

BITUMEN UPGRADING DRIVERS

Presentation to:

Canadian Heavy Oil Association

Facilities & Upgrading Panel

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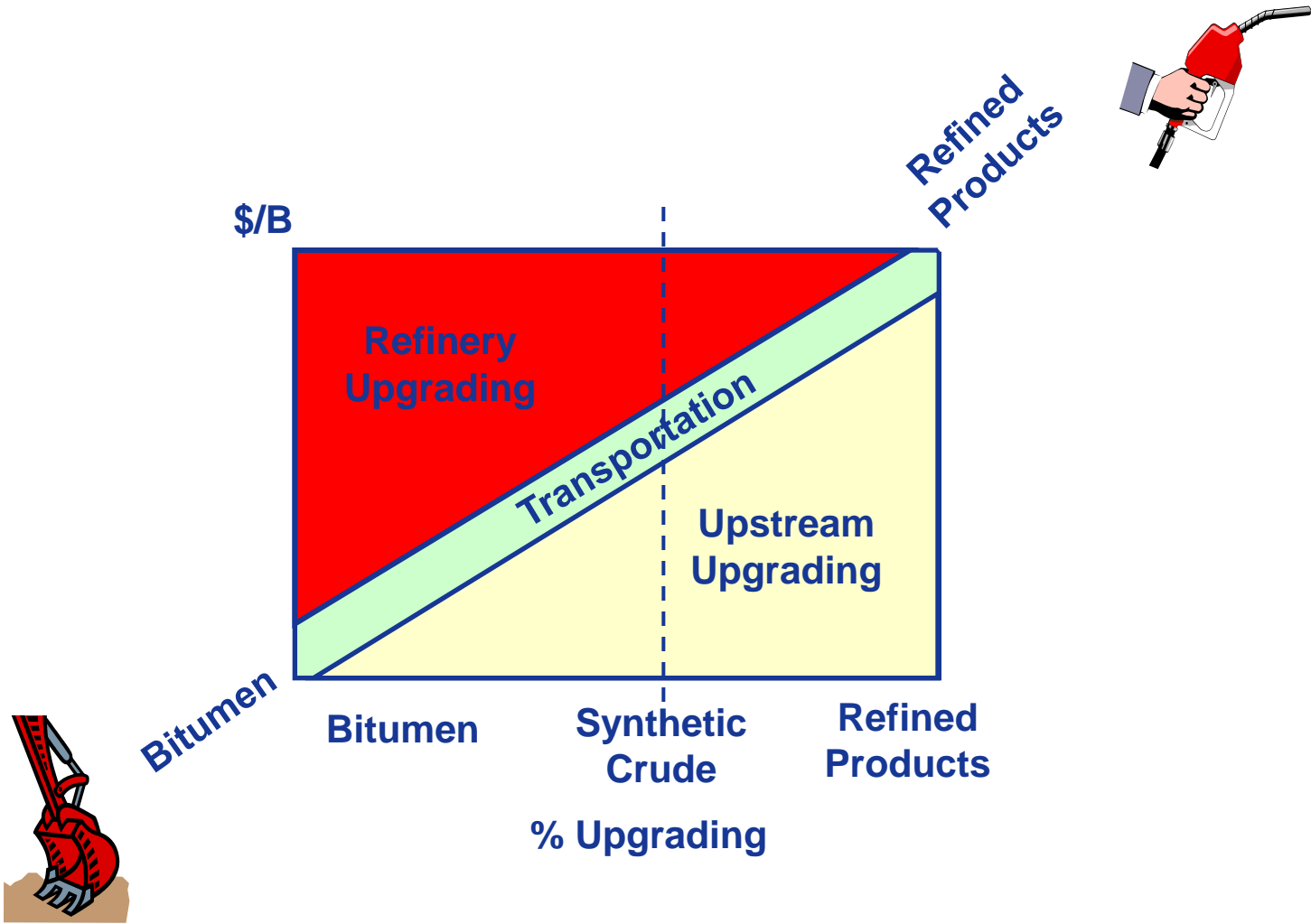
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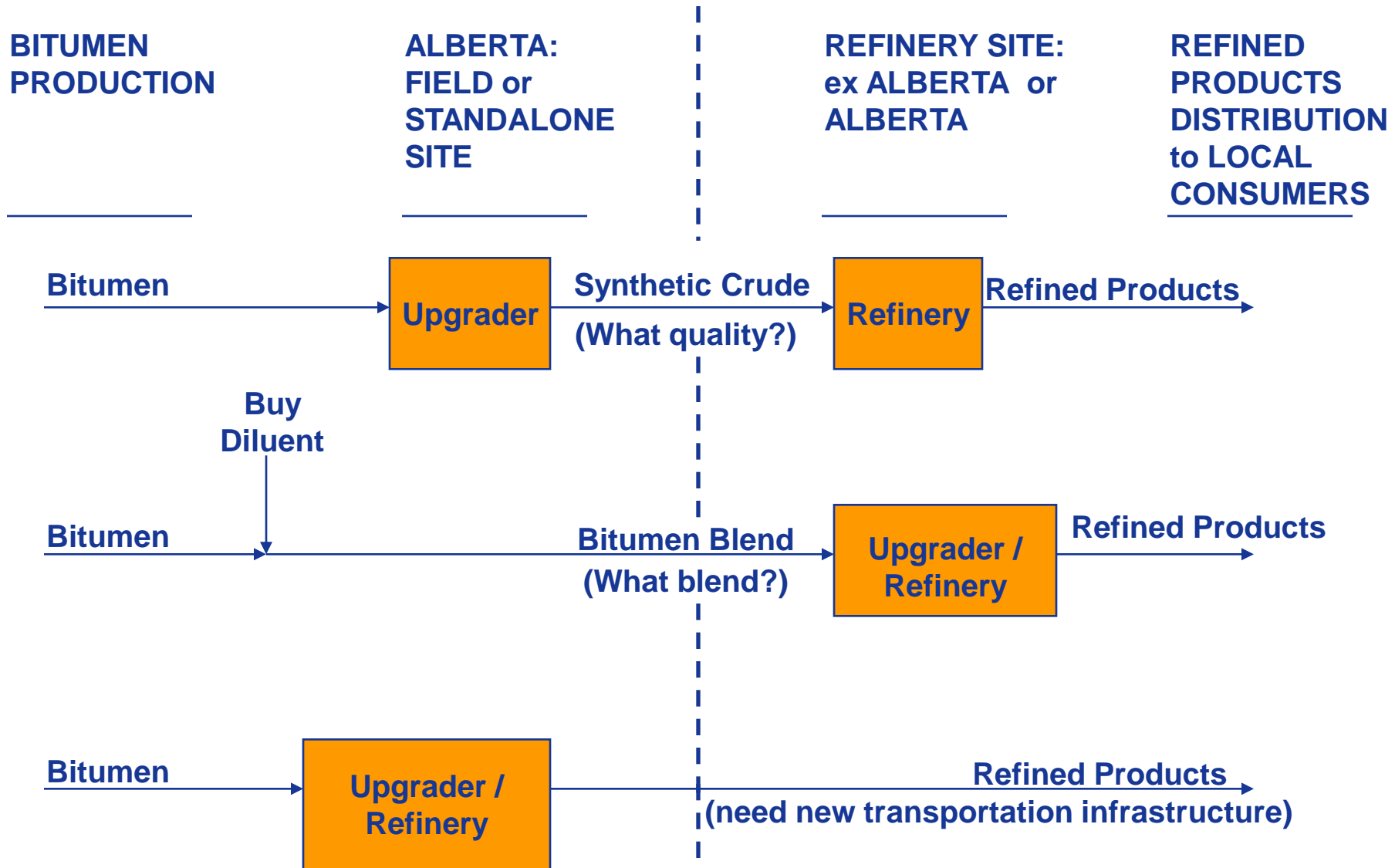
Purvin & Gertz and Oil Sands

- **International Energy Consultancy**
 - Private and Independent
- **Established in 1947**
 - In Canada since 1973
- **35+ years in oil sands**
 - Refining and upgrading technology
 - Economic feasibility
 - Market studies
- **Refinery/upgrading costs and economics**
- **Independent Engineer for banks/investors**
 - Initial project reviews
 - Project and performance monitoring and certification

Upgrading, Transportation & Refining are Needed for the Clean Fuels Market to Utilize Alberta Bitumen



Where Can Upgrading and Refining Occur?



➤ Different oil sands products target different markets and have different market risks

Where to Upgrade?

<p>@ Resource Site eg. Suncor, Syncrude, CNRL, OPTI/Nexen</p>	<ul style="list-style-type: none"> • Large Scale • Upstream Integration • GHG increases but CCS/EOR potential
<p>@ Central Site eg. Husky BPU, Northwest (proposed)</p>	<ul style="list-style-type: none"> • Diluent Recycle • Feedstock Flexibility • Large scale (vs. In-Situ) • Infrastructure depends on location • Impact of B.R.I.K. is unknown • GHG increases but CCS/EOR potential
<p>@ Edmonton Refinery eg. AOSP/Shell, Suncor (former Petro-Canada)</p>	<ul style="list-style-type: none"> • Diluent Recycle • Existing Infrastructure • Finished Product (for export) • GHG increases but CCS/EOR potential
<p>@ Refinery ex Alberta eg. Flint Hills, St. Paul BP, Whiting ⁽¹⁾ WRB, Wood River (COP/Cenovus)⁽¹⁾ Marathon, Detroit ⁽¹⁾</p>	<ul style="list-style-type: none"> • Bitumen blend feedstock, not bitumen • Feedstock Flexibility • Existing Infrastructure • Less Capital • Finished Product • Moves GHG from Alberta to U.S. • LCFS may limit bitumen use

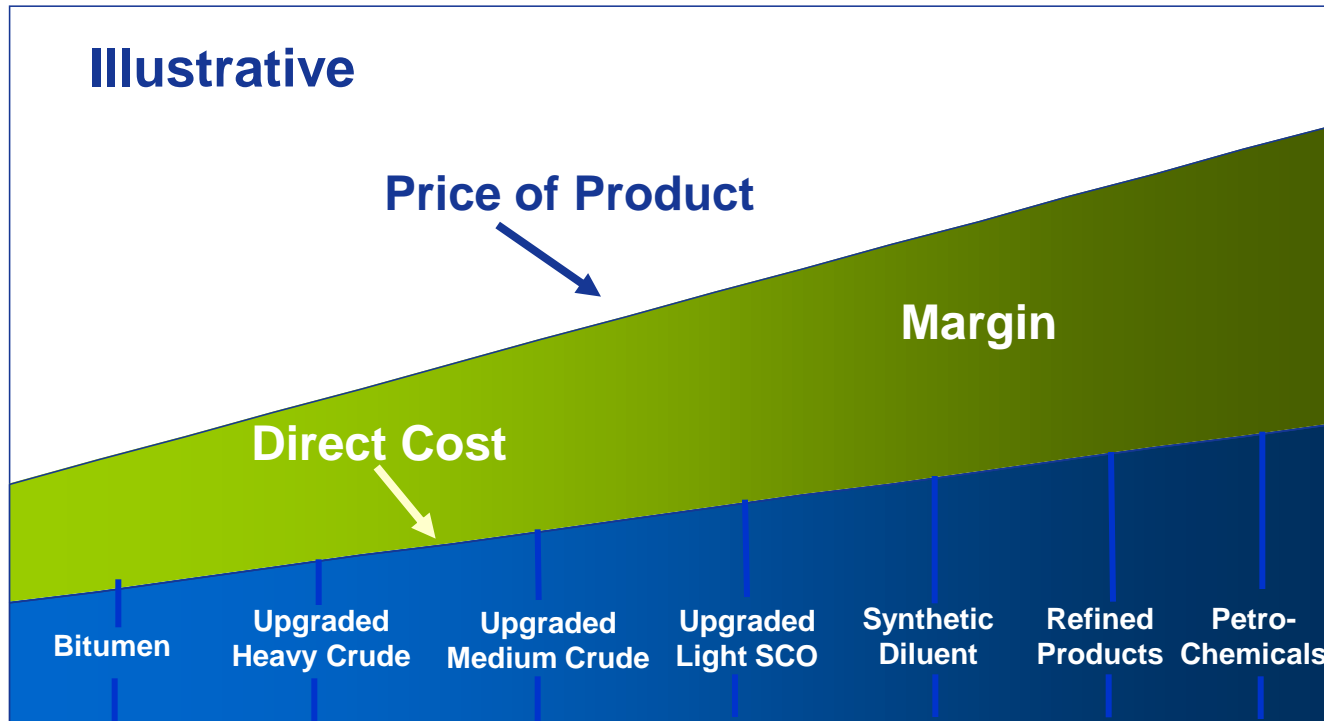
Note: (1) Refineries are expanding or adding coking for bitumen blend.

Markets For Oil Sands Production

- **Oil Sands crudes need refineries.**
 - Different operators perceive different market risks for bitumen blends and for SCO
 - Construction of new grass root refineries in the U.S. unlikely as product demand is not increasing
 - Debottlenecking expansion may be inexpensive, but a major expansion for a brown field site would have high costs.
- **For existing refineries that are expanding or making modifications to run more heavier crudes,**
 - Some synergies expected. Existing infrastructure such as tankage and utilities should save capital cost and operating overhead cost.
 - Major changes could require significant replacements
 - Refinery downtime for modifications has significant costs
 - Pipeline capacity planned to reach Gulf Coast where refineries need more heavy crude
- **With growth in bitumen production, more diluent would be needed and a surplus of heavy crude would emerge.**
 - More upgrading, refining and/or pipelines would be needed.
- **For synthetic crudes, existing refineries may have to make modifications to upgrade large quantities to refined products.**
 - SCO may be needed as diluent

How Much Upgrading? Which Technologies & Products?

Dollars per Barrel



**Return
on Capital?
(Margin/Capital)**

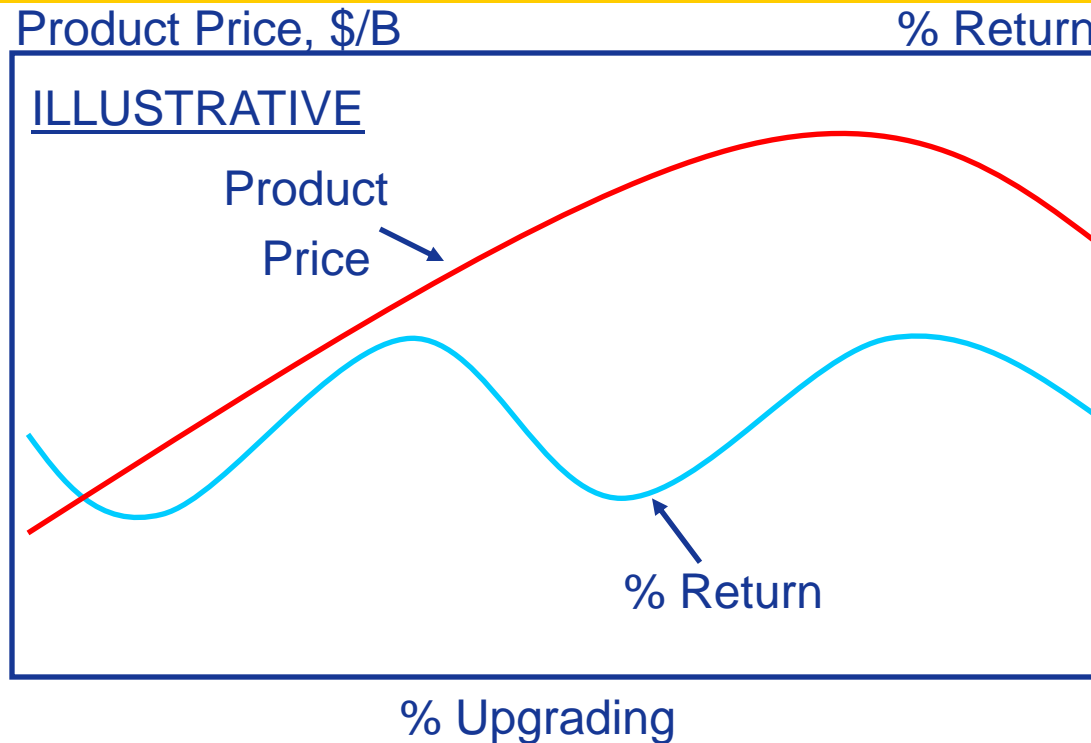
Marketability?

Degree of Upgrading (eg. API) →

Capital Cost →

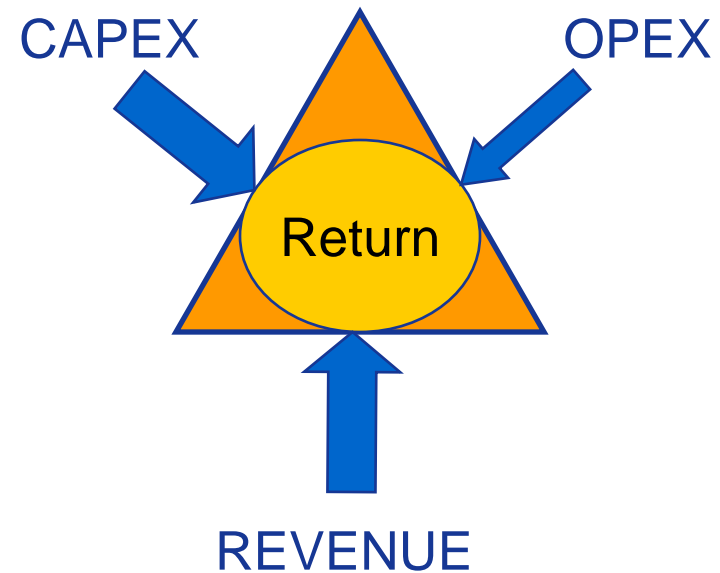
- Capital costs hyper-inflated and slid back
- More capital adds more risk

Will Higher Product Price Add Value?



- Directionally, the average price of products increases with the extent of upgrading
- To “add value” product price needs to exceed the supply cost, including additional capital cost
 - Subject to capex, financing costs etc

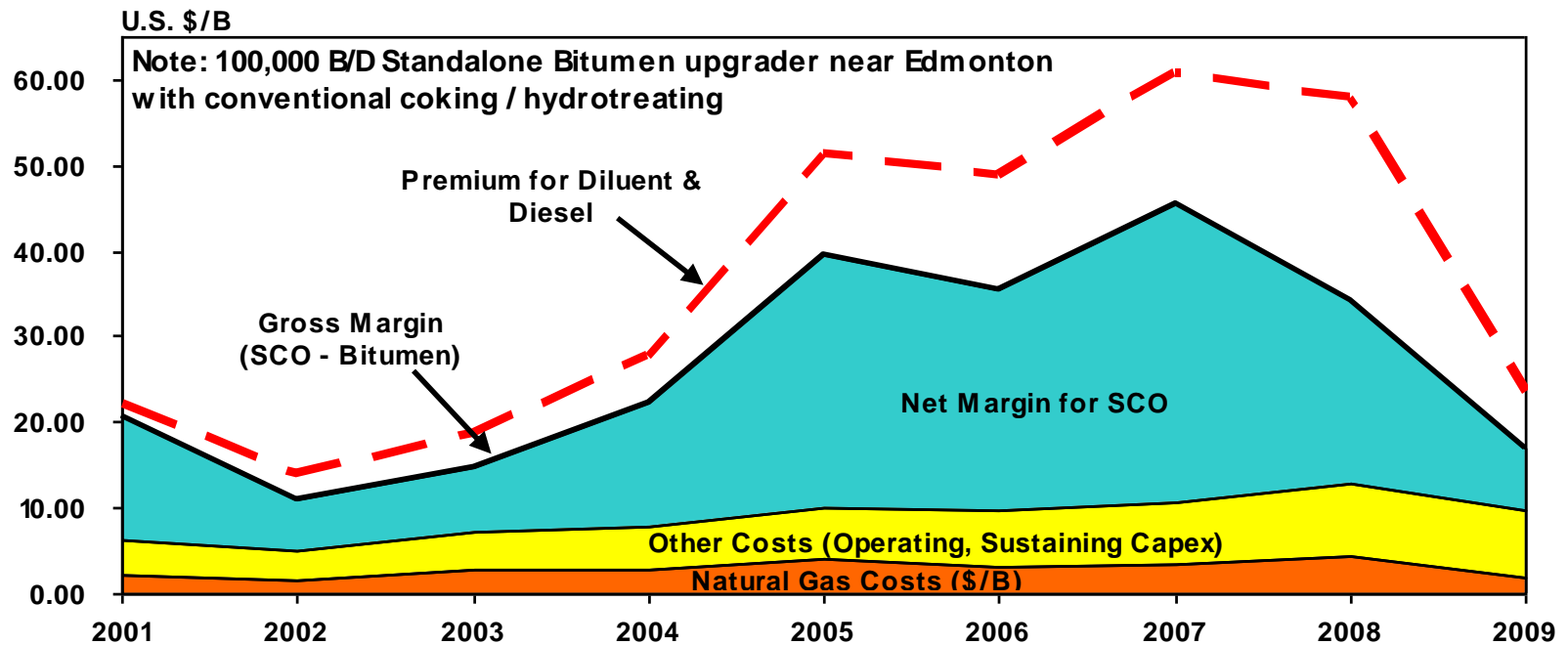
Upgrader Economic Drivers (1)



- Revenue depends on product yield, quality and market value
 - Quality depends on technology.
- Feedstock price for bitumen or bitumen blend is part of opex or net revenue
 - Net revenue driven by light/heavy differential
- Operating costs depend on energy purchased
- Upgrading is capital intensive
 - Depends on technology and capacity
- Return depends on net revenue versus capex.

Note: (1) Climate change regulations and penalties likely impact the market values of bitumen and products, operating costs, capital costs and return

Margin For “Standard” Upgrading



- The upgrading margin depends on the light/heavy differential (delta)
- There are many drivers for this delta, both international and local
- The delta and margin were exceptionally high in 2005 to 2008, but they have fallen to record lows
 - The delta should remain low for a few years due to higher heavy crude demand, then widen due to growing production
 - Although cyclical, the long term average should be less than previous peaks
 - The delta would be higher for products like diluent and diesel, but operating and capital costs would also be higher

Summary Of Upgrading Issues

- **Upgrading is needed**
 - Where and how much?
- **Upgrading in Alberta adds capital and financial risk exposure**
 - It adds jobs and economic activity. How can social benefits offset private risk?
- **Product value increases**
 - Does upgrading “add value” overall, when compared with costs?
- **The refinery targets change when SCO replaces bitumen blend**
 - Does this reduce market risk?
- **Upgrading bitumen removes the need to source diluent**
 - Upgrading could provide diluent
- **Upgrading in Alberta increases local emissions and environmental risk**
 - How to mitigate for sustainable development?

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