OPPORTUNITY CRUDES:

TO PROCESS OR NOT TO PROCESS?

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HYDROCARBON PUBLISHING COMPANY
Translating Knowledge into Profitability℠

OUTLINE

Part 1

- Definition of opportunity crudes
- Drivers
- Concerns

Part 2

- Technology solutions
- Refinery approaches
- Future outlooks

WHAT ARE OPPORTUNITY CRUDES?

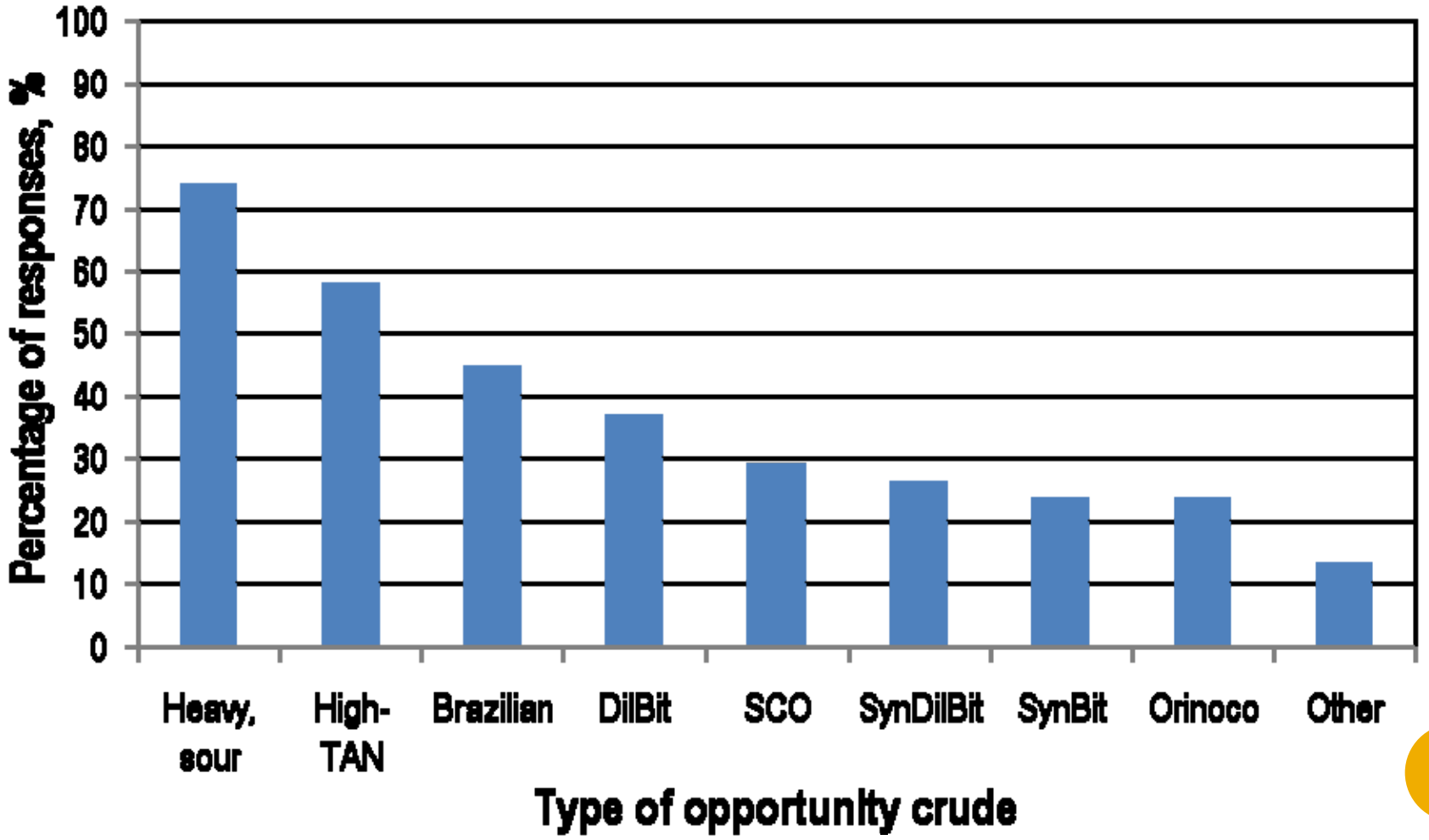
- Heavy, sour (<26°API, >1 wt% sulfur)
  - e.g., Bachaquero (Venezuela), Maya (Mexico)
- Extra-heavy (<15°API)
  - e.g., Athabasca bitumen (Canada), Orinoco (Venezuela)
- High-TAN (>0.5mg KOH/g oil)
  - e.g., Alba (North Sea), Duri (Indonesia)

OPPORTUNITY CRUDES 2011 SURVEY

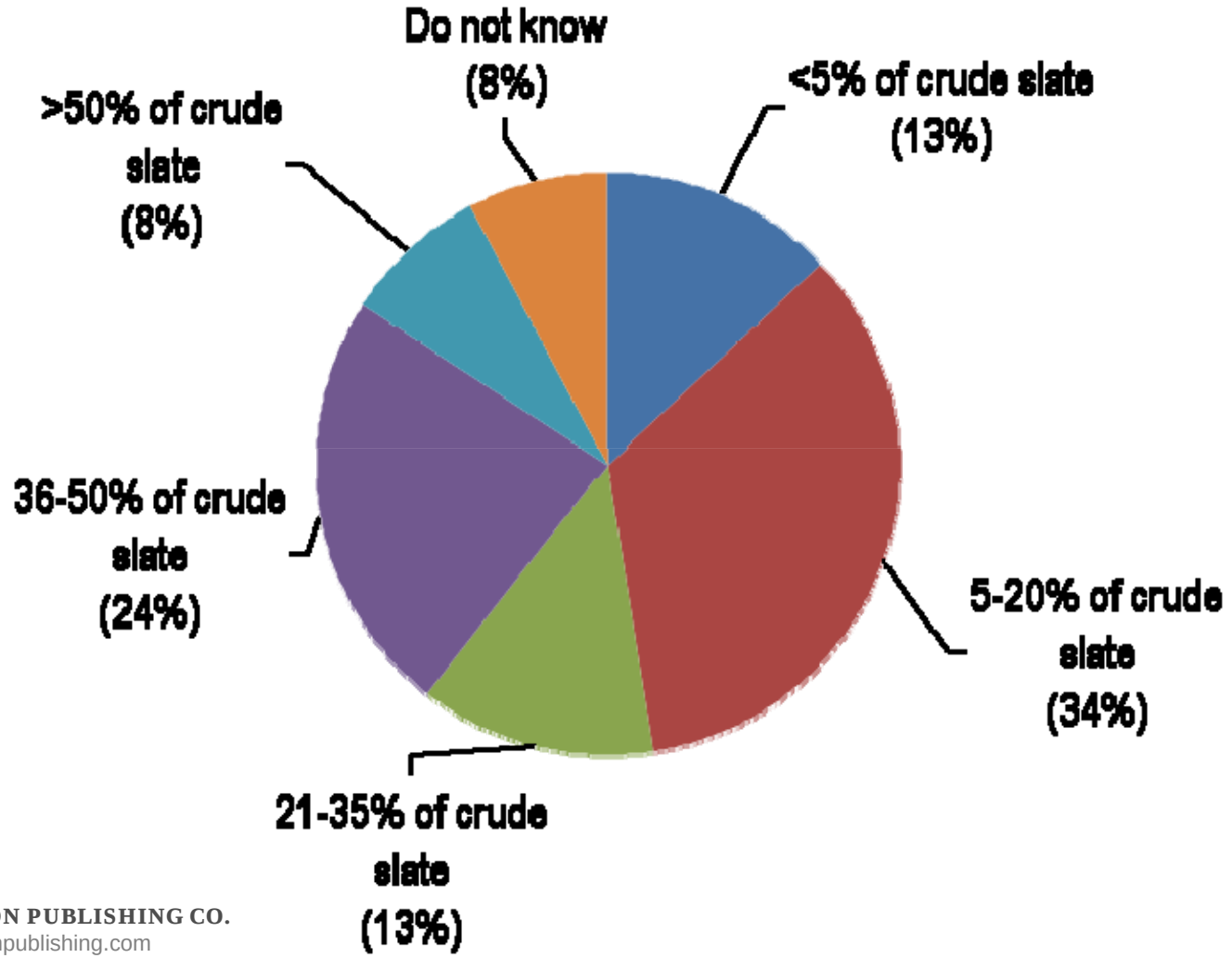
- Timeframe: End of 2010 to early 2011

- Participants:
  - Refineries with capacities >25K b/d
  - Including refineries in North America, South America, Europe, Asia, the Middle East, and Africa

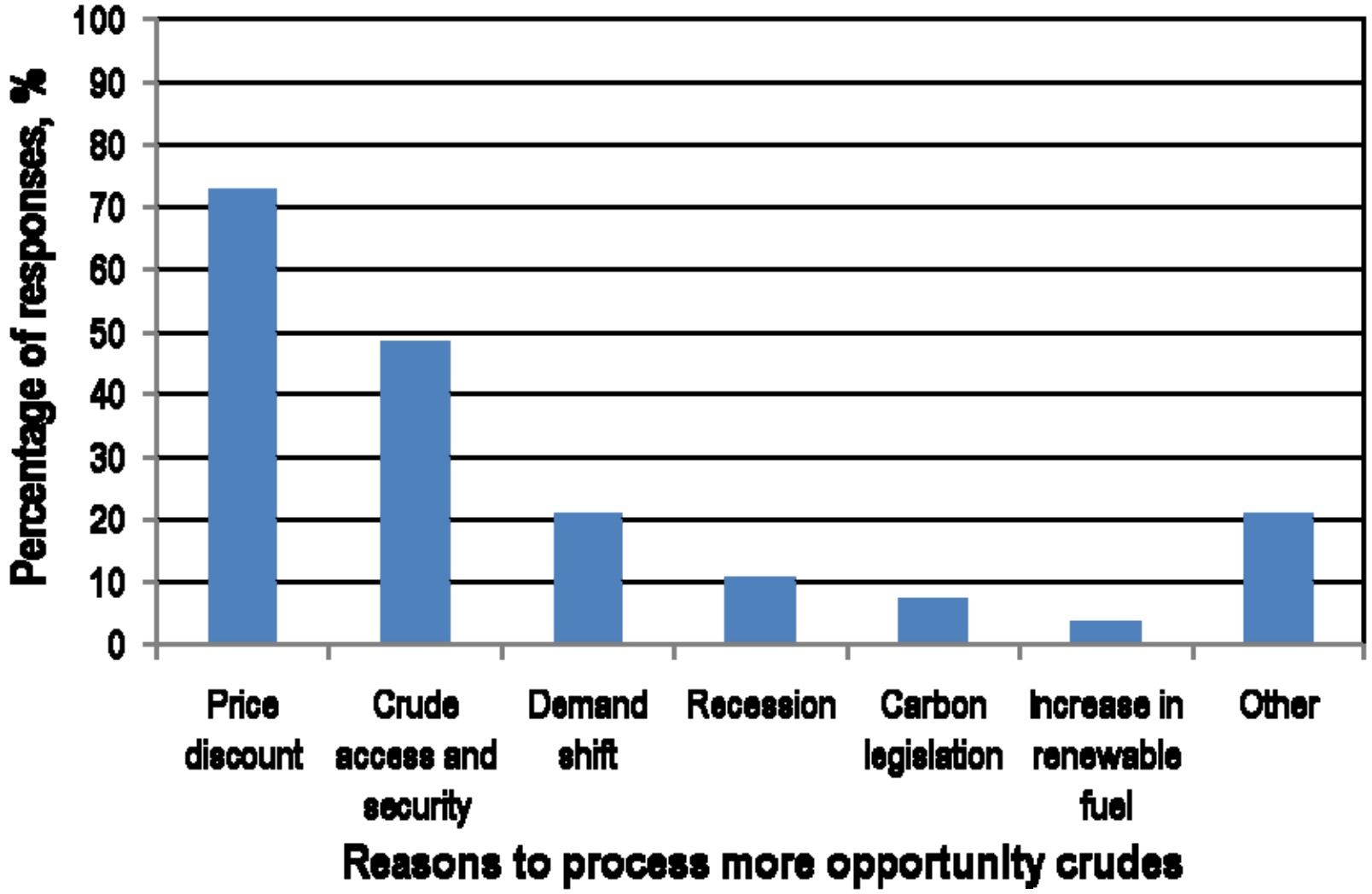
SURVEY RESULTS: TYPES OF OPCRUDES PROCESSED



SURVEY RESULTS: AMOUNT OF OPCRUDES PROCESSED



SURVEY RESULTS: DRIVERS FOR PROCESSING OPCRUDES



DRIVERS FOR PROCESSING OPCRUDES

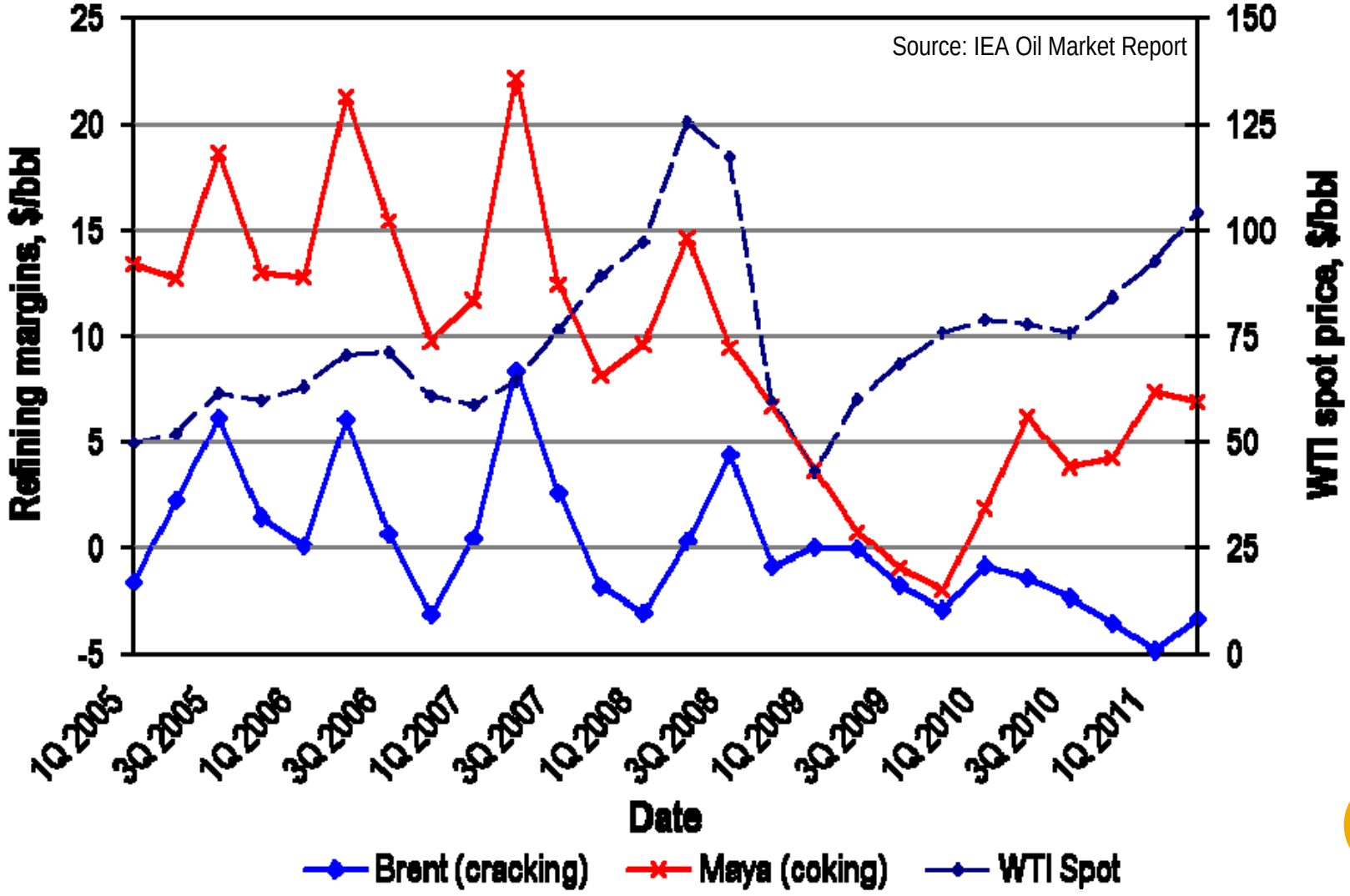
Survey Results

- Lower crude costs
- Accessibility and stability of supply

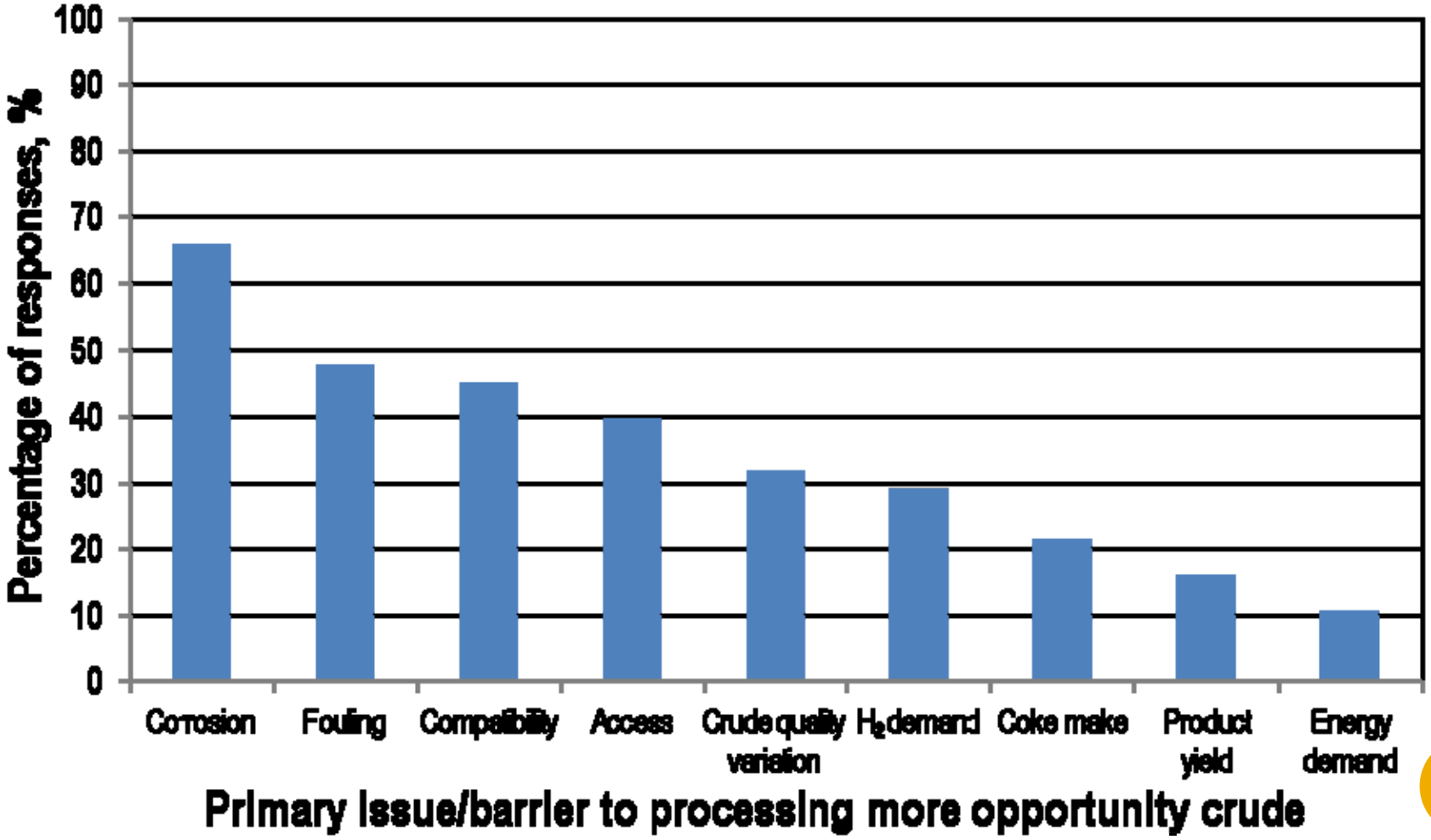
Additional Drivers

- Higher diesel yield
- Increased propylene production
- Increased coking vs. cracking margins

COKING VS. CRACKING MARGINS



SURVEY RESULTS: BARRIERS TO PROCESSING OPCRUDES



BARRIERS TO PROCESSING OPCRUDES

Survey Results

- Increased fouling and corrosion
- Crude compatibility
- Accessibility of opportunity crudes

Additional Barriers

- Production of more high sulfur fuel oil
- Increased CO_2 emissions

TO SUCCESSFULLY PROCESS OPPORTUNITY CRUDES:

- Minimize fouling
- Minimize corrosion
- Convert additional resid material
- Make the products that are in demand
  - Reduce production of high sulfur fuel oil
  - Increase diesel production
  - Consider increasing propylene yield

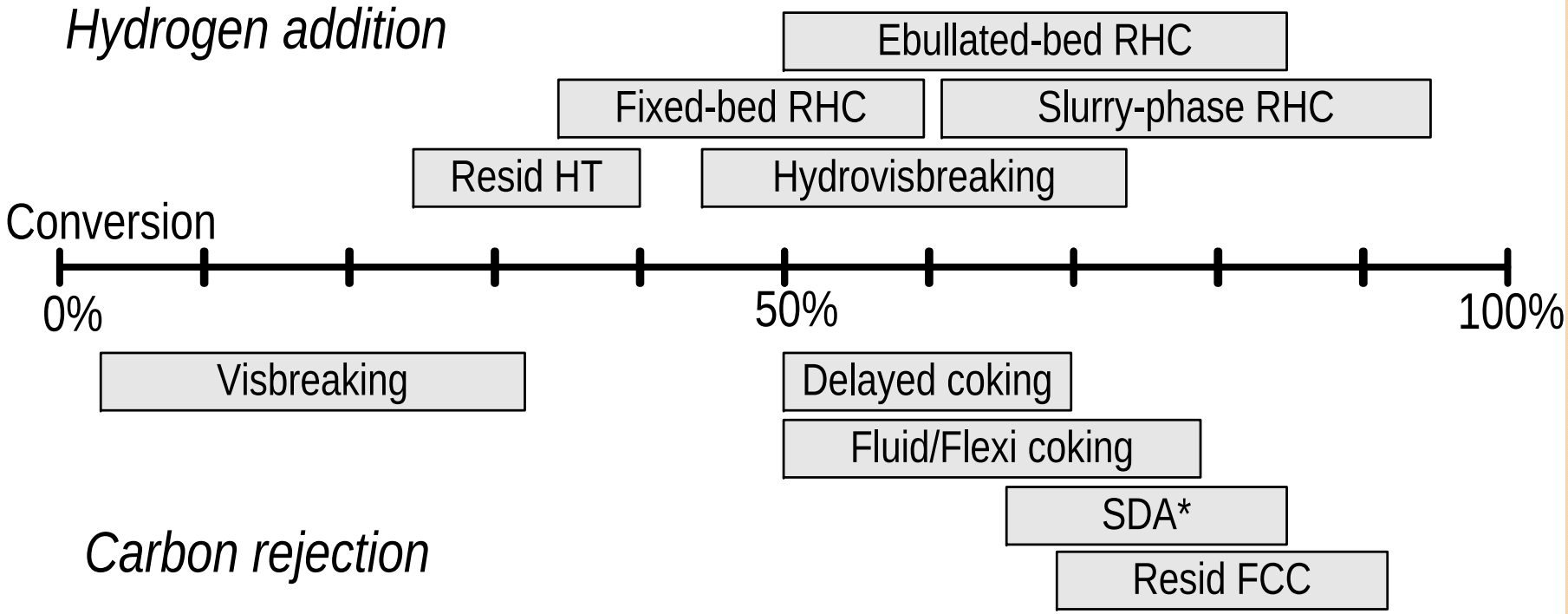
SOLUTIONS FOR FOULING

- Maintain flowrates above 5 ft/s in heat exchangers
- Antifoulant chemicals
- Tube inserts
- Install welded plate heat exchangers
- Utilize programs to monitor stability and optimize cleaning schedules

SOLUTIONS FOR CORROSION

- Monitor desalter operations closely
- Additives
  - Phosphorous vs. phosphorous-free additives
- Upgrade metallurgy
  - Particularly useful in high velocity, turbulent areas
  - Higher Mo content increases resistance to naphthenic acid corrosion
  - Higher Cr content increases resistance to sulfidic corrosion

TECHNOLOGIES FOR UPGRADING RESID



*Deasphalting provides physical separation rather than conversion

OPTIONS FOR HANDLING RESID (1)

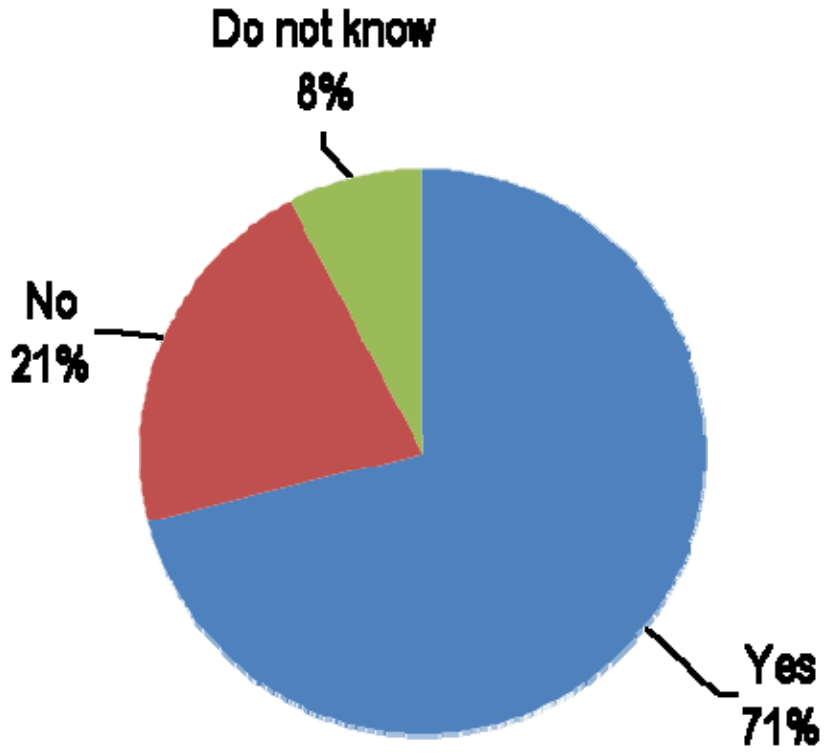
- Fluid catalytic cracker
  - Adjust catalyst composition ($)
  - Add a catalyst cooler ($$)
  - Add a resid HT unit to pretreat the feed ($$$)
- Hydrocracker
  - Increase hydrogen partial pressure ($)
  - Adjust catalyst composition ($$)
  - Add an additional HC stage ($$$)

OPTIONS FOR HANDLING RESID (2)

- Coker
  - Reduce pressure/optimize temperature ($)
  - Minimize recycle ratio ($-$$)
  - Install larger or additional coke drums ($$$)
  - Consider an SDA or visbreaker to reduce feed to coker ($$$)

SURVEY RESULTS: APPROACH TO PROCESSING OPPORTUNITY CRUDES

Has your refinery performed a major revamp to process opportunity crudes?



TO PROCESS OR NOT TO PROCESS?

Pros

- Lower crude costs
- Coking margins > cracking margins
- Dieselization trend
- Rising propylene demand
- Growing supplies of unconventional crudes
- Higher worldwide crude demand

Cons

- Lower demand for HSFO
- Higher processing costs
- Climate change legislation
- Increasing use of biofuels
- Higher vehicle fuel efficiency
- Increasing supplies of shale oil and NG condensates

FUTURE OUTLOOK

- Opportunity crudes will be an important part of refinery crude slates going forward
- Keys to success include:
  - Proactive measures to reduce fouling and corrosion
  - Maximize diesel production
  - Minimize HSFO yield
  - Increase propylene
  - Monitoring CO_2 emissions

ACKNOWLEDGEMENTS

- Much of the information in this presentation is from HPC's recent report titled *Opportunity Crudes II: Technologies & Strategies for Meeting Evolving Market & Environmental Challenges*
- Special thanks to the following HPC staff:
  - Pat Christensen
  - Thomas Garrett
  - Brett Goldhammer
  - Thomas Yeung

Opportunity Crudes II: Technologies & Strategies for Meeting Evolving Market & Environmental Challenges

www.hydrocarbonpublishing.com/Report2011

Report analyzes:

- Market and legislative conditions affecting opportunity crudes
- Technologies to minimize **corrosion**, **fouling**, CO_2 **emissions** & HSFO and to maximize **diesel** & **propylene**
- Three investment levels:
  - Low cost – primarily operational adjustments
  - Medium cost – revamps and modifications to existing equipment
  - High cost – addition of new process units
- Direct survey results and literature study to identify company strategies
- Specific strategies based on refinery configuration or location

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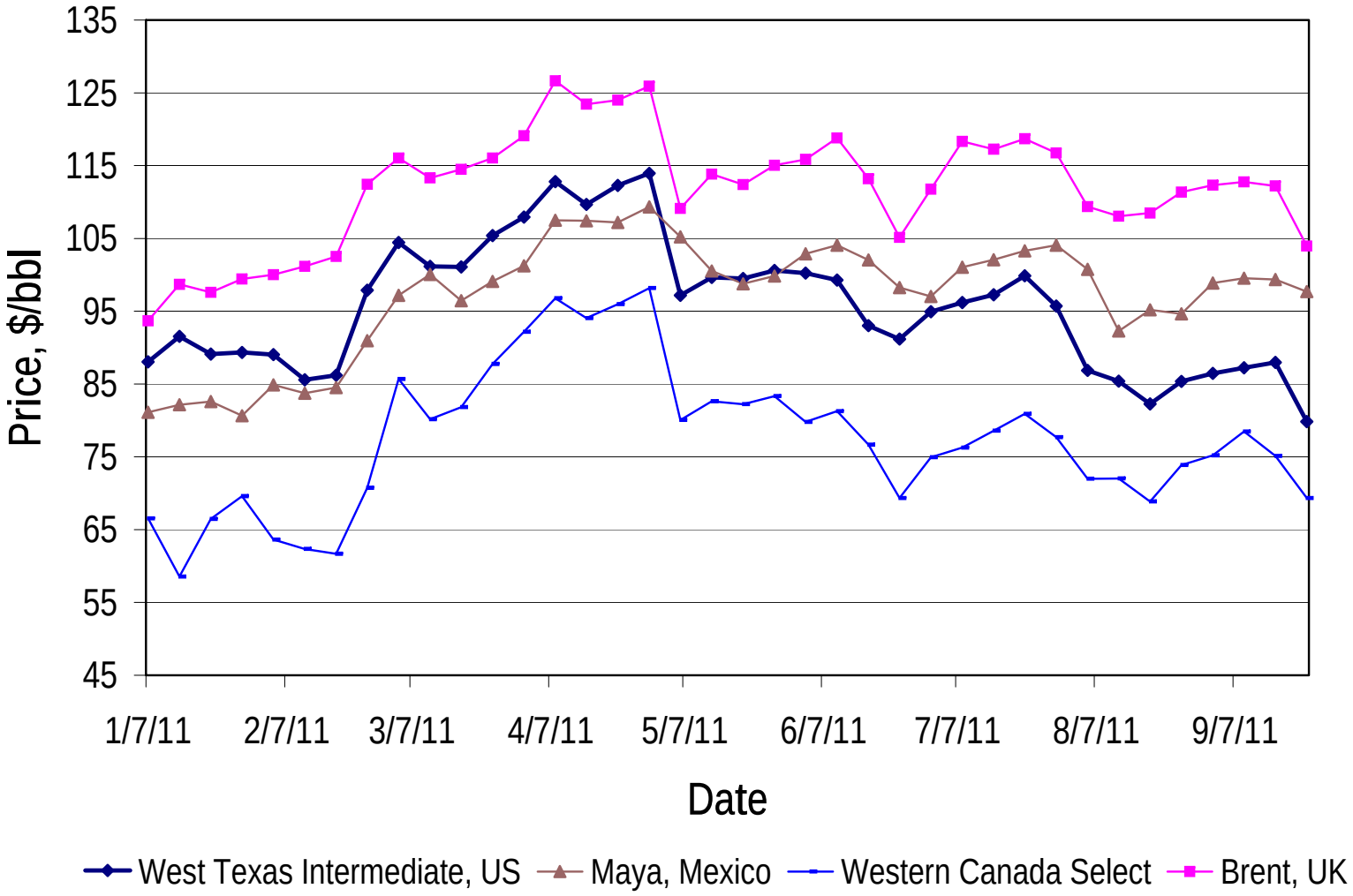
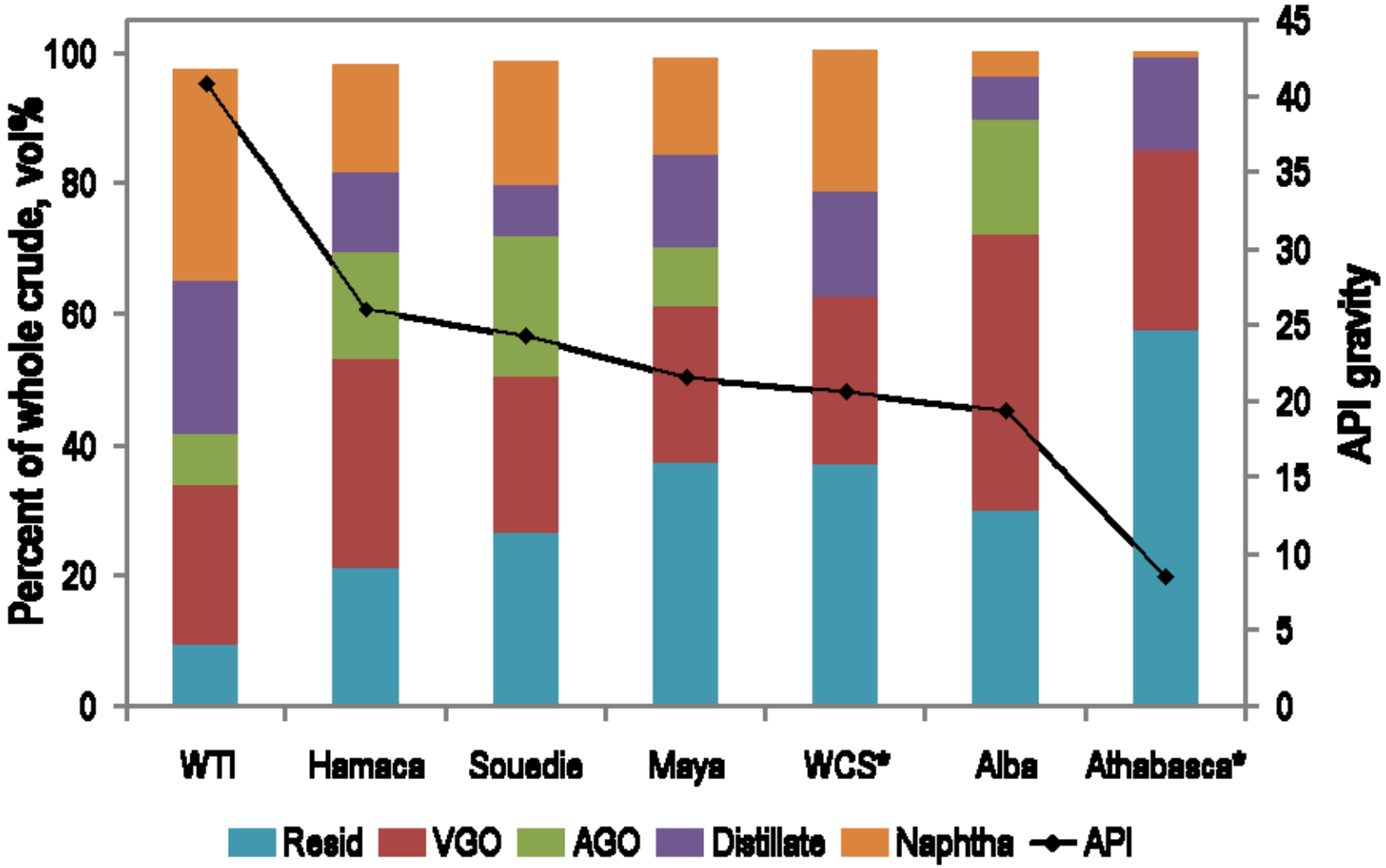
CRUDE PRICES



HIGHER DISTILLATE PRODUCING FRACTIONS



*AGO is divided between distillate and VGO