The next generation of oil and gas pipelines - who, what, where and when....

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Abstract
This paper seeks to identify the next wave of major oil and gas pipeline construction projects around the world, assessing which countries are likely to be able to turn their plans for new pipelines into real, bankable projects. It is not a comprehensive, or exhaustive, list of new pipeline projects. There is no shortage of new oil and gas pipeline proposals that are keeping project sponsors, industry analysts and conference organisers busy. Many of them are grand in their ambition, many seek to meet the political ends of their sponsors, many cross several international borders, and all will compete for capital and resources. Many of tomorrow’s oil and gas supplies are being developed in areas that are remote from existing infrastructure, far from markets or export terminals. Tomorrow’s big, new hydrocarbons consumers live in countries that are only just beginning to develop their oil and gas import and transmission infrastructures, while traditional markets are stagnating. Politics, too, is playing its part, as old alliances are tested and both buyers and sellers seek security of supply and greater diversification.

1. The evolving geography of oil and gas
The geography of oil and gas trade is changing. Big new oil and consumers are emerging. The centre of energy demand growth has shifted dramatically from West to East. At the same time, new centres of oil and gas production are also emerging. While the Middle East and West Siberia remain pre-eminent, important new production areas are being opened up. These changes will inevitably lead to the development of new infrastructure to carry the produced hydrocarbons to market.

For much of its history, oil and gas demand has been concentrated in the countries of the OECD, which continue to account for more than half of the world’s consumption of hydrocarbon fuels. Although the OECD collectively is also a significant producer of oil and gas, it produces just 20% of the world’s oil and around 40% of its gas. In contrast, the Middle East produces over 30% of the world’s oil and 12.5% of the gas, while Russia produces 20% of the world’s gas and 12.5% of its oil. Other significant regions of oil and gas production, although not consumption, have developed in the Caspian Sea region, North Africa, West Africa and parts of Latin America.

The geographical mismatch between the centres of oil and gas production and consumption has led to the development of a complex network of infrastructure – pipelines, ports and ships – to carry oil from where it is produced to where it is consumed. As new oil- and gas-producing provinces are developed and new consumers assume a more important role in global hydrocarbons consumption, so the infrastructure required to deliver oil and gas to consumers must also evolve. While the relative importance of ocean supply routes shift to reflect the changing
patterns of trade, new pipeline routes are also being considered to exploit new hydrocarbons provinces, to open up new markets and new trade routes and to deal with the ever-changing geopolitical landscape. Some of these important new changes have already begun to take shape, others are being explored, but all will have a profound impact on the need for new oil and gas pipelines in the years ahead.

2. New centres of supply
New centres of oil and gas supply are being developed in various parts of the world to meet rising demand and to offset output declines from mature basins. These new oil and gas provinces are often remote, both from centres of consumption and from existing transportation infrastructure. Their development over the coming decades will require major investment, both to bring the resources to the earth’s surface and also to deliver them to market.

2.1 Russia
The development of Russia’s next wave of oil and gas resources will take place away from the current hydrocarbons production heartland of West Siberia. The focus of exploration and development has shifted northwards, to the Yamal Peninsula, the Yamalo-Nenets region and eastwards, to the sparsely populated and undeveloped forests and marshes of Irkutsk, Krasnoyarsk and the Sakha Republic of East Siberia. The production of oil, and later of gas, from these regions will require the construction of some of the world’s longest new pipelines to deliver the produced hydrocarbons to markets. At the same time, Russia is pursuing a policy of export diversification, similar to the policies that newly independent producers in the Caspian Sea region have been encouraged to adopt by Western governments. The result is that Russia has embarked on the construction of an oil pipeline extending more than 4,800 km to carry oil to its Pacific Ocean coast, opening up the Pacific markets to Russian oil and ending the dependence of the world’s largest oil and gas producer on pipeline exports to the West. Russia has already completed construction of the first phase of its East Siberia-Pacific Ocean (ESPO) pipeline, which runs for 2,700 km from Taishet to Skovorodino, and embarked on the construction of the second stage, linking Skovorodino to a new export terminal at Kozmino, close to the city of Vladivostok on the Pacific Ocean, some 2,100 km away. Work has also begun on a spur from the ESPO pipeline to carry oil to China. This 1,030-km-long pipeline will run from Skovorodino to China’s northeastern city of Daqing and is scheduled to be completed in October 2010. The second stage of the ESPO pipeline, which would expand the route’s capacity to 1 mbpd from an initial 600,000 bpd, is expected to cost around Rb350 bn ($12 bn). The construction of the first stage of the pipeline cost Rb420 bn ($14.4 bn). Russia is also in the process of building a 520-km pipeline from Purpe to Samotlor in West Siberia and will follow this with another line of a similar length to bring oil to Purpe from fields that are currently being appraised in the northern Yamal-Nenets basin. These fields are expected to start coming into production around 2013-14 and a pipeline will be needed by then to facilitate their development.

In time, Russia expects to follow the ESPO oil pipeline with a gas pipeline along much the same route. The country’s gas strategy to 2030 envisages the development of gas fields in Eastern Siberia to enable the gasification of Eastern
Russia and to supply Asian export markets. To this end, Gazprom plans to build a gas pipeline stretching more than 5,000 km from the Tomsk region of West Siberia all the way to the Pacific Ocean. This trunk pipeline will be fed by a network of feeder lines that will connect new production centres in East Siberia to the main conduit.

Figure 1  Gazprom’s eastern gas plan

Before this, though, as a first stage of its eastern gas plan, Gazprom is building a 1,800-km pipeline along its Pacific Ocean coast from Sakhalin to Vladivostok. The first phase of the line, at 1,350 km and with a capacity of 6 bcm/yr, is due to be completed by the end of 2011, in order to deliver gas to the city and enable the commissioning of new gas-fired power generation capacities in the Russian far east by 2012, when Vladivostok hosts the Asia Pacific Economic Cooperation summit. Subsequent phases will see the line extended to 1,800 km and capacity raised to 30 bcm/yr and possibly as high as 47 bcm/yr.

2.2  The Caspian Sea region

New oil and gas developments in the Caspian Sea region are also generating the need for new pipelines. A recently completed gas pipeline from Turkmenistan to China is just the first of a number of ambitious projects designed to more increasing volumes of hydrocarbons from the region and to diversify oil and gas export routes, reducing the region’s dependence on its historical linkages to Russia. Among the pipelines that have been proposed for the region are:
• a 10 bcm/yr gas pipeline linking western Kazakhstan to the country’s south-eastern region;
• a doubling of the capacity of the CPC pipeline from Kazakhstan’s Tengiz field to an export terminal on Russia’s Black Sea coast (although this will mostly be achieved through new pumping capacity, rather than new pipelines);
• an oil pipeline in Kazakhstan to carry oil from the offshore Kashagan field to an export terminal to be built in southern Kazakhstan;
• a whole host of pipelines designed to carry gas from the region to Europe, following routes that pass to the south of Russia.
• an oil pipeline across Iran, linking the Caspian Sea to the Indian Ocean;
• a gas pipeline from Turkmenistan via Afghanistan to Pakistan and India (although this remains a project fraught with difficulties);

How many of these pipelines will actually be built remains far from certain. Work has begun on the gas pipeline in Kazakhstan and should be completed by Mid-2010. Expansion of the CPC pipeline was finally approved by the line’s shareholders at the end of 2009, after six years of being blocked by the Russian government, and should now be completed by the middle of 2014. Kazakhstan is still negotiating with the companies that will use the new export pipeline to its Caspian Sea coast over the route’s ownership structure and funding. The government of Kazakhstan wants to retain at least a majority stake in the route, while seeking funding for the line from foreign investors in its oil sector. The standoff is remarkably similar to that which characterised the early attempts to build the CPC pipeline in the mid-1990s, which was not resolved until an ownership structure was developed that gave the government and corporate owners an equal 50:50 stake in the line. Kazakhstan is being much more assertive in its position this time around, though, and may seek ways to fund the line without recourse to its eventual users. The line is scheduled for completion to coincide with the start of production from the Kashagan field, which is currently due on stream by the end of 2012. A solution to the funding and ownership issue will need to be found soon, if the pipeline is to meet this schedule.

If all the words that have been written about gas pipelines from the Caspian Sea region and the Middle East to Europe were laid end to end, they would circle the Earth. The most advanced, and one of the most ambitious, of the projects is the Nabucco pipeline, named after the opera that the line’s original sponsors saw after their meeting at which the project was first proposed. When built, the Nabucco pipeline would operate as a merchant carrier to deliver gas from the Caspian Sea region, the Middle East and possibly North Africa to Europe, crossing Turkey and the Balkans, through the so-called ‘Southern Corridor’. With a planned capacity of 31 bcm/yr, Nabucco would provide an additional, rather than an alternative, capacity to pipelines from Russia to Europe. The project has been derided by Russia’s Prime Minister Putin, a sure sign that Moscow is worried that it will undermine Russia’s position in the European market and has been countered by Gazprom’s own proposal to build a southern pipeline to Europe, running beneath the Black Sea from Russia to Bulgaria (or Romania) and then in two branches to Austria and to Italy. The so-called South Stream pipeline is seen by many as little more than a ploy to disrupt the construction of Nabucco and doubts are mounting over Gazprom’s ability
to fund the line’s construction in the face of the sharp fall in the company’s profits amid the myriad other projects (covering both the development of difficult new fields to maintain production and new pipelines to the east).

All of the countries through which the 3,300-km Nabucco pipeline will pass have now ratified the intergovernmental agreement that they signed in July 2009, granting equal and stable transport conditions for all partners in and customers of the pipeline. The consortium building Nabucco (OMV [Austria], MOL [Hungary], Transgaz [Romania], BEH [Bulgaria], Botas [Turkey] and RWE [Germany]) plans to hold an ‘open season’ to allocate capacity in the line around the middle of 2010. Assuming there is sufficient uptake from the line’s shareholders, who have preferential rights to 50% of the line’s capacity, and other external companies, construction work on Nabucco is scheduled to commence in 2011, with the first phase operation in 2014. During the initial phase of operation, it is planned that the route will use existing Turkish infrastructure to bring gas to Ankara, whence a new line will carry it to Austria. The line will be extended eastwards to Turkey’s borders during 2014 and 2015. During the period 2017-2019, the line’s capacity will be increased to through the addition of further compressor stations.

**Figure 2: Blue Stream, South Stream and Nabucco pipelines**

Russia’s South Stream pipeline is seen as a rival to Nabucco, although neither the Russian government nor Gazprom has identified a source for the gas that might fill it.
Neither has Gazprom made any provision for the construction of additional onshore pipelines in Russia to deliver gas to the starting point of the South Stream pipeline. With no clearly defined route, South Stream’s length is indeterminate at present. The offshore portion of the line, running beneath the Black Sea was originally pegged at 900 km, while the section from the Bulgarian coast to Italy and the section to Austria will each be in the region of 1,000 km in length. The offshore section of South Stream is to be built by a consortium of Gazprom and Italy’s ENI, who could be joined by France’s EDF. The onshore sections will be built by joint ventures between Gazprom and the national pipeline companies of the countries concerned. To date, Gazprom has brought Austria, Bosnia, Bulgaria, Croatia, Greece, Hungary, Serbia, Slovenia, Turkey Bulgaria’s new government has raised doubts about the economic benefits to the country of big energy projects with Russia, including South Stream, and may pull out of the project, leading Gazprom to consider a western landfall in Turkey and an onshore route bypassing Bulgaria. Gazprom has been actively seeking to secure large volumes of gas from Azerbaijan under long-term contracts, perhaps as a possible feed for the South Stream pipeline and certainly in an attempt to derail Nabucco.

Other routes planned to carry gas from the Caspian Sea region and the Middle East to Europe include the Interconnector Greece-Italy (IGI), the Trans-Adriatic Pipeline (TAP) and White Stream. The first two are relatively short, small capacity lines, the first connecting Greece and Italy directly and the second passing through Albania and beneath the Adriatic Sea. White Stream is a more ambitious plan, to build a pipeline from Georgia to Romania or Ukraine under the Black Sea. All of these pipelines will be competing for relatively limited gas resources on the western side of the Caspian Sea, or politically complicated resources in Iraq and Iran. Gas resources on the eastern side of the Caspian Sea could potentially be supplied Europe, but this would require the construction of a trans-Caspian pipeline, which would be strenuously opposed by both Russian and Iran.

Also in the Caspian Sea region, Iran plans to build a crude oil pipeline linking the Caspian Sea to the Indian Ocean. The pipeline would run from Neka on the Caspian to Jask, a port on Iran’s Indian Ocean coast, outside the Strait of Hormuz. In mid-2009, Iran’s Deputy Oil Minister Nureddin Shahnazizadeh announced at a conference in Moscow that an international tender would soon be issued for the construction of the 1,550-km pipeline, which was expected to cost $2 bn. Iran hopes the pipeline will be operational in 2012, but this seems highly unlikely, given the slow pace of other oil and gas projects in the country.

A long-standing plan to build a high-capacity gas pipeline from Turkmenistan to Pakistan and India via Afghanistan still receives serious attention in Central Asia and India. First proposed in the mid-1990s, this pipeline would run 1,300 km from the Dauletabad field in southeastern Turkmenistan to Multan in Pakistan, with a 640-km extension to India. In 2008, the Asian Development Bank, which remains interested in the project, warned that construction costs had more than doubled from the estimated $3.3 bn to $7.6 bn. Much more problematic than the cost, though, is the security situation in Afghanistan, which is not conducive to the laying of a cross-country pipeline, and India’s continued reluctance to become dependent on gas supplies that must first transit Pakistan. The Turkmenistan-Afghanistan-Pakistan-India pipeline remains a distant possibility for the opening up of Central Asia.
2.3 Alberta, Western Canada

A recent study carried out by the Centre for Global Energy Studies and Calgary-based Geopolitics of Energy\(^1\) developed two scenarios for the future development of the oil sands. In the more optimistic scenario, which envisages production from the oil sands of Alberta rising to 3.5 mbpd by 2020, increasing volumes of Western Canadian light and medium oil require the expansion of capacity to deliver crude oil from Alberta to the Eastern Canadian market in the middle of the current decade and the opening up of new export routes to allow exports to the Northeast Asian market (especially Japan, South Korea and Taiwan) towards its end. Interest in oil sands projects from Chinese companies could also see exports moving from Alberta to China, but this would require the construction in China of new refineries capable of processing Canadian crude.

Much of the incremental capacity to supply eastern Canada is likely to come from the reversal of existing pipelines, rather than the construction of new ones. The study concluded that, in order to expand the Ontario market for Western Canadian crude oil and open the Montreal, Quebec market, Enbridge would need to complete the reversal of its Line 9 in mid-2013. To feed the expanding Eastern Canada market, Enbridge’s Alberta Clipper would need to begin batching light and medium oil as of mid-2013; instead of only shipping heavy oil to PADD II, while Enbridge would also have to implement its Line 6B debottlenecking and expansion project to move additional oil to Sarnia, Ontario via the US Midwest.

To open light and medium crude oil markets in Northeast Asia, new oil pipelines will be required to transport crude to an export terminal on Canada’s Pacific Ocean coast. Several such pipelines already exist in the plans of Canadian pipeline operators Kinder Morgan and Enbridge. Kinder Morgan operates the Trans Mountain Pipeline System, which runs from Edmonton to Vancouver and Puget Sound in the US. Plans exist to gradually increase the line’s capacity from its current 300,000 bpd to as much as 1.1 mbpd as oil sands production rises. Kinder Morgan’s expansion plans include the eventual construction of a northern spur from its existing line. The 400,000-bpd line would run to a proposed new export terminal capable of loading VLCCs at Kitimat, but will only be undertaken once shippers have booked capacity in the new line.

Enbridge’s proposed Northern Gateway pipeline would open up a more northerly route from Edmonton to a deepwater export terminal at Kitimat. The project envisages a 1,170 km, 36-inch, crude oil export pipeline, capable of carrying 525,000 bpd, and a similar length, 20-inch, import pipeline to carry almost 200,000 bpd of condensate to Edmonton for blending with heavy Albertan crude to dilute it for export. Enbridge plans to file a regulatory application to build the line in 2010 and begin construction in 2012, for completion and start-up in early 2016. However, the project faces stiff opposition from First Nations groups and environmental campaigners.

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\(^1\) ‘Canada’s Oil Sands’, CGES and Geopolitics Central, Nov 2009. Please contact jenni.wilson@cges.co.uk for more information.
Table 1: Major crude oil pipeline proposals from Alberta to Canadian, US PADD V and overseas markets

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>Origin</th>
<th>Destination(s)</th>
<th>Status</th>
<th>Capacity ('000 bpd)</th>
</tr>
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<tr>
<td><strong>West Coast and Overseas</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Enbridge Northern Gateway (1)</td>
<td>Edmonton, AB</td>
<td>WC (Kitimat, BC); PADD V (CA); Overseas markets</td>
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<td>Kinder Morgan TMX Northern Leg (2)</td>
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<td>WC (Kitimat, BC); PADD V (CA); Overseas markets</td>
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<td>TransCanada - To California (7)</td>
<td>Alberta</td>
<td>PADD V (San Francisco, CA)</td>
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<tr>
<td><strong>Total</strong></td>
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<td><strong>Eastern Canada</strong></td>
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<td>Enbridge Line 6B Debottle and</td>
<td>Griffith/Hartsdale, IN</td>
<td>EC (Sarnia, ON)</td>
<td>TBD</td>
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<tr>
<td>Expansion</td>
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<tr>
<td>Enbridge Line 5 Expansion</td>
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<td>Enbridge Trailbreaker [Line 9</td>
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<td>Reversal] (17)</td>
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<td><strong>Total</strong></td>
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<td></td>
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<td><strong>690</strong></td>
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</table>

Figure 3: Canadian and US crude oil pipelines

Source: CAPP
Table 2: Major crude oil pipeline proposals from Alberta to US PADDs I, II and III

<table>
<thead>
<tr>
<th>Pipeline</th>
<th>Origin</th>
<th>Destination(s)</th>
<th>Status</th>
<th>Capacity ('000 bpd)</th>
</tr>
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<tbody>
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<td>Sunoco Pipeline - To Philadelphia (20)</td>
<td>Buffalo, NY</td>
<td>PADD I (Philadelphia, PA)</td>
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<tr>
<td><strong>Total</strong></td>
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<td></td>
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<td>Enbridge Alberta Clipper Expansion (6)</td>
<td>Hardisty, AB</td>
<td>PADD II North (Superior, WI)</td>
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<td>Enbridge Line 6C Expansion</td>
<td>Griffith/Hartsdale, IN</td>
<td>PADD II East (Detroit, MI, Toledo and Lima, OH)</td>
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<td>Enbridge Ohio Access - Phase 1 (16)</td>
<td>Superior, WI???</td>
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<td>Enbridge Ohio Access - Phase 2 (16)</td>
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<td>ExxonMobil (and Enbridge) Mustang Expansion (18)</td>
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<td>Sunoco Pipeline Expansion - To Toledo (19)</td>
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<td><strong>Total</strong></td>
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<td>BP/Enbridge Gulf Access - Phase 1 (12)</td>
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<td>PADD III (Houston, TX)</td>
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<td>PADD III (Gulf Coast)</td>
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<td>BP/Enbridge Gulf Access - Phase 3 (14)</td>
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<td>PADD III (Port Arthur or Netherland, TX)</td>
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<td>TBD</td>
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<td>Sunoco Pipeline - To Gulf Coast (21)</td>
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<td>TransCanada Keystone XL (8)</td>
<td>Hardisty, AB</td>
<td>PADD III (Port Arthur, TX)</td>
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<td>500</td>
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<td>TransCanada Keystone XL Louisiana Access (23)</td>
<td>Patoka, IL or Port Arthur, TX</td>
<td>PADD III (New Orleans, LA)</td>
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<td>TBD</td>
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<tr>
<td>Portland-Montreal [1 line reversal] (17)</td>
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<td>PADD III (Gulf Coast via Portland, ME)</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,825</strong></td>
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2.4 Unconventional gas

The third major driver for new pipeline capacity from the development of new oil and gas supply sources is the spectacular growth in non-conventional gas production. At present this phenomenon is largely confined to the US, but interest is growing around the world.

The impact on future pipelines from the development of unconventional gas resources is likely to be twofold. On the one hand, development of shale gas resources in the US has already resulted in huge expansion of the country’s gas pipeline system. According to the EIA, 2008 was the most active year of natural gas pipeline construction in the US for more than a decade, with almost 6,500 km of new gas pipeline laid. As further shale gas resources in Texas, Louisiana and elsewhere are developed, so new pipelines will be required to deliver the new resources to
market. The EIA projects that US gas production from unconventional resources in the US will increase by 35% between 2007 and 2030.

The second impact on pipeline construction of US shale gas developments is not so positive. In just three years, the outlook for US gas imports has been turned on its head. Forecasts of growing import dependence and the need for a combination of huge new pipelines and a network of LNG receiving terminals have now been replaced with expectations of lasting self-sufficiency. The EIA has identified around 10,500 km of new gas pipelines that it expects to be commissioned in the US in 2010 and 2011 (see Figure 4).

Figure 4: Major potential natural gas pipeline expansion (2009-2011)

In the words of Canada’s National Energy Board, ‘All these newly in-service and proposed projects serve one purpose: to feed emerging US gas to US markets that have traditionally been served by Canadian pipeline systems. Furthermore, the availability of Rockies gas for import into Canada at the southwestern tip of Ontario has important implications for Canadian pipelines that serve the eastern Canadian market’. One potential market for gas from Alaska and northern Canada, originally earmarked for the US market, is the Alberta oil sands projects and both Denali (the Alaska gas pipeline) and the MacKenzie gas pipeline from Canada’s Northwest Territories could supply gas to Alberta, rather than the US market.

The Mackenzie Gas Project is a proposed 1,200-km, 30-inch natural gas pipeline system along the Mackenzie Valley of Canada’s Northwest Territories, intended to connect northern onshore gas fields with North American markets. The Mackenzie...
Gas Project partners filed the project’s Environmental Impact Statement for review in October 2004 and final hearing arguments have been announced for April 2010. If the project receives regulatory approval, a preliminary plan has been developed based on four years of construction activity for the pipeline and related facilities.

Denali will consist of a gas treatment plant on Alaska’s North Slope, a pipeline more than 2,700 km long to Alberta, Canada, and if required, a 2,400-km pipeline from Alberta to Chicago. Much like Nabucco in Europe, the Denali pipeline’s future prospects will be determined by the results of an ‘open season’ for potential users to book pipeline capacity, due to be held in 2010.

3 Expanding markets
The second major driver of new oil and gas pipeline projects is the opening up of new markets for hydrocarbons. Chief among these will be the rapidly developing economies of China and India, but they will not be alone. The development of oil and gas resources off the coast of Brazil will trigger the construction of new pipelines to deliver fuel to customers in the country, while Venezuela’s President Chavez retains grand plans to build a gas pipeline to carry hoped-for gas reserves off Venezuela’s coast across the Amazon basin to potential customers in the southern cone of Latin America.

3.1 China
China’s appetite for the construction of long-distance oil and gas pipelines shows no sign of being satisfied. The first west-east pipeline, carrying 12 bcm/yr of gas from the Tarim Basin in the eastern Xinjiang province of the country to consumers in the east was put into commercial operation at the start of 2005. Construction of a second line, with a capacity of 30 bcm/yr, began in 2008. The overall length of the line is more than 9,000 km and it is expected to be fully operational by mid-2011, although parts of it have already been commissioned. There are also plans to build a third and even a fourth west-east pipeline. The third line would run from Xinjiang to Fujian province in south eastern China, while the fourth would link either the the Tarim Basin or Sichuan province to consumers in the south and east.

The country is also in the process of constructing pipelines to import oil from Russia, with a 300,000-bpd from the Russian border to Daqing well underway. Plans are also being developed to build both oil and possibly gas import pipelines across Myanmar to China. The 1,100-km route from the Bay of Bengal to Kunming in China’s Yunnan province would reduce China’s dependence on deliveries of oil and gas from Africa and Middle East passing through the Malacca Strait and shorten the route by an estimated 1,200 km.

If, or when, China and Russia manage to resolve their differences over gas pricing, which have been dragging on for many years, Russia could begin exporting several billion cubic metres of gas per year to its southern neighbour. Russia’s long-term gas strategy envisages exports of 50-55 bcm/yr of gas to Asian customers by 2020, rising to 70-85 bcm/yr by 2030 and China is viewed as a key market. In October 2009, Gazprom and CNPC signed a basic Heads of Agreement for gas deliveries to start in 2014-2015 and are now working on Commercial Agreement. Russia has proposed two routes for its gas trade with China. The Western Route would deliver
gas from West Siberia to western China, whence it could form part of the throughput of the west-east pipelines. The Eastern Route, based on supplies from Sakhalin and East Siberia, would enter northeast China and require the development of new delivery routes.

**Figure 5:** Routes of China's first and second west-east gas pipelines

3.2 **India**

India plans to build 10,000 km of new 30-inch gas pipeline, almost 7,500 km of which should be built over the coming 2-3 years. The lines are needed to bring gas to parts of the country that are not currently connected to India’s gas supply network. The Gas Authority of India Ltd (GAIL) is currently laying 5,000 km of new transmission lines in the country, almost doubling its network. Plans include the construction of the following pipelines:

- Kakinada to Panwel (1,000 km),
- Kakinada to Kolkata (1,000 km),
- Kochi to Bangalore (860 km),
- Kolkata to Jagdishpur (850 km),
- Dabhol to Bangalore (850 km),
- Kakinada to Chennai (600 km),
- Bangalore to Chennai (300 km),
- Dadri to Panipat (130 km),
- Kochi to Kayamkulam (100 km).

There are also plans for an import pipeline from Myanmar, although these are less certain.
3.3 Australia
A number of new gas pipeline developments are planned in Australia to allow the country to utilise gas resources discovered of the northwest coast. These include:

- the trans Northern Territory pipeline linking the Blacktip gas field in the Bonaparte basin to Darwin (500 km);
- the Amadeus Basin to Darwin pipeline linking to Mount Isa and onto Moomba (1,500 km);
- the linking of the South Australian and Queensland networks with a pipeline link between Moomba and Barcaldine (700 km) and the linking of the South West Queensland pipeline (Ballera to Wallumbilla) through to northern New South Wales and on to Sydney (800 km);
- Additionally a number of new pipeline connections are expected from many of the newer coal seam gas accumulations in the Bowen Basin in Queensland and the Sydney Basin to major centres of population.

4 Diversification
The third major source of new pipeline building in the years ahead will be the desire on the part of both producers and consumers of hydrocarbons to diversify their markets and sources of supply, respectively. Several of the pipeline projects that have been discussed under the sub-headings of new production areas and expanding markets could equally well be covered in this category. Russia’s pipelines to the Pacific Ocean and the Southern Corridor pipelines between the Caspian Sea region and Europe, fall into this category, as does the proposed pipeline from the
Alberta oil sands developments to the Canadian Pacific coast. There are, however, a few pipelines that fall into this category and no other, chief among them Russia’s Nord Stream pipeline.

4.1 Accessing Europe from Russia
To be built in two stages, the 1,220-km Nord Stream gas pipeline will run beneath the Baltic Sea to create a direct link between Russia and its most important export customer, Germany. Following the receipt of the final construction permit in early 2010, the Nord Stream consortium has now raised €3.9 bn of funding from a group of 26 banks, with the remaining €1.8 bn needed for completion of the project’s first phase to come from shareholders. A further €2.5-3.0 bn will need to be raised to fund the project’s second phase. Nord Stream will consist of two parallel 48-inch pipelines, each with a capacity of 27.5 bcm. Construction of the first will commence in 2010, with the line due to become operational by the end of 2011. The second string of the pipeline is scheduled to be laid in 2011-12 and commissioned by the end of the year. There are some doubts, though, whether this schedule for the second line will be adhered to in the light of the downturn in European gas demand and Gazprom’s decision to delay work on the Shtokman field in the Barents Sea, identified as a major source of supply for the second phase of Nord Stream.

The South Stream pipeline, discussed in section 2.1, designed to reduce Russia’s dependence on transit across Ukraine for its gas supplies to Europe, is another example of the new pipelines that have been proposed to meet the desire for diversified supply routes. Looking eastwards, Russia’s plans to build oil and gas pipelines to its Pacific Ocean coast are driven as much by the country’s desire to diversify its export routes and reduce its dependence on the European export market as they are by the opening up of new oil and gas resources in East Siberia.

4.2 Reducing Europe’s future dependence on Russia
The ‘Southern corridor’ pipelines to carry gas from the Caspian Sea region and the Middle East can be seen as much in the light of diversification as in that of opening up new areas of oil and gas production. European politicians have become extremely concerned about the continent’s rising dependence on imported gas and the dominant position that Russia is expected to play in Europe’s future gas supply. These concerns may begin to evaporate if the US experience with unconventional gas (shale gas and coal bed methane in particular) is replicated in Europe. Even without a surge in European unconventional gas production, the developments in the US over the past three years have altered radically the international gas trade and Europe has reaped the benefit of an abundance of liquefied natural gas.

Europe is also looking to increased gas supplies from West Africa. While most of this is likely to arrive in liquefied form, there are grand plans to build a major gas pipeline across the Sahara Desert to carry gas from Nigeria to Europe via Niger and Algeria. Although still only a line on a map, a 4,000-km pipeline capable of carrying 20-30 bcm/yr has been proposed and carries an estimated price tag of $10-12 bn. However, suggestions that the pipeline could be operational by 2015-2017 appear extremely optimistic, particularly in the light of the changes to the international gas market caused by the development of unconventional gas reserves.
4.3 Diversifying export markets for Canada’s oil sands
Just as the Russian oil and gas industry has historically been dependent on the European export market, so Canadian producers have been dependent on the US. The surge in US unconventional gas production will undoubtedly have an impact on future gas pipeline plans from Canada to its southern neighbour. At the same time, a growing concern with man-made climate change in the US has led for calls for a ban on the importation of ‘dirty’ oil from the Canadian oil sands projects. Proposals to build oil export pipelines from Alberta to Canada’s Pacific Ocean coast can be seen as much as an attempt to diversify markets as they can part of the ongoing development of Alberta’s vast oil reserves.

4.4 Sudan and Uganda
Another significant pipeline project that could get a boost from geopolitical shifts is the proposal to link oilfields in southern Sudan to an export terminal at Lamu on Kenya’s coast. Existing pipelines run northwards to Port Sudan on the Red Sea, but the government of the semi-autonomous south wants a new route that would reduce its dependence on the north. Chinese and Japanese companies are considering the construction of a 1,400-km, 450,000-bpd line at a cost of around $1.5 bn. In the same part of the world, the development of oil reserves along the Rift Valley in Uganda may well result in the construction of a pipeline from Lake Albert to the Kenyan coast, although the Ugandan government would like to see the oil refined in Uganda, rather than exported as crude. An export pipeline would be around 800 km in length.

5 Conclusions
In this paper we have attempted to look beyond the industry’s immediate and well publicised pipeline construction plans in order to get a sense of the factors that will drive oil and gas pipeline construction in the coming years. The opening up of new hydrocarbons basins, often remote from both potential markets and existing infrastructure, the growing importance of oil and gas to the industrialisation of the world’s developing economies and the political imperative to diversify hydrocarbons export and import routes will all provide strong spurs to the next phase of pipeline construction. Many of the large pipelines that countries and/or companies are planning to build over the coming decade can, of course, fit into more than one of these categories.

As remote new oil and gas deposits are developed, new markets established and new political alliances forged, the oil and gas industry is, perhaps, embarking on the most prolific period of new pipeline construction since the huge export corridors from the Soviet Union to Europe were developed in the 1960 and 70s.