Implications for oil refining and trade

The great migration

Highlights

- The global refining sector is set for turbulent times over the coming decades as the industry is re-shaped by declining oil demand in OECD markets alongside rapid growth in demand in non-OECD Asia and the Middle East. Anticipated refinery additions are concentrated in China, India and the Middle East, corresponding in part to the traditional model of refining close to the point of consumption, but also reflecting the ambition of crude exporters in the Middle East to expand into products trade and petrochemicals.

- Strains on the refining system are amplified by the changing composition of feedstocks. A growing share of oil supply bypasses the refining system altogether, including most natural gas liquids as well as oil products produced directly from gas or coal. As a result, global demand for refined products grows only by 10 mb/d over the period to 2035, less than the growth in overall liquids demand of 16.8 mb/d (including biofuels) and less than anticipated net refinery capacity additions of 13 mb/d.

- Refining over-capacity means increased competition for available crude as well as for product export markets. The consequences in terms of lower utilisation rates and potential rationalisation of capacity are mostly borne by the refining sectors in OECD regions, where oil demand is falling. Europe's vulnerability is increased by declining local crude production, product demand that is heavily skewed towards diesel and disappearing export markets for gasoline.

- The outlook for the United States is helped by the increasing availability of local crude, although infrastructure constraints and continuing, if diminishing, import reliance means that not all refineries are in a position to benefit. The net North American requirement for imported crude all but disappears by 2035, and the region becomes a large exporter of products.

- Asia becomes the unrivalled centre of the global oil trade as the region draws in a rising share of the available crude not only from the Middle East (where total crude exports start to fall short of the Asian import requirement), but also from Russia, Africa, Latin America and Canada. Even with the large additions to refining capacity, both India and China are net importers of oil products in 2035.

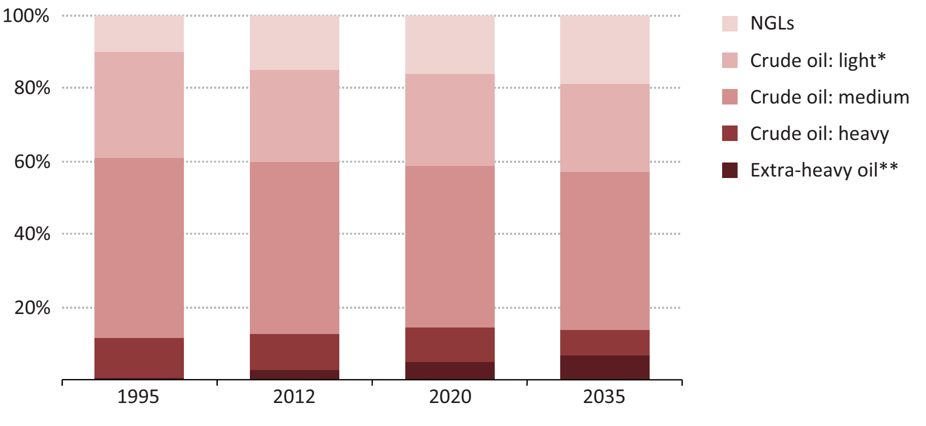
- Refinery capacity additions in the Middle East contribute to a decline in the region's crude and condensate exports over the period to 2020 and a rise in exports of products. However, by 2035, most of this new refining capacity serves to cater to increasing product demand from within the region.

Making the connection between oil demand and supply

Between the extraction of oil and the delivery of oil products to final consumers are two large and complex industrial and commercial operations: oil refining and trade. Refiners, traders and shipping companies provide the ultimate link between oil demand and reliable supply, determining the fate of each barrel of oil produced and its destination. By virtue of this position in the oil value chain, these industries must frequently adjust to changes in the composition or location of oil supply and demand, always seeking to find the most advantageous ways to transform the various oil input streams into the right combination of products for the market.

The global refining sector is now undergoing a period of major adjustment. One of the main issues confronting refiners worldwide is the changing composition of feedstocks (Figure 16.1). Before the shale gas and light tight oil revolutions in the United States, world crude supply was generally getting heavier and higher in sulphur, with a higher yield of residual fractions. Refiners were preparing for a heavier crude slate by constructing cracking and coking units to break down long carbon chains of heavy residues into the ranges of lighter, more desirable products. However, with the start of large-scale production of light tight oil (LTO) and increasing output of natural gas liquids (NGLs), the world crude slate has bifurcated. The heavy side of the barrel is still getting heavier, as output of Canadian and Venezuelan extra-heavy oil and bitumen increases, requiring more severe cracking processes with high yields of petroleum coke and sulphur. But the share of lighter crudes in global output is also getting bigger, with the contribution of LTO and the condensate portion of NGLs.

Figure 16.1 ▷ World oil production by quality in the New Policies Scenario



* Includes light tight oil. ** Includes Canadian oil sands.

A related challenge for refiners is the increasing share of products that find a way to market without passing through the refining sector at all. These include a proportion of fractionated NGLs (ethane, liquefied petroleum gas [LPG] and natural gasoline), products from coal-to-liquids (CTL) and gas-to-liquids (GTL) technologies, and biofuels. If we subtract all of these elements from total liquids demand, we find that total demand for refined products in 2012 amounted to 79 million barrels per day (mb/d), considerably less than total demand for liquids that was nearly 89 mb/d (Table 16.1). Moreover, while total liquids demand increases by some 17 mb/d over the period to 2035 in the New Policies Scenario, nearly half of this is met by the non-refinery components of total supply, so the increase in demand for refined products in the New Policies Scenario is a more modest 10 mb/d.

Table 16.1 ▷ Global total demand for liquids, products and crude throughput in the New Policies Scenario (mb/d)

	2012	2020	2035
Total liquids demand	**88.7**	**97.6**	**105.5**
of which biofuels	1.3	2.1	4.1
Total oil demand	87.4	95.4	101.4
of which CTL/GTL and additives	0.9	1.4	3.0
Total oil product demand	86.5	94.0	98.4
of which fractionation products (from NGLs)	7.7	9.2	9.7
Refinery products demand	**78.9**	**84.9**	**88.7**

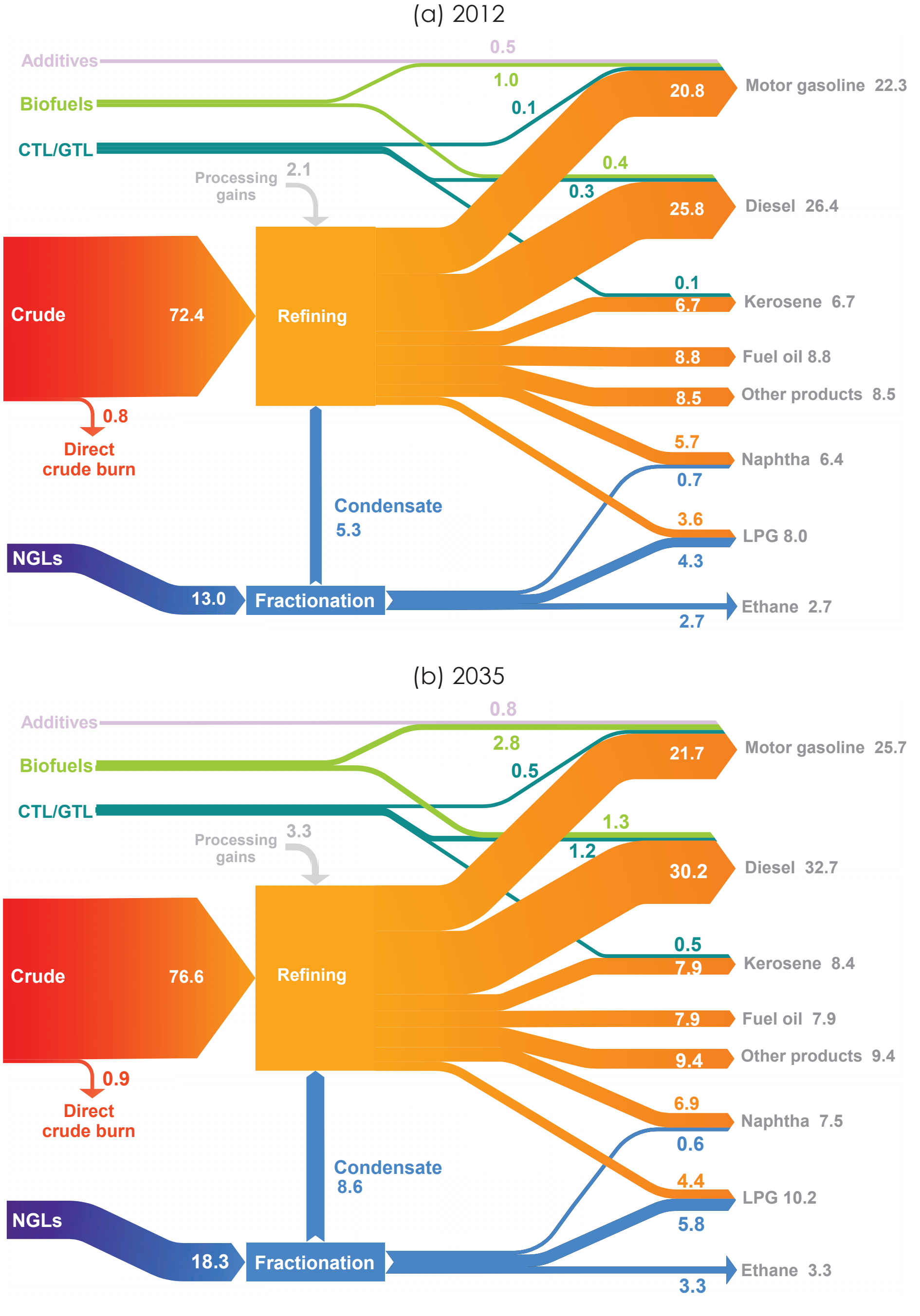
Products bypassing the refining sector

For as long as oil supply remained dominated by conventional crude oil, so the refining sector retained a firm grip on oil product supply. For conventional crude, refining remains a necessary and sole link with oil demand (with the exception of some crude oil burned directly for power generation, mostly in the Middle East). But, as seen in Figure 16.2 and in Chapter 14, the composition of oil supply is changing. CTL/GTL technologies generate transport fuels directly from natural gas or coal (in regions where the two feedstocks are especially cheap), producing various combinations of diesel, kerosene and gasoline, depending on local demand or export priorities. Broadening the horizon to total liquids supply, the biofuels industry also produces bioethanol and biodiesel for transport use, which are blended into gasoline or diesel at various rates in refineries or storage facilities, or, less frequently, sold as pure ethanol or biodiesel.

Natural gas liquids

NGLs are an increasingly important part of global oil production. Their output rises by 5 mb/d to about 18 mb/d in 2035, 45% of the overall growth in output. NGLs congregate at the light end of the oil spectrum and do not yield as high a proportion of transport fuels as more conventional crude oils. Nonetheless, some of the heavier NGLs (the condensate portion) do work their way into the regular refining system and into transport fuel; in our projections, the petrochemicals industry absorbs a large share of the lighter ends.

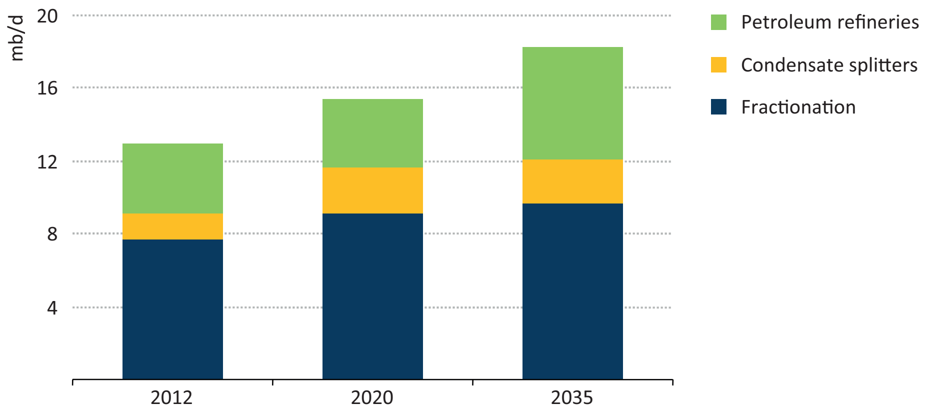
Figure 16.2 ▷ World liquids supply in the New Policies Scenario, 2012 and 2035 (mb/d)



Notes: Volumes of crude oil and NGLs here do not correspond to the values in Chapter 14, Table 14.1, as some US ultra-light crude is treated as condensate for the purposes of refining analysis. Rounding may lead to minor differences between totals and the sum of their individual components.

The definition and composition of NGLs differs by region. In the United States, for example, condensate is reported as part of the crude stream, so the remaining NGLs are lighter, with a greater share of ethane and LPG, the lightest components. In other regions, such as the Middle East, the Caspian and West Africa (which provide a significant share of NGLs output growth in the latter part of the projection period), there tends to be a higher proportion of heavier, refinable liquids, like condensate, included in the definition of NGLs. All of these NGLs are fractionated (*i.e.* separated out) from the natural gas stream. For around 60% of NGLs, mostly ethane, LPG and natural gasoline (a type of light naphtha), this is where the process ends.[1] The remainder is heavier condensate that is sent either to condensate splitters or to petroleum refineries.[2]

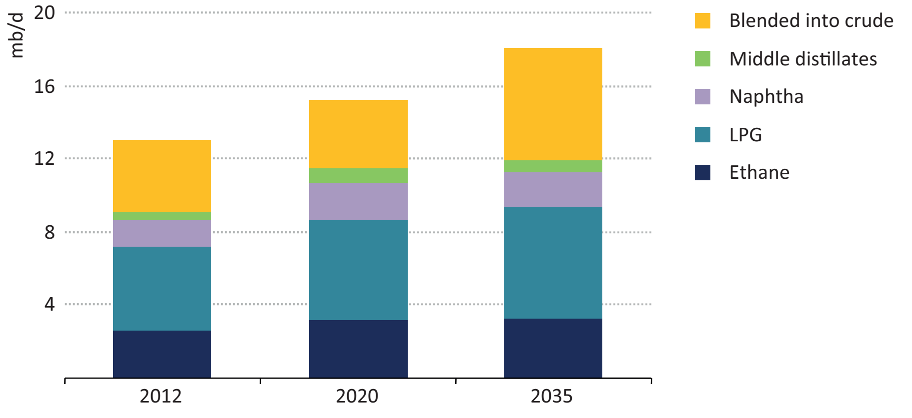
Figure 16.3 ▹ Routes to market for NGLs by process in the New Policies Scenario



In petroleum refineries condensate is mostly blended with crude oil, and it is not possible to derive product yields specifically for the condensate part of the refinery intake. The rest of NGL volumes can be split into products that are the output of condensate splitters and earlier fractionation: middle distillates, naphtha, LPG and ethane (Figure 16.4). All of the ethane and naphtha, and around half the volumes of LPG, in the projections, go to the petrochemical sector as feedstock.[3]

1. This is the component shown in Table 16.1 under "fractionation products (from NGLs)".
2. This share is included as an input to the refinery model (which incorporates condensate splitters).
3. The use of oil as feedstock would have pleased the Russian chemist Dmitry Mendeleev, the father of the periodic table of chemical elements, who was not happy seeing crude oil from the fledgling oilfields of Baku, then part of the Russian empire, used as a fuel, famously claiming that it is the same as burning money in boilers. His point was that one should use oil to derive versatile chemical compounds that otherwise do not occur in nature.

Figure 16.4 ▷ NGLs product yields in the New Policies Scenario



Note: The share blended into crude corresponds to the amount going to petroleum refineries in Figure 16.3: this is used to produce a standard range of refined products.

The refining sector

Refining has come a long way from its origins in small, unsophisticated "teapot" facilities, although this form of refining still survives in certain regions. Modern day refining operations are a complex manufacturing process that brings a wide range of products to market, from primary transport fuels to specialised petrochemical feedstocks. In addition to initial distillation of crude oil, refineries contain a variety of secondary processing units that use a range of catalysts and hydrogen to process intermediate feedstocks into finished products.

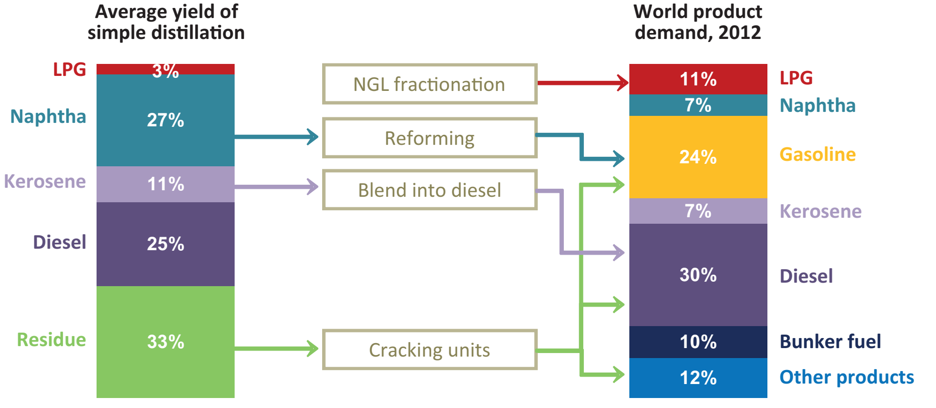
Crude distillation units (CDU), sometimes known as topping units, are the starting point for crude oil refining operations. They essentially boil the crude in order to separate it into different fractions. The lightest fractions, like LPG, come out at the top of the distillation tower, followed by light and heavy naphtha, kerosene, straight-run (or atmospheric) gasoil and, finally, residual oil, that has the highest boiling temperature of above 350 degrees Celsius.

LPG and naphtha (and gasoline by association with the latter) are known as light ends, or light distillates. Light and heavy naphtha undergo hydrotreatment, in which hydrogen is used to remove excess sulphur. After this they can either be sold as they stand for petrochemical use or be sent to reformer or isomerisation units that upgrade naphtha into, respectively, reformate and isomerate, the main components of gasoline.[4]

4. Reformer units boost the octane rating of naphtha by removing excess hydrogen atoms through catalytic processes, thereby producing the hydrogen that is needed for diesel hydrotreatment units. Hydrogen can also be produced by dedicated units using another feedstock – methane (natural gas), but for many refineries naphtha reforming remains the only source of hydrogen production. Thus, since diesel production needs the hydrogen that is the by-product of gasoline output, lower gasoline output may affect the quality of diesel output.

Next is the middle distillates fraction, which includes kerosene and straight-run gasoil. Kerosene can be used either as aviation fuel or as heating/cooking oil.[5] Gasoil is hydro-treated to remove close to 100% of its sulphur when destined for use as road diesel, and slightly less intensively than that for other applications, such as domestic heating oil, off-road use in agriculture and power generation. Marine gasoil is the heaviest type of gasoil and most often represents a blend of middle distillates with residual oil derivatives.

Figure 16.5 ▷ Outputs from simple distillation versus final product demand



Residual fuels can be used with little or no further processing to make heavy products such as bunker fuel, lubricants, asphalt or bitumen, or they can be partially converted into lighter products. A refinery's ability to do so depends upon its complexity. In addition to their CDUs, simple refineries might have only reformers and hydrotreaters. Complex refineries will have a range of specialised units to deal with the heavier residues. These include vacuum distillation units (VDU) that distil residual fuel oils into vacuum residue and vacuum gasoil, a feedstock for upgrading units that convert it into various combinations of gasoline, jet fuel and diesel, along with a range of by-products. Catalytic cracking units (mostly fluid catalytic cracking units [FCC]) are geared to producing gasoline; their by-products include gases, petrochemical feedstocks and light cycle oils that can be used in heating oil blending. Hydrocracking units are designed to produce ultra-low-sulphur diesel and kerosene. These units are ideal for maximising a refinery's middle distillates yield, but are generally expensive to build and operate, and require a large hydrogen supply. Another upgrading process, called coking, also produces a solid by-product called petroleum coke.

This traditional measure of a refinery's sophistication, or complexity, may need to be re-thought somewhat in the future as the crude input slate changes. With the growth in supply of lighter crudes and continued strong demand for middle distillates, there may instead be a growing call for processes that can build heavier products out of light

5. In Europe and Russia, kerosene is traditionally blended into the diesel pool to increase the volumes, and also to improve the cold properties of the latter, especially during winter.

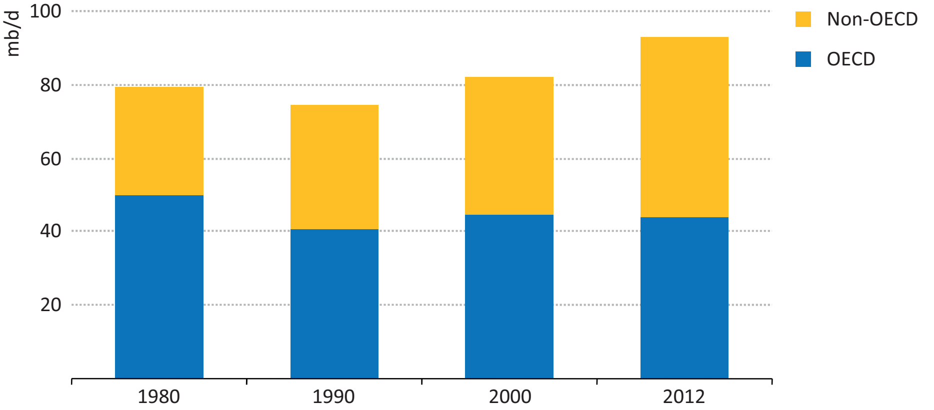
ends. In refining, breaking something down is somewhat simpler than building it up, but there are some promising technologies that can combine molecules of light products, such as LPG and naphtha, with a small number of carbon atoms to obtain heavier, more carbon-intensive products. This can be achieved by a combination of processes, known as dehydrogenation and oligomerisation, which can convert lighter products into middle distillates. The dehydrogenation process was first developed in the petrochemical industry, where it constitutes an important part of operations, and now refiners are also looking at it, in combination with oligomerisation, to enhance middle distillate yields. For the moment, there are no known commercial projects of stand-alone LPG-to-middle distillates conversion plants but, given the projected increase in LPG supply, such facilities may not be far away.[6]

Aside from their capacity to process conventional crude oil, refineries often have facilities to handle condensates. A condensate splitter, like a CDU, separates out LPG, naphtha and kerosene, with heavier condensates yielding some volumes of diesel and even residual oil. The naphtha and middle distillate fractions are reformed and hydrotreated respectively to meet gasoline and diesel specifications.

Global refining outlook

Traditionally, well-to-wheel fuel supply has involved transporting crude oil and refining it close to the point of consumption, as products are transported in smaller vessels, compared with crude oil, and thus incur higher shipping costs. The present distribution of refinery capacity between OECD and non-OECD countries, therefore, broadly matches their respective shares of oil products consumption (Figure 16.6). As of 2012, non-OECD countries account for just under half of global oil use, and just over half of refinery capacity.

Figure 16.6 ▷ World refining capacity*



* CDU and condensate splitter capacity.

6. The projections foresee stand-alone facilities appearing in North America and Middle East, as well as such processes integrated within refineries to enhance middle distillate yields at the expense of refinery produced LPG and naphtha.

This traditional model remains fundamental to the projections: oil-importing regions maintain or build refinery capacity roughly to match their internal product demand, preferring reliance on imported crude to reliance on imported products. In some cases, investments are made in order to develop (or sustain) oil product exports. The consequences are that, with the shift of the main demand centres towards Asia and the Middle East, refining capacity builds up in these regions, while, in many of the historically dominant refining industries in OECD countries, declining domestic demand and competition in export markets cause shutdowns. However, some major oil-producing countries, building on a trend that is already apparent, become important refining centres, not only to cover growing domestic demand but also to capture the added value from exports of refined products. A related motivation is to expand into the highly specialised petrochemical business that, although not particularly labour-intensive, generates much-needed jobs for fast-growing populations (and provides a degree of diversification for economies that are often very dependent on crude oil exports).

Aside from the changing composition of refining feedstocks, refiners also have to adapt to the shifting patterns of global demand for oil products, described in Chapter 15. By 2035, these result in an increase in the share of middle distillates (diesel plus kerosene) in world consumption from 37% to almost 40%, as well as an increase for light petrochemical feedstocks, such as ethane and LPG (which increase their total share of global demand by 0.8 percentage points). By contrast, the share of other light ends – gasoline and naphtha – declines by 0.5 percentage points. The share of fuel oil falls from 9% to 7% even without a switch away from fuel oil use in bunkers. This means that refiners have to shift the product slate away both from the refinery light ends (naphtha and gasoline) and the heavy ends (fuel oil) towards the middle distillates. This is achieved by deploying additional hydrocrackers and, in places, oligomerisation technologies, with the result that global yields of middle distillates increase from an average of 41.4% in 2012 to 42.9% in 2020 and 44.4% in 2035. Over the same period, gasoline and naphtha yields decline from 33.7% to 32.8% and those of fuel oil fall by two percentage points to 9%. These changes play an important role in dictating the pattern of refinery investment.

Another challenge that refiners face in many parts of the world is the need to meet higher standards of product quality and environmental performance. In OECD and other mature demand markets with stricter regulations, the investments focus on upgrading secondary units and processes for fine-tuning product specifications. In emerging markets, where mandatory product quality specifications are less stringent and product demand is growing, the investments are more balanced between distillation and upgrading units.

The survival of refineries ultimately depends on their profitability, the margin earned depending on crude purchase and transportation costs, the costs incurred during processing and the value of the various products in the market. These can vary from refinery to refinery, but regional indicative margins give a broad idea about the state of the industry in different parts of the world.[7] Refinery margins tend to have both a cyclical and seasonal nature, but they ultimately depend on demand for products from the world economy and demand for crude oil from competing refiners. While such indicators can be used in short-term analysis of the refinery sector as a guide to the overall state of the sector, the focus here is on their long-term drivers that provide the fundamentals for the refinery sector: regional and global oil product demand, the availability of crude oil and projected refining capacity.

Capacity

As of 2012, global refinery capacity stood at 93 mb/d while refinery runs were under 78 mb/d. However, this does not mean that there was 15 mb/d of excess capacity: refineries need operational downtime for repairs and maintenance, usually put at around 5% of capacity. We have a higher downtime assumption, at 14%, to take into account not only scheduled maintenance, but also temporary run-cuts in lower margin environments as well as emergency closures due to natural catastrophes and industrial accidents.[8] By this measure, the "real" excess capacity is far from 15 mb/d, but is still a quite significant 4.8 mb/d, almost equal to India's current refinery capacity.

Despite this existing overhang, there is no shortage of countries planning to add refining capacity. Over 10 mb/d of new refinery projects have been announced by countries around the world, even after excluding some of the more speculative projects. We have made a critical assessment of the announced projects in order to identify those that we consider very likely to go ahead, from which the assumption is derived that 7.4 mb/d in net refining capacity is added over the period to 2020 (after offsetting announced shutdowns over this period). After 2020, a further 5.8 mb/d of refinery capacity is added in selected regions between 2020 and 2035.

In the New Policies Scenario, the projections suggest that, over the period to 2035, some 9.5 mb/d of global capacity is "at risk" of permanent shutdown, up from 4.8 mb/d today (Table 16.2).[9] This capacity is not removed from our calculations (beyond closures that have already been announced) so that, in our model, the refinery sector is balanced instead via lower utilisation rates. But, in practice, the implication of the projections is that at

7. Calculation of indicative margins is currently limited to areas where there is an open spot market to determine product and crude prices and where price assessment agencies publish feedstock and product price sets. These are the North-West Europe (NWE), Mediterranean (MED), Singapore and US Gulf coast, Midcontinent and New York Harbour trading hubs. Estimates of margins for Russian, Middle East, Indian, Chinese or other regional refiners are approximations, often defined as netbacks from international markets.

8. In regions where refineries have historically run between 90-100% of nameplate capacity, we assume zero excess capacity (rather than negative).

9. Our assumption of global capacity additions in the New Policies Scenario is conservative, compared with the volume of announced projects, but it remains sufficient in the aggregate to cater for the higher oil demand and, correspondingly, higher refined product demand of the Current Policies Scenario. In this scenario, required refinery throughputs are significantly higher than in the New Policies Scenario, at 84 mb/d in 2020 and 94 mb/d by 2035, but still 10-12% below the nameplate capacity that accumulates in the New Policies Scenario.

least some of this capacity is likely to face closure before 2035. In our assessment, the largest reductions in refinery runs occur in Europe and North America, both regions with significant projected declines in oil consumption. The decline in refinery runs in Europe is larger, relative to the size of the decline in demand, because many North American refiners benefit from access to lower priced locally produced oil.

Table 16.2 ▹ World refining capacity and refinery runs in the New Policies Scenario (mb/d)

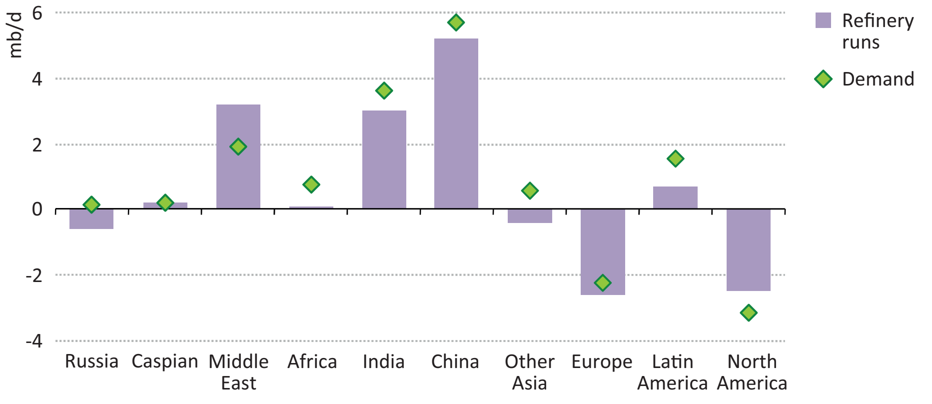
	2012 Capacity	Capacity additions to 2035	Refinery runs			Capacity at risk		
			2012	2020	2035	2012	2020	2035
Europe	17.2	0.2	13.7	12.0	11.1	1.3	3.5	4.5
North America	20.9	0.3	19.0	18.4	16.5	-	-	2.0
China	11.7	4.7	9.1	12.2	14.4	1.0	0.6	-
India	4.4	2.6	4.0	4.9	7.0	-	-	-
OECD Asia	8.1	-0.7	6.7	6.3	5.7	0.3	0.1	0.9
ASEAN	4.8	0.4	4.0	4.0	4.6	0.2	0.4	-
Russia	5.7	0.2	5.3	5.1	4.7	-	0.1	0.5
Middle East	7.6	3.4	6.7	9.1	9.9	-	-	-
Brazil	2.0	1.4	2.0	2.6	3.4	-	-	-
Others	10.3	0.5	7.2	7.7	7.8	1.9	1.7	1.7
Total	**92.8**	**13.1**	**77.7**	**82.3**	**85.2**	**4.8**	**6.3**	**9.5**

Note: "Capacity at risk" is defined for each region as the difference between refinery capacity, on one hand, and refinery runs, on the other, with the latter including a 14% allowance for downtime.

The need to cut capacity in some regions is accompanied by continued growth in capacity in others, where growth in product demand outstrips refining capacity to a significant extent. Most of the assumed 13.1 mb/d of capacity additions are in China, India and the Middle East. Brazil dominates in the refinery construction in South America (see Chapter 10), while other crude oil exporters in Africa, the Caspian region and Russia add less than 1 mb/d of capacity in total. Despite the large capacity additions in China and India, both of these countries are net importers of petroleum products in 2035, as capacity additions slightly lag the projected growth in demand. New refineries in the Middle East reflect the ambition of key producers in this region to become significant product exporters, although almost 80% of the additional capacity by 2035 serves to cover increased oil consumption within the region.

The implications for refinery runs are not limited entirely to net importing regions with declining demand. There are two considerations driving the projections for refinery runs – the dynamics of regional demand, *i.e.* the domestic market for refined products in each of the regions; and the developments in local crude supply that determine reliance on imported crude for the refining sector. Thus, lower utilisation rates and potential refinery shutdowns also concern some oil-exporting countries, for example Russia, where local oil production declines.

Figure 16.7 ▷ Changes in refinery runs and changes in demand in the New Policies Scenario, 2012-2035



Refining sector outlook by region

The countries and regions analysed can usefully be divided into four categories, depending on their current roles in global crude and products trade (Figure 16.8).

I. Net importers both of crude oil and of refined products (Group I): these currently are Europe, China and many other parts of Asia, including ASEAN and Japan. In the case of China and Europe, both are large net importers of crude oil. China, although it has recently become self-sufficient in gasoline and diesel, imports larger volumes of fuel oil, some of which goes into teapot refineries as their main feedstock. Europe still imports more distillates than it exports gasoline.

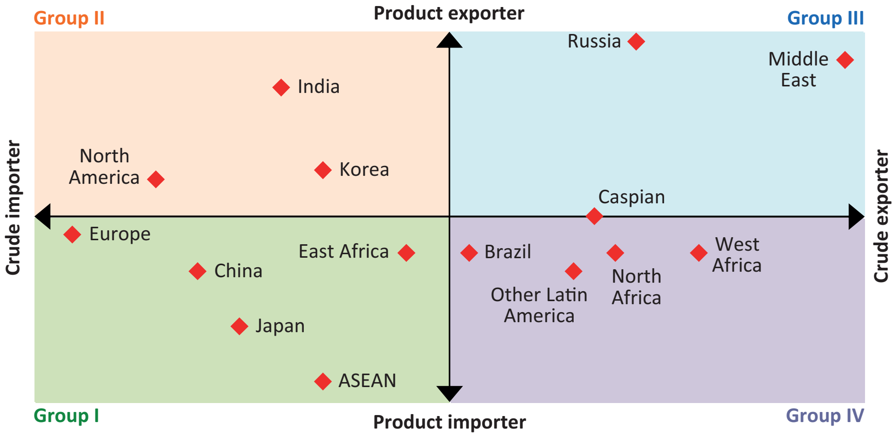
II. Net importers of crude oil that are net exporters of oil products (Group II): these include North America, India and Korea.

III. Net exporters both of crude oil and oil products (Group III): this is where many hydrocarbon resource-holding countries declare that they want to be, although currently only Russia and the Middle East occupy this quadrant. Aside from crude oil, Russia exports mostly diesel and fuel oil. The Middle East as a whole is a net exporter of kerosene and naphtha.

IV. Net exporters of crude oil that are net importers of refined products (Group IV) (all of the other crude exporting regions are in this group): Latin America (including Brazil), the Caspian, North and West Africa, none of which has yet become self-sufficient in oil products.

The regional analysis starts by looking at Europe and North America, historically the largest refining centres in the world, where the fortunes of the refining industry diverge in the projections, even though demand in both of these regions follows the same downward trajectory. Europe remains a net importer of both crude and oil products, while North America makes a major transition over the period to 2035, all but removing its need for net crude imports and becoming a significant net exporter of oil products (in the process getting very close to moving into Group III).

Figure 16.8 ▷ Selected regions shown by their net trade position in crude oil and oil products, 2012



Notes: The position of countries on each axis provides an indicative sense of their trading volume relative to the largest importer or exporter. The East African net crude import position is due to inclusion of South Africa. Oil products include both refinery and NGL fractionation products.

This is followed by a review of other net crude importing regions, notably those in Asia, where demand and refinery capacity is on the increase. The most dramatic change here is the loss by India of its position as a net exporter of oil products: it joins the group of net importers of crude and products (Group I). In addition, we examine the outlook for the various regions that are net exporters of crude oil and the way that their crude and product flows evolve. Here, the only significant change is with Brazil obtaining product self-sufficiency and increasing its ranking as a crude oil exporter.

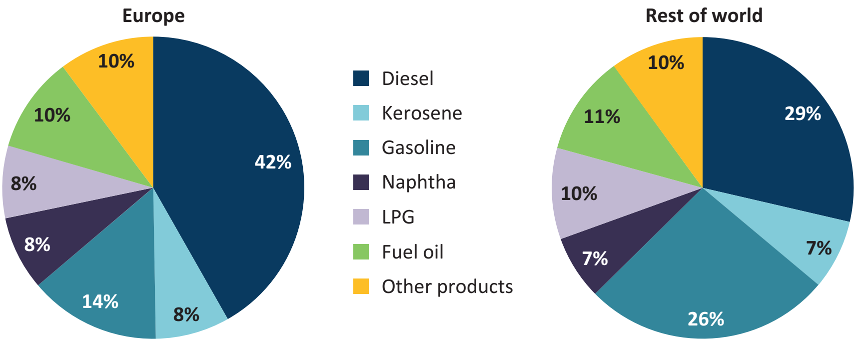
Europe

In the *Outlook*, the European refining sector (encompassing both OECD and non-OECD Europe) continues to face the most acute challenges in the global refining sector. Refinery shutdowns have already become a feature of the European landscape: of the 4 mb/d of refining capacity that has been permanently shut down worldwide over the last five years, half was in Europe.[10] But despite these reductions, European refining capacity is still well above the continent's demand for refined products. This would not in itself be a problem if European refiners had access both to sufficient crude oil and to sufficient product export opportunities. However, Europe is being squeezed on both these counts, and it is anticipated that trends will continue to work against the European refining sector over the coming decades.

10. Table 16.2 shows a 200 thousand barrel per day addition to refining capacity in Europe. This is a refinery project in Turkey, being built by Azerbaijan's state-owned oil company. The refinery is already under construction, and we assume it will be completed.

One reason for Europe's refining woes is a pronounced imbalance in European demand for refined products, with diesel accounting for an unusually high share of consumption (Figure 16.9). Since the end of the 1990s, European gasoline consumption has decreased by about 1.2 mb/d, but diesel demand has increased by a similar amount, turning Europe into the biggest importer of diesel and the largest exporter of gasoline in the world. This situation is largely a result of government policies, notably fuel taxation, which have stimulated diesel consumption over gasoline. In the projections, total European oil product demand declines by 2.4 mb/d by 2035, but middle distillates retain their dominant position in the mix, their share of total product demand growing from 50% to 55%.

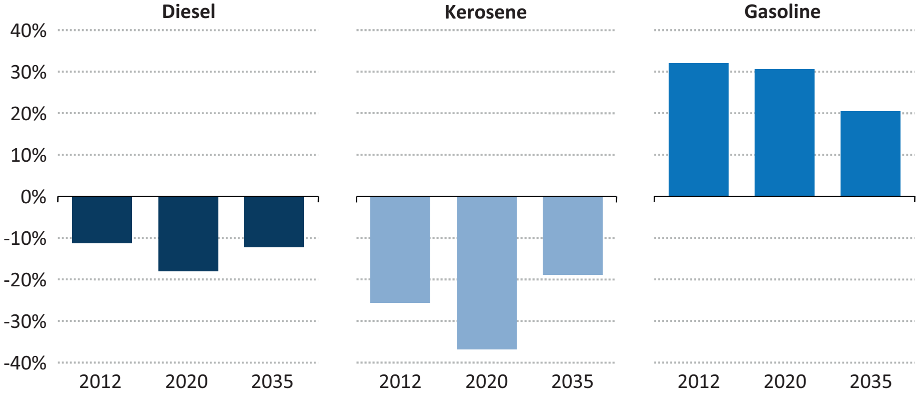
Figure 16.9 ▷ European product demand split compared with the rest of the world, 2012



Imbalances in demand for different products can in many instances be managed by the refinery industry through short-term measures such as adjustments to operating unit parameters and choice of catalysts or, in the longer term, by actions such as investment in specialised refining units that can alter the yields of products. However, the scope for this in Europe is limited: having added hydrocrackers and hydrotreaters since the end of the 1990s, European refineries already have one of the highest diesel yields in the world, with an average 40% yield of diesel and only 22.6% of gasoline. The projections include an increase in the total yield of middle distillates from an average of 46.6% in 2012 up to 52.5% in 2035, primarily at the expense of gasoline yields that go down by 7.4 percentage points to a very low 15.1% (a necessary decrease given the anaemic domestic demand and the limited export outlets for European gasoline). This assumes shutdown of refineries that have the lowest middle distillates yield (which often coincides with the highest gasoline yields), and deployment of the most advanced of today's refining technologies, including incorporation of oligomerisation processes within some refineries. However, these are very capital-intensive projects that could prove to be beyond the reach of many of European refiners, especially in the light of the generally unfavourable margin environment since 2009. If there is no shift in refinery yields, and no reversal in policies that favour diesel use over gasoline, then a further 2-3 mb/d of refinery runs in Europe would be at risk.

Even with the move to higher diesel and lower gasoline yields, Europe's dependence on imports of diesel and jet fuel (imports as a share of total demand) grows substantially by 2020, while its surplus of gasoline for export (as a share of refinery gasoline output) recedes only very slightly (Figure 16.10). By 2035, this share of gasoline exports remains relatively high, while dependence on imported diesel is at the same level as in 2012 because European demand for diesel falls.

Figure 16.10 ▷ European dependence on trade for selected transport fuels in the New Policies Scenario



Note: Negative numbers show the share of imports in total consumption; positive numbers show the share of exports in refinery output.

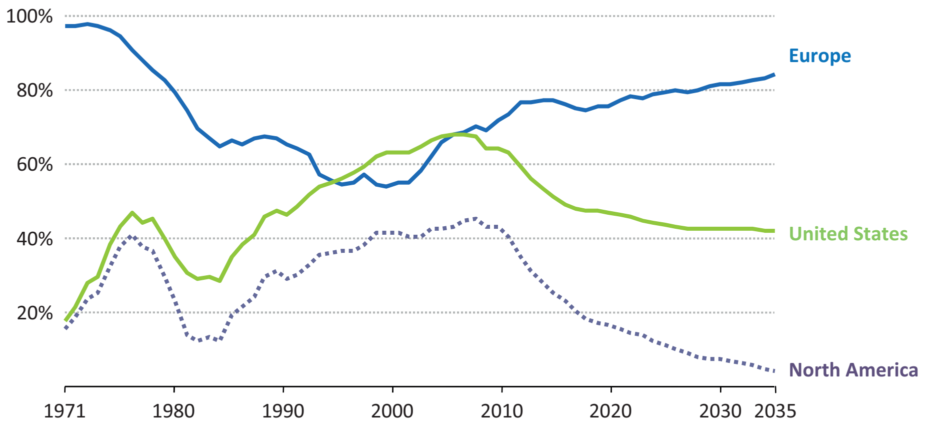
The current lifeline for European refining is the export of excess gasoline to the northeast of the United States and, for lower grades of gasoline and naphtha, to West Africa. These exports have been declining since 2006 and we see export opportunities closing further over the projection period. With declining US gasoline demand and increasing production from US Gulf Coast refineries, it is only a matter of time before the product deficit in northeast North America is covered from domestic refineries. Currently infrastructure bottlenecks and the Jones Act[11] slow this process, but it is assumed that large-scale solutions for supplying the northeast of the United States and Canada from the Gulf Coast will not be long delayed, eventually turning the North American region into a substantial net exporter of gasoline. Gasoline exported from the Gulf Coast refineries is already making its way to West Africa. This may be the final blow for those European refineries whose margins cannot survive without sustained gasoline export outlets.

A second cause of concern for European refining is increasing reliance on imported crude, a dependence that is expected to reach over 80% by the end of the projection period (Figure 16.11). This is significant because it occurs in a broader context of increased

11. The Jones Act restricts cabotage activities, *i.e.* coastal navigation between two US ports, to only vessels built in the United States, owned by US entities and manned by US citizens or permanent residents, thus generally raising its cost relative to international shipping that is not subject to such restrictions.

competition for crude in international markets, in which refining margins may come under pressure from even slight increases in transportation costs. One contributing factor, specific to Europe, is that Russia has been reducing exports of crude oil via the Black Sea and the westward Druzhba export system, routes that bring crude oil to dozens of refineries in the Mediterranean region and Central Europe. These deliveries have halved to only 600 thousand barrels per day (kb/d) since 2007 and increased flows through the new Baltic export system have not fully compensated for this fall. The main reason for this decline, up until now, has been an increase in Russian refinery runs, which have boosted Russian product exports (another blow to European refinery margins). The diversion of Russian crude for eastern export has, thus far, been a minor additional factor, but a new 25-year agreement between Rosneft and China National Petroleum Company (CNPC) to increase supplies of Russian crude to China (through the direct ESPO pipeline link, various rail links and possibly through swaps with Kazakhstan), means that diversion of Russian crude oil is set to become a more important consideration over the coming decades.

Figure 16.11 ▷ Share of imported crude in North American and European refinery runs



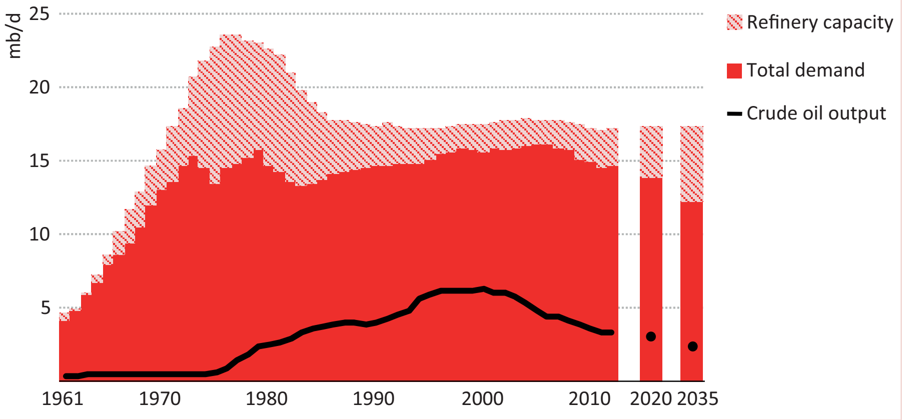
Notes: The graph shows US import reliance as a function of crude oil produced in the United States (excluding NGLs) and US refinery runs. Thanks to Canadian and Mexican exports to the United States, in practice, the reliance of the United States on crude oil imports from other regions is smaller.

By the mid-2020s, it is estimated that the availability of crude oil to Europe from its traditional sources of supply will have declined by 2.1 mb/d, as North Sea oil output and Russian exports decline. The European refining industry has faced difficult times before (Box 16.1), but this combination of declining domestic crude output, more competition from refiners elsewhere for internationally traded crude, loss of gasoline export markets and continued dieselisation at home adds up to a very challenging environment ahead. In the projections, the net result is that European refinery runs by 2035 decline by 2.6 mb/d, more than the 2.4 mb/d reduction in European demand.

Box 16.1 ▷ Is history repeating itself for European refining?

The current over-hang of capacity in European refining has more than a few echoes of the situation that faced the industry in the 1970s. At its peak, in the mid-1970s, Europe had over 23 mb/d of refining capacity (almost one-third of global capacity at the time), with an astonishing 7 mb/d excess compared with European demand for oil products. This gap had arisen because of a frenetic expansion in refinery capacity that started in the late 1960s, all in anticipation of demand growth that failed to materialise (Pinder, 1986). A rise in European natural gas production and the arrival of gas imports from the Soviet Union in the early 1970s gradually reduced demand for fuel oil, which was the most important product of European refineries at the time. The oil price shocks of the 1970s also held back oil consumption, while prompting policy efforts on efficiency and diversification (such as the wider deployment of nuclear power) that switched demand away from oil-derived fuels.

Figure 16.12 ▷ European refining capacity, demand and oil production in the New Policies Scenario



Sources: BP (2013) and OPEC (1982).

By the mid-1980s, European countries had shed some 5 mb/d of capacity and increased utilisation rates from 65% to a more sustainable 75%. The current refining capacity of France, Italy and the United Kingdom is only half of its peak in the 1970s. Although this was a dramatic turn for the industry, it could have been even more severe had it not been for the rise of North Sea oil production, which helped to reduce reliance on imported crude oil from nearly 100% in the beginning of the 1970s to less than 60% in the mid-1990s.

North America

Almost all OECD countries see declining or relatively flat oil demand in the New Policies Scenario, but North America (the United States, Canada, and Mexico) is the only region where the oil production rises significantly. The robust availability of local crude for a large refining sector and the availability of cheaper natural gas for refinery fuel mean that this region becomes an important product exporter to the rest of the world in the projections. North America is already supplying Europe and South America with middle distillates and, by mid-2020s, it also switches from net gasoline imports to net gasoline exports.

The share of imported crude in refinery intake in North America has historically been low compared to Europe, but reliance on imports started to rise in the 1980s as domestic output fell increasingly far behind rising oil consumption. For around ten years, from the mid-1990s, refineries in the United States were more reliant on imported crude even than their European counterparts, whose access to crude was temporarily bolstered by North Sea output (Figure 16.11). Since 2007 the picture has switched again, with the import reliance of the US refining sector declining, a trend that is expected to continue throughout the projection period.

Not all refineries in North America are in a position to benefit from rising domestic oil output. In the projections, crude and condensate output in this region plateaus at 15.5 mb/d, while refinery capacity is over 20 mb/d. In the United States, which has the lion's share of the region's refining capacity at over 17 mb/d, crude and condensate output peaks at 8.4 mb/d in the second half of 2020s.[12] This, with domestic infrastructure constraints, means that some refineries along the east and west coasts of the continent continue to rely mostly on imported crude (although LTO from the Bakken play is already reaching both the east coast and west coasts [PADD 1 and PADD 5]).[13] These import-dependent refineries are squeezed from two directions in the projections: by competition from other refiners for available crude, both domestic and imported and by competition in domestic product markets from better-placed refiners in the Gulf Coast and midcontinent. For this reason, lower refinery runs are projected in the North American region, to the tune of 2.5 mb/d by 2035, with capacity rationalisation most likely in the periphery of the system along the United States and Canadian east coast and the US west coast.

Increasing production in North America does present certain challenges, even to those domestic refiners with reasonably easy access to it. All of the increase in crude supply comes from Canadian oil sands and LTO in the United States, the most vivid regional example of the bifurcation in crude supply described at the start of this chapter. These two types of feedstocks both require special facilities to extract best value from the crude: cokers and topping units respectively.[14] If a refinery has been constructed mostly to process heavy crude oil, it can still process very light crudes, but at lower utilisation rates as it may not have the necessary scale of downstream equipment for evacuating and treating the very light components (such as LPG and light naphthas) that make up a higher proportion of the

12. NGLs in North America bypass the refining sector and are therefore not included in crude oil supply volumes.

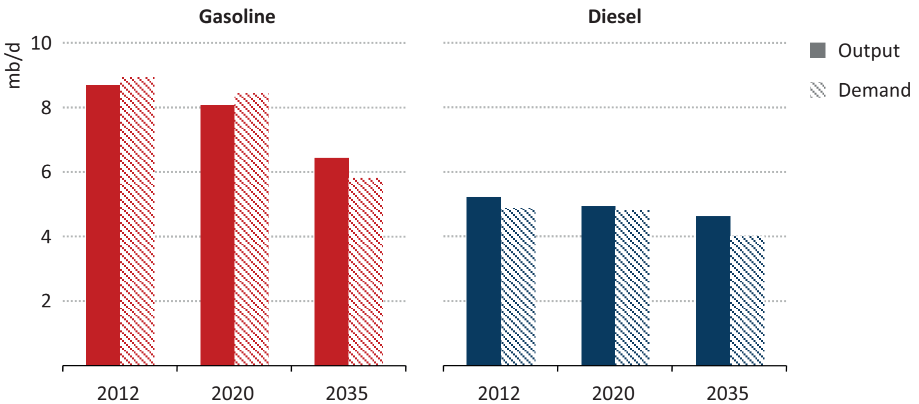
13. The US Department of Energy splits US territories into five Petroleum Administration for Defence Districts, (PADD), for petroleum analysis purposes. PADD 1 is generally the US east coast, and PADD 5 is the US west coast with Hawaii and Alaska.

14. Cokers break extra-heavy oil into lighter products such as diesel and gasoline. Topping units boil off gaseous overheads of extra light crude oil and condensate before they enter main refining operations.

very light crudes. The short-term dilemma facing the owners of highly complex refineries is whether to under-utilise capacity, using cheaper domestic crude or continue importing (more expensive) heavy crude at international prices.

Over the coming years, it is anticipated that the North American refining industry adjusts to cater to the new balance of feedstocks. There is a growing interest in processing local light crude, with refiners and midstream operators announcing plans to add condensate splitters, topping units, pipelines, storage units to existing refineries or construct greenfield facilities in the Gulf Coast to refine lighter crudes and export the products. In the absence of any indications to the contrary, it is assumed that the existing ban on crude oil exports in the United States will remain in place. But we also see that these planned investments, once made, are set to diminish the economic case for exports. At the same time, some of the more complex refineries are expected to continue importing heavier crudes from other countries in the American continent or the Middle East.

Figure 16.13 ▷ North American gasoline and diesel balances in the New Policies Scenario



Canadian extra-heavy oil is refined mostly in the United States in the *Outlook*, exported there as syncrude (synthetic crude produced from bitumen in upgraders), diluted bitumen (dilbit)[15] or pure bitumen. This results in fewer straight-run middle distillates, but the impact on diesel output is offset in the projections by the installation of more hydrocrackers (increasing diesel yields and bringing down currently high gasoline yields). Even with these lower gasoline yields, which decline by around seven percentage points to 39% by 2035, the gasoline balance for the North American region still switches into surplus, as the decline in demand outstrips the reduction in supply (Figure 16.13), although the current debate in the United States about a possible revision of the Renewable Fuel Standard could affect the long-term projections for ethanol and gasoline balances (see Chapter 6). In addition to the switch in gasoline to diesel yields, another

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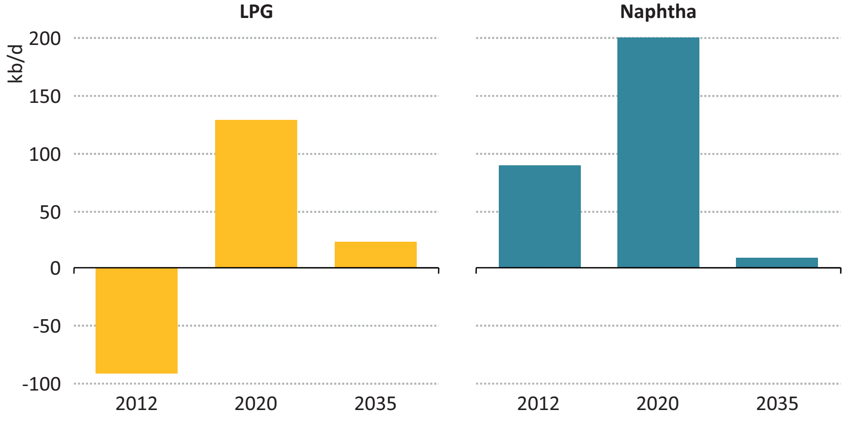
15. Dilbit, which is a mixture of bitumen and diluents such as natural gasoline or butanes, is difficult to refine, yielding relatively lower volumes of middle distillates but higher proportions of heavy residue and gases. This consideration is taken into account in projecting refinery yields.

boost to diesel output comes from stand-alone oligomerisation projects that start by the end of this decade, reaching 70 kb/d of output capacity by 2035 and utilising propane to produce middle distillates.

A final aspect of the product outlook for North America is the way that the increase in production of NGLs and lighter crude oils affects the balances of LPG and naphtha. Although these are eventually absorbed by an increase in feedstock demand from the petrochemical industry, this takes time. In the interim, around 2020, North America becomes a significant net exporter of LPG and naphtha (Figure 16.14).

Figure 16.14 ▷ North American trade of LPG and naphtha in the New Policies Scenario



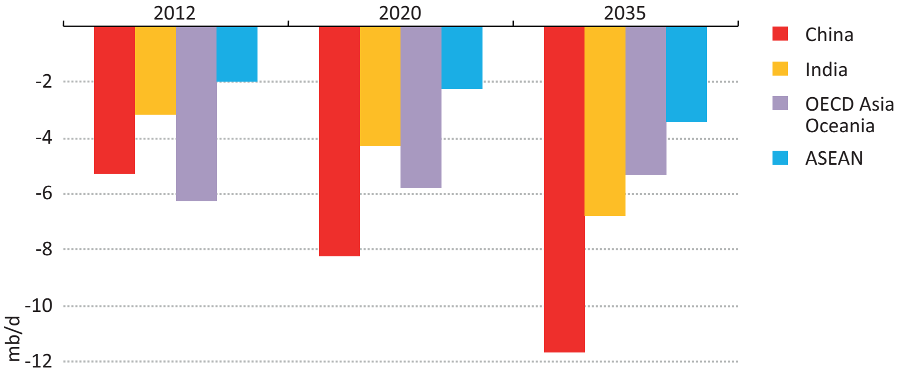
Note: Positive balances denote exports; negative balances denote imports.

The crude oil balance of North America shows the most dramatic improvement of any of the regions analysed. By 2035, North America's net import requirement for crude oil drops to just 400 kb/d, down from 6 mb/d in 2012. Half of this decline takes place before 2020, during which time the net import requirement already falls to less than 3 mb/d. This fall does not mean that crude oil trade with the rest of the world dries up to the same extent. It is more likely that some North American crude, such as Canadian production, will find its way to refiners in Asia, while the United States will continue importing a variety of crudes from different international sources, mostly due to individual refinery preferences for specific crudes, especially in cases where refineries are owned by foreign large oil-producing nations such as Venezuela or Saudi Arabia. There is also the possibility that some Mexican exports may be re-routed to markets outside the region.

Asia

Asia is the destination for the largest share of crude oil traded internationally. In 2012, over 17 mb/d of crude oil from other regions went to the major refining centres of Asia – India, China, Japan, Korea, Singapore and Chinese Taipei. In the New Policies Scenario, this figure rises to 28 mb/d by 2035, to feed the expansion in refining capacity (notably in China and India) and to compensate for the decline in regional oil output (2.5 mb/d across Asia as a whole). The Asian region is, though, far from homogenous and the refining sectors of different countries evolve in different ways.

Figure 16.15 ▷ Crude oil trade in selected Asian countries and regions in the New Policies Scenario



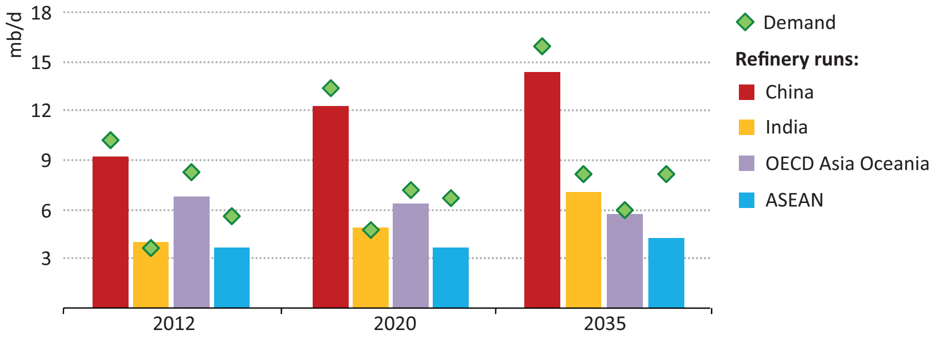
Note: Negative balances denote imports.

The projections take into account a loss of 0.7 mb/d of refining capacity in Asia, mostly in Japan, (where already mandated shutdowns account for 500 kb/d), a planned shutdown in Chinese Taipei and in Australia, where oil majors have started to exit refinery operations. Continued pressure on refining margins and utilisation rates is seen in many of the OECD markets, where demand is declining, although the Korean refining industry is anticipated to be relatively resilient because of its strong integration with petrochemicals and its ability to export valuable middle distillates. By contrast, Japanese refinery runs decline, in part due to the announced government initiative to discontinue the use of excess topping units (to increase the complexity of the remaining capacity), but also because demand in Japan declines by 1.8 mb/d to 2035, or by 2% annually, a faster rate than elsewhere in the OECD. In ASEAN countries, 450 kb/d of capacity is added and utilisation rates rise.

Capacity additions in China and India exceed those of any other country in the region and in the world, reflecting the strong growth in demand for oil products in both countries. In India, current refinery capacity (4.4 mb/d) is increased by 500 kb/d over the period to 2020 and a further 2.2 mb/d by 2035. China's refinery capacity, currently 11.7 mb/d, rises by 3.2 mb/d over the period to 2020 and another 1.5 mb/d by the end of the projection period.[16] Together, China and India more than double their crude oil imports, reaching a combined import volume of 18.5 mb/d in 2035.

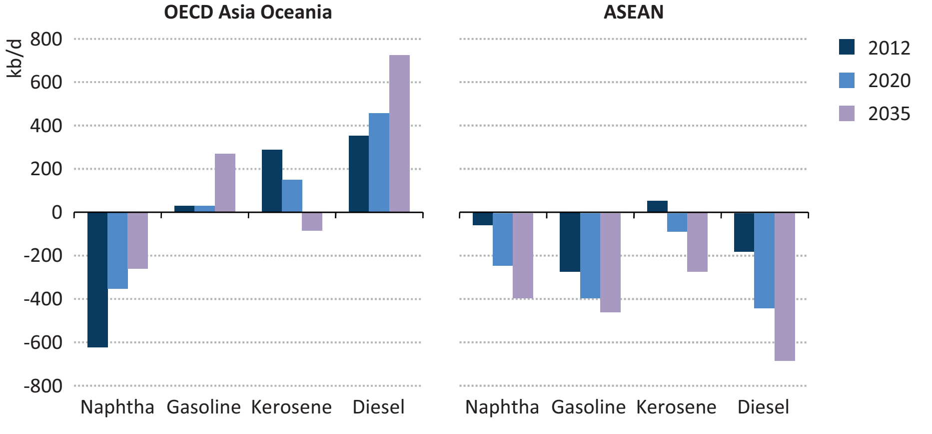
16. Our starting point for total Chinese capacity does not include teapot refineries that use fuel oil as feedstock and hence are not crude consumers. It also lowers the nameplate capacity of small-scale independent refiners that have operated at just 20-30% utilisation rates. Chinese fuel-oil teapot refineries are expected to gradually shut down by 2020, losing market share to newly built capacity.

Figure 16.16 ▷ **Refinery runs and demand in selected Asian countries and regions in the New Policies Scenario**



These capacity additions lag behind the increases in oil product demand in both countries (which rises by 4.5 mb/d to 2035 in India and by 5.8 mb/d in China). India remains a significant exporter of oil products in the medium term, but this situation is reversed in the latter part of the projection period as it becomes the single largest source of global oil consumption growth. By 2035, India is a net importer of oil products. China continues to rely on net product imports throughout the period to 2035, as rising demand absorbs all of the output from newly built refinery capacity. Combined net product imports of China and India are around 1 mb/d in 2035.

Figure 16.17 ▷ **Oil product trade balance in selected Asian regions in the New Policies Scenario**



Note: Positive balances denote exports; negative balances denote imports.

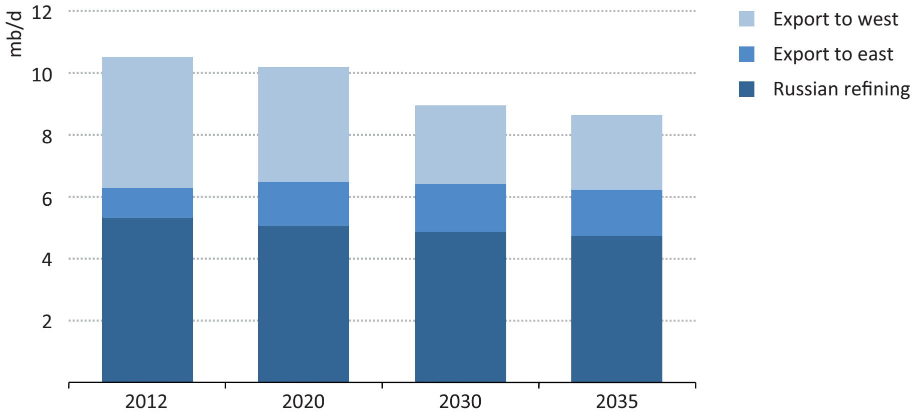
The outlook for OECD Asia Oceania and for ASEAN shows some significant changes in total product balances (Figure 16.17). The OECD grouping manages to increase exports over the period, as its own domestic demand declines, freeing up product to supply to the large and growing demand centres elsewhere in Asia. In ASEAN, growing refinery runs do not keep pace with the increase in consumption, leading to an increase in imports of both crude and products.

Russia

As well as being a major exporter of crude oil, Russia is currently the largest net exporter of refined products, exporting large volumes of diesel, naphtha and fuel oil and importing only some gasoline from Belarus.[17] Judging by the pronouncements of other oil-exporting countries, this appears to be a model that many would like to emulate, but in the projections only the Middle East does so, in aggregate. In the *Outlook*, the composition of Russia's product exports changes over time, with a falling share of fuel oil and a higher share of more valuable transport fuels.

The post-Soviet resurgence of oil production in the mid-2000s initially resulted in an increase in exports of crude oil, but a change in the system of export duties subsequently created more favourable conditions for refining at home. The intention had been to incentivise investment in refinery upgrades, but what happened in practice was that crude runs in old refineries rose again, mostly at simple refineries with high fuel oil yields, and numerous small and very simple teapot refineries appeared along the oil export pipelines. As a result, instead of increasing export only of higher margin products, Russia became a very large exporter of relatively low-value fuel oil: Russian fuel oil exports were 1 mb/d in 2012, larger than the crude oil exports of countries like Oman and Qatar.

Figure 16.18 ▷ Allocation of Russian crude oil and condensate production in the New Policies Scenario



Over the projection period, Russian crude oil and condensate production declines from about 10.6 mb/d in 2012 to 9 mb/d in 2035. This decrease has to be felt somewhere; either in crude exports (to east or west) or in the amount of crude flowing to domestic refineries.

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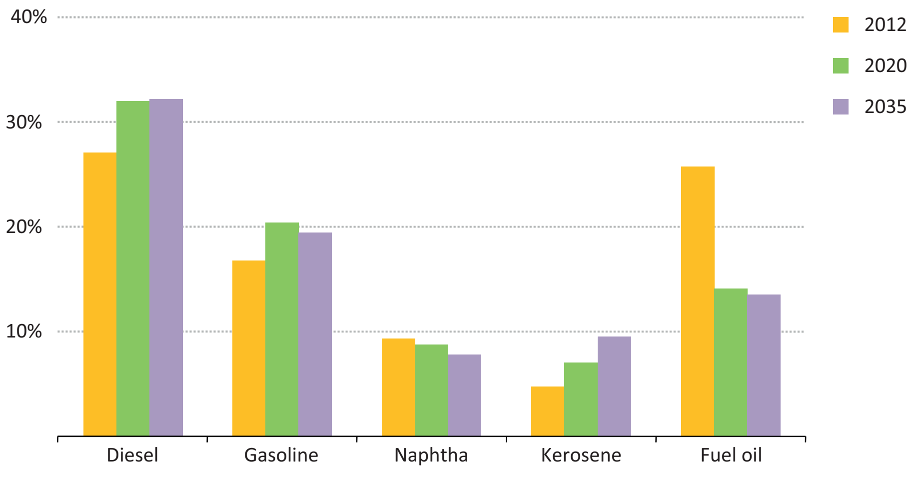
17. If LPG exports are added to the mix, then the Middle East catches up with Russia as an exporter of total oil products, but Russia is a larger exporter of refined products.

Almost all of Russia's refineries, except two in the far east, feed from the pipelines that also supply the western export routes. Since east-bound crude oil exports are set to rise, for strategic as well as commercial reasons, the supply of crude to the western part of the system is expected to be affected, with Russian refiners winning out against crude exports.

Figure 16.19 ▷ Main oil product yields in Russian refineries in the New Policies Scenario

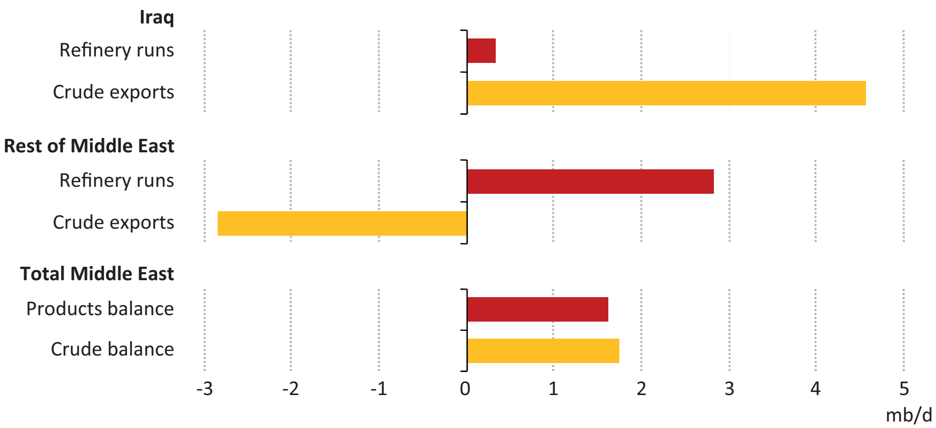


In practice, fiscal policy will play a major role in the allocation of crude between exports and domestic refining and in the composition of Russian product exports. The process of re-balancing oil export taxes that started in 2011 will take a few years to complete, but is expected to disadvantage the least efficient refiners by discouraging fuel oil exports (and reducing refinery runs as a result). Fuel oil exports reduced also because capacity is upgraded at bigger and more complex refineries, increasing the output of more valuable transport fuels, such as diesel, gasoline and kerosene (Figure 16.19). This investment helps to maintain Russia's diesel exports despite the decline in refinery runs, to balance the growing domestic market for gasoline and kerosene, and to meet assumed higher quality standards that are introduced for transport fuels. Russia's exports of transport fuels do not change significantly over the projection period, but those of naphtha and fuel oil decline to below half of their current volumes.

Middle East

The Middle East adds about 3.4 mb/d of refining capacity over the projection period, an increase of almost 45% over its refining capacity today. As a result, the 4.7 mb/d increase in crude and condensate output over the period to 2035 results in only a 1.7 mb/d growth in crude exports. That the Middle East sees any increase in crude exports in the projections is because of Iraq, where the increase in crude production of 4.5 mb/d over the period to 2035 is almost entirely available for export, offsetting a net decline in crude availability from other Middle Eastern countries (Figure 16.20).

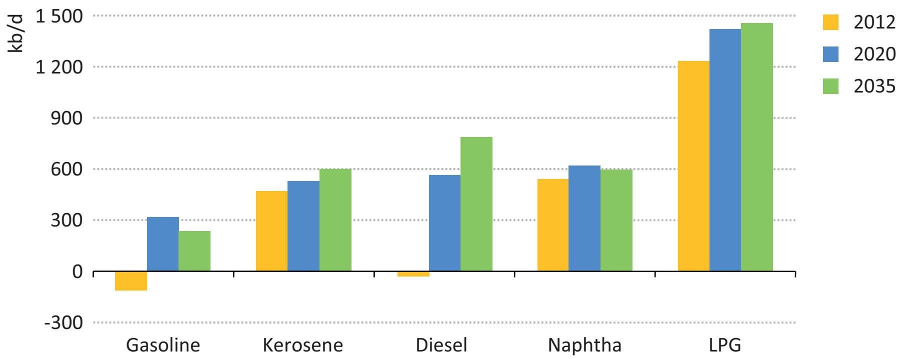
Figure 16.20 ▹ **Changes in refinery runs and exports in Iraq and the rest of the Middle East in the New Policies Scenario, 2012-2035**



Note: The figures for crude export are for crude and condensate only and exclude trade in the non-refinable portions of NGLs, which are included in total product exports.

This overview of the period to 2035 masks a very significant development in the medium term. Three-quarters of the new refinery capacity assumed to be built in the Middle East is added before 2020, outpacing growth in oil output from the region. This contributes to a decline of some 2.3 mb/d in crude oil and condensate exports from the Middle East by 2020 (before these recover later), forcing many Asian buyers to look further afield for crude supplies, to West Africa, Brazil and the Caspian, thus encroaching on Europe's traditional supply sources and potentially increasing the pressure on Europe's refining industry.

Figure 16.21 ▹ **Middle East trade of selected oil products in the New Policies Scenario**



Note: Positive balances denote exports; negative balances denote imports.

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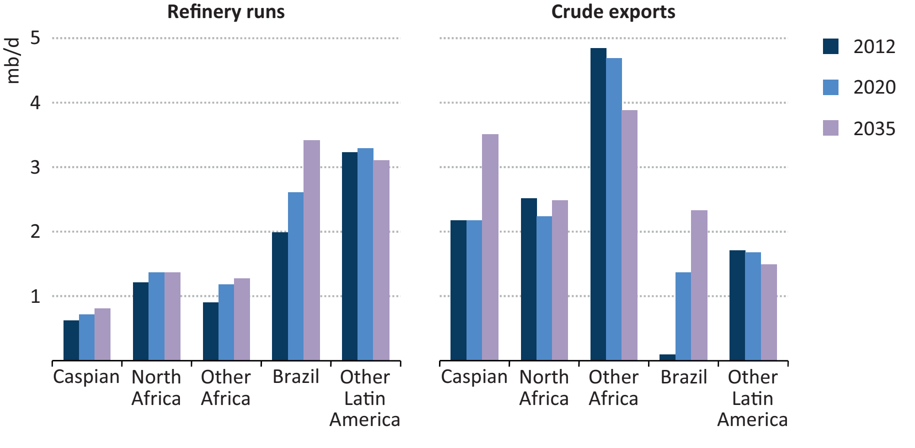
Some 80% of the additional capacity in the Middle East is used to supply incremental domestic demand by 2035, but the region also emerges as a major net exporter of oil products, adding diesel and gasoline to its usual exports of petrochemical feedstocks and kerosene (Figure 16.21). Net LPG and naphtha exports are constrained by higher feedstock demand in the region's petrochemical sector, but – in a much more significant turnaround – the Middle East switches from net imports of gasoline and diesel to net exports within the next several years.

Other crude exporters

In the projections, most of the other crude oil exporting regions do not achieve product demand self-sufficiency, let alone net product exports. In our judgement, the financial burden of sustaining and expanding upstream operations and the need for oil revenues for other social and economic purposes will severely constrain their ability to finance increasingly large refinery construction projects. The main exception is Brazil, which succeeds in constructing enough refinery capacity to catch up with product demand by around 2020 (see Chapter 10). With Brazil adding almost 1.5 mb/d of new refinery capacity over the projection period as a whole, its 3.7 mb/d rise in oil production results in only a net 2.2 mb/d addition to crude oil exports. The rest of South America, which – thanks mainly to Venezuelan volumes – is a net oil exporting region, nonetheless remains a net importer of products, as capacity additions in Colombia are more than offset by the assumed eventual closure of the Isla refinery on Curaçao. The region (excluding Brazil) sees a steady growth in dependence on imported diesel, from 470 kb/d to almost 800 kb/d, providing an outlet for North American diesel exports.

Figure 16.22 ▷ Crude export and refinery runs in selected crude oil-exporting countries and regions in the New Policies Scenario



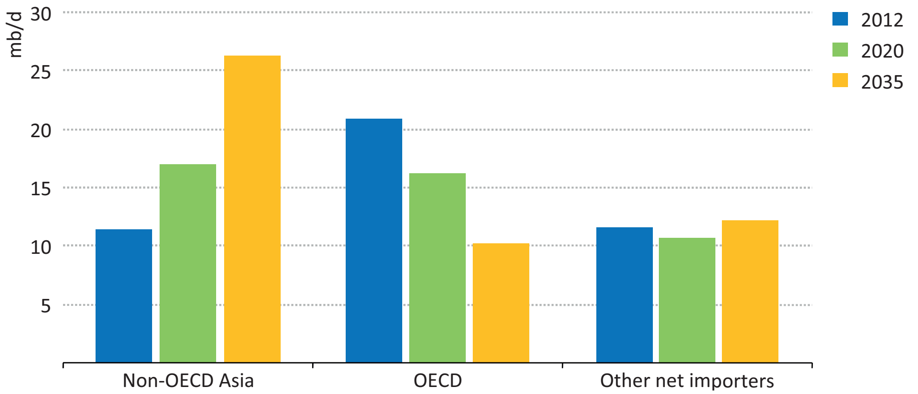
The Caspian is another region where crude output increases significantly, driven by higher output from Kazakhstan. Crude oil exports in 2035 reach 3.5 mb/d from 2.2 mb/d currently. With only one new refinery assumed to be built, in Kazakhstan, the region remains a small net product importer, supplied by Russia. It is assumed that the crude oil pipeline from Kazakhstan to China is expanded to 400 kb/d, as planned, and further to 800 kb/d by 2035, but the remaining increase in production is conveyed via other routes, notably the expanded CPC pipeline to the Black Sea and shipments via the Russian network. The export direction of a post-2020 expansion in Kazakhstan output, which should come primarily from further development phases of the Kashagan field, is open to question: the producing consortium has expressed a preference for westward routes, including via Caspian trans-shipments and the South Caucasus, but the arrival in the consortium of CNPC could shift this orientation eastwards.

West African crude oil production declines in the *Outlook* from 5.6 mb/d to 4.7 mb/d. Some 300 kb/d of refining capacity is projected to come online in the 2020s in Angola, Nigeria and Equatorial Guinea, which will meet a part of incremental product demand. However, the region remains a net importer of diesel and gasoline. East Africa sees refining capacity additions in Uganda and, possibly, South Sudan. However, it does not achieve product self-sufficiency and imports of gasoline and diesel are projected to continue. In the projections, we do not assume any net refinery capacity additions in North Africa (despite the announcements of a number of projects by governments and oil companies in the region). It remains a net product importer while crude exports from Algeria and Libya are partly offset by imports into Egypt, Tunisia and Morocco.

Oil trade

The changing geography of oil production and consumption brings with it a fundamental re-ordering of global oil trade over the coming decades. Although the growth in inter-regional oil trade (from 44 mb/d in 2012 to 49 mb/d in 2035) is broadly proportional to the growth in global oil supply, the direction of trade flows in 2035 represents a dramatic departure from the patterns seen today, a shift that has implications for the way that countries co-operate to ensure security of oil supply.

Figure 16.23 ▷ Net oil imports in selected regions in the New Policies Scenario



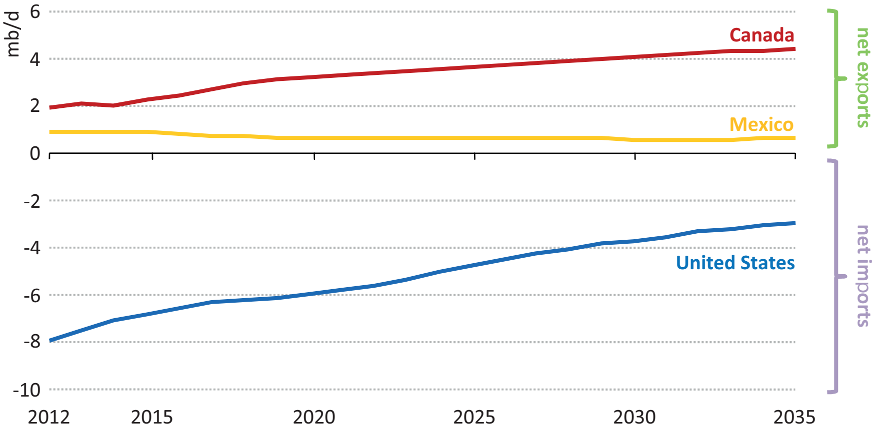
Aggregate figures for net oil imports reveal how the destination of global oil trade moves away from OECD countries towards the emerging demand centres of Asia (Figure 16.23).[18]

18. In previous *Outlooks* we referred to oil trade in net terms as the difference between total production and total demand in any given country or region; this section starts with an analysis on this basis, before proceeding to separate treatment of crude oil and oil products.

The combined net requirement for imports among non-OECD Asian countries grows by almost 15 mb/d over the period to 2035 to reach 27 mb/d, more than half of total inter-regional trade. Most of this increase comes from China (where imports grow by almost 7 mb/d), India (by 4.8 mb/d) and ASEAN (by 3 mb/d). China is in the process of overtaking the United States to become the largest net oil-importing country and its net import levels also overtake those of the European Union around 2020.

The countries of the OECD – traditionally the largest importers of oil – all see their imports decline. Their combined share of total inter-regional trade declines from around 50% today to only 20% in 2035. The fall in net oil imports is modest in European and Asian OECD countries, but is very pronounced in North America, where a 5.1 mb/d net import requirement in 2012 turns into a 1.7 mb/d net oil export position by 2035 (Figure 16.24). This 6.8 mb/d turnaround in North America is attributable in part to increased oil production (which rises by 3.8 mb/d), but also to reduced oil consumption (which falls by 3 mb/d); the net decline in North America almost exactly counter-balances the increase in Chinese net imports.

Figure 16.24 ▷ Net oil trade in North America in the New Policies Scenario

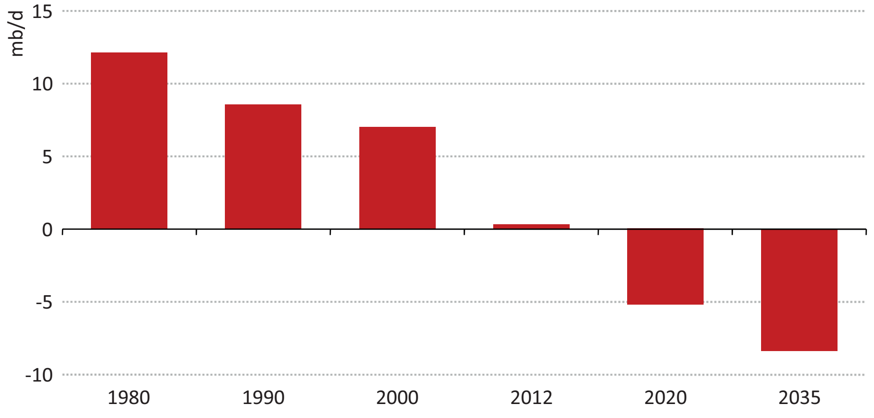


Examining only trade in crude oil (which accounts for the dominant share of total trade), many of the same themes are apparent.[19] Over the coming decades, the main crude oil flows shift decisively from the Atlantic basin (where Europe is left as the only substantial import market) to the "East of Suez" region, as the combined Middle East and Asian region is traditionally referred to in trading analysis. The latter region, taken as a whole, used to be a big net exporter of crude oil to the rest of the world, mainly from the Middle East to Europe and North America. In 2000, for example, the East of Suez region exported 7 mb/d in net terms (Figure 16.25). With increasing refinery capacity additions in this region (reflecting rising demand for oil products), this net contribution to the rest of the world started to fall. By 2012, the East of Suez region was roughly in balance, meaning that

19. For trading analysis purposes, crude oil includes also the condensate part of NGLs.

Middle East net crude oil exports were just matching total Asian imports. In practice, of course, the Middle East exports oil to regions outside Asia as well, including to European and North American refineries; but Asia also receives roughly equivalent volumes from other sources, such as Russia, the Caspian region and West Africa.

Figure 16.25 ▷ Combined crude oil trade balance of Middle East and Asia in the New Policies Scenario

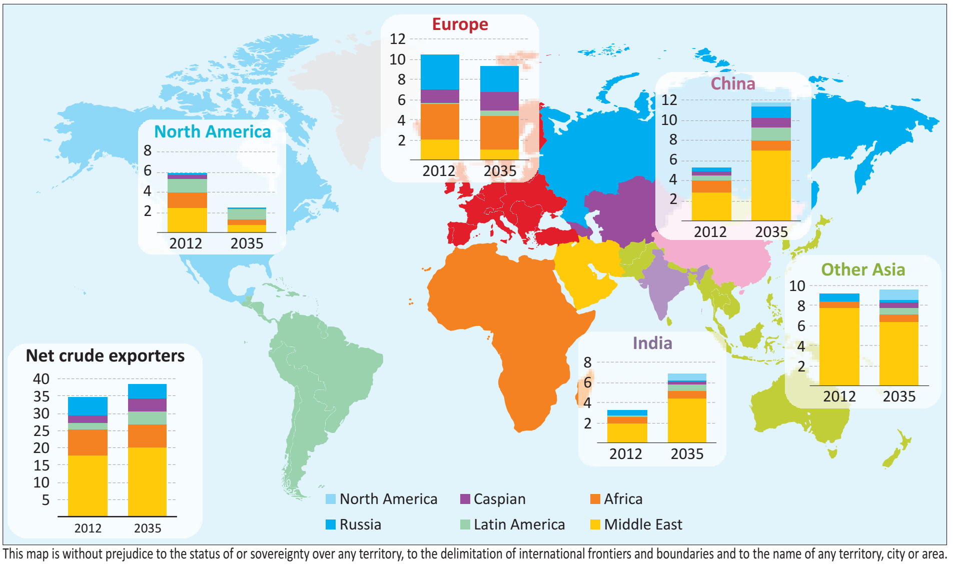


Note: Positive numbers denote net exports; negative numbers denote net imports.

Over the period to 2035, crude oil exports from the Middle East rise only modestly, as the region adds refining capacity, absorbing most of the growth in its production. Asian refinery capacity also increases substantially, while its crude output declines, pushing up its crude oil import needs even further and driving the East of Suez region into deficit. Meanwhile, North American crude oil imports decline dramatically, with the rise in production of LTO and Canadian oil sands, and falling demand for oil products. The consequence is that crude oil from other exporting regions is drawn to the East of Suez region on an unprecedented scale, with a net crude requirement in 2035 of over 8 mb/d.

Since some Middle Eastern crude exports are still expected to go westwards (mainly to Europe, albeit in reduced volumes compared with today), flows of crude oil from the rest of the world to the East of Suez region are projected to be even greater, at more than 9 mb/d by 2035. Direct imports into Asian markets, either via pipelines from Russia or Kazakhstan or through ports in Russia's far east, are assumed to rise to some 2.3 mb/d (based on current and planned infrastructure projects). This still leaves another 7 mb/d to be shipped by tankers through Russia's European ports, West Africa, Latin America and Canada (Figure 16.26). Overall, inter-regional crude oil trade increases by 3.6 mb/d, or about 10%, between 2012 and 2035. However, we estimate that tanker trade (volumes of oil-on-water) is set to increase by around 18%, as average shipping distances lengthen.

Figure 16.26 ▷ Crude oil imports by region and source in the New Policies Scenario (mb/d)



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

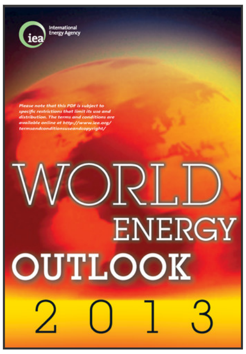
The volume of oil products traded internationally increases from 8.7 mb/d in 2012 to 9.7 mb/d in 2035. In the case of diesel, the East of Suez region continues to export to Europe, Latin America and Africa, with Russia and, increasingly, North America making up the difference. For gasoline, the East of Suez region switches from being more or less self-sufficient to becoming a net importer, with imports reaching about 600 kb/d, coming mainly from the Atlantic basin. Similarly, Middle Eastern LPG exports are not sufficient to meet growing needs in Asia, and thus the East of Suez region relies increasingly on supplies from North America, Russia and North Africa. Naphtha and fuel oil continue to be shipped from Europe and Russia to Asian markets, albeit in smaller volumes than at present. Most Middle Eastern kerosene exports go to Asia.

The projections imply that, in 2035, the share of oil products in inter-regional oil trade is around 20%, roughly the same figure as today. This finding, however, is very sensitive to assumptions about the volume and location of refinery additions, in particular the extent to which major oil producers build refinery capacity in order specifically to target product exports. In the New Policies Scenario, we make a generally cautious assessment of the prospects for this type of refinery additions. Most new refinery capacity in this scenario is concentrated in countries and regions experiencing strong demand growth; only a relatively small amount, mainly projects under construction or considered highly likely to go ahead in the Middle East, is oriented towards product exports.

The opening of this export-oriented refining capacity in the Middle East temporarily pushes the share of products up towards one-quarter of global oil trade around 2020, before this trend is reversed in the latter part of the projections as the capacity in question is increasingly required to meet growing demand from within the Middle East itself. But the structure of oil trade would evolve very differently if more refineries were built in the Middle East, North Africa, West Africa, or Brazil, than what is assumed in the New Policies Scenario, or if Russia were to continue to de facto prioritise domestic refinery runs over crude oil exports. Increased competition from these regions in product supply markets would imply a new round of rationalisation of refining capacity among the importing countries, notably in OECD countries. If refining were to become more of an export industry, this would also expand a debate (that is already visible in some importing countries) about the security-of-supply implications of increased reliance on oil product streams transported over larger distances. The higher risks of disruption implicit in longer supply chains would require importers to build additional storage capacity and, in some cases, to alter the balance in their strategic inventories between crude oil and products.

With or without a shift towards trade in oil products, the projections already point to a need for a reappraisal of oil security and how best to achieve it. By 2035, the two largest crude oil-importing countries in the world are China (11.7 mb/d) and India (6.8 mb/d), while the share of the United States in inter-regional crude oil trade declines from 27% today to 15%. As oil import needs rise across Asia, so the countries concerned are developing their capacity to deal with the possibility of oil supply interruptions. Changing patterns of global oil trade have implications for the volumes of oil flowing through certain strategic choke points in the oil supply system. For example, flows of crude oil through the Malacca Straits are projected to rise from around 13 mb/d in 2012 to 17.5 mb/d in 2035.

Countries that rely increasingly on imports will have a heightened interest in engaging actively in efforts to ensure the security of such international shipping routes. More broadly, all oil importers share a strong interest in mitigating the risk of an interruption in supplies – wherever it might take place – because of the potential impact on prices and economies globally. Increasingly, building oil stocks and contributing to plans for their co-ordinated use are becoming essential features of national and regional strategies to secure long-term oil needs. Oil (and gas) trade can underpin a strengthening of political relationships between the main importers and the main oil exporters. There has already been reference in some quarters to a sea-change in the politics of oil, its implications are best explored jointly by all those engaged in the trade.



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