Executive Summary

- The Department of Trade & Industry (DTI), with support from Cogent and UKPIA and other government departments, has commissioned a review of UK oil refining capacity to understand the dynamics of the sector and the challenges facing it.

- The key conclusions of this review of UK oil refining capacity are:
  
  - The UK refineries need to adapt to evolving trends in oil product demand (falling demand for petrol, growing demand for jet and diesel/gas oil) within a global refining environment that is projected to become more challenging (declining market opportunity to export petrol to the United States with Europe competing with the UK for imports of jet fuel and diesel/gas oil).
  
  - Falling North Sea oil production will require UK refiners to either invest to process other poorer quality feedstocks or process more expensive feedstocks. The closest alternative major supply source is from Russia, which is of lower quality than present sources and so will require refiners to invest in order to process significant quantities. Alternatively, they can source crude similar in grade to the North Sea from Africa and the Mediterranean which has higher delivery costs.
  
  - The UK refineries face the challenge of improving their competitiveness – they presently are mid to low performers within the EU peer group, so do not attract discretionary investment.
  
  - UK refiners are also challenged by an aging workforce and shrinking pool of available talent to replace those scheduled to retire from the sector.

- Overall, we project the UK refining sector to continue to make significant contributions to the wider UK economy. However, the UK will become increasingly reliant upon more distant sources of both feedstock and supplemental oil product imports.
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Part A: Dynamics Of UK Refining
Dynamics Of UK Refining - Introduction

- The aim of this section is to illustrate the projected evolution of refined product demand in the UK.
- The demand for refined products in the UK is primarily satisfied by refiners in the UK, supplemented by trade (both imports and exports). This section hence provides the market framework for establishing the challenges facing UK refiners, determined by their capabilities to supply the evolving product mix.
- An additional market context is the projected developments of relevant markets. The projected net trade evolution of these regions could either enhance or counter the pressure faced by UK refiners.
- Recent moves to increase alternative fuels component in the energy matrix also impact the UK future product balance. Although there is considerable uncertainty as to the precise chronology of the introduction of alternative fuels, their introduction will have an impact upon the future product balance. It is hence important to determine the impact of their introduction on the challenges faced by UK refiners.
UK Oil Product Demand (History & Outlook)
Between 2000 and 2020, overall oil product demand in the UK is projected to remain relatively static.

The UK market is characterised by a relatively high level of petrol demand relative to North Western Europe, accounting for 22% of the demand barrel in 2005 compared to 17% in North West Europe.

The demand matrix, however, is projected to evolve with a declining demand for petrol, countered by demand growth for diesel/gas oil and jet/kerosene.
Incremental UK Product Demand

- Petrol consumption is projected to fall due to:
  - the dieselisation of the car parc,
  - consumption per car continuing to fall due to improved efficiency and a reduction in the average distance travelled by each car.

- Jet/Kerosene demand is projected to increase. The driver of this is the aviation market but as the skies get increasingly congested, this demand growth will continue but at a falling rate.

- Diesel is projected to experience significant growth from the dieselisation of the car parc. From 21.14 Mt in 2005 (19.436 for road transport, 0.784 for rail and 0.920 for inland waterway), we expect transport demand to rise to a maximum annual volume of 24.2 Mt between 2010 and 2015.

- Gas Oil demand (primarily for heating purposes) is projected to remain flat.

- Fuel oil consumption has fallen sharply over the past decade and now constitutes only 6% of the demand barrel in the UK, compared to 18% in 1990. Fuel oil demand decline expected to slow as there are now fewer opportunities for further substitution of fuel oil by gas. Also, inland demand reduction is mitigated by increasing bunker fuel demand.

Source: Wood Mackenzie, IEA
The total demand for transport fuels is projected to marginally increase through to 2020 but this masks wide variations by fuel type.

- Petrol demand is projected to continue to decline from 19Mt in 2005 to 13Mt in 2020.
- Road diesel demand is projected to experience significant growth from the dieselisation of the car parc.
- Jet Fuel demand is also expected to experience growth from 13Mt in 2005 to 18Mt in 2020.
UK Supply, Resultant Balance & Effect Upon Trade
UK Refinery Capacity

The UK had a total refinery nameplate capacity of 1,774,650 barrels per calendar day (bpcd) in 2006.

<table>
<thead>
<tr>
<th>Main Fuel Refineries</th>
<th>Owner</th>
<th>Capacity (bpcd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coryton</td>
<td>BP</td>
<td>163,400</td>
</tr>
<tr>
<td>Fawley</td>
<td>ExxonMobil</td>
<td>317,000</td>
</tr>
<tr>
<td>Grangemouth</td>
<td>INEOS</td>
<td>196,650</td>
</tr>
<tr>
<td>Killingholme</td>
<td>ConocoPhillips</td>
<td>190,000</td>
</tr>
<tr>
<td>Lindsey</td>
<td>Total</td>
<td>218,000</td>
</tr>
<tr>
<td>Milford Haven</td>
<td>Total &amp; Murco</td>
<td>102,600</td>
</tr>
<tr>
<td>Pembroke</td>
<td>ChevronTexaco</td>
<td>209,000</td>
</tr>
<tr>
<td>Stanlow</td>
<td>Shell</td>
<td>267,000</td>
</tr>
<tr>
<td>Teesside</td>
<td>Petroplus</td>
<td>111,000</td>
</tr>
</tbody>
</table>

*Where companies do not provide the bpcd (barrels per calendar day) Wood Mackenzie has applied a factor of 95% to the bpsd (barrels per stream day).

Sources: Wood Mackenzie, Petroplus, Total, ExxonMobil
UK Future Supply

- Wood Mackenzie’s UK future supply projections assume:
  - No capacity creep, typical of the recent past.
  - Refiners elect to source crude oil of similar quality to that currently being processed which enables present production yields to be maintained.
  - Refiners maintain operations at current utilisation levels and refinery margins. High refinery margins prompted increased supply in 2000 and 2005 with low margins reducing supply in 2002.
  - No further refinery projects other than investments already announced.

- The falling feedstock production from the North Sea and the potential differences in feedstock quality (see later) are a challenge for the refiners.

Source: Wood Mackenzie, IEA
Net Trading Balance By Product 2000 & 2005

- In 2005 the UK was a net exporter of 9.9 Mt of total products, a level much greater to that seen in 2000.
- Exports to the US continued to increase, representing 60% of net product exports in 2005. This trade is primarily driven by an increase in exports of petrol to meet the US deficit.
- The UK forms part of a triangle of trade with the Netherlands and Belgium and there are substantial flows of product between the three countries. It also is a significant exporter to Mediterranean Europe (primarily Spain and Portugal) with 2.1 Mt oil products exported in 2005.
- Supply of product to Ireland is also important – the UK supplied over 90% of Ireland’s total net product imports in 2005.
- The large and growing aviation market in the UK has meant that the UK imports large quantities of Jet Fuel.

Source: Wood Mackenzie, IEA
Main Trading Partner By Product In 2005

<table>
<thead>
<tr>
<th>Crude Product</th>
<th>UK Export / Import Status</th>
<th>Main Trading Partner</th>
<th>% of Net Trade of Identified Product Conducted With Main Trading Partner</th>
<th>Total Net Trade (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>Net Exporter</td>
<td>USA</td>
<td>98%</td>
<td>4.6</td>
</tr>
<tr>
<td>Jet/Kerosene</td>
<td>Net Importer</td>
<td>Middle East (Saudi Arabia &amp; Kuwait)</td>
<td>- 49% (UK imports)</td>
<td>- 7.4 (UK imports)</td>
</tr>
<tr>
<td>Diesel/Gas Oil</td>
<td>Net Exporter</td>
<td>France, Germany</td>
<td>16% (UK exports)</td>
<td>0.3</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>Net Exporter</td>
<td>USA</td>
<td>32%</td>
<td>6.3</td>
</tr>
</tbody>
</table>

- Developments in the USA's petrol market hence are of significance.
- Deficits in jet/kerosene are currently supplied by Middle East exports, so the evolution of these markets is of significance to the UK.
- Although the UK is a Net Exporter of diesel/gas oil, it imports significant quantities of diesel/gas oil from Russia (approximately 800,000 metric tons in 2005).

Source: IEA
When considering long term supply/demand balances, our “supply response” out to 2020 only accounts for firm investment plans (so up to approximately 2011). The reason for presenting the analysis in this way is to understand the likely rate of potential future imbalances and to provide an indication of the future pressures on the industry.

The petrol surplus grows as demand continues to decline from today while supply remains constant.

The UK is projected to become increasingly deficit in jet/kerosene, so drawing supplies from both the Mediterranean and Middle East.

The diesel/gas oil surplus turns into a deficit in 2010 with demand growing strongly over the period. However, post 2015, demand begins to fall.

Fuel oil surplus continues to increase but at much lower increments.

It is hence important to consider the evolution of other regions as either target markets for exports or source of supply for deficits.
Regional & Global Background For Supply/Demand Balances
North West Europe (NWE) is a mature market and total oil product demand is forecast to grow by 3.4% between 2005 and 2015. This equates to a growth rate of just over 0.3% per annum over the period. Although growth is faster in the first five years of the decade, the overall picture is of a slowing in demand growth and demand peaks in 2015.

The NWE petrol demand is relatively much lower than in the UK but it is also projected to fall substantially.

The NWE diesel/gas oil demand represents a greater percentage of total demand compared to the UK. However, we do not anticipate its contribution to the demand barrel to grow as fast as the UK.

Source: Wood Mackenzie, IEA
The total demand for transport fuels is projected to marginally increase through to 2020 but as per the UK this marginal total demand change masks wide variations by fuel type.

- Petrol demand is projected to decline from 83Mt in 2005 to 58Mt in 2020 due to rising vehicle efficiency, lower vehicle distances travelled and an increase in the number of diesel cars in the passenger car fleet.

- Jet/Kerosene demand is expected to grow, reflecting increasing amounts of air travel, with demand projected to increase from 39Mt to 53Mt in 2020.

- Road diesel demand is projected to increase from 97 Mt in 2005 to 108 Mt in 2020 as a result of more diesel cars.

Source: Wood Mackenzie, IEA
NWE Incremental Oil Product Demand

- Petrol demand is forecast to fall due to rising vehicle efficiency, lower vehicle distances travelled and an increase in the number of diesel cars in the passenger car fleet.

- The long-term growth in jet/kerosene demand reflects the growth in air travel. In the longer term, increasing saturation of ground infrastructure and air corridors will limit future growth rates post-2010.

- Diesel/Gas oil demand is forecast to grow at 1.3% per annum over the next five years. Demand is split between the growing transport sector (mainly road, but also a small proportion used for marine bunkers, railways and inland waterways) and the generally declining industry, residential/tertiary and other static sectors.

- Demand for fuel oil is forecast to remain broadly flat after 2005. In inland markets, fuel oil demand has been falling as a result of substitution by gas and this trend is forecast to continue. This contrasts with the bunker fuels market, which is expected to continue to grow in size as the world economy expands, bringing about further increase in shipping trade.
We do not envisage any new build refineries in the region during the timeframe of this study and only selected upgrading investments at certain advantaged facilities. Most of the investment that has taken place over the last five years has been geared towards the manufacture of lower sulphur petrol and diesel. In this region, this phase of investment is more or less complete.

Refinery capacity in the region remains largely unchanged through to 2010, as the closure of the crude distillation column at Antwerp Petroplus is offset by small increases in capacity at other sites. We do not expect significant refinery closures in the region but the occasional uneconomic site may close. Overall capacity in the region will continue to increase through the effects of capacity creep which we have assumed to be around 0.5% per annum.

Beyond 2015 refinery supply falls as a result of lower crude throughput in the face of declining demand.

Source: Wood Mackenzie, IEA
When considering long term supply/demand balances, our “supply response” out to 2020 only accounts for firm investment plans (so up to approximately 2011). The reason for presenting the analysis in this way is to understand the likely rate of potential future imbalances and to provide an indication of the future pressures on the industry.

- The petrol surplus grows as demand continues to decline from today while supply grows until 2015
- NWE is projected to remain deficit in jet/kerosene oil, drawing supplies from both the Mediterranean and Middle East
- The diesel/gas oil deficit grows to 2015 with demand growing strongly over the period. However, post 2015, demand begins to fall and supply increases marginally
- Fuel oil surplus is expected to fall until 2020. Refinery investment in the region results in some upgrading of low sulphur fuel oil, predominantly into middle distillates.

NWE will hence:

- Compete with the UK to export petrol to other markets
- Compete with the UK for middle distillate imports

Source: Wood Mackenzie, IEA
When considering long term supply/demand balances, our “supply response” out to 2020 only accounts for firm investment plans (so up to approximately 2011). The reason for presenting the analysis in this way is to understand the likely rate of potential future imbalances and to provide an indication of the future pressures on the industry.

The US supply is expected to increase with new crude capacity coming on stream, increased crude utilisation rates and capacity creep, however the US market will continue to be a deficit refined products marketplace, with the deficit continuing out to 2020.

The petrol deficit peaks between 2005 and 2010. Slowing demand growth and increased domestic supply reduces this deficit out to 2020. The East Coast in particular is projected to remain substantially deficit.

Naphtha remains in small deficit

The jet/kerosene deficit grows after 2010 as the growth in demand outpaces growth in supply

Diesel/Gas oil is projected to become surplus in 2010 as demand for gas oil falls however strong demand growth in the transportation sector (mainly commercial diesel) negates the effect to some extent and by 2020 the surplus is expected to have moved towards balance.

The total fuel oil deficit declines from 16 Mt to around balanced by 2020. Total fuel oil demand falls due to increasing competition from gas in the power generation sector, while refinery output remains constant

The declining petrol deficit represents a challenge to the UK refining industry, as the US is a key export market for the UK.
When considering long term supply/demand balances, our “supply response” out to 2020 only accounts for firm investment plans (so up to approximately 2011). The reason for presenting the analysis in this way is to understand the likely rate of potential future imbalances and to provide an indication of the future pressures on the industry.

Petrol is projected to move from an 8 Mt deficit in 2005 to a surplus of 10 Mt by 2010. This is due to significant investment in crude and upgrading capacity coming on stream in Saudi Arabia and Kuwait.

The diesel/gas oil surplus grows sharply post 2010 to reach over 50 Mt by 2015. The majority of this growth in surplus is from Saudi Arabia, due to the two new 400 kbd export-oriented refineries coming on stream in 2011 and 2013. The surplus reduces slightly post 2015 as demand continues to grow strongly post 2015.

The current fuel oil surplus is set to disappear over the next few years as additional upgrading capacity reduces supply.

The opportunity for importing oil products from the Middle East will grow.
When considering long term supply/demand balances, our “supply response” out to 2020 only accounts for firm investment plans (so up to approximately 2011). The reason for presenting the analysis in this way is to understand the likely rate of potential future imbalances and to provide an indication of the future pressures on the industry.

The naphtha deficit increases sharply over the forecast period with strong demand growth (in particular for petrochemicals use) outpacing supply growth.

Petrol moves to a surplus of 15 Mt by 2010. This is due to investment in crude and upgrading (additional FCC/reforming capacity). Post 2010 demand growth strengthens and gasoline moves to deficit by 2015.

Overall growth in jet/kerosene demand is slow due to switching out of the residential sector.

The small diesel/gas oil surplus grows slightly out to 2010 due to significant investment in crude and upgrading. However strong demand starts to outpace the known supply growth soon after 2010.

The fuel oil deficit increases in the short term as upgrading capacity is brought on stream reducing fuel oil supply. As demand growth stagnates in the long-term and supply continues to grow the deficit starts to reduce.
Alternative Fuels Impact
The UK government has expressed its intention to introduce a Renewable Transport Fuels Obligation (RTFO). This will require companies selling transport fuels into the UK market to ensure that a certain percentage of their total sales are renewable fuels.

Companies are expected to meet their RTFO by placing the maximum amount of bio-diesel allowed under current CEN fuel specification legislation into diesel, 5%, and satisfying the remainder with the addition of ethanol to the petrol supply.

Working on the assumption the companies meet their required RTFO obligations on diesel oil and petrol demand the additional supply into the UK market in 2015 will be 0.77 mt of ethanol and 1.62 mt of bio-diesel.

The implementation schedule of the RTFO is shown below, however, it should be noted that this schedule will be reviewed and the possibility exists that the original targets will be increased.

Instead of meeting these targets, companies can choose to buy-out their obligation. The buy-out level has provisionally been set at 15p per litre of biofuel, the purpose of which is to encourage the companies to meet their RTFO.
UK - Future Petrol Balance Including Introduction Of Ethanol

- The overall impact of the Renewable Transport Fuels Obligation (RTFO) on the future petrol product balance will be to increase the surplus by the amount of ethanol being introduced into the UK market, 0.77 mt of ethanol in 2015.

- This forecast assumes that the companies meet their RTFO obligations and that there are no changes to either the implementation schedule, RTFO targets or current CEN fuel specification legislation.

Note: 2020 assumes that current CEN fuel specification legislation EN 228 (Gasoline) is amended to permit 10% ethanol in gasoline.
The introduction of Bio-Diesel into the UK market will improve the future Diesel/Gas Oil balance by delaying the UK entering into a net deficit from 2008 until 2011 and then assisting the UK to return to a net surplus position once again in 2017.

This forecast assumes that the companies meet their RTFO obligations and that there are no changes to either the implementation schedule, RTFO targets or current CEN fuel specification legislation.

Note: 2020 assumes that current CEN fuel specification legislation EN590 (Diesel Oil) is altered to permit 10% Biodiesel in diesel oil by 2020.
Dynamics Of UK Refining - Summary Of Findings

Overall, the total UK oil product demand remains relatively static. However, petrol consumption is forecast to decline whilst both diesel and jet fuel are forecast to increase. Unless the UK refining sector makes significant investments, these demand developments are projected to result in a substantial increase in:

- Petrol surpluses
- Deficits of jet/kerosene whilst turning the present surplus of diesel/gas oil into a deficit position.

In other key regions:

- NWE is forecast to experience similar changes to its oil products balance as the UK.
- North America is expected to have a declining deficit for petrol an increasing deficit for jet/kerosene and a period of surplus diesel/gas oil.
- The Middle East is projected to have increasing surpluses of all clean products.

The implications are that there could become a glut of petrol in the Atlantic Basin with Asia offering the only obvious market for this but there would also be increased competition to supply this market, making it increasingly difficult for the UK to export its surplus supply. On the other hand several of the major regions are becoming deficit diesel/gas oil, so making sourcing of jet fuel and diesel/gas oil more difficult.

The forecast impact of Alternative Fuels for the UK is to increase the petrol surplus and reduce the diesel deficit to an approximate balance. The additional surplus petrol will need to be exported, increasing the market challenge faced by UK refiners.
Part B: Implications For UK Wider Economy & Energy Security
UK Wider Economy & Energy Security - Introduction

In this section, we forecast UK refinery margins in order to illustrate the economic environment facing UK refiners. This will be done by forecasting oil product prices and examining the market environment for refineries in NWE and considering recent historical refining margin trends.

It is clear that by having domestic refineries the UK receives a benefit and this is analysed on two bases. The first is a comparison of the cost of supplying the UK product demand with imports against the current status where domestic refineries supply much of the domestic demand with additional trading occurring to achieve a domestic demand supply balance. This analysis is done on a dollar per barrel basis. The second basis is a qualitative approach which looks at employment generated by having a domestic refining sector and identifies the challengers which refiners are presently facing in this regard.

A third aspect that this section will examine is the supply potential and availability to the UK of both crude and oil products. An analysis looking at traded volumes compares the market liquidity of crude and oil products, followed by a summary of the relative merits associated with trade in either material.
Domestic Energy Price Projections
NWE Refining Margins - History

- NWE refining margins remained depressed for much of the 1990’s due to low demand growth and a growing petrol surplus
- After an exceptionally weak 1999, margins increased dramatically in 2000 with the introduction of new product specifications and strong demand pull for petrol from the US
- However, 2002 saw the lowest margins that many commentators could remember
- Margins in 2004 were the best since the 1st Gulf War and were due to strong global demand (primarily US petrol and Chinese fuel oil)
- 2004 margins were not supported by European fundamentals and we were expecting a significant weakening in 2005.
- However, 2005 margins surpassed the highs seen in 2004
  - This was due to hurricanes Katrina and Rita which shut down a significant amount of refining capacity in the US and impacted European prices and margins (the impact of the hurricanes added approximately 50 pence per barrel onto the NWE margin)
- We believe that the 2005 margins are not sustainable and going forward we expect the margin environment in NWE to remain challenging – although better than margins seen for much of the 1990s
- The underlying fundamentals of supply and demand in Europe are significantly weaker than in the US or Asia Pacific
NWE Refining Market Environment

Throughout the period of this study the market environment in NWE will remain challenging for refiners.

Demand growth remains sluggish and overall oil demand begins to decline post 2015.

- Petrol demand falls due to rising vehicle efficiency, lower distances travelled per vehicle and an increase in the number of diesel cars in the passenger car fleet.
- Jet/Kerosene demand rises strongly reflecting the growth in air travel.
- Diesel demand grows due to the commercial transport sector (linkage to economic growth) and ongoing passenger car dieselisation.
- Heating gasoil demand declines modestly.
- Overall fuel oil demand remains broadly flat with declining inland demand being offset by growing bunker demand.

Refinery supply remains geared towards producing petrol with selective upgrading projects geared towards the production of middle distillates and desulphurisation.

As a result the structural imbalances currently present will get worse.
NWE Refining Margins - Outlook

- In the medium term we are forecasting a weakening of margins as increased refinery supply comes on stream in Europe but more importantly the United States – which has been a significant source of support for European margins in recent years.

- The underlying fundamentals of supply and demand are weaker in Europe than both the US and Asia due to the surplus capacity in the region and slow demand growth that does not eliminate this surplus. We expect margins to remain challenging going forwards.

- In fact post-2015 we expect that European demand growth will go into decline thus further weakening the outlook.

- Mediterranean margins will remain closely linked to margins in NWE although the longer term prospects are more promising due to stronger underlying fundamentals.
NWE Refining Margins
Brent Complex Refining Margins

$/bbl

History (nominal)  Forecast (nominal)  Real ($ 2007)
Refining Contribution To UK
UK Refining Contribution – Methodology

In order to assess the benefit the domestic refining sector provides to the UK two methodologies will be applied:

Methodology 1

1. Calculate cost of satisfying UK demand by examining domestic refinery production of main fuels (LPG, naphtha, petrol, jet/kerosene, diesel/gas oil and fuel oil) and the cost of any imports/exports that result from deficit/surplus production relative to domestic demand.
   - Calculate the cost of UK refinery feedstock considering the geographical source of crude.
   - The UK earns income from exporting its surplus refinery production however it also spends on the importing of oil products where domestic UK production is insufficient to meet demand. The net effect of this is calculated.
   - The sum of the feedstock and net value of imports and exports provides the actual cost expended by the UK on satisfying its main fuels oil product demand.

2. Calculate the cost of satisfying 100% of the UK oil product demand of main fuels by imports.
   - If no refineries were to exist in the UK demand for oil products would be met at CIF product prices, this cost is calculated by examining demand and CIF product prices.

3. Calculate the net benefit of the present refinery infrastructure to the UK by comparing the values of the calculations above (i.e. 100% oil product importation cost – cost of actual supply structure), excluding any taxation effects.
UK Refining Contribution – Second Methodology

Methodology 2

1. Calculate cost of satisfying UK demand by examining domestic refinery production and the cost of any imports/exports that result from deficit/surplus production relative to domestic demand. This methodology is as per methodology 1.

2. Calculate the cost of satisfying 100% of the UK oil product demand by imports
   - If no refineries were to exist in the UK, demand for main fuels oil products would be met at CIF product prices, this cost is calculated by examining demand and CIF product prices.
   - The crude made available by not having any refineries in the UK would be exported and so the value of these exports is deducted from the cost of importing the main fuels oil products.

3. Calculate the net benefit of the present refinery infrastructure to the UK excluding any taxation effects:
   - 100% oil product importation cost
   - cost of actual supply structure
   - cost of domestic crude (due to the import calculation counting domestic crude exports as a 100% benefit to the UK, domestic crude has a zero price to UK refiners in the first stage of the calculation).

After this analysis an assessment on the robustness and security implications of sourcing crude as compared to sourcing products is made.
UK Refining Contribution

This models projections work upon the following assumptions:

- UK refiners source crude of similar quality and maintain similar yields going forward.
- An exchange rate $/£ of 0.54 in 2007 and 0.55 going forward.
- The FOB/CIF oil product differentials remain constant.

The key uncertainties in this assessment are:

- International crude oil price.
- The global refining market environment and its impact on European refining margins.
- Legislative requirements that materially impact the UK refining operations (either in the UK, EU or export markets, such as North America).
- Response of UK refiners to their changing market environment.
- Shift in the comparative value of “other products” relative to main fuels.

The models result is:

- The net refining benefit to the UK which is the difference between the cost of supplying the UK using the present infrastructure and the supply cost were the UK not to have a refining sector. This cost saving is a benefit to the UK economy which may be shared between those companies involved in the UK downstream sector and the end consumers.
UK Refining Margins

—the results for both methodologies are identical.

—Comparing the Wood Mackenzie forecasts for NWE refinery margins to the models UK refinery margins shows how UK refinery margins are forecast to follow a similar pattern to those of NWE. The projected decline in the UK’s premium to NWE reflects the difference in supply and net trade positions between the sectors.

Sources: Pre 2005 figures IEA, 2005 figures IEA & DTI (not yet incorporated by IEA)
Elaboration & Projection Wood Mackenzie

* Figures used in this graph are nominal historical figures and real 2007 projections going forward
Refining Margins & Net Refining Benefit To The UK

The results for both methodologies are identical.

The modelled net refining benefit per dollar barrel follows the forecast UK refinery margins and hence the total refining benefit to the UK based upon the refinery throughput projections also has the same curvature.

Sources: Pre 2005 figures IEA, 2005 figures IEA & DTI (not yet incorporated by IEA)
Elaboration & Projection Wood Mackenzie

* Figures used in this graph are nominal historical figures and real 2007 projections going forward
UK Refining Contribution To The UK Economy

The results show that UK refiners have historically produced oil products for the UK at a lower cost than would have been the cost if the UK were to have imported all of its oil products. It is projected that this benefit will continue throughout the forecast period.

For 2005, the UK refinery’s contribution was to supply the UK with main fuel oil products approximately £2.3 billion lower than what the cost would have been had the UK imported main fuel oil products to satisfy domestic demand.

The model methodology provides a cost comparison for supplying the UK oil product demand via the existing UK refining infrastructure and a scenario where no UK refining sector exists. The net benefit of UK refining to the UK economy differs to the results calculated by this methodology. The actual economic benefit provided to the UK differs in that it incorporates several other factors:

- Product exports provide an additional benefit as they earn the UK export revenue, so supporting balance of payments.
- Provides a local source of feedstock for the petrochemical sector
- Higher value speciality products (lubricants, solvents, petroleum coke) that are not included in the “main fuels” analysis
- Employment created by refineries is significant with UKPIA estimating this to be £360m per year.
- The investment enacted by the sector in the UK with UKPIA indicating a typical annual level of £518m per year, a proportion of which will be UK based expenditure.
- The multiplier effect from the above, reflecting impact on wider UK economy
UK Refining Employment

- In the UKPIA Statistical Review 2006, the members (BP, Chevron, ConocoPhillips, Esso, INEOS, Murco, Petroplus Shell and Total) directly employs approximately 15,000 individuals in the refining and marketing industry in the UK.

- The UK Refining sector employs highly skilled individuals with senior officials, professionals and associate professionals and technical positions making up 59% of this workforce (see chart below).

<table>
<thead>
<tr>
<th>Occupational Profile Of Petroleum Industry Workforce</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers &amp; Senior Officials – e.g. Managers: Production, Maintenance, Electrical, Electronic, Chemical, Design, Production, Process</td>
<td>23</td>
</tr>
<tr>
<td>Professionals – e.g. Scientists, Chemists, Physicists, Geologists, Engineers: Mechanical, Electrical, Chemical, Design, Production, Process</td>
<td>16</td>
</tr>
<tr>
<td>Associate Professional &amp; Technical – e.g. Technicians: Laboratory, Electrical/Electronic, Maintenance, QA</td>
<td>20</td>
</tr>
<tr>
<td>Administration &amp; Secretarial – e.g. General Administration &amp; Administrative Support</td>
<td>11</td>
</tr>
<tr>
<td>Skilled Trades – e.g. Electricians, Electrical Fitters, Machine Setters, Setter Operators, Riggers</td>
<td>7</td>
</tr>
<tr>
<td>Sales &amp; Customer Services – e.g. Forecourt Retail Staff, Technical Sales Staff</td>
<td>2</td>
</tr>
<tr>
<td>Process and Machine Operatives – e.g. Operators: Process, Plant, Field, Control Room, Panel Laboratory Assistant, Forklift &amp; Crane Drivers</td>
<td>14</td>
</tr>
<tr>
<td>Elementary Occupations – e.g. Packers, Roustabouts, Security</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Labour Force Survey (Q1-Q4 2004), excludes Forecourt Retail.

- Much of these individuals are high wage earners and an approximate salary range for the Senior Managers and Officials is between £60,000 and £80,000 per year (Source Cogent).
UK Refining Employment Challenges

- UK refiners are challenged by insufficient individuals being attracted to replace the ageing senior officials presently employed by the sector.

- An indicator of this is that despite the number of students entering and completing higher education courses rising by 19% between 1999 and 2003 whilst the number choosing courses which are considered to be of value to the sector declined substantially (8% for Mechanical Engineering, 41% for Polymers and 15% for Chemistry) (Source Cogent).

- Since 1997, 18 Physics departments and 28 Chemistry departments have closed which reflects on the fact that only 2000 Chemistry students are now graduating each year as opposed to 5,000 in 1995.

- Another potential problem for UK refiners is the lack of industry specific degrees with only one university in the UK offering undergraduate opportunities in the sector. As a result UK refiners are required to provide training to new hires.

- The net result has being that UK refiners have experienced problems recruiting and are having to look increasingly overseas for suitably qualified individuals.
Security Of Supply - Robustness, Resilience & Responsiveness
World Trade

- An important factor to examine when ascertaining the security of supply for the UK is the opportunity to import oil products as compared to crude.

- The difference in magnitude of the current global trade of these materials is explored by comparing the total amount of world trade in crude to the total world trade in petrol.

- Petrol is chosen as a comparison as it is one of the most widely traded oil products with OECD countries importing 90.6 million tons in 2005 (IEA).

- In the following slides the results of this analysis are shown. We consider it to be clear that the trade in crude is far greater than that in products and hence it would prove challenging for the UK to source oil products to match its demand rather than the raw material (crude oil) for subsequent processing.

- The import of oil products is further challenged by the availability of sufficient material of the appropriate quality (as the UK and EU have some of the tightest product quality specifications).
Trade Maps Key

Arrow thickness is proportional to the size of the trade flow with the same scale being applied for both the crude and petrol trade charts which is as follows (Mt):

- **Crude Trade (Mt)**: >25, 50, 75, 100, 150, 200, 250, 300, 350 +
- **Petrol Trade (Mt)**: <3, 3, 6, 10, 15, 20, 25

**Petrol Trade Balances**
- Deficit
- Surplus

Trade position is proportional to bubble area (1 million tons/year)
2005 Indicative Global Crude Net Trade

Net crude trade
(arrow width represents trade)
2005 Indicative Global Petrol Net Trade

Net trade <500 kt not shown.

Regional petrol deficit (1 Mt)
Regional petrol surplus (1 Mt)
Net petrol trade (arrow width represents trade)
## Sourcing Crude vs Sourcing Products

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sourcing Crude</th>
<th>Sourcing Products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advantages</td>
<td>Disadvantages</td>
</tr>
<tr>
<td><strong>Supply</strong></td>
<td>Huge quantities of crude are traded everyday making crude very easy to source.</td>
<td>Potential suppliers of crude to the UK are located in politically unstable territories. UK refineries are not configured to process all types of crude.</td>
</tr>
<tr>
<td>Product Cost</td>
<td>Importing crude (CIF) to process in UK refineries produces oil products cheaper than importing them at CIF pricing.</td>
<td>Domestically produced products may cost less to produce but the cost saving may not necessarily be fully passed on to the consumer.</td>
</tr>
<tr>
<td>Opportunity Cost</td>
<td>Refinery infrastructure presently exists.</td>
<td>Refineries use various resources which have an opportunity cost. For example they employ highly skilled individuals whom could be employed in other areas of the economy.</td>
</tr>
<tr>
<td>Product Delivery</td>
<td>Products are supplied to satisfy UK specifications.</td>
<td>Crude requires subsequent processing to produce end user products.</td>
</tr>
</tbody>
</table>

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UK Wider Economy & Energy Security - Summary Of Findings

- The forecast is for weakening refinery margins in both the UK and NWE. This is attributable to the global refining environment, with additional supply coming on line in the United States projected to reduce the need for the United States imports of gasoline, which will impact margins in the Atlantic Basin. The situation for European refiners is forecast to become particularly challenging after 2015 when European total oil product demand growth is forecast to go into decline.

- UK refining has historically provided a net economic benefit to the UK. This positive contribution is projected to remain, confirming that the present refining infrastructure in the UK supplies and is forecast to supply the UK Oil Products market at lower cost than reliance on oil product imports. Clearly there are other indirect and multiplier effects which this model does not take into consideration but in view of the 15,000 people employed in the UK refining sector, these could be considerable.

- UK refiners, however, are also challenged by an ageing workforce and shrinking pool of available talent to replace those scheduled to retire from the sector.

- The analysis of trade in Crude and Oil Products illustrated that there is much greater trade in crude. Sourcing crude as opposed to oil products provides access to much wider markets and hence offers greater security of supply. Also, importing oil products rather than crude is generally more expensive for consumers.

- Growing trade in oil products is forecast in the future as product imbalances are forecast to grow.
Part C: Challenges Facing The UK Refining Sector
Challenges Facing The UK Refining Sector - Introduction

Throughout this study items have come to light which are and will become challengers to UK refiners. By first examining the plans for investment in the UK refineries as compared to other areas of the World we will see what preparations UK refiners are making to tackle these challenges.

It is well known that North Sea Oil Production is in decline. It does, however, represent a major feedstock for UK refineries. Our analysis forecasts this decline in production and then looks at the implications for UK refiners.

An aspect of investment attractiveness is the competitiveness of the UK refining sector. This will identify from the viewpoint of an investor which refineries are performing well and which are attractive or unattractive for further investment. By then looking at the Oil Product demand matrix compared to typical yields from different types of refinery we will ascertain which type of refinery is best suited to supply present and forecast UK demand and the implications this has for investment requirements.

A review of UK primary distribution has been undertaken, as the ability to distribute the products to the end-user is also important.

For completeness, we review the implications of supporting the use of sustainable fuels.
Comparison Of Investment Outlook In The UK, EU
UK & EU Refinery Investment Outlook

- In the UK, Total have announced a £130 million investment in a desulphurisation unit at its Lindsey refinery in the Humber Estuary (EUR200 million when announced in February 2006). The project has a reported completion date of 2010 and will allow the refinery to increase the amount of sour crude processed.

- There are presently no other UK refinery investment announcements.

- In the EU there are in excess of 100 refinery investments which have being announced.

- A third of the announced investments relate to quality compliance matters.

- A further third are associated to increasing upgrading facilities.

- Only 9% of the announced refinery investments are planned at increasing refinery capacity.

Source: Wood Mackenzie
Global Refinery Investments

- The global position of refinery investments is similar to that in Europe with approximately a third of the announced investments related to quality compliance matters and another third associated to increasing upgrading facilities.
- However the global position differs in that the remaining third of the announcements are equally split between increasing crude capacity and new crude capacity.
- There are also clear regional differences to the matrix of planned refinery investments with particularly large increases to crude capacity and new crude capacity being planned in Africa, the Middle East and Asia Pacific.

* Other investments refers to projects other than those categorised such as petrochemicals, lubricants and power/utility generation.

Source: Wood Mackenzie
Evolution Of UK Refinery Feedstock
Historical Refinery Feedstock Sources

- The UK’s crude slate comprises 78% low-sulphur crudes (<0.5 wt%), compared to a European average of 48% in 2005.

- The average sulphur content of the UK crude slate has remained around 0.5 wt% for a number of years. This sweet slate is as a result of a high throughput of North Sea crude. As a result, the UK has one of the lowest sulphur crude slates in Europe, and at 0.56 wt% is well below the European average of 0.93 wt% for 2005.

- In common with much of the rest of Europe, imports from the FSU have increased over the past few years and in 2005 were 6.6 Mt crude and 2.5 Mt feedstock, comprising 11% of the 2005 crude slate.

Source: Wood Mackenzie, IEA
UK Crude Supply Outlook

› 36% of 2005 UK refinery feedstock came from domestic production.

› UK production projections show a falling trend for all crude types but particularly for the production of light crude.

› Projections for output from the UK show a significant decrease in the production of sweet crude, whilst although the production of medium sour is set to decline it will do so at a much lesser rate.

› In 2005 sweet crude was 79% of total UK production whilst by 2020 this is projected to be 55% with a large increase in the percentage of medium sour production.

Source: Wood Mackenzie – Global Oil Supply Service
Norway Crude Supply Outlook

- The bulk of Norwegian production is of medium density.

- Norwegian production is projected to maintain a large proportion of sweet crude.

Source: Wood Mackenzie – Global Oil Supply Service
Russia Crude Supply Outlook

- Russian production of Urals provide the closest significant source of alternative crude, which is a medium quality high sulphur crude.

Source: Wood Mackenzie – Global Oil Supply Service
Africa has the potential to supply the UK refineries with crudes similar to the present feedstock.

Source: Wood Mackenzie – Global Oil Supply Service
North Sea Crude Supply Outlook

- The total crude oil production from the North Sea is projected to fall.

- Nine major consumers of the North Sea Oil production consume the vast majority of the production and are shown on the chart opposite.

- Simplistically, by maintaining the 2005 consumption levels of the nine major countries, it can be seen that North Sea crude production would be unable to satisfy 2005 demand levels from 2016, without substantial new discoveries.

- The declining supply of North Sea crude oil to other countries, at a time of limited change in refining capacity, provides evidence that these countries have adjusted to process other crude oil feedstock.

* The 9 major consumers are Canada, France, Germany, Netherlands, Norway, Spain, Sweden, USA and the UK.

Source: Wood Mackenzie & IEA
Feedstock Summary

- The UK’s crude feedstock presently comprises a very high proportion of low sulphur crude, primarily being supplied by North Sea production.

- Future North Sea production is envisaged to fall for both the UK and Norway and as a result UK refiners are expected to source their feedstock from alternative regions.

- Other crude of a similar quality would need to be brought from Africa / Caspian both of which are located at a substantial distance from the UK which would involve higher freight costs and so increasing the cost of feedstock.

- An alternative crude source would be to purchase Russian Urals. However this is medium grade and sulphur rich and would present challengers to refiners present configurations. Urals feedstock would also present a challenge for oil product exports as fuel oil production would become high sulphur fuel oil which has implications for exports to the US which primarily imports light sulphur fuel oil.

- Falling domestic crude production has implications for UK energy security.
UK Refining Competitiveness
Refinery Competitive Position – Net Cash Margin Methodology (NCM)

- In analysing the competitiveness and profitability of an individual refinery, Wood Mackenzie focuses on Net Cash Margin. This captures most of the critical elements of a refinery’s performance that define its competitive position in the short/medium term. It is defined as:

  Net Cash Margin = Gross Margin ($/bbl) - Cash Operating Expenses ($/bbl)

- In financial terms, it is the equivalent of EBITDA (Earnings before Interest, Tax, Depreciation and Amortisation).
Refinery Competitive Position – NCM Methodology

The constituent parts of the NCM, which represent the different activities having the greatest impact on the margin, are examined to identify sources of sustainable competitive advantage. These are, as illustrated in the graphic:

- Cost of crude oil
- Crude oil delivery costs
- Refinery Configuration
- Efficiency/operating costs
- Product despatch facilities
- Location/environment

A unique aspect of our build-up of the NCM is the fact that it allows us to identify those aspects of a refinery’s operation that are having the greatest impact on its financial performance.
Refinery Competitive Position – NCM Methodology

Taking each of the constituent parts of Wood Mackenzie’s NCM methodology in turn:

- **Crude oil costs and transportation** – Although the important feature is the delivered cost of crude to the refinery gate, for a full understanding it is important to differentiate between the cost of crude at its source and the costs associated with transportation to the refinery. For example, a coastal and an inland refinery may run the same crude slate, but the cost of transportation of the crude could be much higher to the inland refinery, depending on the supply route and associated crude delivery costs.

- **Refinery Configuration** – In Europe and the US, this is normally the most important parameter affecting NCM; however this is not the case in Asia Pacific. We model the output slate of each refinery in order to evaluate the added value due to refinery configuration. In this analysis we have assumed that the costs associated with a particular configuration are those that would be achieved by a top-quartile cost performer. Deviations from top-quartile cost performance are captured under efficiency.

- **Efficiency** – Defined as the deviation from the standards achieved by the best performer after allowing for the complexity of the refinery operation, efficiency reflects how much of the potential added value is lost through less-than-ideal performance in a range of parameters such as cost performance, scale economies or the physical layout of the refinery.
**Refinery Competitive Position – NCM Methodology**

- **Product despatch facilities** – Refinery gate prices are influenced to an extent by product despatch facilities. The ability to load product to various transport modes widens and lowers the cost of the refinery’s supply envelope and hence impacts upon the netback price.

- **Location** – This covers those factors not directly related to the assets themselves or the efficiency with which the assets are managed. Location covers aspects such as local pricing (e.g. inland versus coastal), remuneration levels, import tariffs, etc. Pricing is linked to each reference market. For each refinery, we analyse all of these key parameters based upon Wood Mackenzie’s view of the refining operation.
Competitive Position of UK Refineries

The NCM ranking system ranks 106 European refineries. By using NCM this ranking captures those elements that have the greatest impact upon a refinery’s performance in terms of competitiveness and profitability.

Generally the UK refineries (highlighted in red) are considered as mid to low performers.

Source: Wood Mackenzie – Global Refinery View
Competitive Refinery Position By Country - The Investor Viewpoint

- By taking the NCM per barrel capacity of the Crude Distillation Unit and taking an average for each country provides evidence for the earlier statement that UK refiners are generally low to mid performers.
- Hungary, Slovak Republic and Poland are highly competitive partially as a result of large investments which were carried out, frequently with assistance from the EBRD, in order for each country to satisfy EU accession requirements.
- The competitive position of UK refiners overall relative to other countries broadly reflects its specific national characteristics (use of high cost crude and significant exports)

![Graph showing competitive refinery position by country](attachment:image.png)

Source: Wood Mackenzie – Global Refinery View
The competitive position of UK refiners overall relative to other countries in 2010 remains the same as in 2005.

- The relative positioning of other countries in this ranking are projected to experience only minor changes from the position in 2005.

- Certain mid ranking countries are projected to change their relative position, notably Greece, Italy and Lithuania, although they still are expected to remain as mid ranking countries.

Source: Wood Mackenzie – Global Refinery View
The key factors affecting the relative competitiveness of UK refining compared with refinery sectors in other European Member States can be best illustrated by looking at those member states in the Triangle Of Trade, i.e. France, Belgium and the Netherlands.

When examining the weighted average of the NCM input categories for the countries in the Triangle of Trade in NWE it becomes quite clear that it is the UK crude cost that has the greatest impact upon the refinery NCM.

Belgium and the Netherlands which were both shown to have much higher NCM’s than the UK have a lower crude cost which results in them having a much greater NCM than the UK.

Source: Wood Mackenzie – Global Refinery View
Ideal Refinery Configuration In 2005

- Considering UK demand in 2005 the refinery configuration which would have produced yields best aligned with the UK demand profile would have being a hydrocracker and coking configuration.

- As expected, the actual UK refinery supply of main oil products largely matches that of a FCC configuration, typical of facilities in place.

- This model works on the assumption that refiners feedstock is based upon a blend of Brent and Arab Heavy to match the expected 35°API.
Considering projected UK demand in 2015 the refinery configuration which would produce yields most suitable for meeting UK requirements would remain that of a hydrocracker and coker.

The UK refiners’ configuration is primarily based on the FCC, which is becoming increasingly mis-aligned with the projected demand profile in 2015.

This model works on the assumption that refiners maintain a crude slate similar to present and is based upon a blend of Brent and Arab Heavy to match the expected 35°API.

Source: Wood Mackenzie
Refinery Investment Required To Operate Ideal Configuration

› The development of a hydrocracker and coking configuration requires extensive modification to an existing FCC refinery

› The vacuum gas oil (an intermediate stream that if not upgraded would be blended into lower value fuel oil) currently processed in the FCC would need to be fed to a hydrocracker unit. These high pressure, high temperature units are typically more costly than an FCC. Hydrocrackers also need significant amounts of hydrogen as a secondary feedstock, so it is typical for the construction of a hydrogen unit to be incorporated. These hydrogen units either process natural gas or other refinery streams, such as LPG and naphtha and typically increase carbon dioxide emissions

› The vacuum residue that currently is blended to fuel oil is to be fed to a coking unit, which primarily produces vacuum gas oil (for processing in the above hydrocracker) and typically fuel grade coke. The development of a coker is relatively low cost, but significant investment is often required in the storage and transportation systems for the resultant petroleum coke (which is typically a low value component)
Primary Distribution
UK – logistical Infrastructure

- Majority of petroleum products delivered into inland market are either supplied directly from the road loading terminals adjacent to the refineries or from the network of oil company owned/operated terminals linked to these refineries by various product pipeline networks the two most major are:
  - The UKOP system – linking BP’s Coryton refinery in the south east with the midlands to Shell’s refinery at Stanlow in the north west
  - The ExxonMobil owned and operated Mainline/Midline system linking Fawley and Milford Haven/Pembroke refineries with the midlands and Manchester
- Other pipelines include the ‘Fina Line’ linking Total’s Lindsey Oil Refinery on the Humber with Buncefield terminal in the south/ Heathrow, the various other pipelines supplying jet fuel to the main UK airports and the Government Pipeline and Storage System (GPSS) which includes the ‘West-East-North-South-Avonmouth-Thames (WENSAT) line
- Quantities of refined product are also delivered ex-refinery by sea to oil company owned/operated coastal storage terminals and by rail to certain inland terminals for onward distribution by road.
- There is a significant amount of independent storage, especially on the east coast of the country:
  - Kaneb Pipeline Partners subsidiary ST Services have sea fed oil terminals at Belfast, Eastham, Grays, Clydebank & Grangemouth
  - Vopak’s terminals at West Thurrock (Thames), Ipswich, and Tees
  - Simon Storage at Seal Sands, Immingham, Tyne, and Workington
UK Storage Going Forward

International Trade

• No real international hub opportunities exist in the UK, due to:
  • Vicinity to ARA centre
  • Petrol is exported directly from UK refineries – especially Milford Haven/Pembroke and Humber
  • Jet: Imports to grow to service major airports in southern England
  • Key issue is access to pipelines that serve the airports. Potential location in Avonmouth. Kuwait Petroleum have already constructed a new deep sea storage terminal at the Royal Portbury Dock in the Bristol Aviation Fuel Terminal on the west bank of the river Avon. The first berth for petroleum products (berth number 7) opened in May 2003 and is used for Aviation Fuel imports which are being directly discharged into the pipeline and storage network. The berth can accept 120,000 tonne tankers and has pipeline access.
  • Buncefield closure has exacerbated the problem – long term effects need to be evaluated with terminal closures being possible due to increased costs of compliance with stricter safety measures.
  • Diesel: Volume growth and quality changes provide opportunities
    • Emerging deficits support could support new storage sites in Southern England (demand centre) and North West (current logistics constraints). (Logistics constraint even provides opportunity for petrol storage, in spite of country-wide structural product surplus)

Local Market Opportunities

• Storage and blending of imported bio-diesel components
  • Petrol components anticipated to be blended at key marketing terminals, due to the issues associated with ethanol
  • Key locations for process plants of both bio-diesel and bio-ethanol
• Storage and blending of differentiated diesel fuels
  • Utilising imported GTL components or bio-fuels
• Future impact of Buncefield incident on UK logistics in the South East is uncertain, as it is unclear as to whether this facility will be allowed to be rebuilt
UK Storage Going Forward

- Logistical infrastructure in south east England (especially along UKOP pipeline) already understood to be constrained even before Buncefield fire
  - Buncefield explosion has exacerbated this situation, particularly for jet fuel
- Avonmouth and in particularly the Royal Portbury Dock in the Bristol Aviation Fuel Terminal would be one of several possible locations for jet fuel imports
  - But this would require access to the GPS pipeline and also for there to be spare pipeline capacity in the GPS system which goes to Heathrow.
- There are jetty capacity constraints at various refineries, e.g. Fawley.
- As a result of declining UKCS production an additional 25% storage will be required for oil stocks with refiners and importers as a cost of doing business, so compliance with this provision could become a future challenge.
- Further storage in at Eastham would be primarily aimed at local market in north west
  - no direct access to UKOP pipeline
  - Manchester Ship Canal/ Mersey Docks charges are a possible issue
Adequacy Of UK Storage

- Wood Mackenzie considers that, subject to present facilities being maintained as 'fit for purpose', the current UK primary distribution infrastructure is broadly adequate for current and future needs.

- The one area that potentially could benefit from additional facilities is the South East in the wake of the cessation (temporary or otherwise) of product storage and distribution activities at Buncefield and the still high rate of growth in oil product demand within the region, especially of jet fuel at the two main London airports of Heathrow and Gatwick.

- These constraints could be alleviated by further expansion of storage facilities on the Thames or extending the use of the GPSS.
Refining Industry Support For Sustainable Fuels
Refining Industry Support For The Development & Use Of Sustainable Fuel Technologies

› Vegetable Oil
  • This can be used as a feedstock for a refinery to produce environmentally friendly fuels. However it can only be done in existing refineries where there is spare hydrotreater capacity and spare hydrogen available. Refiners do have the option to make specific investments to treat vegetable oils, but there is limited commercial experience to date to support such an investment.

› Ethanol For Petrol Blending
  • Investment in ethanol tanks and an ethanol distribution system is needed, as ethanol cannot be blended at the refinery if the finished product is to be distributed by pipeline (which is a key mode in the UK). The ethanol will hence be blended at the marketing terminal, requiring the development of an ethanol supply chain throughout the UK which will require a significant number of road tanker movements.

› Bio-Diesel
  • Blending – it is likely that blending of bio-diesel will occur at the refinery, as, unlike ethanol, there are no particular problems with its subsequent distribution. This would require refineries to invest in storage tanks to store the Bio-Diesel. The viability of blending biodiesel at refineries will be confirmed in pipeline trials due to take place in summer 2007.
Challenges For Incorporating Bio Fuels

- Both technical and physical challenges must be overcome for bio fuels to be successfully introduced into the UK.

- Technical:
  - Ensuring any changes to fuel specifications do not adversely affect the car parc. We note that the introduction of a separate new bio-diesel grade at the pump could be both costly and confusing for the general public. Furthermore a percentage greater than 5% bio-diesel in diesel is currently opposed by many in the motor industry due to incompatibility with various engine seals.
  - Blending – it is likely that blending of bio-diesel will occur at the refinery, though this will require development of appropriate tankage.

- Sourcing of a secure supply of ethanol.
  - Rising demand in the US means the market is very tight in the USA and Brazil.
  - Current high prices of sugar mean that sugar cane producers are aiming for maximum sugar, rather than ethanol, production.
  - Carbon reporting requirements could require a carbon reporting supply chain which would be difficult for suppliers to satisfy.
  - Investment in ethanol tanks and an ethanol distribution system needed, as ethanol can not be blended at the refinery or shipped in pipelines because it is hygroscopic and absorbs water, so potentially contaminating a multi-product pipeline. As legislation surrounding this area remains uncertain, we understand that refiners are waiting for clarity prior to making any investments.

- Vegetable Oil
  - This can be used as a feedstock for a refinery to produce environmentally friendly fuels. However it can only be done in existing refineries where there is spare hydrotreater capacity and spare hydrogen available. Refiners can develop specific investments, but there is limited suitable commercial experience regarding such an approach.
Challenges Facing The UK Refining Sector - Summary Of Findings

- UK refiners have announced few refining investments in stark contrast to Europe and global developments. We attribute this to these refiners typically being in a weak competitive position and so unattractive for further investment from an sponsor/company viewpoint, particularly as many sponsors/companies have a portfolio of investment options.

- When examining the feedstock for UK refineries, the present feedstock comprises a very high proportion of low sulphur crude, primarily being supplied by North Sea production. The projected decline in North Sea supply will mean that UK refiners need to source their feedstock from alternative regions. Similar quality crude could be brought from Africa / Caspian but there will be cost implications for UK refiners due to higher freight costs resulting from the greater shipping distance. Alternatively Russian Urals crude could be sourced which is a medium density grade and sulphur rich crude which would be a challenge for refiners present configurations. Urals feedstock would also present a challenge for oil product exports as the fuel oil produced would become high sulphur fuel oil which makes exports more challenging, as the US primarily imports light sulphur fuel oil from Europe.

- The UK primary distribution is broadly considered adequate for purposes however it does face challenges, particularly with regards to jet fuel as the incident at Buncefield illustrated. Jetty constraints may delay vessels unloading and as North Sea Production declines there is also the challenge of maintaining sufficient oil stocks storage capacity.

- With regards to bio fuels, it has being illustrated that both technical and physical challenges must be overcome for bio fuels to be successfully introduced into the UK in a manner that is sustainable for refiners.
Conclusions
Investment in the UK refinery sector could address projected various market developments

- The UK refineries need to adapt to evolving trends in oil product demand as:
  - Demand for petrol in the UK is projected to fall, as is that of NWE, so increasing exports (conditional on no change in refinery configuration/supply)
  - The US market, which has traditionally provided an outlet for UK and European petrol markets, is projected to move to a balanced situation for petrol, so requiring UK refineries to target other markets or invest to produce other products (such as middle distillates)
  - Europe is projected to be deficit of middle distillates, so any UK deficits require long haul imports
- Falling North Sea oil production will require UK refiners to either invest to process other poorer quality feedstocks or process more expensive feedstocks.
  - The closest alternative major supply source is from Russia, which is of lower quality than present sources and so will require refiners to upgrade.
  - An alternative is to source crude similar in grade to the North Sea from Africa but this would have cost implications arising from the additional transportation costs.
- The UK refineries face the challenge of improving their competitiveness – they presently are mid to low performers within the EU peer group, so are not well placed to attract investment.
- UK refiners are also challenged by an aging workforce and shrinking pool of available talent to replace those scheduled to retire from the sector
- The UK will become increasingly reliant upon more distant sources of feedstock
- The global refining environment projected to become more challenging, so impacting the viability of UK refiners
Appendices
Appendix 1 - Crude Definitions

When analysing the feedstock for the refineries the following crude definitions were used throughout this consultancy:-

- Sweet (ST) $ S < 0.5 \text{ wt } \%$
- Medium Sweet (MS) $ S \geq 0.5 \text{ and } <1.5 \text{ wt } \%$
- Sour (SO) $ S \geq 1.5 \text{ wt } \%$
- Extra Light (XL) $ \text{API} \geq 50$
- Light (L) $ \text{API} \geq 38 \text{ and } <50$
- Medium (M) $ \text{API} \geq 30 \text{ and } <38$
- Heavy (H) $ \text{API} \geq 15 \text{ and } <30$
- Extra Heavy (XH) $ \text{API} <15$

API GRAVITY – The American Petroleum Institute gravity expresses the gravity or density of liquid petroleum products and is calculated as follows:

\[
\text{Degrees API} = \left(\frac{141.5}{\text{specific gravity } 60^\circ\text{F}}\right) - 131.5
\]
Appendix 2 - Country Groupings

Throughout this study reference has being made to several country groupings such as NWE, Med, EU and Europe. The countries comprised of in each grouping are as stated below:-

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