# Light and Heavy Crude Availability and the Challenge for Refiners

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**The balance between light and heavy crude oil is important for refiners for three reasons: first, the light–heavy spread impacts on current upgrading capacity utilisation; second, the future course of the spread is a factor in determining the type and capacity of conversion units to build; and finally, the spread is relevant to which crude oil benchmarks will best represent the global crude mix in the future.**

Quality specifications for petroleum products have tightened and the demand barrel has shifted relentlessly towards higher value lighter and lower sulphur oil products in recent years. This has forced refinery configurations to become ever more complex.

The growth in demand for light products looks set to continue; demand growth for gasoline and diesel is expected to grow rapidly as freight traffic and passenger vehicle fleets expand in high population emerging market countries.

These trends in demand, and the fact that nearly two-thirds of the world's oil reserves have been located in the Middle East, a region that traditionally has been the source of relatively heavy and higher sulphur crude, have favoured the building of deep conversion refineries in recent years. However, as the refining stock has become more sophisticated, the rise in oil prices to above $100/barrel has encouraged the large-scale development of unconventional crude oil resources that could never have been commercialised at lower prices. Because of this, the price spread between light and heavy crude oils has become a moving target.

Crude oils that produce higher yields of light products such as gasoline and diesel in a refinery are typically described as 'light' while those that make heavier products such as residual fuel oils and bitumen are described as 'heavy'. Unfortunately, in the real world, there is very little standardisation of terminology. Today, crude oils with an API gravity of more than 28–30 are typically seen as lighter grades. Twenty years ago, light crudes were typically considered as ones with an API above 34. Geographical variations also exist. For example, the Indonesian crude Minas is generally considered as heavy sweet in Asia in spite of having an API of around 34, as most grades in the region are lighter.

The balance of light versus heavy products in a crude oil is more precisely determined through the distillation curve of the crude oil. Based on this curve, the products can be split into groups from the lightest to the heaviest products, and this is used to determine the Gross Product Worth (GPW) of the crude oil.

Naphtha, gasoline, jet, diesel and gasoil are considered as lighter products while low-sulphur fuel oil (LSFO) and high-sulphur fuel oil (HSFO) are heavy parts of the barrel. Typically a five-cut yield is used based on the proportion of LPGs, naphthas, kerosenes, gasoils and fuel oils in the crude oil; however, four-, six- and seven-cut yields may also be used.

The density of a crude oil, typically measured by the API gravity, is often used as a simple proxy for the yield of different products in the crude oil, and therefore of whether a crude is light or heavy. As is well known, crude oils range from very heavy grades with an API of around 10 to light condensates with API gravities above 40.

The light–heavy spread is typically measured by comparing the price of pairs of 'benchmark' crude oils in the different geographical regions: for instance, Maya–WTI in the USA, Brent–Urals in Europe, Brent–Dubai in the Middle East, and Dubai–Tapis in Asia. However, because the value of each crude oil in such a pair may be affected by a multitude of factors other than the quality difference, such as infrastructure bottlenecks, these measures provide only a high-level snapshot of the relative value of light and heavy crude oil.

## Conversion Capacity Utilisation

Recent trends have seen a rise in light crude production compared to heavy sour crude. This trend coincided with a wave of refinery building which came on stream in the period 2009–2013, most of which is deep conversion capacity such as coker-hydrocracker and residual fluid catalytic crackers which typically maximise value when the light–heavy spread is wide. Indeed, many of the decisions to build such units were taken in the years immediately after light–heavy spreads blew out in 2005 to unusually wide levels because of the shortage of upgrading capacity at the time.

Due to rising shale production in the USA, lighter crude supply in the Americas has increased at a faster pace than heavy crude production. Tight oil supplies have displaced significant volumes of light sweet crude oil that were traditionally imported from Nigeria and Algeria. As the volume of crude oil from sub-salt Brazil gradually ramps up, Angolan supplies also, which have typically headed transatlantic, are increasingly being directed into Asia.

As US shale production rises, there will be growing efforts to export these barrels and to get rid of the surplus mostly concentrated in the Midwest. At present, oil producers in the USA are not allowed to send oil to other countries. Many analysts believe that the Obama Administration might allow exports to some friendly countries. The United States is already delivering around 130,000 b/d of crude mostly to Canada while some of these barrels are being processed to refined products, which can be exported. There are also reports of this crude being put into different processing units to convert them into products, which can no longer be classified as crude oil. If allowed, exports of crude will put pressure on lighter crude in countries that acquire these barrels. This has the potential to narrow the light/heavy differential globally.

In Saudi Arabia, the balance between light and heavy crude available on the international market has changed as light streams have been marketed and heavier grades have been used domestically, either for direct-burning in power stations to meet soaring electricity demand, or to feed the kingdom's own refineries. The Manifa oilfield started up production recently and will increase heavy crude production from the region but a key part of this is being used to offset declining production at other fields in the kingdom.

As Saudi Arabia builds sophisticated new refineries at Jubail, Yanbu and Jizan, which are geared to using heavy feedstocks, and as it goes ahead with joint-venture downstream investments in countries such as China, which are also maximised by using poorer quality crude oils, the future availability of heavier feedstocks can no longer be considered as assured. Similar trends can be seen in other OPEC Gulf countries such as Kuwait which are planning to build sophisticated refineries capable of meeting ultra low sulphur specifications of diesel and gasoline that have become the norm in the developed countries because of environmental standards.

These trends have seen a narrowing of light–heavy spreads in recent years, albeit that these spreads are volatile and erratic. In 2005, the Urals–Brent spread widened to $8–9/barrel and the Brent–Dubai spread widened to as much as $14/barrel; in recent years, both spreads have been close to parity at times. The same trend is seen in WTI–Maya, although the latter spread has been distorted by the infrastructure bottlenecks besetting the US sweet crude benchmark.

## Investment Trends

Looking forward, it is crucial for refiners to estimate the relative value of light and heavy crude oils in their investment decisions. A refinery that decides to spend billions of dollars on sophisticated and expensive conversion capacity in order to be able to process heavy crude oils will be at a competitive disadvantage if he finds that he can just as cheaply have bought light sweet crude oil to make the light products required. However, because the outright level of oil price is important in terms of which reserves are developed, there can be very little certainty as to which qualities of oil will preponderate in the crude oil slates of the future.

For instance, high oil prices would potentially favour the development of unconventional and ultra-heavy crude oils. Venezuelan heavy production has been hit hard in recent years due to the exodus of key management at the state oil company, PdVSA, with most estimates showing a drop of at least 1 mb/d since 1999. But Venezuela has the largest reserves of unconventional oil in the world – around 500 billion barrels estimated to be trapped in the Orinoco sands, which could be exploited if oil prices were high enough. If this great resource were to be exploited, the current tightness of heavy crude oil could be alleviated.

Similarly, Canada is also currently facing headwinds due to the lack of pipelines to the US Gulf Coast with its output from oil sands unlikely to grow significantly in the next few years from its present level of less than 2 mb/d. Even if prices remain at current levels of around $100/barrel for North Sea Brent a part of the future investment is likely to either be scrapped or delayed. This is likely to curtail heavy crude supply in the near future. Any big drop in oil prices to $50–60/barrel, however, would result in prices falling below the long-run marginal cost of oil sands, and would stop this resource being developed.

Meanwhile, North Sea oil production has been declining both in the UK and Norway, and much of this oil is light and

sweet in quality. Interesting here, however, is the kind of oil that can be developed under different price scenarios. For instance, the UK has abundant reserves of very heavy conventional oils that were explored in the 1970s and 1980s but were not developed because oil prices were too low – let's not forget that crude oil prices dropped below $10/barrel in 1986 and 1998.

In reality, the feedback loops of different levels of oil price in developing different types of resource are more subtle than this.

The high price scenario argues for ultra-heavy oil being developed, reducing the value of heavy crude oil relative to light grades, but it would also encourage development of gas in transport, shifting some of the demand for light products to non-liquid fuel. The high price scenario also would continue to favour development of tight oil and shale oil through fracking. These resources in the USA are typically light in quality. So what you could get is a dumb-bell crude slate, lots of light oil, lots of ultra-heavy oil, and a relatively tight middle of the barrel. In contrast, a low price scenario would favour the development of deep water conventional oils which have a range of different qualities but within narrower limits, while the unconventional resources at the very light and very heavy ends of the spectrum would be relatively tightened.

## Benchmarks

These trends have a bearing on which – if any – of the oil benchmarks that are currently used to price oil will have longevity.

Currently, the most widely used crude oil benchmark is North Sea Dated Brent. In the past, this represented a single crude oil blend gathered from the Brent fields in the North Sea but, as production of Brent Blend itself has declined, the benchmark has morphed to reflect the lowest in value of a group of broadly similar crude oils produced from under the North Sea: initially, Forties and Oseberg and more recently Ekofisk were allowed for delivery as dated Brent, and it is likely that other grades will be allowed by the main Price Reporting Agency Platts in its price assessment process in the future. Platts dated Brent is widely referenced in oil and gas contracts around the world, increasingly, in Asia and Australia, but also in the west in Canada and Latin America. These countries are far outside the traditional range of geographies in which the North Sea crude oils have typically been refined.

Although Brent is dominant in international crude oil pricing, different geographical regions have different light and heavy benchmarks. In the absence of a typical heavy grade in Europe, Urals from Russia is typically compared with Brent to reflect the value of the sweet/sour differential. In the United States, WTI has lost some of its status as a sweet benchmark due to its land-locked delivery point, and Louisiana Light Sweet (LLS) is used as a physical light sweet marker. While Maya from Mexico is seen as a heavy benchmark in North America, many also use Western Canadian Select (WSC), although the latter faces similar problems as WTI in delivering to the Gulf Coast. In Asia, Malaysian crude Tapis has so far been the light sweet benchmark but its dwindling production and rising supply of the Russian grade ESPO is likely to change that. Dubai from the Middle East remains the key heavy benchmark in Asia in spite of its falling output with Oman also being used as a marker.

Whether these benchmarks remain representative depends to a large extent on which oil reserves are developed over time. There are many theories as to what conditions must be met for a grade of crude oil to become a benchmark. Among the key factors are 1) that the benchmark grade is representative of the crude oil quality that is typically used in a region and 2) that it reflects the value of the marginal barrel in the region.

At least in theory, the spot market is used in oil pricing because market value is determined by the marginal unit of production. In the old days, heavy oils from the Middle East and Russia formed the base load of a refiner's crude oil slate, while lighter grades from regions such as the North Sea and Africa were used at the margin to optimise the yield. So it was natural to use a light sweet oil such as Brent Blend to represent the 'marginal' barrel.

Whether this will be the case in a decade is up for grabs. Heavy and light crude oil reserves are not evenly distributed around the world. If more heavy oil is developed under certain price scenarios, the existing benchmarks may become less representative of the overall crude oil slate in a region. This is not necessarily a problem in itself, provided the benchmark still reflects the marginal barrel being used by refiners. But if the definition of the marginal barrel also changes, the existing benchmarks may become less relevant.