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Bottom of the Barrel Conversion

What does the future hold?

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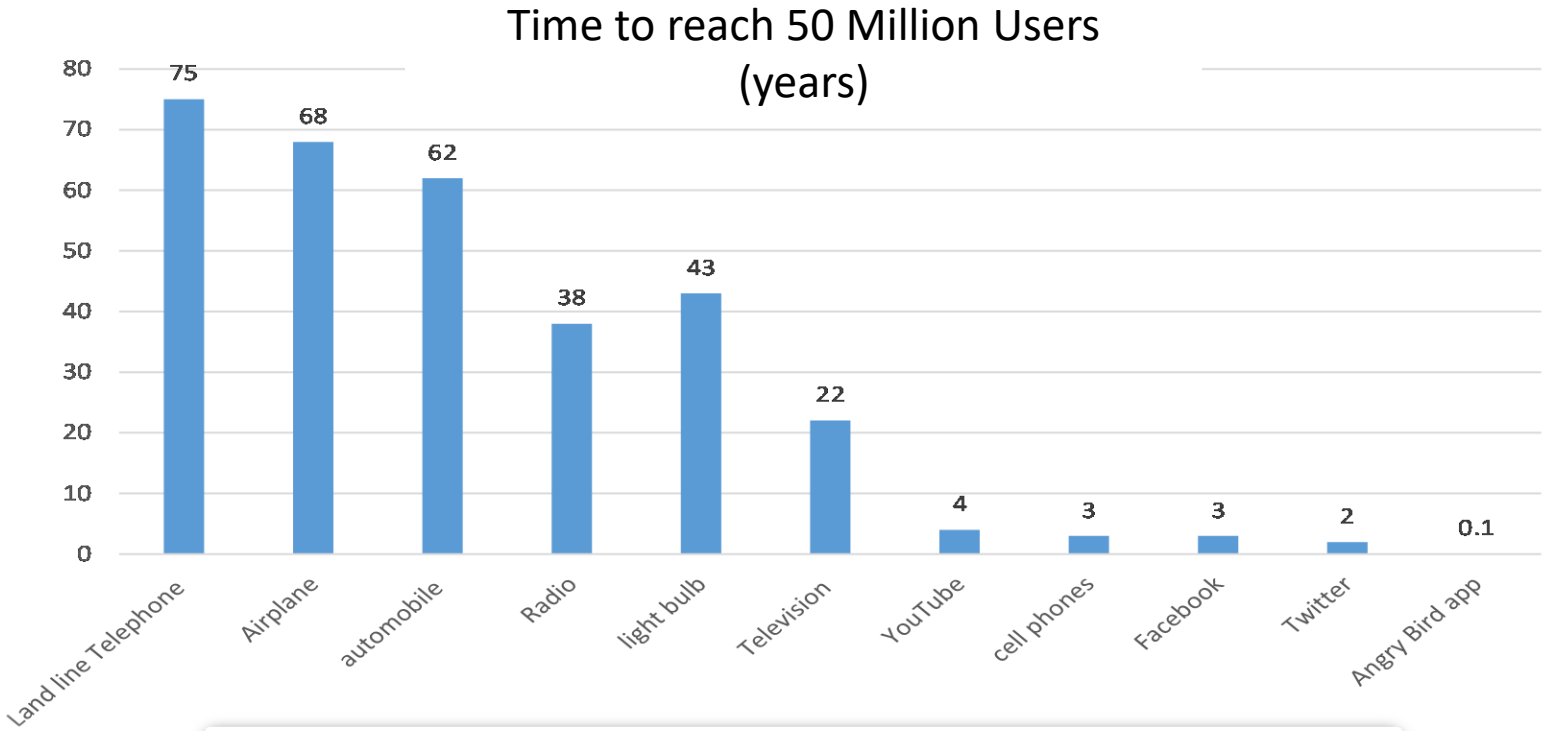
- Work life balance / stress
- Take time to move around
- Become active
- Find hobby outside of work
  - Cycling
  - Cooking
  - Reading novels
  - Community activities
- Monitor health
  - Over 45 - Get stress test / cardio review
  - Other screenings

Safety Moment

Work to live …
Not live to work

Perspective of change: Embrace It



Technology is transforming

Bunker shifts from by-product to 'on-purpose' product

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TODAY

Crude purchases to produce the highest value of regulated products at the "lowest" cost given the asset configuration

Bunker fuel is a by-product

If the refiner could make high value product they would

TOMORROW

- ✓ On purpose bunker production means
  - ✓ Higher priced, low sulfur crude
  - ✓ Major capital investment for bottoms upgrading and desulfurization
- ✓ Capacity rationalization
- ✓ Its cost → build or buy

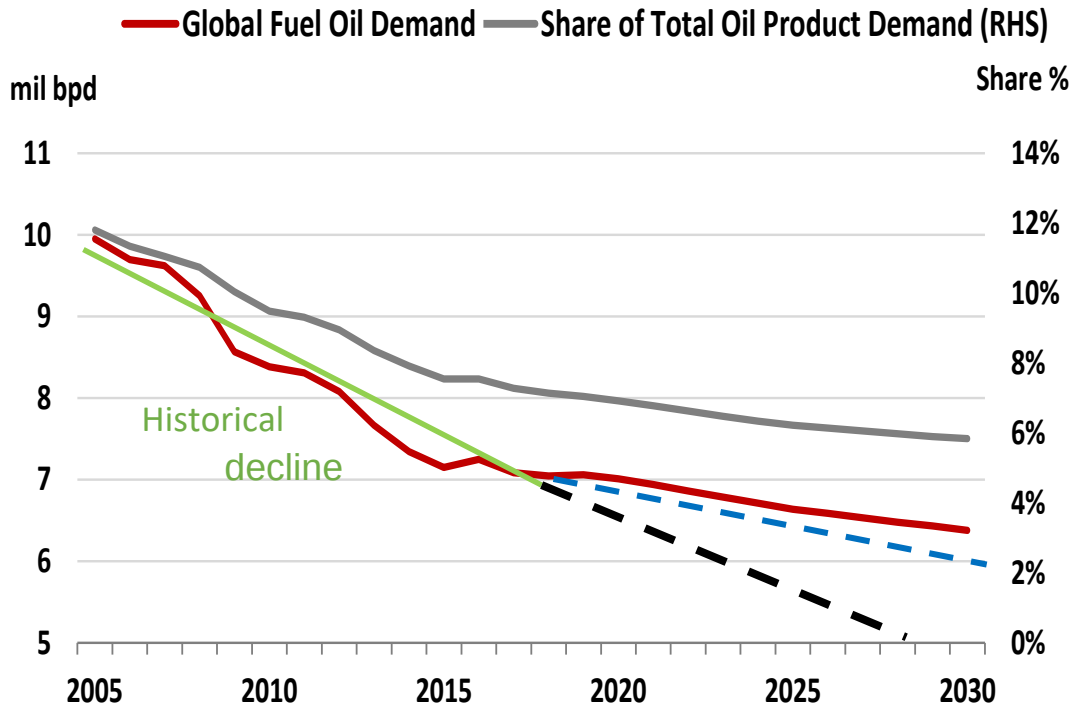
Not all crudes are created equal, i.e. not all crudes or blends of crude make an acceptable IMO Fuel

Market Shifts Overall

Demand for heavy fuel oil, has been declining since the 1980s.

The demand growth for lighter products – such as ethane, liquefied petroleum gas (LPG) and naphtha – almost triple of total oil demand.

Global Fuel Oil Demand Outlook



Continuing the decline or

potential trend of HS Fuel Oil

considering potential Utility demand

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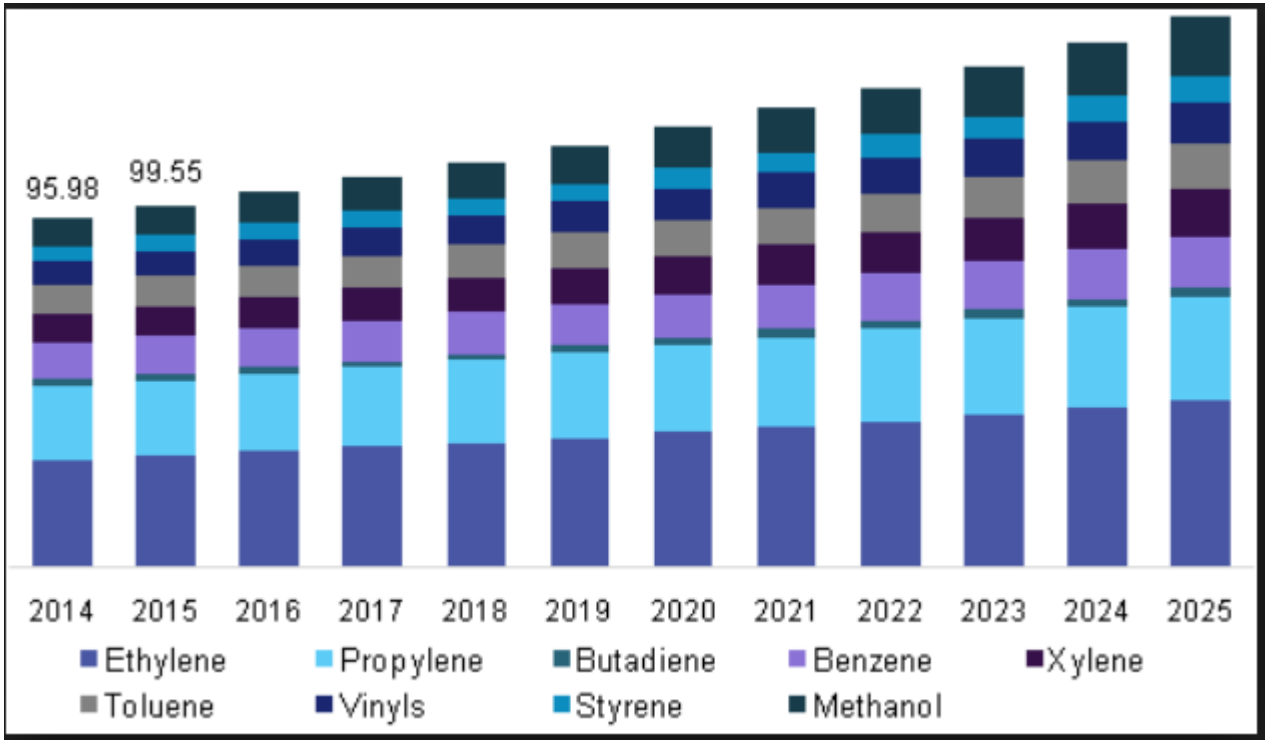
Looking at the Future

Global residual fuel demand has been declining for decades.

What is the future of Heavy Carbon Rich Fuel sources?

Chemicals Market

- Petrochemicals market continue to grow globally
- US market expanding with cheap NGLs
- LNG demand continues globally



Grand View Research, Inc, North America petrochemicals market

Motor Fuels Demand

- US / EU Flat to Declining
- East of Suez – Increasing
- South of US – Slight increase
- Fleet Efficiencies are on the rise
  - Car ownership/life cycle >13 yrs
- Shift in consumer demand

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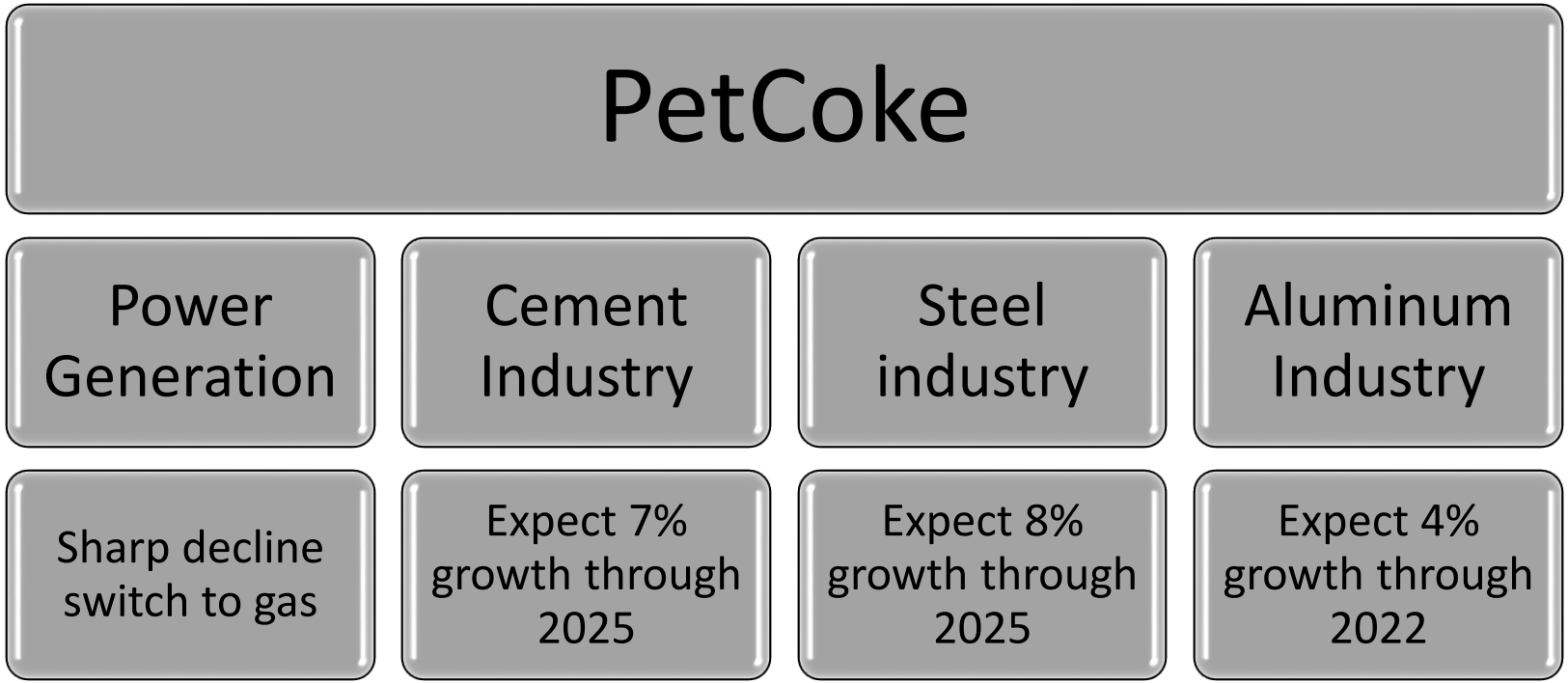
Back to Front Analysis: Cyclical demand



The reality

- Renewables (bio diesel / ethanol) still emit CO2
- Wind / Solar power are inconsistent to a population that demands consistency
- Infrastructure does not and will not exist sufficiently for 30 years.

Oil use continue forward

- Fuel flat to decline
- Plastics increasing overall

What does this mean to bottom of the barrel?

- Light Crude vs Heavy Sour
- What options for managing the bottom of the barrel efficiently

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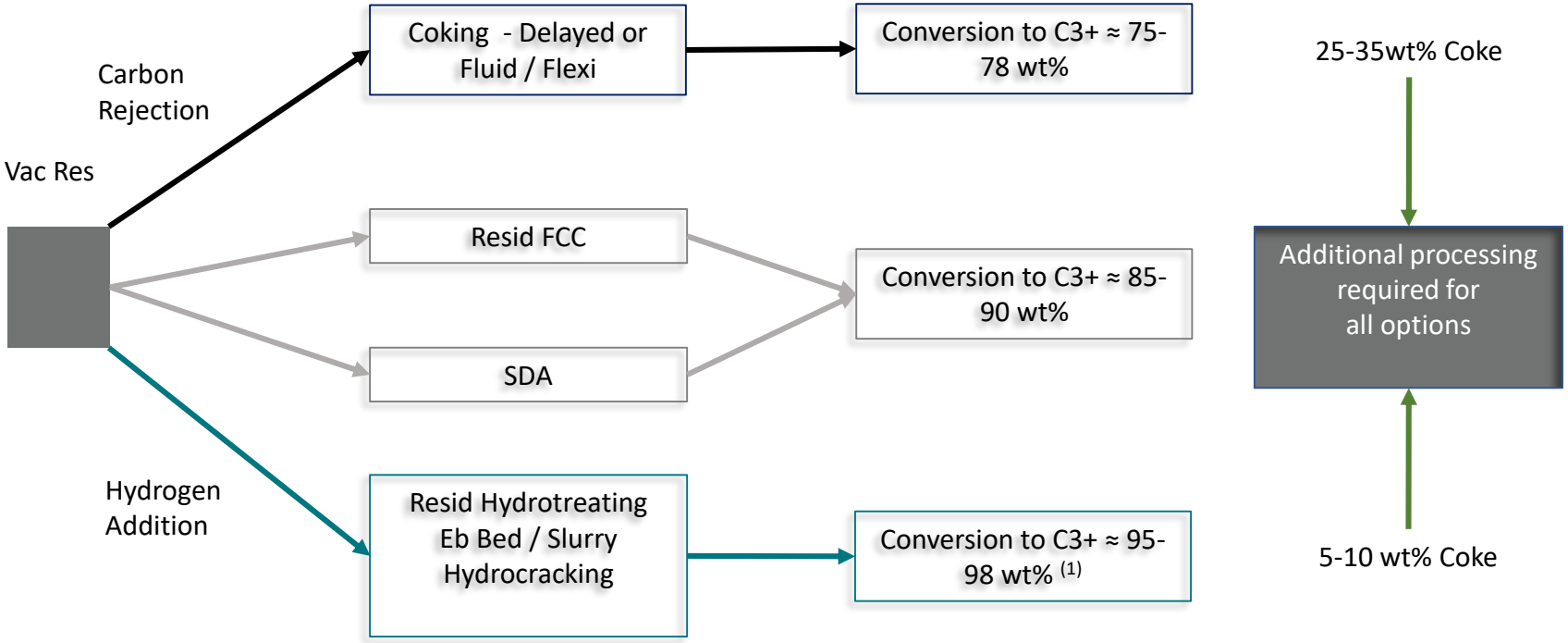
I want to be Green!!

CO2 reduction
=
Energy Efficiency

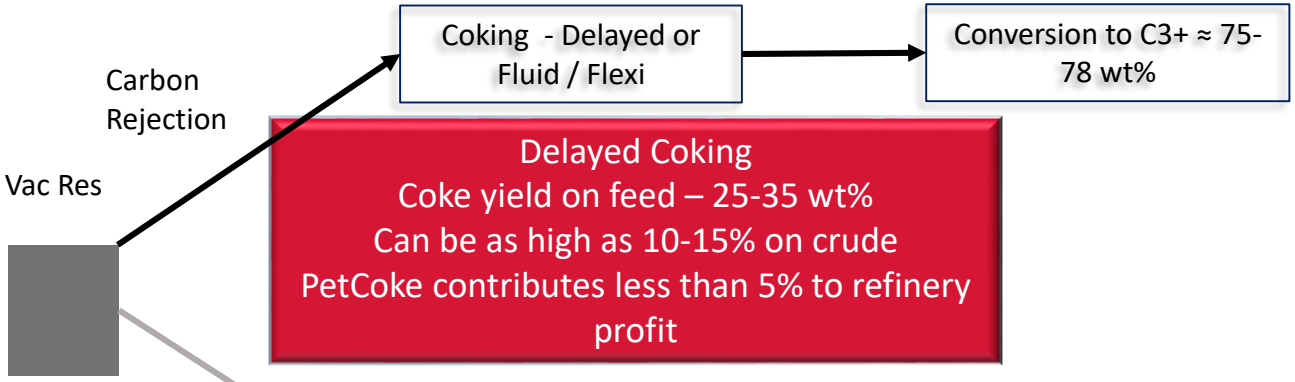
What are the bottom of the barrel options



Fundamental Question:
What is most energy efficient and cost effective solution?
Options will include crude source and margin value

(1) Advertised

What are the bottom of the barrel options



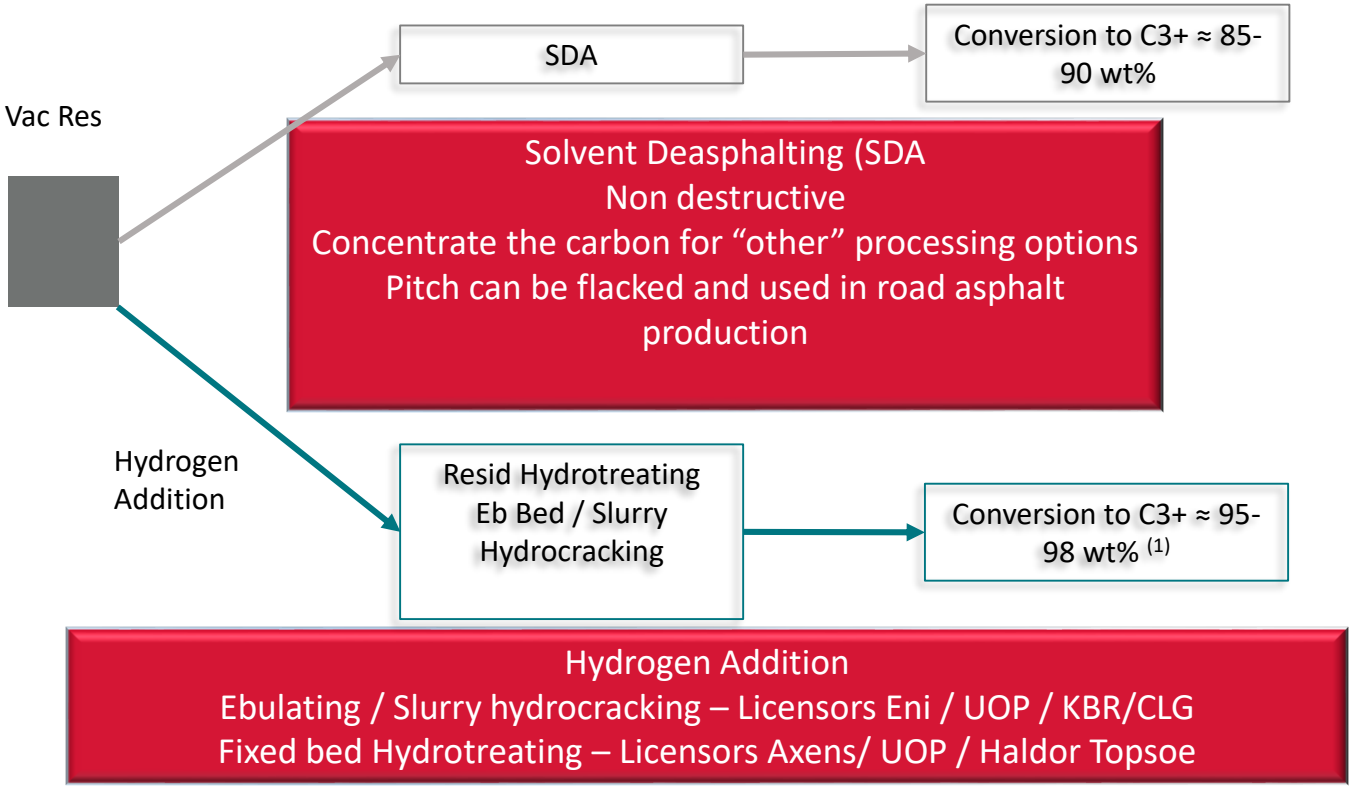
Resid FCC

Feed Concarbon challenged i.e. max commercial experience is ≈ 10 wt%

Heat removal required with large steam generators

Insufficient for “total” destruction

What are the bottom of the barrel options



(1) Advertised

Refiners: Pinched in from all sides

Emissions Regulated

Fuels – Low sulfur, lower GHG (VOC, NOx, SOx, Benzene)

Stack Emissions – CO2, VOC, NOx, SOx

Investment Challenges

Proven Technology vs Emerging Technology that is disruptive

ROCE is critical and cash not readily available

Market Shifts

Diesel demand in EU falling faster than expected

Green push for EV and Hybrids increasing globally

Petchem demand continues to increase

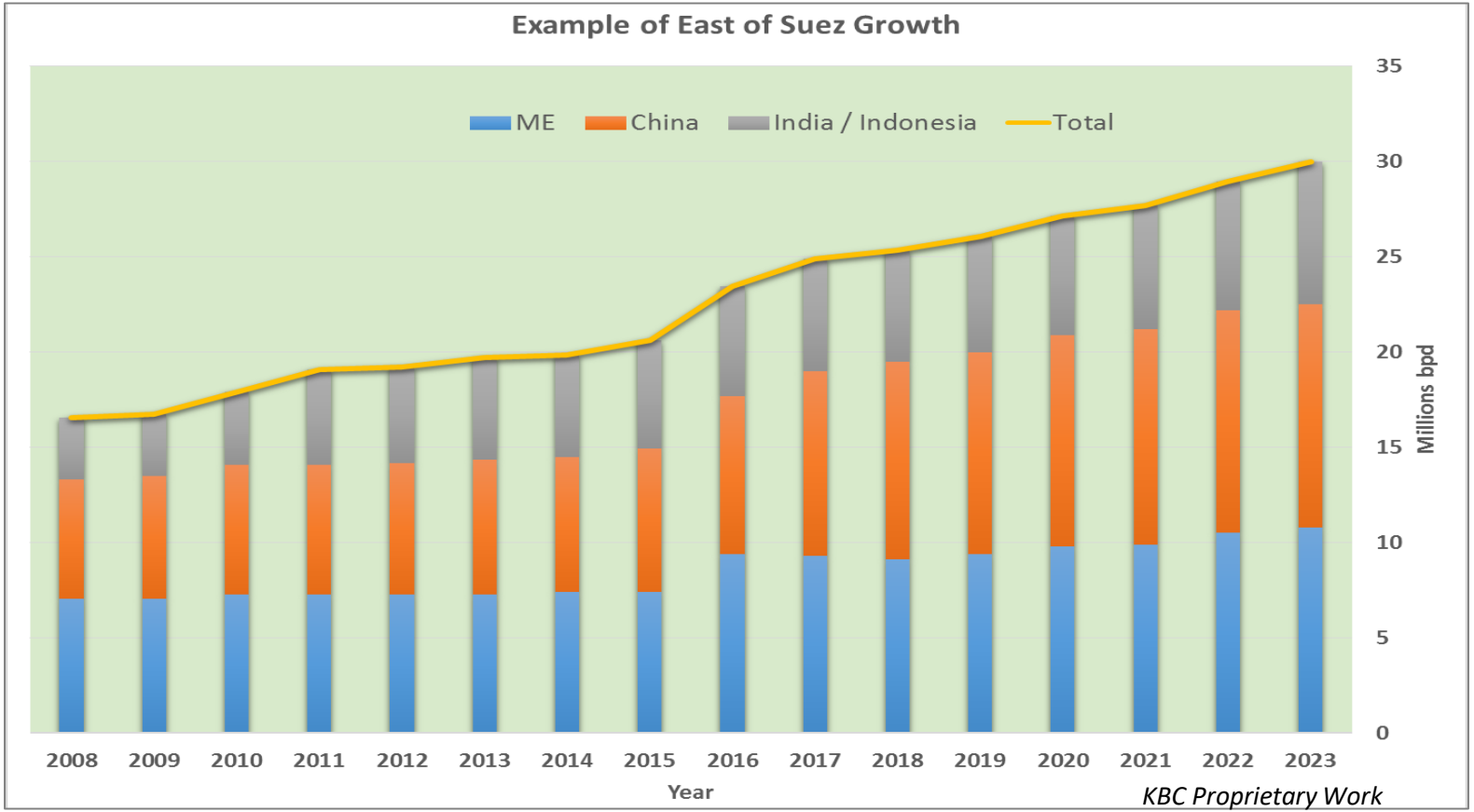
Efficiency Demands

Corporate Average Fuel Economy (CAFE) standards increasing

Gasoline demand and octane increasing

Crude to Chemicals Drive

Crude capacity growth



Shift In global refining




Decreasing crude quality, increasing hydro-processing / conversion / maximum value lift

Simple Hydroskimming Economics unfavorable

- Crude diet limited to sweet options
- Nelson CI 5 or less

Cracking refinery complex with HS Bunker product at risk

- Crude diet low to medium sour to blending to HS Bunker
- Nelson CI 6 to 9

Full conversion refinery positioned for profit

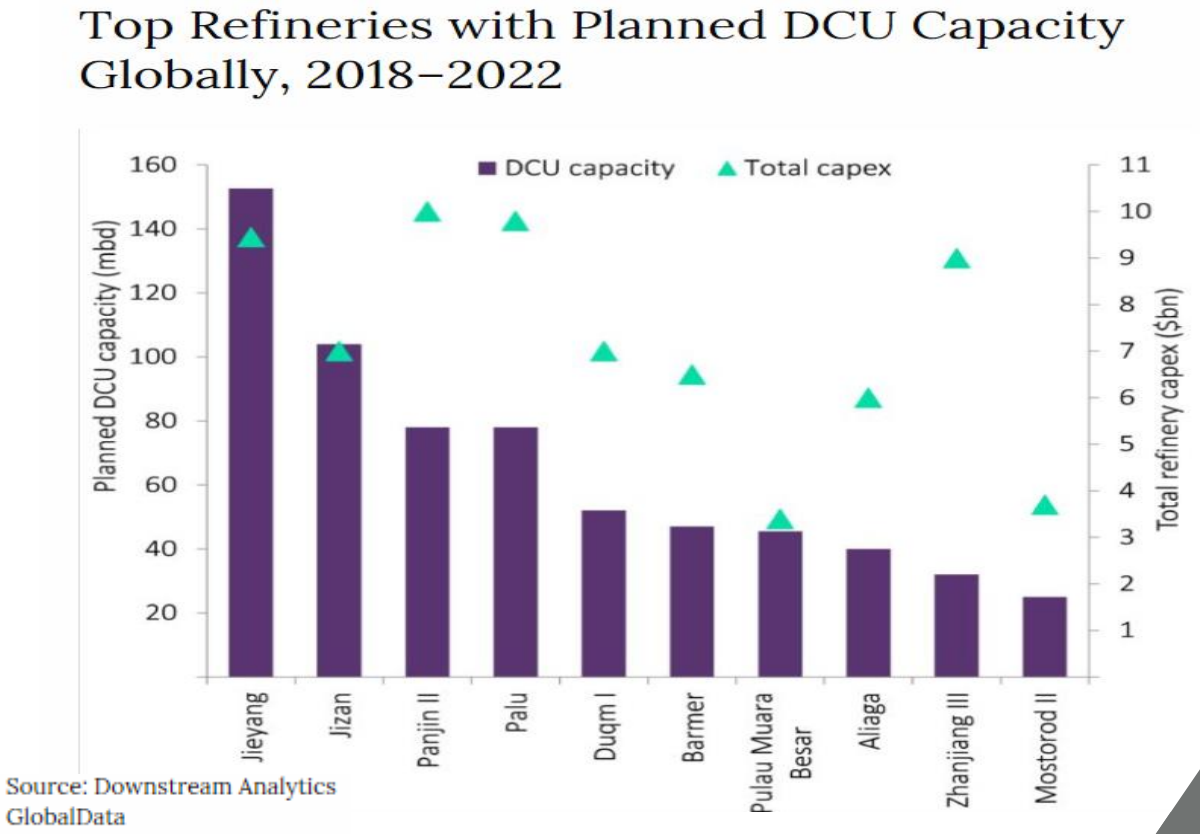
- Crude diet only limited by metallurgy and hydroprocessing assets
- Nelson CI 9 to 12

Full conversion integrated Petrochemical complex insulated from nearly all threats

- Complete crude diet flexibility
- Nelson CI 13 plus

Some of the projects for DCU

- Add to the list
  - Singapore 100 kbpd
  - Gunvor 30 kbpd
  - Lukoil
  - India
- The total delayed coking capacity starting 2018 to be near 1.00 MMbpd name plate
  - Cokers can do 20% of name plate w/o mods
- Three ENI slurry hydrocrackers



Capital investment risks: Bottoms conversion

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Technology	Crude Flexibility?	Secondary Processing Required?	Commercially Proven?	Specific Bottoms Stream	Cost
Coking	++	Yes	Yes	Coke	$$
RFCC	+	Yes	Yes	Decant Oil	$$
SDA	++	Yes	Yes	High Viscosity Residue	$$$
“Slurry-Rx” Hydrocracking	+	Yes	No	Residue w/Metals	$$$$
Residue Hydrotreating	+	Yes	Yes	Residue	$$$$
Gasification	++	Yes (flue)	Yes	None	$$$$
$ Relative cost including secondary system investments					

- Take a carbon rich stream and either produce coke or attempt to add hydrogen to upgrade
  - Hydrogen addition on slurry or residua systems are 210 to 310 barg without accounting for additional hydrogen demand, metals on catalyst and cycle length and other aspects
- Sulfur recovery systems upgrades

Choices Emerging

- Delayed Coker Expansions in US / EU
  - Proven Technology
  - Access to Discounted sour crude
    - US is Canadian WCS
    - EU will be discounted Urals (IMO impact)
- East of Suez
  - Mix of Technologies
  - Delayed Coking in India
  - Slurry Hydrocracking in China / Russia
    - Even shutting down Cokers?
  - Flexicokers re-emerging
- Factors
  - Cost
  - Reliability of technology
  - Disposition of coke (will it be banned)

The solution involves industry becoming more efficient

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- Reduced variable costs and energy efficiency
- Consider raw material to finished product and the value chain optimization
- Being responsive and agile through Digitalization

In closing

- Decisions forward will be based upon margin value
- Near term in US may see more tight oil consumption
- Technology cost and maturity is limiting pathway to adapting hydrogen approach
- Hydrogen addition pathway will reduce the “overall” demand of crude by converting more to a liquid product

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Thank You

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is never an accident. It is always the result of high intention, sincere effort, and intelligent execution; it represents the wise choice of many alternatives - choice, not chance, determines your destiny.

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