11 OIL SUPPLY

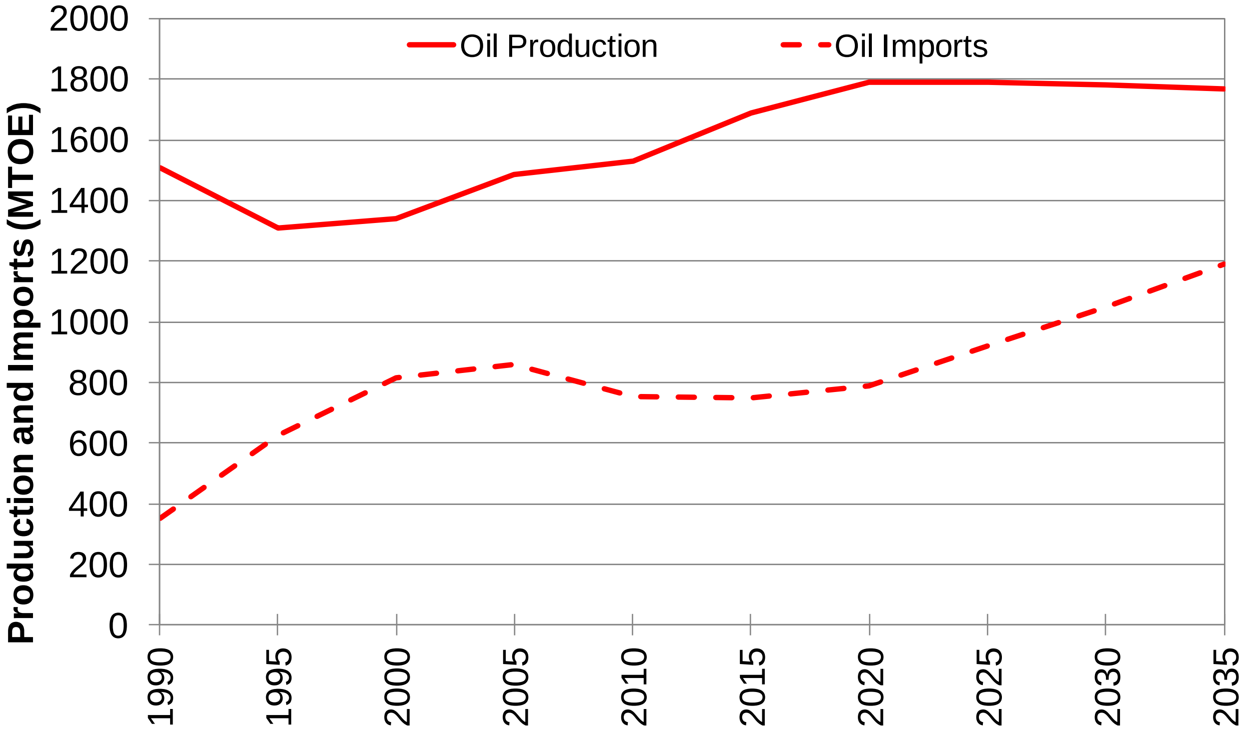
APEC OIL PRODUCTION AND IMPORTS

Since 1990, oil production in the APEC region has increased only slightly, while oil demand has risen significantly. As a result, oil imports into the APEC region have grown faster than oil production. APEC's oil production, including natural gas liquids (NGLs) reached 1498 million tonnes of oil equivalent (Mtoe) in 2009, which accounted for roughly 37% of worldwide production.

As shown in Figure 11.1, oil production in the APEC region is projected to grow to about 1790 Mtoe in the early 2020s and then to roughly level off. On the other hand, APEC's oil demand is likely to continue to grow faster than its oil supply.

As discussed in Chapter 5, rapid oil demand growth is being driven primarily by growing vehicle ownership in the developing economies of the APEC region. As a result, APEC's oil imports are likely to grow 55% between 2009 and 2035. There are, of course, many uncertainties in these projections, especially in the later years when the increased production of unconventional oil could push production upward.

Figure 11.1: APEC Total Oil Production and Net Oil Imports, 1990–2035



Source: APERC Analysis (2012)
Historical Data: *World Energy Statistics* 2011 © OECD/IEA 2011

Today, technologies for oil exploration and production are evolving quite rapidly. As the existing oil reserves deplete and traditional supplies become scarcer, producers are shifting their targets towards resources that are more costly and technically complex. High oil prices have made this shift possible, stimulating advances in technology that have made many unconventional and frontier resources economic. Resources long considered sub-commercial are now being integrated into the world oil supply; see the sidebar 'The Increasing Importance of Frontier and Unconventional Oil' in this chapter.

Unlike conventional oil, which is predominantly located in a few regions in a few economies, unconventional resources are more widely distributed, which is another incentive for developing them. Since the late 2000s, efforts to develop unconventional oil resources have been especially intensive in the APEC economies in North America. As with unconventional gas, discussed in Chapter 12, the ability to develop these resources in other APEC economies may depend as much on the institutions that make their development possible as it does on the resources themselves. In addition to extensive technology transfer, providing a reasonably stable and transparent system of regulations, taxes, and fiscal terms for oil producers is of critical importance.

THE CHALLENGE OF OIL SECURITY

This increasing dependency on oil imported from outside the region in the business-as-usual (BAU) case means the APEC economies may face at least four kinds of risks to their economies:

1. The availability of oil supplies could be threatened by political events in other regions, such as the Middle East and Africa.
2. The availability of oil supplies will depend on the ability of national and international oil companies in these other oil producing regions to make adequate investments.
3. As oil production becomes more concentrated in a few countries, oil prices will be increasingly influenced by the market power of the producing countries.
4. Increasing amounts of oil will need to be moved longer distances, typically from the Middle East or Africa, which poses additional security risks.

The likely outcomes of the APEC region's import dependency are:

- Continued oil price volatility will be a near certainty.
- There will be significant risks of supply disruptions.
- Both of the above threaten the economic stability of APEC economies and the world.

These conclusions hold even for the APEC economies that are not oil importers, or that are likely to become less dependent on oil imports over the outlook period (such as the United States). In today's globally-integrated economy, a crisis in the oil market affecting oil imports anywhere, will be felt everywhere.

THE INCREASING IMPORTANCE OF FRONTIER AND UNCONVENTIONAL OIL

Frontier and unconventional oil development requires complex technologies, facilities, and processes which differ from those traditionally used by the oil industry. Compared to conventional oil, their cost is higher and their environmental impacts are potentially larger. Nevertheless, their emergence has substantially expanded the scope of hydrocarbons available for mankind. This section provides a brief overview of the opportunities and challenges posed by each type of frontier and unconventional oil.

Deepwater Oil

Generally, the greater the water depth, the greater the efforts required to extract hydrocarbons and hence the larger the investment required. Oil extraction activities at water depths of less than 300 metres (1000 feet) are regarded as shallow water wells and are similar to onshore wells since the continental shelf is still present. On the other hand, wells drilled in water depths from 300 metres (1000 feet) to approximately 1500 metres (5000 feet) are considered deepwater wells. Although this range may differ among producers and economies, these are the boundaries adopted by the industry in the Gulf of Mexico, the most intensive deepwater oil producing area in the world (USEIA, 2009a; USBSEE, 2012). Production beyond the upper limit is regarded as ultra-deepwater, entailing the highest risks and most intricate technical requirements.

Despite this complexity, technological progress is constantly allowing the drilling of oil wells in water of greater depths. While many wells in the Gulf of Mexico and Brazil are producing oil at water depths of 2 kilometres (km), in April 2011 a well was drilled in India at a water depth of over 3.1 km (10 194 feet) (Transocean, 2012). Especially since the early 1990s (USBSEE, 2012), deepwater oil has increased its strategic role in the total oil supply. This is particularly true in the US, where deepwater operations started in the 1970s. The contribution of the deepwater output in the Gulf of Mexico accounted for almost a quarter of US domestic oil production in 2010 (USEIA, 2012b).

In addition to the US, deepwater operations are concentrated in Brazil and West Africa. Deepwater output is estimated to account for as much as 7% of the world's total oil output in 2012, and is expected to rise to nearly 10% by 2020 (BP, 2012). The general consensus is that this contribution is likely to grow over the next few years. In Brazil, for instance, the ultra-deepwater reservoirs at Lula in the Santos Basin hold resources estimated to be 5–8 billion barrels (Petrobrás, 2009); while nearly all of Angola's current production and proved reserves of 9.5 billion barrels lie offshore, mostly in deepwater (USEIA, 2011).

Deepwater oil projects require special technology and infrastructure. Since their costs are greater than those for conventional oil production, they call for significant capital expenditure and expansion of current technical frontiers. As a reference, in the US from 2007 to 2009, the average total costs of offshore oil production were 64% higher than the costs of onshore oil production (USEIA, 2012c). Adding to this complexity, tighter environmental and safety requirements after the 2010 Deepwater Horizon oil spill in the Gulf of Mexico could entail additional costs.

Arctic Oil

The Arctic is one of the world's least explored and exploited oil frontiers. In spite of being regarded as conventional in terms of its geological characteristics, the technical challenges of developing it are huge. This is primarily due to the Arctic's extreme weather and ice, its lack of infrastructure, its logistical limitations and its isolated conditions. Even though the first large field discovered was Russia's Tazovskoye in 1962, the Alaskan North Slope is by far the best known project (USEIA, 2009b). According to a US Geological Survey's assessment of 25 Arctic basins (USGS, 2008), the potential technically-recoverable conventional oil resources are estimated to be nearly 90 billion barrels, which amounts to about three years of global oil demand in 2010. A third of those resources are concentrated in the Arctic Alaska Basin.

The rapid development of the Arctic oil in the US started in the 1970s when significant oil resources were discovered at Prudhoe Bay in Alaska's North Slope. In spite of its high costs and environmental challenges, the energy shocks in the 1970s helped push the project to completion. By 1988 production had reached its peak at 2.2 million barrels per day, accounting for 24% of the US oil production in that year. Although natural decline and the lack of significant further discoveries have resulted in a production drop at an average annual pace of 5.3% from 1988 to 2010, the North Slope still represents nearly all of Alaska's oil output. The state accounted for 11% of the US production in 2010 and it is the second-largest oil producing state after Texas. According to the US Department of Energy (USDOE, 2009a), Alaska's untapped oil resource in its already developed fields has an estimated potential of 6.1 billion barrels. That could expand to roughly 35 billion barrels if restrictions are lifted on exploration and production in the 1.5 million-acre coastal plain designated as the 1002 Area of the Arctic National Wildlife Refuge, the National Petroleum Reserve and the Outer Continental Shelf.

During the second quarter of 2012, Russia's oil company Rosneft reached agreements with several international oil companies to advance its Arctic exploration and production activities, including in its four blocks in the Kara and Barents Seas (Rosneft, 2012b). These blocks have an oil potential amounting to 46 billion barrels. According to current schedules, seismic studies will be done shortly, with the first wildcat well to be drilled by 2015 and full-scale production expected from 2016 or 2017 (Rosneft, 2012a).

Tight Oil

'Tight oil' is a term used primarily to describe oil produced from low permeability shales, the same shales that produce 'shale gas', as described in Chapter 12. Tight oil is sometimes referred to as 'shale oil'. Although it might seem more natural to refer to tight oil as 'shale oil', that term is easily confused with 'oil shale', a term which describes a completely different type of resource (see below). APERC uses the term 'tight oil'. The word 'tight' denotes the characteristic low permeability of the rock in the reservoirs. It is this characteristic which calls for different production methods to extract the oil.

Due to this low permeability, tight oil has historically been unattractive for development, with producers in the US bypassing it to focus on other resources less difficult to develop (USDOE, 2009b, p. 14). It was only in the late 2000s that tight oil was able to be commercially produced by means of a combination of hydraulic fracturing and horizontal drilling.

Technological advances in the last few years, as well as high oil prices, mean conditions are favourable for the expansion of tight oil supply in the US. Since the technology and methods involved in producing tight oil and shale gas are basically the same, at least in the US, tight oil supply is affected by the relative prices of oil and gas. Specifically, gas producers have moved to reservoirs richer in oil as the price of gas has fallen relative to oil. According to recent US Government projections (USEIA, 2012a), tight oil production in the US could grow at an average rate of 8.1% per year under the most optimistic scenario, rising from 0.4 million barrels per day in 2010 to 2.8 million barrels per day (about 140 Mtoe per year) by 2035. This is roughly equivalent to 37% of the total oil output of 7.5 million barrels per day produced in the US in 2010.

As with other unconventional resources, tight oil development presents some challenges. It requires cutting-edge technology and expertise, intensive drilling, the availability of considerable volumes of water to be injected into the wells, and extensive infrastructure and auxiliary services. All these mean tight oil production requires larger capital expenditures in comparison to conventional oil production (IHS, 2011). Rising environmental concerns, mainly to do with the risk of polluting groundwater aquifers and with land disturbance due to drilling activities, might hinder accelerated tight oil development on a global basis (USDOE, 2009b).

In response to these concerns, governments are considering or implementing stricter environmental standards, which could slow the development of tight oil. There are also uncertainties about the ability of other economies to replicate the successful experience of the US. The US has some advantages including a vast resource base, flexible land leasing arrangements, extensive oil development infrastructure and supporting services, and decades of practice and knowledge not present in most other economies. Additional characteristics of the US stimulating the development of tight oil supply are an abundance of small-sized independent oil producers who are willing to take risks, combined with a financial sector eager to fund new ventures (Maugeri, 2012).

Extra-Heavy Oil

Extra-heavy oil is viscous and does not flow easily under normal conditions. Apart from being far more challenging to produce, it yields less high-value products in comparison to lighter crude oil types. Extra-heavy oil reservoirs are located mainly in Venezuela and Russia as well as in the oil sands of Canada.

Oil sands are a solid, extra-heavy type of crude oil composed of a mixture of natural bitumen, sand, water and clay. The largest known deposits are located in the Athabasca oil fields of the Canadian province of Alberta. Sometimes referred to as 'tar sands', this term is considered less appropriate in the industry as oil is the ultimate product obtained from these resources. Since its beginning in 1967, Canada's oil sands production has grown continuously—by 2010 it amounted to 1.6 million barrels per day, accounting for as much as 57% of Canada's total oil production. According to domestic industry projections, oil sands supply is likely to grow 2.3 times by 2030 to reach 5.3 million barrels per day (about 265 Mtoe per year) and represent 85% of Canada's total oil production (CAPP, 2012a).

For oil sands to be economically produced, two methods are employed. For deposits that are deeply buried, a process intensive in energy and water known as in-situ recovery is used. In this process, steam is injected into the ground to soften the bitumen and allow it to flow to the wellbore. Later, it can be converted to synthetic crude (syncrude) at special processing units (upgraders). For resources that lie close to the surface, the oil sands can be mined and processed aboveground. Although both methods are used in Canada, in-situ production accounts for about 80% of the total production (CAPP, 2012b).

Extra-heavy oil and oil sands are expected to become more significant in global oil production. While the extra-heavy oil deposit in the Orinoco Belt of Venezuela is believed to be one of the largest oil reservoirs in the world and constitutes 86% of Venezuela's total oil reserves (PDVSA, n.d.), the share of oil sands in Canada's oil reserves, at 97%, is even higher (CAPP, 2012b). The abundance of these unconventional resources gives both these economies the largest oil reserves in the world along with Saudi Arabia (OGJ, 2011).

Since late 2011, the available pipeline network that transports Canadian oil to the consuming and refining centres in eastern Canada and across the US has reached capacity. This poses a major challenge to the further development of the oil sands. Apart from the large investments required to develop the potential of these unconventional resources, the role of technology in increasing their sustainability will be critical in determining their future contribution. As a reference, technology has enabled a 26% reduction in carbon emissions per barrel of oil produced in 2012 compared to 1990 levels (IPIECA, 2012) and the improving trend is expected to continue.

Oil Shale

Oil shales are sedimentary rocks (mudstones and shales) containing organic matter known as kerogen. Since these rocks have not been buried deep enough and long enough for heat and pressure to transform the kerogen into oil, it is common to find them at shallow depths. This calls for production methods different to those used for conventional oil. Since the main component present in the rock is kerogen, oil shale is sometimes known as 'kerogen oil' (IEA, 2011, p. 120).

The most common method of yielding oil from rock is to retort the rock to very high temperatures (approximately to 450°C) either in place or by having the rock mined first and processed later. Since the in-situ heating and injection of fluids, or the mining, retorting and upgrading of the rock, involves huge amounts of capital and energy, oil prices need to be high for oil shale to cover the investment required and to be considered viable. Studies done for the US Department of Energy (Bartis et al., 2005) found that for a project of this kind to be feasible oil prices would need to be at least USD 70–95 in 2005 terms. For this reason, some economies just burn the mined rock in a similar manner to coal. This is the case in Estonia, where this method provides more than 90% of its electricity generation (EMOE, 2008).

Estimates suggest the global oil shale resources are very large, amounting to at least 4.8 trillion barrels (WEC, 2010, p. 93). One of the richest oil shale deposits is in the Green River area of the US, in the states of Colorado, Utah and Wyoming. Other significant oil shale resources are located in Australia, Brazil, China, Estonia, Jordan and Morocco. However, commercial exploitation was carried out in only a few of those economies in 2010, and mainly on a small scale. In the APEC region, apart from the US there are projects underway in Australia, Canada, China, Russia and Thailand (WEC, 2010).

As well as needing sustained high oil prices to cover its costs, oil shale production is energy intensive. It entails larger emissions of CO_2 than conventional oil production and it may have other significant environmental impacts. Therefore, to promote oil shale production and to increase its integration into the global oil supply, intensive research aimed at lowering its costs and minimising its environmental impacts is needed.

Other Sources of Oil

Apart from the unconventional resources discussed above, other technologies have not been widely commercialized yet, due to their prohibitive costs and adverse environmental impacts. One of these technologies is gas-to-liquids (GTL). This involves the use of natural gas as an input which is then processed to produce heavier hydrocarbons, similar to those obtained from oil refining. In 2011, the application of GTL was limited, with some plants installed in Malaysia, South Africa and Qatar. However, more GTL facilities could be built, especially on the US Gulf Coast and in Russia (IEA, 2011; Shell, n.d).

In the case of coal-to-liquids (CTL), coal is used as a feedstock to produce oil products. The use of CTL is also limited and its employment is favoured in those economies with abundant coal resources. In South Africa, a little less than one-third of its gasoline and diesel demand is supplied from coal (World Coal Organization, n.d.).

The development of these technologies may appear tempting—gas and especially coal reserves are larger and better distributed, and their prices are usually lower on an energy basis compared to conventional oil. Nonetheless, the technology involved in these processes is costly; and the processes themselves are energy intensive due to the loss of heat value in processing, and they require huge amounts of water.

Technology could play a critical role, not only in adding volumes of unconventional oil to the global oil supply, but also in designing solutions to reduce the environmental impacts. To illustrate, one of the processes of enhanced oil recovery aimed at improving the productivity of oil wells, CO_2 injection, could both increase oil production and avoid the release of CO_2 into the atmosphere. But for this practice to be feasible, costs need to be reduced. Although there has been limited use of CO_2 injection in the US and Saudi Arabia (IEA, 2011, p. 132; Hyne, 2001, p. 443), the speed and magnitude of technology developments during the outlook period will influence its further implementation.

OIL PRODUCTION BY ECONOMY

APEC's oil production is expected to grow 15% from 1530 Mtoe in 2010 to 1767 Mtoe in 2035. Nearly all of this growth is expected to come from North America, with the contributions from Canada, the US and Mexico projected to expand by 114%, 42% and 29% respectively during the outlook period. This growth will be driven mainly by the development of their unconventional resources.

The increase in oil production in Canada is expected to be supported by its oil sands, and in the US by its tight oil supply going hand-in-hand with its rapidly-growing shale gas production. In Mexico, the beginning of its deepwater production, the development of new fields, and the use of enhanced recovery methods in mature fields will provide the incremental production.

Outside North America, other economies are also likely to increase their production by 2035. These economies include China, Peru and Australia, although their joint contribution to APEC's growth during the outlook period is expected to be less significant.

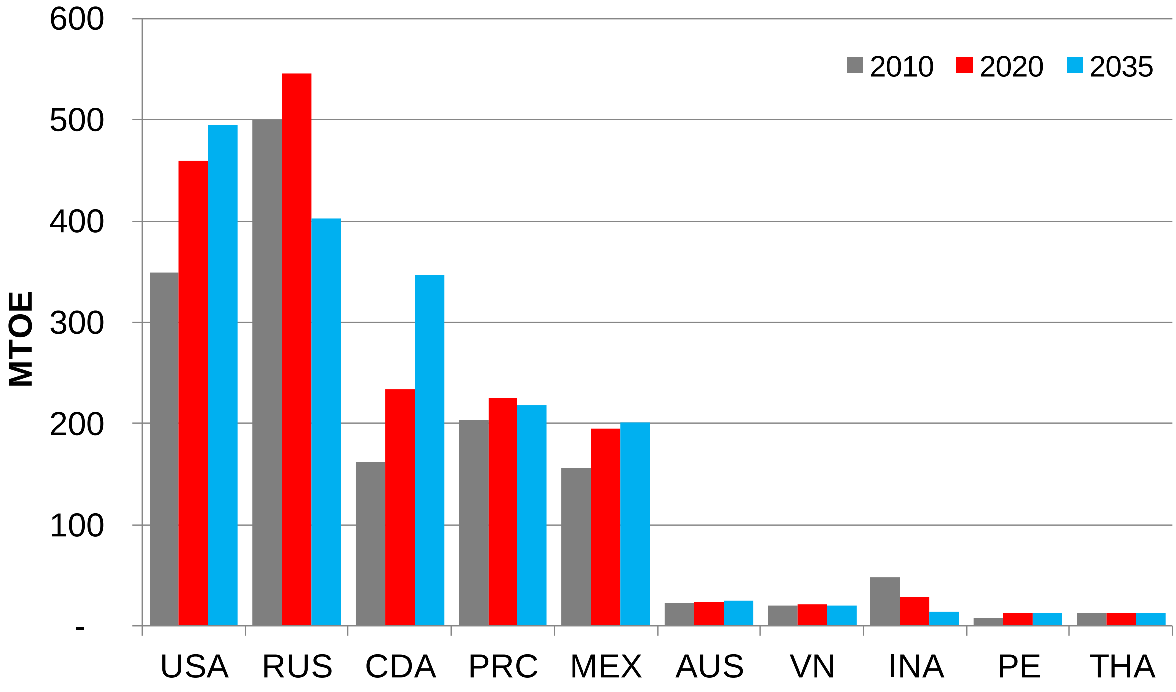
In contrast, oil production is projected to decline in Russia, Indonesia, Malaysia, Brunei Darussalam and the Philippines over the same period. As noted earlier, though, there are large uncertainties in these projections. In the remaining APEC economies, a lack of resources prevents them from developing significant domestic oil production.

In 2010, Russia was APEC's largest oil producer followed by the US, China, Canada and Mexico. By 2035, it is projected the US will lead APEC's oil production, followed by Russia, Canada, China and Mexico, with their joint output representing 94% of the APEC region's production.

Apart from exploration and production activities, the APEC region has a significant role in refining. The largest crude oil refining economies in the APEC region are the US, China, Russia, Japan and Korea, which together represented nearly 80% of the region's distillation capacity and about one-third of the worldwide distillation capacity in 2010.

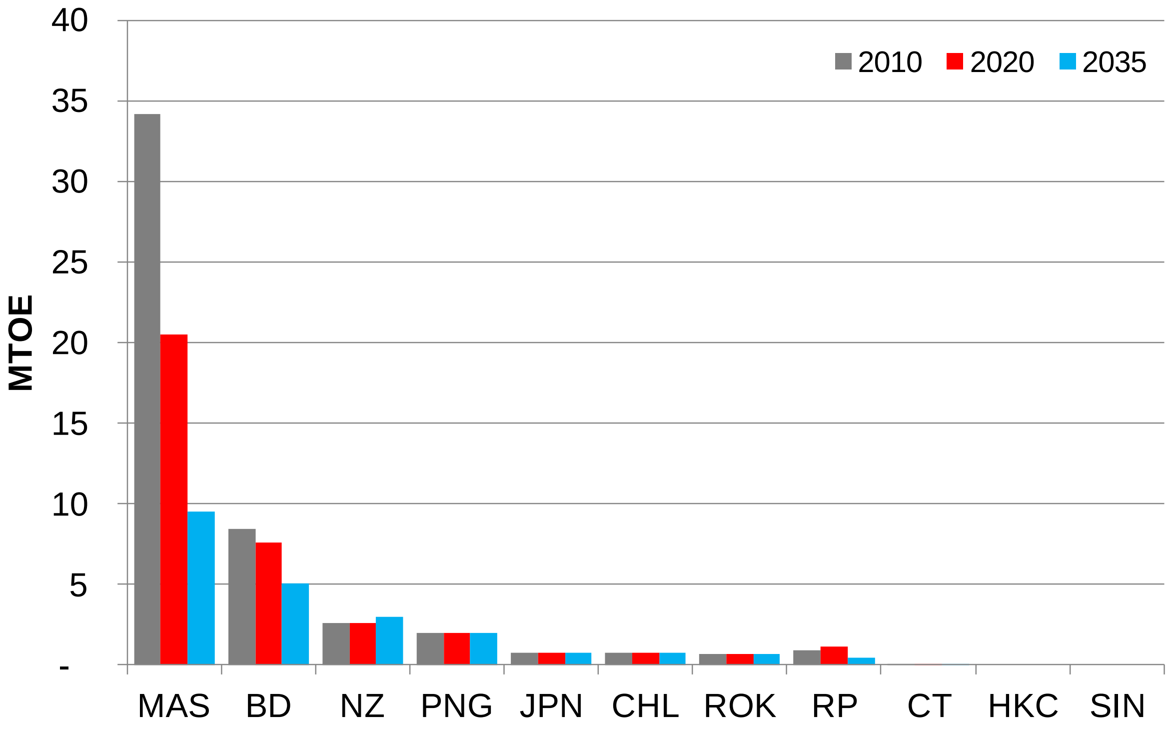
Beyond distillation, the APEC region also has a leading role in other refinery processes. Many refineries are adding capacity to process increasingly heavier crude oil feedstock and to yield more high-value oil products such as gasoline and distillates. In 2010, APEC's refineries accounted for 65% of the global catalytic cracking capacity, 61% of the global hydroconversion capacity (including hydrocracking and catalytic hydrotreating) and 70% of the global coking capacity (OGJ, 2010).

Figure 11.2: APEC's Projected Oil Production in 2010, 2020 and 2035, Higher Oil Production Economies



Source: APERC (2012)

Figure 11.3: APEC's Projected Oil Production in 2010, 2020 and 2035, Lower Oil Production Economies



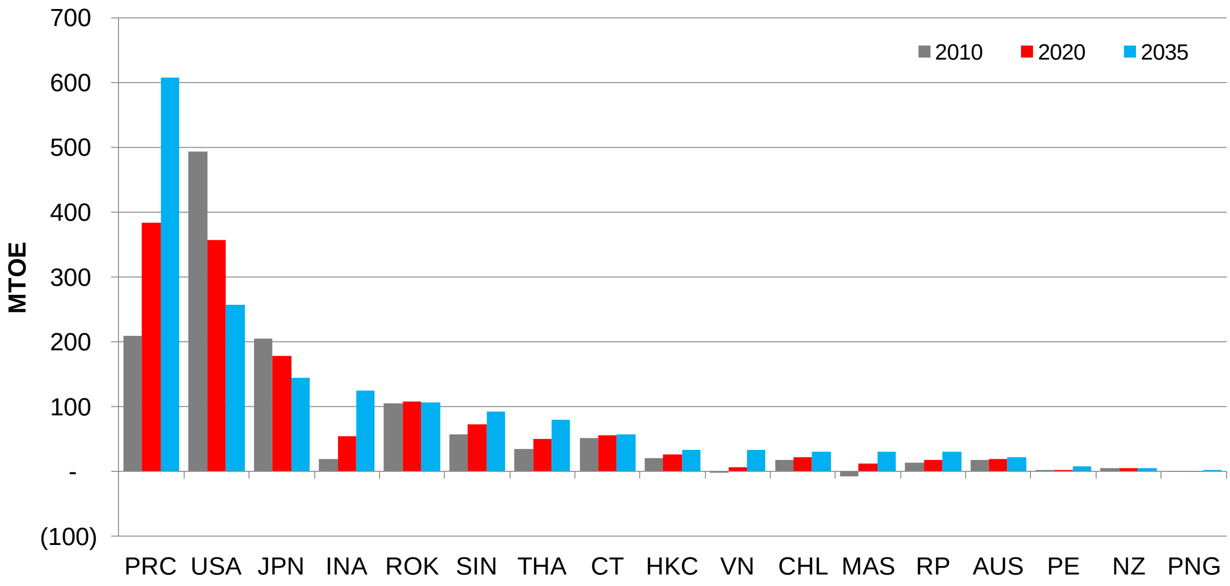
Source: APERC (2012)

INTERNATIONAL OIL TRADE BY ECONOMY

In the BAU case, the APEC region will be a growing oil importer, with its net imports expanding 58% between 2010 and 2035. Much of this growth in imports will be driven by China's rising primary oil demand, which is expected to almost double between 2010 and 2035. Despite the fact China's domestic production is expected to increase during the outlook period, it will be insufficient to meet the growth in demand. It is projected the net oil imports to China will grow 191%, from 209 Mtoe in 2010 to 608 Mtoe in 2035. This will account for almost half of the APEC region's net imports.

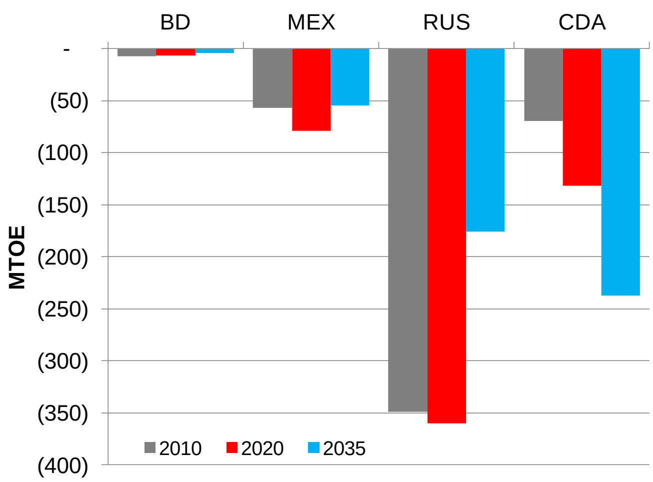
After China, the largest net importers in the APEC region in 2035 are expected to be the US, Japan, Indonesia and Korea, though the US is expected to reduce its oil imports significantly over the outlook period. Viet Nam, Malaysia, and Papua New Guinea will go from net oil exporters in 2010 to net oil importers by 2035. Projections indicate that by 2035 Canada, Russia, Mexico and Brunei Darussalam will continue to be net oil exporters.

Figure 11.4: Net Oil Imports for Net Oil Importing Economies



Note: (Negative) indicates net exports
Source: APERC (2012)

Figure 11.5: Net Oil Imports for Net Oil Exporting Economies



Note: (Negative) indicates net exports
Source: APERC (2012)

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