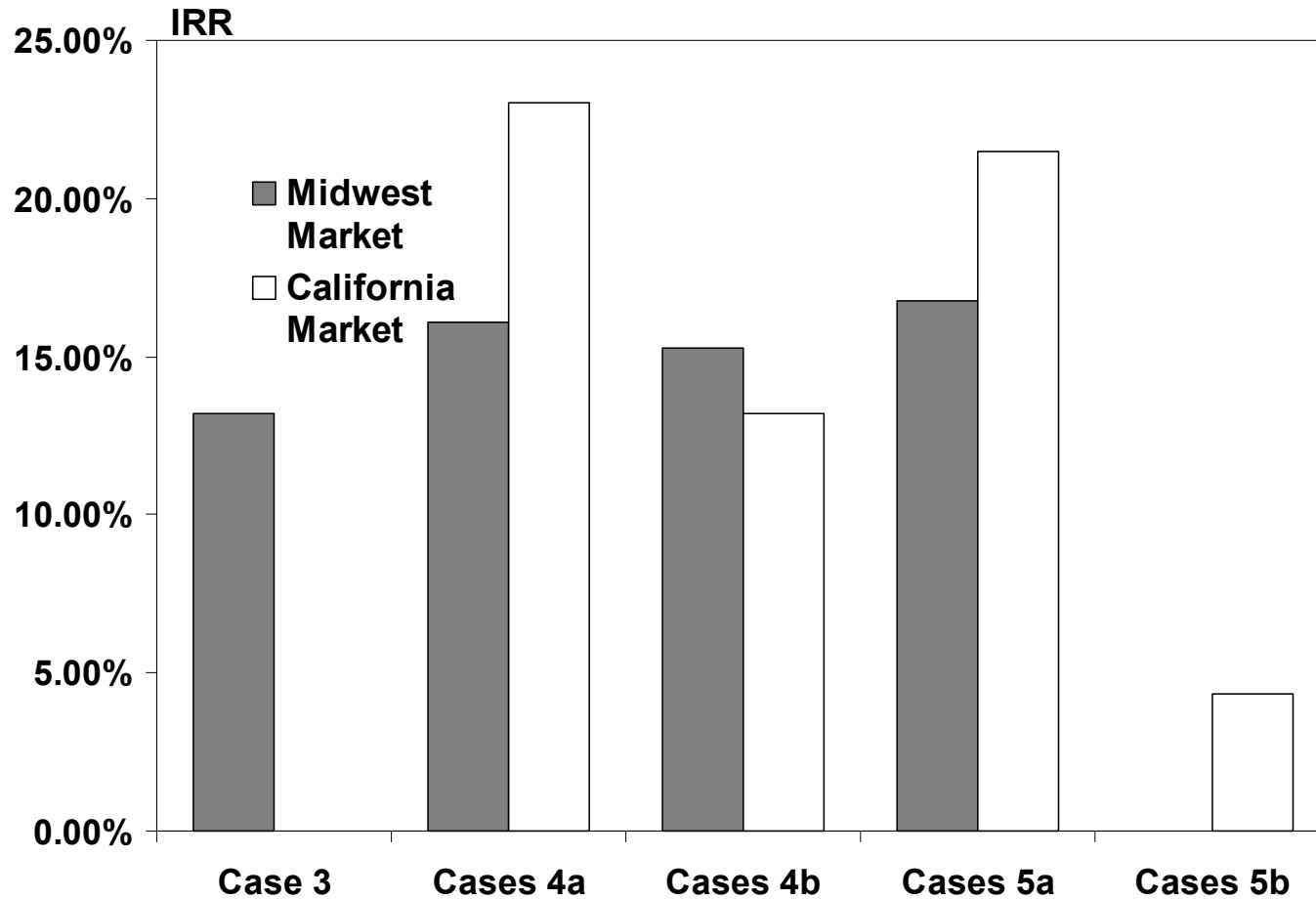


California: Case 5a(2) Sensitivity



➤ Capital cost is the most sensitive variable.

Incremental IRR Comparison Based on Case 1 SCO Price



- Hydrocracking cases (4a & 5a) show positive returns over base case.
- Addition of styrene to case 5a improves overall economics.

Conclusions

- **Good economic value added attributed to refined products and petrochemicals incremental to stand alone upgrading.**
- **Large capital investment required. Potential to reduce capital costs has a very positive impact on overall economics.**
- **Large volume of exports to Midwest or California markets based on product pipeline availability.**
- **Enbridge expansions need to be configured to accommodate refined products.**
- **Terasen capability to ship products contingent on major expansion to ship crude oil.**
- **Californian market should provide superior returns as compared to U.S. Midwest.**

Recommendations for Further Study

- **Selection of a likely business case should be made.**
- **Logistical options need to be further developed.**
- **Potential Market Barriers**
 - Introduction of large supply into market may result in price discounting.
- **Competitiveness of Alberta Based Projects**
 - Need to examine staging of project to manage capital cost.
- **Impact on Alberta Industry**
- **Synergies with other Projects Should be Explored**
 - Procurement of third party fuel/hydrogen could reduce capital cost exposure
 - Extraction of propylene & styrene in combination with existing operations could help to improve economics

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