Outlook for Marine Fuels Demand & Regulation: Implications for Refining and Are We Getting Global Oil Demand Forecasting Wrong?

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Disclaimer

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Abstract

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With progressively advancing quality regulations for domestic transport fuels, international marine bunkers are becoming increasingly visible – and unacceptable – contributors to global pollution. New MARPOL regulations and the advent of SOx Emission Control Areas (SECAs) are but the first steps in a potentially long road ahead for extensive clean-up of these fuels. Recent work by the authors has focused on projecting bunker fuel demands and then simulating, using the EnSys WORLD model, the impacts of SECAs and other regulations on the global downstream and refining industries.

- Compared to the widely-used IEA estimate of around 150 mmtpa for international bunker demand (marine diesel plus residual fuels), rigorous analysis of shipping fleets, engines, fuel consumption characteristics, trade patterns and volumes has led to the conclusion that actual bunker consumption is more like twice the IEA figure, i.e., in today’s oil statistics, there is a misallocation of fuel uses. Further, based on the authors’ estimate, bunker fuel demand will grow at close to 3% pa, compared to flat growth in inland residual fuel demand. The implication is that current forecasts understate future global oil — and especially residual - demand, by potentially 17 mbpd gross in 2020 (This is partially offset by reductions in by-products). Such a significant shift in future product demand levels and patterns (i.e., more residual fuel) would have important implications for refining investments and margins. These changes have been evaluated and quantified for 2020 using the EnSys WORLD model.
Abstract

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Superimposed on this scenario are potential major new regulations to reduce emissions of SOx, NOx and probably particulates from marine fuels. While bunker fuel desulfurization represents one primary means for compliance, regulations in place and under consideration actively encourage other methods, notably on-board scrubbing and emissions trading. These present a range of plausible compliance scenarios, from a potential need to incur widespread costly desulfurization of residual streams to an outlook where (through scrubbing and emissions trading) marine fuels sulfur levels could increase and emissions targets still be met. The potential for substantially higher bunkers demand than are conventionally considered further raises the costs – and the stakes – for the global downstream industry.

- The implications of this work for projecting global oil demand and impacts on the downstream are far reaching. This paper examines the issues and presents quantitative projections.
Summary of Presentation

- Marine fuels emissions becoming unacceptable
- Will be increasingly regulated (IMO/MARPOL)
- Current statistical sources understate bunkers demand
- Means future bunkers and total oil demand is being under-estimated
- Under-estimates & regulatory outlooks impact on the refining industry & add uncertainty
Marine Fuels Emissions & Regulation
marine is energy efficient form of transport

Comparison: ship, train, truck
Same cargo, same distance:

<table>
<thead>
<tr>
<th></th>
<th>Ship</th>
<th>Train</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric pollutants</td>
<td>1 (15.73g/t-km)</td>
<td>1.4</td>
<td>7.6</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>1 (130kJoule/t-km)</td>
<td>2.2</td>
<td>9.7</td>
</tr>
</tbody>
</table>

Source: Canadian Shipowners’ Association, MARPOL Annex VI Consultation Meeting, Washington, DC, February, 2006
Marine Fuels Emissions & Regulation

3 main classes of marine fuel

<table>
<thead>
<tr>
<th>Marine Bunker Fuel Types</th>
<th>&quot;No 2&quot;</th>
<th>&quot;No 4&quot;</th>
<th>&quot;No 6&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGO</td>
<td>Marine Gasoil</td>
<td>middle distillate / diesel</td>
<td></td>
</tr>
<tr>
<td>MDO</td>
<td>Marine Diesel</td>
<td>heavy distillate / some resid content</td>
<td></td>
</tr>
<tr>
<td>IFO 180/380/500/700</td>
<td>Residual/Intermediate</td>
<td>primarily resid fractions / cracked stocks</td>
<td></td>
</tr>
</tbody>
</table>

several grades within each class

shift to higher IFO viscosities (500/700)
Approx 75% of bunkers is residual (IFO grades)
Marine Fuels Emissions & Regulation

• With advancing regulation of gasoline, diesel, marine fuels emissions stand out – and are unacceptable
  – Ships generate
    • 30% of global NOx
    • 10% global SOx
  – 1 ship’s emissions = 350,000 cars
  – People near ports are claimed to experience more cancer, asthma, respiratory illness
  – Image as “dumping ground”
  – High sulfur and also high metals, used lubes, catalyst fines, petrochemicals by-products
Marine Fuels Emissions & Regulation

• Regulations geared to SOx, NOx, VOC, PM potentially CO2 controls
• Multiple regulatory levels
  – international UN /IMO / MARPOL
  – Regional/national “SECA’s” SOx Emission Control Areas
  – State/port e.g. CA, Los Angeles, Houston
Marine Fuels Emissions & Regulation

- We have set off down a long, continuing, complex regulatory path
- Multiple stages continuing to/beyond 2015

### Possible Timeline IMO & SECA's

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>ratification of Annex VI</td>
</tr>
<tr>
<td>2005</td>
<td>global 4.5% cap</td>
</tr>
<tr>
<td>2006</td>
<td>EU SECA Baltic &amp; ferries</td>
</tr>
<tr>
<td>2007</td>
<td>EU SECA North Sea</td>
</tr>
<tr>
<td>2007</td>
<td>CA MDO max 0.5%</td>
</tr>
<tr>
<td>2008</td>
<td>global PM, NOx ??</td>
</tr>
<tr>
<td>2010</td>
<td>global 3% ??</td>
</tr>
<tr>
<td>2010</td>
<td>CA MDO max 0.1% + ??</td>
</tr>
</tbody>
</table>

2010 - 2015 additional SECA's
- EU Med
- USA, Canada, Mexico
- Japan, Korea, Singapore
- other?
- tighter standards in SECA's global 1.5% ??
Marine Fuels Emissions & Regulation

Legislative overview – IMO and European Union

- **19 May 2005**: Global sulphur limit 4.5% on BDN
- **19 May 2006**: Baltic Sea SECA 1.5%
- **November 2007**: North Sea SECA 1.5%
- **11 August 2007**: North Sea SECA 1.5%
- **11 August 2008**: EU Member States laws enacted:
  - 1.5% in Baltic SECA
  - 1.5% for all passenger ships sailing between EU ports
  - Use of abatement technology as an alternative to 1.5% fuel
- **January 2010**: 0.1% sulphur limit on all marine fuel used in EU ports
- **EU Commission review on**: further restrictions on sulphur in marine fuels, "possibly down to 0.5%"
  - additional SECAs
  - alternative measures including proposals on economic instruments
Marine Fuels Emissions & Regulation

- Latest international standard (basis Annex VI) is ISO 8217 2005
  - Establishes standards in form of emissions
  - Limits used lube oils catalyst fines
  - Recognizes on-board abatement
  - Recognizes SECA’s (SOx Emission Control Areas)

<table>
<thead>
<tr>
<th>Emissions Controls</th>
<th>MARPOL / ISO 8217</th>
<th>SECA (initial standard)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOx gm/kWh</td>
<td>equivalent S standard</td>
</tr>
<tr>
<td>Sulfur</td>
<td>18</td>
<td>4.5%</td>
</tr>
<tr>
<td>NOx</td>
<td>9.8 - 17 gm/kWh depending on engine type</td>
<td></td>
</tr>
</tbody>
</table>
Marine Fuels Emissions & Regulation

- Sulfur cap has been 5% (now 4.5%) on IFO but
- Global average is 2.7%
- Some 60 ports supply <1.5%
Marine fuel regulations

• Compliance options
  – Desulfurize refinery fuels and use lower sulfur content fuel
  – Use only middle distillates for bunker fuel
  – Reduce NOx emissions by lowering nitrogen content of the fuel
  – Undertake custom blending of fuels on board and/or use segregated bunkers tanks
  – Reduce SOx emissions via on-board scrubbers (also helps reduce particulate matter, PM)
  – NOx and PM reductions via on-board emission controls and engine design
  – Establish emissions trading, which could allow trading of marine and shore-based credits
  – Switch to alternative fuel sources (eg, LNG)
  – Re-register ships to a country that has not ratified the IMO standards
Marine Fuels Emissions & Regulation

• Resid upgrading costly
• Coking upgrading too
• But coking offers bigger value upgrade

<table>
<thead>
<tr>
<th>Product</th>
<th>Value as a % of Crude</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTI Cushing Crude (1)</td>
<td>100</td>
</tr>
<tr>
<td>Premium Gasoline (2)</td>
<td>150</td>
</tr>
<tr>
<td>Regular Gasoline (2)</td>
<td>137</td>
</tr>
<tr>
<td>LS Diesel (2)</td>
<td>141</td>
</tr>
<tr>
<td>Regular Diesel (2)</td>
<td>136</td>
</tr>
<tr>
<td>Home Heating Oil (2)</td>
<td>134</td>
</tr>
<tr>
<td>Butane (1)</td>
<td>87</td>
</tr>
<tr>
<td>No. 6 HFO 1% S (1)</td>
<td>76</td>
</tr>
<tr>
<td>No. 6 HFO 3% S (1)</td>
<td>67</td>
</tr>
</tbody>
</table>

Capital Costs for Processing
Arab Light Vacuum Resid

<table>
<thead>
<tr>
<th>Process</th>
<th>Cost (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDS</td>
<td>$450-600</td>
</tr>
<tr>
<td>Coking project</td>
<td>$750-900</td>
</tr>
</tbody>
</table>

Source: Andrew Madden, ExxonMobil Refining & Supply

(1) Platts Cargoes
(2) Toronto Rack
Avg of 2000 to 2005
Source: Gerry Ertel, Shell Canada
Marine Fuels Emissions & Regulation

• Compliance options
  – Desulfurize refinery fuels and use lower sulfur content fuel
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  – Re-register ships to a country that has not ratified the IMO standards
Marine Fuels Emissions & Regulation

initial scrubber trials looking successful
opens possibility to maintain even raise S level

- P&O Ferries mv Pride of Kent
  - SOx reduction > 99%
  - NOx reduction < 5%
  - Particulate reduction ~80%

but issues of retrofitting ($0.5 – 4 mm), waste disposal, use in harbor
Marine Fuels Emissions & Regulation

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Bunkers Demand Analysis
rigorous “activity” based approach

Data/modeling system comprises several activity components / sub-models

• major trade routes
• estimated volumes of cargo of various types on each route
• types of ship serving those routes and carrying those cargoes
• types/characteristics of engines used by those ships
• types and estimated quantities of fuels used by those engines
Bunkers Demand Analysis
rigorous “activity” based approach

Employs multiple data sources / projections

• Shipping fleet data
  » Clarksons

• Engine characteristics
  » Industry sources / marine engine manufacturers
  » Prior research

• Fleet turnover
  » Ship efficiency trends

• International cargo trade flows historical & projected
  » Global Insight Global Trade Service 23 regions
  » Basis?? In terms of world economic growth

• Port / other data
Bunkers Demand Analysis
rigorous “activity” based approach

Disaggregates international cargo categories
- liquid bulk – crude oil
- liquid bulk – refined petroleum products
- liquid bulk – residual petroleum products
- liquid bulk – chemicals (organic and inorganic)
- liquid bulk – gas (including LNG and LPG)
- dry bulk (e.g. grain, coal, steel, ores and scrap)
- general cargo (including neobulk, lumber/forest products)
- containerizable cargo
Bunkers Demand Analysis
rigorous “activity” based approach

Defines U.S. domestic traffic
- liquid bulk – crude oil (Alaska)
- liquid bulk – petroleum products
- dry bulk – Great Lakes
- container trade

Characterizes non-cargo shipping
- Passenger ships – cruise / ferry
- Fishing (blue water)
- Military
Bunkers Demand Analysis

Modeling System – validated on 2003 - projections to 2020

Ship Analysis: by Vessel Type and Size Category

- Inputs
  - Deadweight for all Vessels of Given Type & Size
  - Horsepower, Year of Build for all Vessels of Given Type & Size
  - Specific Fuel Consumption (g/SHP-hr) by Year of Build
  - Engine Load Factors

- Outputs
  - Average Cargo Carried (Tons)
  - Average Daily Fuel Consumption (Tons/Day)
  - Average Daily Fuel Consumption (Tons/Day) - Main, Aux. Engine at Sea - Aux. Engine in Port

Trade Analysis: by Commodity and Trade Route

- Inputs
  - Average Ship Speed
  - Round Trip Mileage
  - Tons of Cargo Shipped
  - Average Cargo Carried per Ship Voyage

- Outputs
  - Days at Sea and in Port, per Voyage
  - Total Days at Sea and in Port
  - Number of Voyages

Total Estimated Bunker Fuel Demand

- Average Daily Fuel Consumption (Tons/Day) - Main, Aux. Engine at Sea - Aux. Engine in Port
- Total Days at Sea and in Port

Driven by changes in engine efficiency.
Driven by growth in commodity flows.

\[ \text{Bunker Fuel Demand} = \left( \frac{ \text{Average Daily Fuel Consumption (Tons/Day)} }{ \text{Total Days at Sea and in Port} } \right) \times \text{Bunker Fuel Demand} \]

References:
- Clarksons Ship Register Database
- Engine Manufacturers' Data, Technical Papers
- Corbett and Wang (2003) "Emission Inventory Review, SECA Inventory Progress Discussion"
- Combined trade routes and heavy log analysis
Bunkers Demand Analysis
Historical / Current Demand

Major statistical sources understate bunkers demand

Reported / Estimated World Bunkers Consumption

<table>
<thead>
<tr>
<th></th>
<th>Distillate</th>
<th>Resid</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEA (2003)</td>
<td>79</td>
<td>133</td>
<td>212</td>
</tr>
<tr>
<td>EIA (2003)</td>
<td>71</td>
<td>234</td>
<td>305</td>
</tr>
<tr>
<td>RTI/Navigistics/EnSys (2003)</td>
<td>305</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koehler (2003)</td>
<td></td>
<td></td>
<td>281</td>
</tr>
<tr>
<td>Corbett &amp; Koehler (2004)</td>
<td>289</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meech (2004)</td>
<td></td>
<td></td>
<td>255</td>
</tr>
</tbody>
</table>

IEA acknowledges there is an issue

EnSys Energy - Navigistics - RTI
Bunkers Demand Analysis
Historical / Current Demand

Issues / Implications
- 305 mmtpa bunker dmd across 400 ports appears plausible but
- implies inland resid demand is overstated
- or demand bbls missing
- questions of regional allocation of bunker demand
- warrants further investigation
- Biggest implication is for future global oil demand

<table>
<thead>
<tr>
<th>Bunker Ports</th>
<th>mmtpa</th>
<th>000 bpd</th>
<th>growth %pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore (2005)</td>
<td>25.5</td>
<td>460</td>
<td>5.6%</td>
</tr>
<tr>
<td>Rotterdam (2004)</td>
<td>12.5</td>
<td>225</td>
<td>7.9%</td>
</tr>
<tr>
<td>Fujairah (2002)</td>
<td>&gt; 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other major bkr ports</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total major</td>
<td>100</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>Minor ports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- approx 400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 0.5 mmtpa average</td>
<td>205</td>
<td>9 average</td>
<td></td>
</tr>
<tr>
<td>Grand total</td>
<td>305</td>
<td>5475</td>
<td></td>
</tr>
</tbody>
</table>
Bunkers Demand Analysis
Demand Growth
Global Total Bunkers 2.7% p.a.

growth rates
2005 - 2020
IFO380+ 2.83%
IFO180 2.94%
MDO 2.10%
MGO 0.17%

2.64%
Bunkers Demand Analysis
Demand Growth
System Gives Breakdown by Fuel Type

IFO 380

IFO 180

MGO/MDO

EnSys Energy - Navigistics - RTI
Bunkers Demand Analysis

Demand Growth

Switching resid demand from inland (0% growth rate) to bunkers (2.7%) alters the outlook for total oil demand – volume and mix.

Impact of RTI Bunkers Projections on Global Oil Demand 2020

<table>
<thead>
<tr>
<th></th>
<th>GASOIL/DSL</th>
<th>BKRS - MGO</th>
<th>BKRS - MDO</th>
<th>RESIDUAL - INLAND</th>
<th>BKRS - IFO180</th>
<th>BKRS - IFO380</th>
<th>TOTAL OIL</th>
<th>TOTAL DISTILLATES</th>
<th>TOTAL RESIDUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series 1</td>
<td>(1.44)</td>
<td>0.17</td>
<td>1.12</td>
<td>(1.33)</td>
<td>0.48</td>
<td>2.69</td>
<td>1.68</td>
<td>(0.15)</td>
<td>1.84</td>
</tr>
</tbody>
</table>
Bunkers Demand Analysis
Demand Growth

Switching resid demand from inland (0% growth rate) to bunkers (2.7%) alters the outlook for total oil demand – volume and mix

- 2020
  - Total oil demand + 1.68 mmbpd
  - Total resid demand + 1.84 mmbpd
  - Shifts in allocation of demand from inland to marine
  - Resulting quality (sulfur) shifts depend on status of MARPOL/SECA regs
Global Refining / Market Analysis
WORLD Model

• Integrated LP model of the global downstream:
  – Crudes & non-crudes supply
  – Refining and “non-refinery” processing & investments
  – Product demand & quality
  – Transportation of crudes, non-crudes, intermediate and finished products

• Not a price/supply/demand forecasting tool
• Captures the activities and economics of the downstream under user-defined short/medium/long term scenarios
• Valuable for analysis of the combined impacts of sector developments on refining activities, investments, crude and product trade, associated economics
• Used by and for: DOE, EIA, EPA, API, OPEC, major oil companies
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WORLD Model

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Global Refining / Market Analysis
WORLD Model

- Study undertaken using 18 region global version

<table>
<thead>
<tr>
<th>Region</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>US East Coast</td>
<td>North Europe</td>
</tr>
<tr>
<td>US Gulf Coast, Interior &amp; Canada East</td>
<td>South Europe</td>
</tr>
<tr>
<td>US West Coast &amp; Canada West</td>
<td>Eastern Europe</td>
</tr>
<tr>
<td>Greater Caribbean</td>
<td>Caspian Region</td>
</tr>
<tr>
<td>Rest of South America</td>
<td>Russia &amp; Other FSU</td>
</tr>
<tr>
<td>West Africa</td>
<td>Middle East</td>
</tr>
<tr>
<td>North Africa/Eastern Mediterranean</td>
<td>Pacific High Growth – OECD</td>
</tr>
<tr>
<td>East/South Africa</td>
<td>Pacific High Growth – non OECD</td>
</tr>
<tr>
<td></td>
<td>Industrialising</td>
</tr>
<tr>
<td></td>
<td>China</td>
</tr>
<tr>
<td></td>
<td>Rest of Asia</td>
</tr>
</tbody>
</table>
Global Refining / Market Analysis
WORLD Inputs & Outputs

• Inputs
  – Supply, demand, world oil price scenario
  – “Bottom up” detail of supply, demand, quality, refining, transport

• Outputs US and global:
  – refinery throughputs, capacity additions & investments
  – crudes & products market pricing / differentials
  – crude & product trade flows
Global Refining / Market Analysis
WORLD Results 2020 – Effects of RTI Projection

• 2020
  – Total oil demand + 1.68 mmbpd
  – Total resid demand + 1.84 mmbpd
  – Shifts in allocation of demand from inland to marine

<table>
<thead>
<tr>
<th>GLOBAL OIL DEMAND BY PRODUCT CATEGORY</th>
<th>&quot;IEA&quot; and &quot;RTI&quot; Bases for Bunkers</th>
</tr>
</thead>
<tbody>
<tr>
<td>million bpd</td>
<td>2020</td>
</tr>
<tr>
<td>Bunkers Basis</td>
<td>IEA</td>
</tr>
<tr>
<td>DEMAND BY PRODUCT TYPE</td>
<td></td>
</tr>
<tr>
<td>LPG</td>
<td>8.56</td>
</tr>
<tr>
<td>NAPHTHA</td>
<td>6.88</td>
</tr>
<tr>
<td>GASOLINE</td>
<td>25.20</td>
</tr>
<tr>
<td>KERO/JET</td>
<td>8.07</td>
</tr>
<tr>
<td>GASOIL/DIESEL/NO2</td>
<td>30.59</td>
</tr>
<tr>
<td>GASOIL/DIESEL - BKRS</td>
<td>0.63</td>
</tr>
<tr>
<td>RESIDUAL - INLAND INCL RFO</td>
<td>8.17</td>
</tr>
<tr>
<td>RESIDUAL - BKRS</td>
<td>3.70</td>
</tr>
<tr>
<td>OTHER</td>
<td>11.88</td>
</tr>
<tr>
<td>TOTAL OIL DEMAND</td>
<td>103.70</td>
</tr>
<tr>
<td>Total Residual Demand</td>
<td>11.87</td>
</tr>
<tr>
<td>Residual as % Total Demand</td>
<td>11.4%</td>
</tr>
</tbody>
</table>
Global Refining / Market Analysis
WORLD Results 2020 – Effects of RTI Projection

- Increased crude run (n.b. 50% light stream content) & increased proportion of resid demand
  - Raise crude capacity but
  - Reduce upgrading
  - Reduce desulfurization (only Baltic SECA in 2020 base case)
  - Cut refining investments

<table>
<thead>
<tr>
<th>Investments $bn</th>
<th>($10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(before replacements)</td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Process Capacity mmbpcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>crude distillation</td>
</tr>
<tr>
<td>coking / visbreaking</td>
</tr>
<tr>
<td>cat - cracking</td>
</tr>
<tr>
<td>hydro - cracking</td>
</tr>
<tr>
<td>HDS - distillate</td>
</tr>
<tr>
<td>HDS - VGO/resid</td>
</tr>
<tr>
<td>H2 (mm bfoed)</td>
</tr>
<tr>
<td>Sulfur tpd</td>
</tr>
</tbody>
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Global Refining / Market Analysis
WORLD Results 2020 – Effects of RTI Projection

- Cut:
  - Crude differentials
  - Light / heavy product differentials
  - Refining margins

Crude Price Differentials (FOB)
Saudi Light Marker Price = $45.50/bbl

EnSys Energy - Navigistics - RTI
Global Refining / Market Analysis
WORLD Results 2020 – Effects of RTI Projection

- Cut:
  - Crude differentials
  - Light / heavy product differentials
  - Refining margins

ULSD - Resid (IFO380 HS)

Gasoline - Resid (IFO380 HS)
Implications

- **Marine Fuels Quality**
  - Marine bunker fuels will join gasoline and diesel and be increasingly regulated
  - Goals are emissions reduction
    - SOx, NOx, PM, VOC, CO2
  - Responsibility and mechanisms for compliance highly uncertain
    - Shippers?, refiners / blenders?
    - Processing?, replace resid with diesel? Scrubbing?, emissions trading?
Implications

• Marine Fuels Demand
  – Global shipping cannot function on the amount of bunkers reported to / estimated by IEA / EIA
  – Future global bunkers / resid / total oil demand being under-estimated
    • Impacts crude production / call on OPEC, refining
  – Rigorous projections need further assessment
    • Bunker port throughputs / reporting data
    • Bunkers regional demand make-up
    • Mis-allocation / mis-reporting vs. missed demand
Implications

- Refining
  - Marine fuels outlook adds yet another layer of uncertainty to the future of refining
    - Growing alternative fuels supplies
      » Ethanol, biodiesel, GTL, CTL, NGL – light clean
    - Transport efficiencies cut into gasoline/diesel demand
    - Global shift to distillates alters refining economics
    - High oil prices shift economics from carbon rejection (coking) to H addition (hydro-cracking)
  - Technology
    - mostly evolutionary but some processes e.g. Sonocracking could revolutionize
  - Capacity additions insufficient through 2008/9 but major post 2010
    - 11+ mmbpd announced projects
      » (not all will be built)
Implications

• Refining
  – Marine fuels outlook adds yet another layer of uncertainty to the future of refining
    • Continuing need to invest in environmental / regulatory compliance notably: fuels quality, emissions
    • GHG / CO2 growing regulation / cap & trade
  – Uncertainties likely to continue to curb refining investments in most regions
  – But could 2004 to 2009 have been the “golden age” of refining?!