Refining Schemes Adapting to High Quality Motor Fuels

Stephane Wambergue

Agenda

- **Gasoline**
- **Diesel**
- **Marine Fuels**

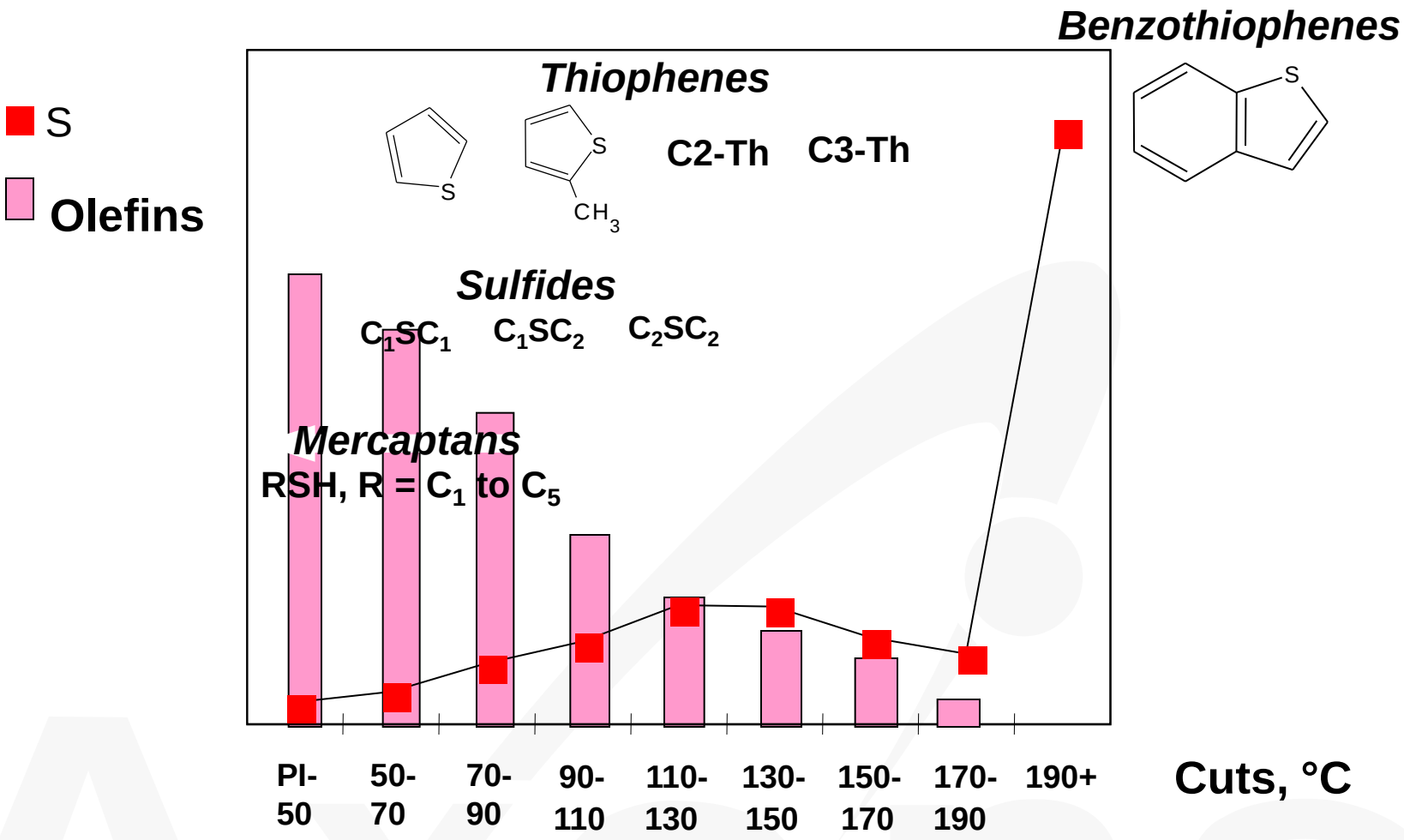
Gasoline - Euro V Specifications

- **Gasoline Euro V:**
  - **35% vol max aromatics and less than 1 vol% benzene**
  - **10 wt ppm max Sulfur**
  - **RON/MON clear 95/85**
- **2016+ specs in Sth Africa may not be as stringent as Euro V, but refiners will have to decrease sulfur (and benzene?)...**
  - **While increasing or retaining the current octane**
  - **With not a lot of H2 available**

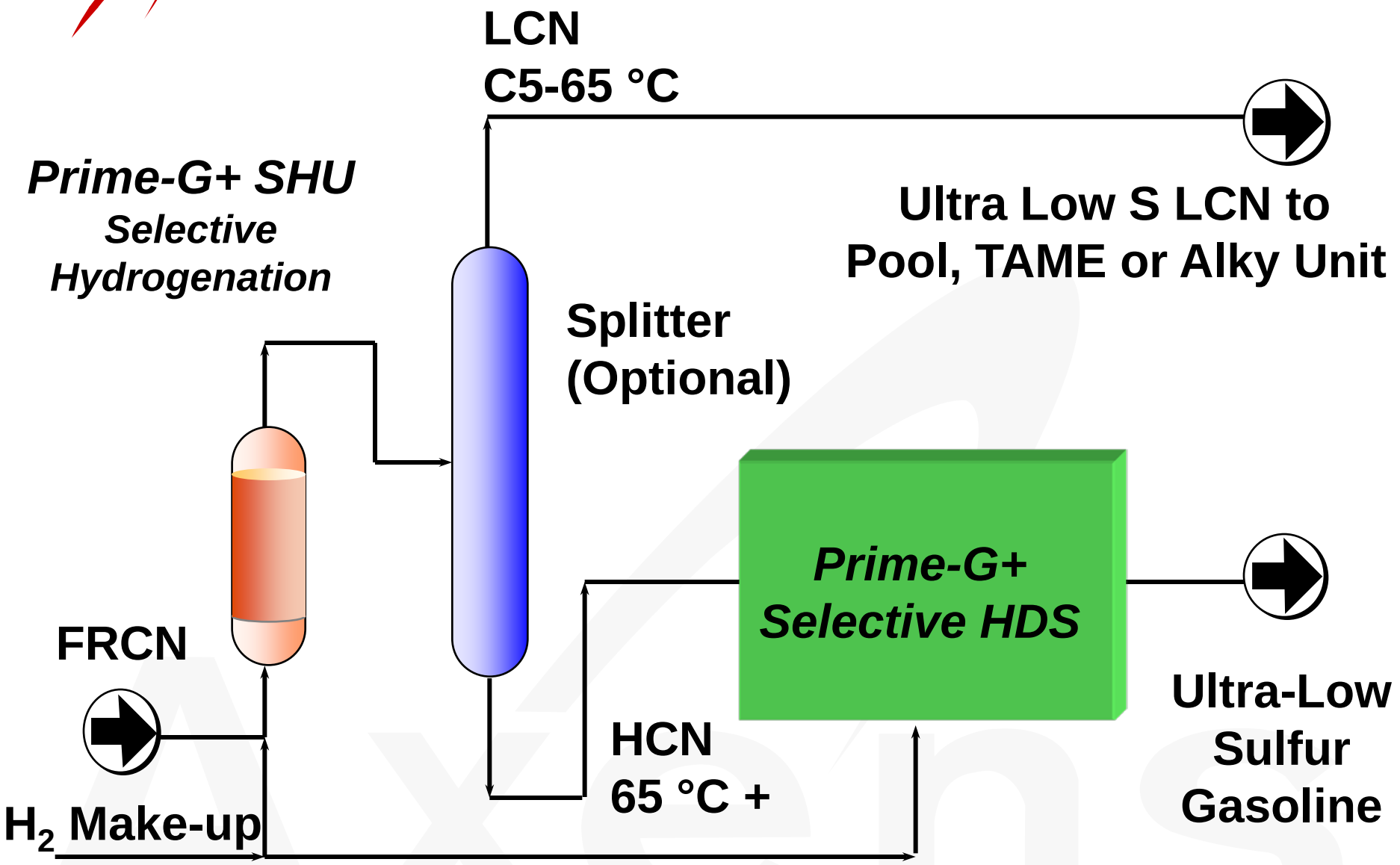
Selection criteria for the FCC Gasoline Desulfurisation

- The sulfur compounds in the gasoline pool mainly come from the FCC gasoline
- The only way to get rid of S in the gasoline pool is to Hydrodesulfurize the FCC gasoline
- The selected HDS technology will therefore need to minimize the saturation of the olefins in the FCC gasoline, in order to
  - Provide maximum octane retention
  - Minimize H2 consumptions and needs

FCC Gasoline Composition



Prime-G+ Typical Scheme
10-50 ppm Sulfur Spec



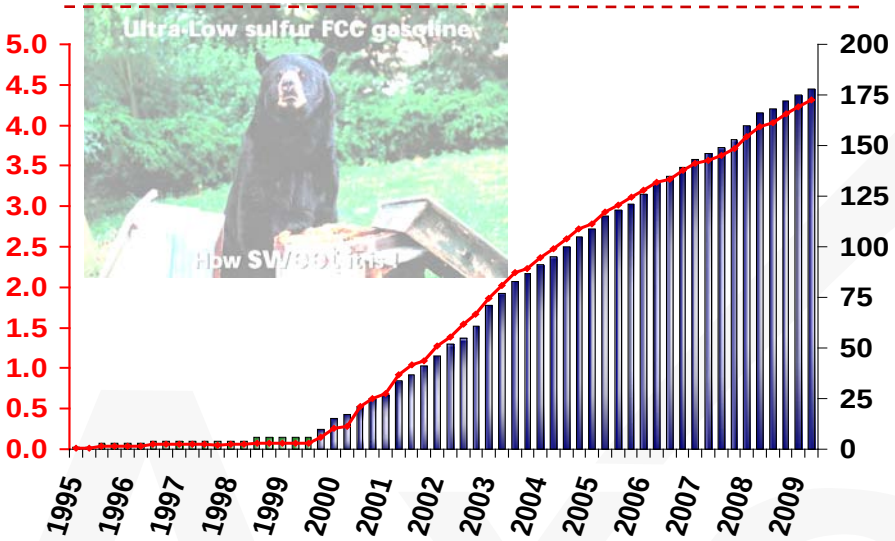
Prime-G+ FCC Gasoline Desulfurization Process

- **178 licensed units**
- **> 100 units started-up and operating successfully**

Cumulative Capacity, MBPSD

> 4.2 MBPSD

References



- **In 2003 Kirkpatrick Chemical Engineering Achievement Honor Award**

"Chemical Engineering" magazine

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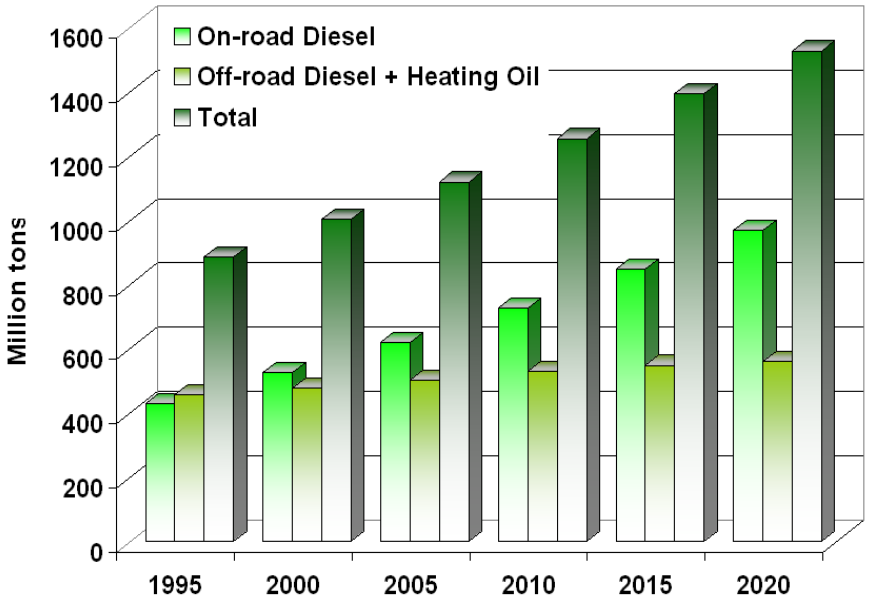
A Growing Need Worldwide For Middle Distillates HDT

- **Growing demand on diesel**
  - **Mainly due to on-road diesel growing demand**
- **Tighter quality specifications**
  - **ULSD for on-road pool**
  - **Towards more stringent sulfur specification for the off-road pool**

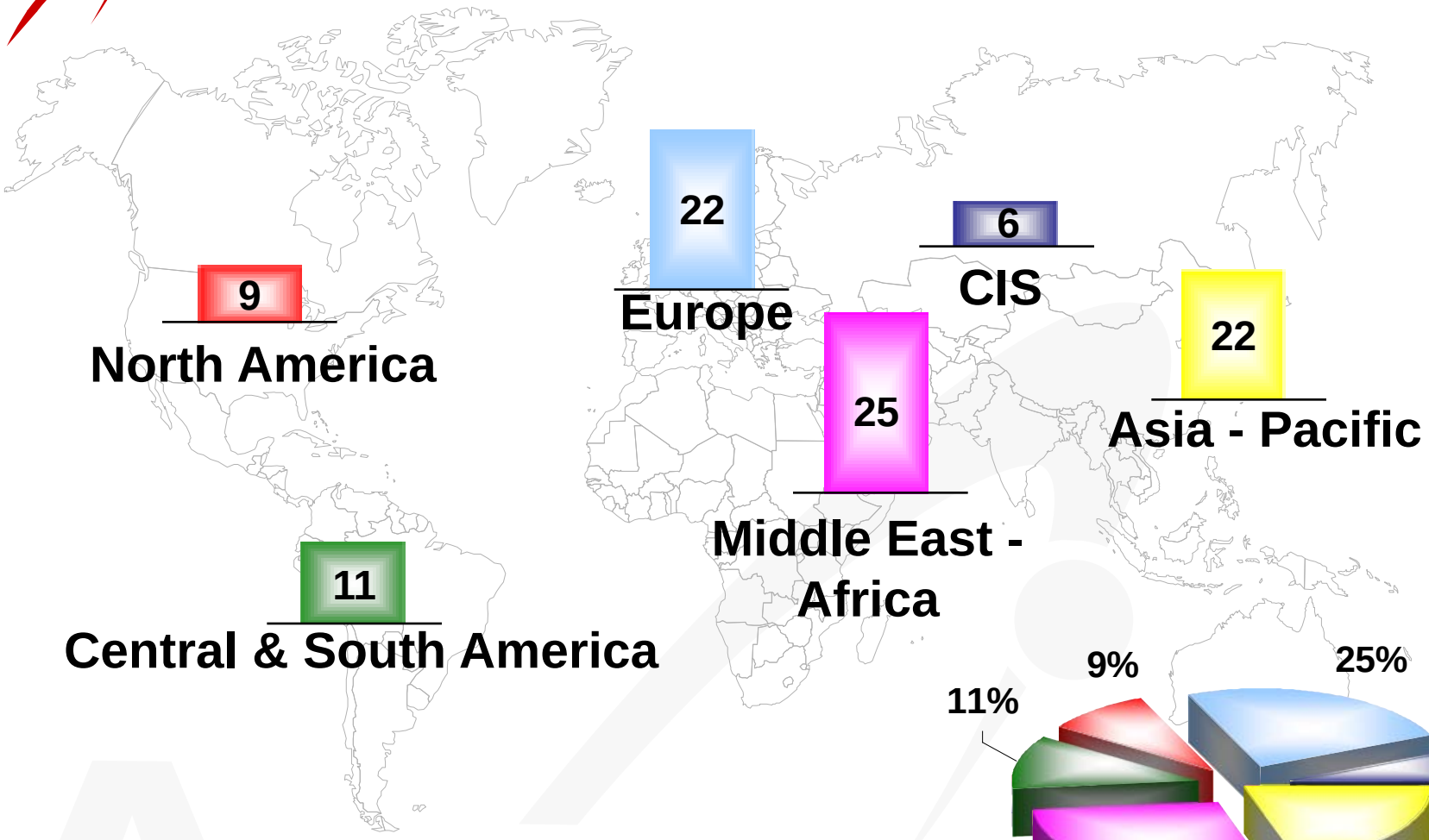


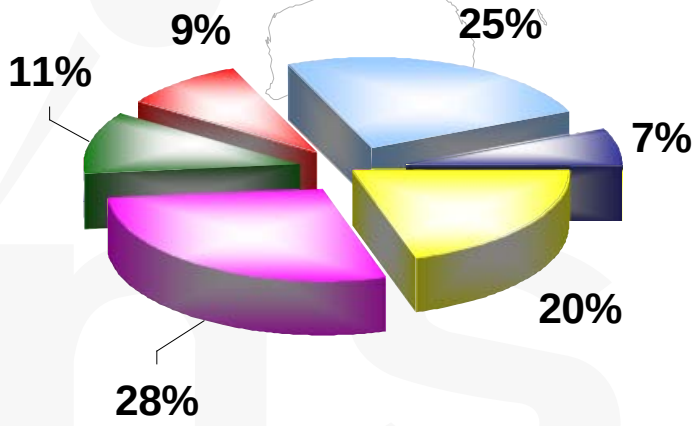
- **Progressive increase of middle distillates feeds refractoriness**
  - **Continuous increase of crude oil heaviness (0.10 to 0.15 API/year) and sulfur content**
  - **Increase fractions of conversion diesels**
  - **Severe cetane gain services are increasing**

HR Catalyst Series Main Features

- **Very High Activity** more...
  - Development with the ACE Technology
- **Outstanding Stability** more...
  - Probably the most stable HDT catalysts on the market
- **Regenerability** more...
  - Up to 95% of the initial activity recovered
  - No chemical treatment (single stage conventional regeneration)
  - Easy handling and activation

Prime-D Licensing For ULSD & Cetane Uplift





- 95 Prime-D Units Licensed
- 45 awards since beginning 2006

as of March 2009

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Industrial Fuel Oil / Marine fuels Qualities

- **Industrial fuel oil sulfur tends to decrease. Less than 50% of the fuel oils exported by Europe to Asia are above 1% sulfur, and less than 20% are above 3% sulfur**
- **The marine fuels became a sulfur sink over the past decades for the vacuum residues**
- **The marine fuels will represent 35% of the fuel oil demand, while it is only 17% today**
- **The coming new specifications of Marine Fuels with less than 0,5% S will radically change the landscape for the bottom of the barrel**

Production of Low Sulfur Marine Fuels

3 options to cope with low Sulfur marine fuels:

- **Low investment associated to High value feedstocks, pretty close to atmospheric distillates**
- **Medium investment associated to Medium value feedstocks (Vacuum distillates, DAOs)**
- **High to very high investment associated to Low value feedstocks (Vacuum Residues)**

Conclusion 1)

- **The South African refining sector will have to meet**
  - **Growing domestic demand in motor fuels**
  - **Higher quality gasoline and diesel pools**
  - **Decreasing Fuel Oil Demand and Low sulfur in Marine Fuels Worldwide: threats on the current heavy fuel oil export markets**

Conclusion 2)

- **Axens well positioned to accompany this evolution, as a leading licensor in**
  - **Naphtha processing for gasoline production (Prime G+, isomerisation, CCR reforming)**
  - **Middle Distillates Hydrotreating**
  - **VGO and Residue Conversion**

Feasibility studies for refinery expansions: Conclusion 3)

Customized expertise

- Feasibility studies for refinery modernization and expansion programs
- Projects to meet future product specifications
- CO2 reduction programs

Benefits

- Anticipate future market demands
- Focus on required modifications at minimum cost
- Ensure maximum refining margin