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Commodities
Global

The sustainability of higher oil prices

Revenge of the old economy, Part II

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A special publication from *Commodity Research* and *Global Energy Research* that discusses the implications of recent events in the energy markets.

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Global Commodity Research

Low investment rates in infrastructure have pushed energy prices higher

A sharp rise in the energy price level that began in 2000 is the result of two decades of extremely low investment rates in the global infrastructure to supply and deliver oil.

The energy industry has entered a new investment phase

The industry has re-entered an investment phase that could last the next five to ten years as large-scale "next-generation infrastructure" projects will be required to increase supply.

A $30/bbl WTI price will be required for the rest of this investment phase

We believe that a WTI price of at least $30/bbl will likely be needed for the remainder of this investment phase to keep older high-cost fields cost effective while at the same time attract the substantial spending required to develop the necessary infrastructure and new supplies. To re-enter a lower-priced "exploitation phase," the market needs to invest enough capital to not only meet demand but, more importantly, displace older, more expensive production that is supporting higher prices at the margin.

Spending will need to be higher than in the past

Three main reasons explain why spending needs to be significantly higher during the 2000s than in the past: (1) a shift in government policies from subsidizing to taxing energy production, (2) the exhaustion of substantial low-cost capacity in transportation, refining and other core infrastructure, built with the help of governments during the 1970s, and (3) the acceleration of decline rates in existing production basins, requiring more capital to maintain production and ultimately replaced the aging fields.

The industry is not running out of oil

The argument for a higher equilibrium price of oil is not dependent upon rising industry costs, nor is it a statement that the industry is running out of oil. The argument is dependent upon the requirement for a significant increase in spending by the industry resulting from the need to build new infrastructure without government subsidies as in the past while at the same time support the existing, more expensive supply base.

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Executive summary

Low investment rates in infrastructure have pushed energy prices higher

A sharp rise in the energy price level that began in 2000 is the result of two decades of low investment in the global infrastructure to supply and deliver oil, caused by the poor rates of return on these types of investments. Crude oil production, transportation and refinery output are all operating at record levels, and are doing so against the backdrop of only a modest increase in investment and nearly no growth in capacity. As a result, the market is pushing up against capacity constraints in every aspect of the system.

The energy industry has entered a new investment phase

Large-scale "next-generation infrastructure" projects will be required to grow supply. The last time the industry built infrastructure on this scale was during the 1970s, which provided years of energy demand growth at a relatively low marginal cost. This "exploitation phase" that lasted for nearly two decades, however, has come to an end, as the industry has re-entered an "investment phase" that could last the next five to ten years before new infrastructure is sufficient to re-enter a new lower-priced exploitation phase.

A WTI price of at least $30/bbl will be required for the rest of this investment phase

We believe that a WTI price of at least $30/bbl for the remainder of the investment phase will likely be required to keep older fields cost effective as the industry builds next-generation infrastructure. While the super majors are likely to generate higher returns on investment, and do not require prices this high, the same cannot be said for almost all of the rest of industry including the sovereign oil companies (once an analysis of social spending is included). Once the next-generation projects are completed, prices will likely decline as the new production displaces the older, more expensive fields that are currently supporting prices at the margin.

The increase in spending is the result of three significant industry shifts

The total amount of capital spending required over the next ten years in the oil industry to meet trend demand growth is likely to be $2.4 trn, nearly triple the level of spending during the 1990s. Furthermore, the industry's tax bill is likely to rise by $1.8 trn to $4.2 trn over the next ten years. We believe three main reasons explain why spending needs to be significantly higher during the 2000s than in the past: (1) a shift in government policies from subsidizing to taxing energy production, (2) the exhaustion of substantial low-cost capacity in transportation, refining and other core infrastructure, which was built with the help of governments during the 1970s, and (3) the acceleration of decline rates in existing production basins, requiring more capital.

The industry is not running out of oil

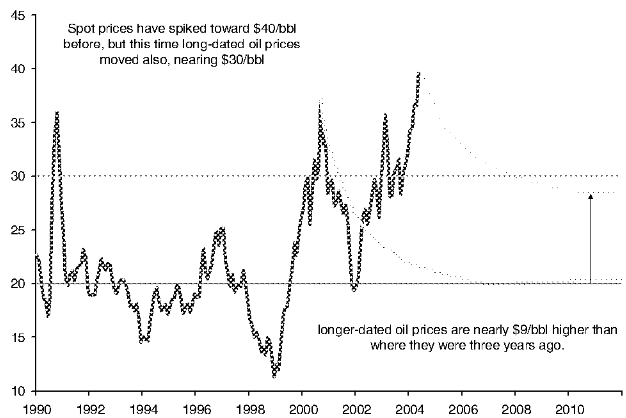
This argument for a higher equilibrium price of oil is not dependent upon rising industry costs, which have only risen modestly, nor is it a statement that the industry is running out of oil (rather, infrastructure has been exhausted). Instead, the argument depends on the need for higher prices to keep older supplies cost effective as spending increases.

The sustainability of higher oil prices

Revenge of the old economy, Part II

This Spring, WTI oil prices surged above $38/bbl, much like they did last winter, in Autumn 2000 and during the first Gulf War in 1990. This time, however, the price increase was different, as a deeper and more fundamental shift occurred in market prices. Longer-dated oil prices also rose sharply, with the ten-year swap for crude oil trading above $30/bbl for the first time, more than $10/bbl above the $18-$22/bbl band it traded within during most of the 1990s (see Exhibit 1).

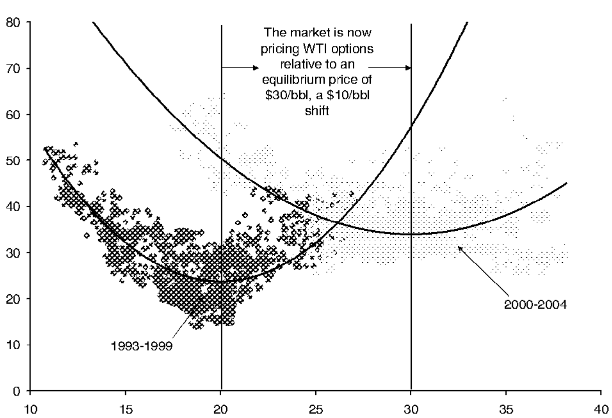
Exhibit 1: Long-dated oil prices have increased by nearly $10/bbl since 2002
$/bbl



Source: Goldman Sachs.

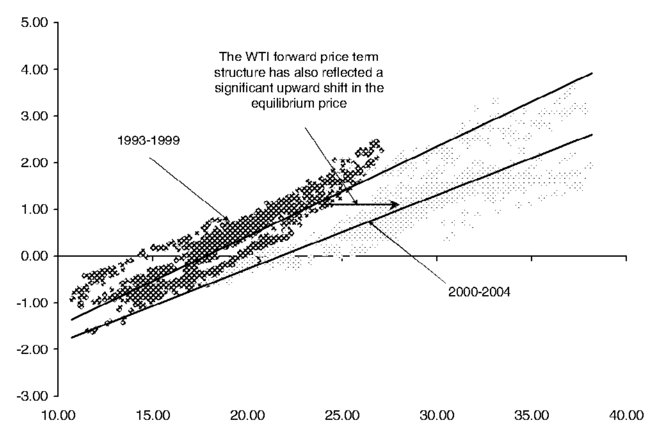
Further evidence of such an upward shift in longer-dated oil prices can also be found in the trading patterns of the oil option markets and the term structure of the forward oil curve, both of which have been reflecting an upward shift in the long-dated oil price to near $30/bbl (see Exhibits 2 and 3).

Exhibit 2: Options markets embed a higher crude price
% implied volatility (vertical axis); $/bbl (horizontal axis)]



Source: Goldman Sachs.

Exhibit 3: The term structure shows a similar shift
$/bbl timespread (vertical axis); $/bbl (horizontal axis)



Source: Goldman Sachs.

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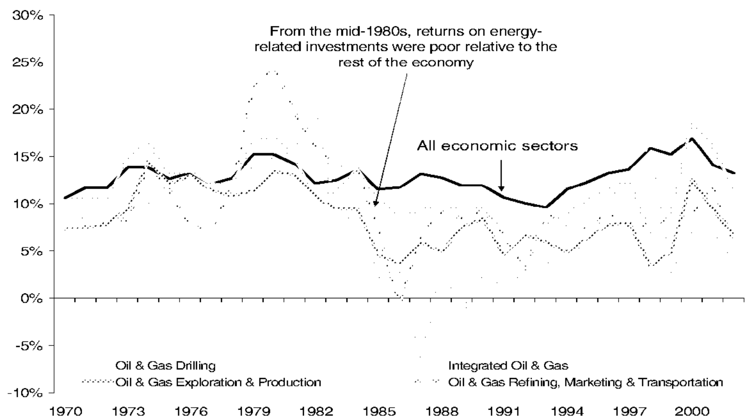
As we have discussed in the past, this sharp rise in the energy price level, which began in 2000, is the result of two decades of extremely low investment rates in the global infrastructure to supply and deliver oil, caused by the poor rates of return on these types of investments (see Exhibit 4). Crude oil production, transportation, and refinery output are all operating at record levels, and are doing so against the backdrop of only a modest increase in investment and nearly no growth in capacity. As a result, the market is pushing up against capacity constraints in every aspect of the system. At the same time, strong demand has helped draw down inventories of crude and products to 30-year lows, leaving the system extremely vulnerable to the recent increased geopolitical uncertainty.

Exhibit 4: Returns in the energy sector have remained below the economy average
% return on capital employed in US sectors (which proxy for the world)

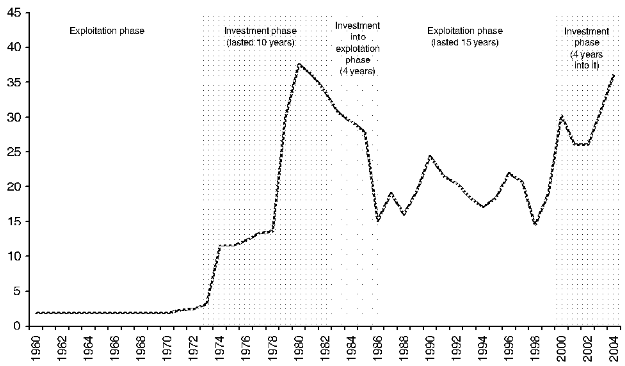


Source: Compustat and Goldman Sachs Commodity Research.

Furthermore, the modest investment that has occurred has been concentrated not in new areas with high returns on investment but in old areas with sufficient infrastructure and low returns on investment. More productive investment will require massive "next-generation infrastructure" projects to open up new areas for drilling. These projects include new rigs and platforms for development, new pipelines and tankers for transportation, and green-field refineries for processing – all of which have very long lead times. The last time the industry built infrastructure on this scale was during the 1970s, which provided years of energy demand growth at a relatively low marginal cost. This "exploitation phase" that lasted for nearly two decades, however, has come to an end, as the industry has re-entered an "investment phase" that could last the next five to ten years before new infrastructure is sufficient to re-enter a new lower-priced exploitation phase (see Exhibit 5).

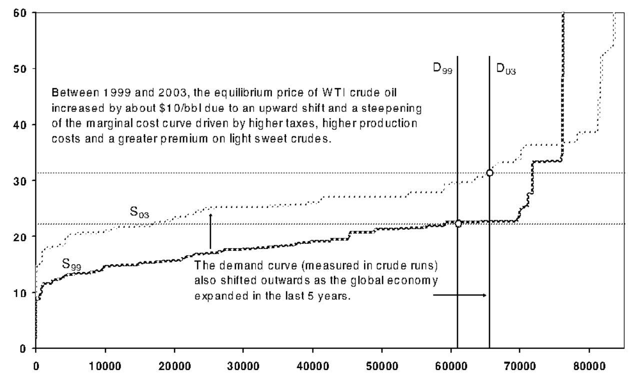
We believe that a WTI price of at least $30/bbl for the remainder of this investment phase will likely be required to keep the older supply base cost effective and generate sufficient investment to displace the older supply base while meeting new demand growth (see Exhibit 6). However, once next-generation projects are completed and new production comes online, prices will likely decline as the new production displaces the older, more expensive fields that are currently supporting prices at the margin (see Exhibit 7). Five to ten years from now, as the industry reduces spending on major infrastructure projects and moves back into a low-cost exploitation phase similar to the 1980s and 1990s, industry returns will likely improve despite lower prices. It is important to note, though, that prices could fall to even lower levels than during the 1990s, as technological advances have significantly reduced the cost of producing the oil once the infrastructure is put into place (see Exhibit 8).

Exhibit 5: The previous investment phase lasted for ten years, providing the market with two decades of growth
$/bbl



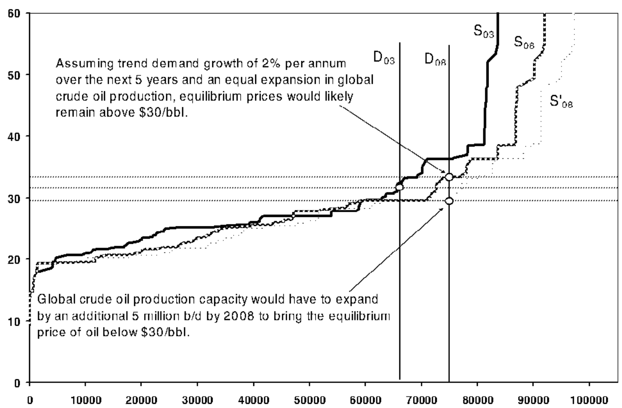
Source: Goldman Sachs Commodity Research.

Exhibit 6: However, now costs are rising, reflecting the need for substantial new investment
Breakeven WTI price in $/bbl(vertical); Kb/d (horizontal)



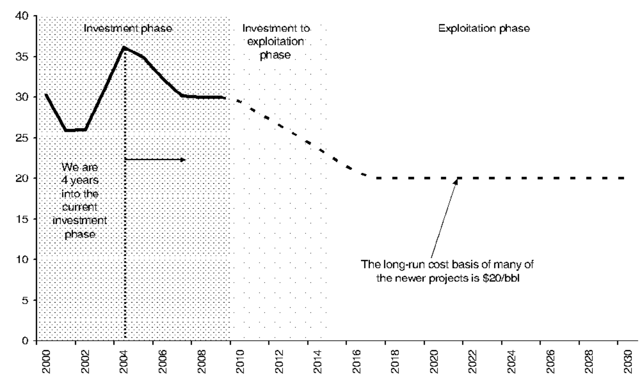
Source: Goldman Sachs Commodity Research.

Exhibit 7: Prices will only decline if the industry can meet both demand growth and displace older fields
Breakeven WTI price in $/bbl(vertical); Kb/d (horizontal)



Source: Goldman Sachs Commodity Research.

Exhibit 8: The current investment phase will likely last at least another five to ten years
$/bbl



Source: Goldman Sachs Commodity Research.

Near term, the required increase in spending is significant. We estimate the total amount of capital spending required over the next ten years in the oil industry to meet trend demand growth at some $2.4 trn, nearly triple the level of spending during the 1990s (see Exhibit 9). This spending, combined with a likely rise in the tax bill by $1.80 trn to $4.20 trn over the next decade, will likely raise the equilibrium oil price by $10/bbl, from $20/bbl during the 1990s to $30/bbl during the 2000s (see Exhibit 10).

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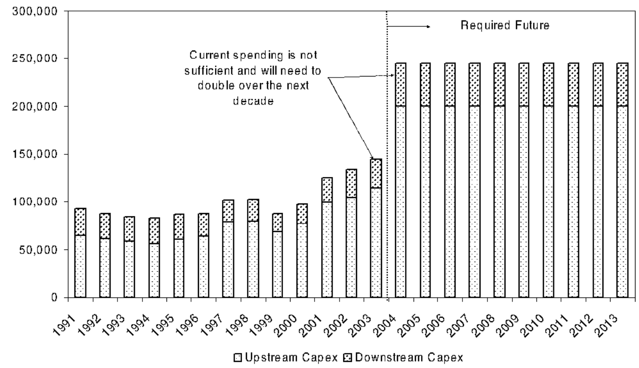
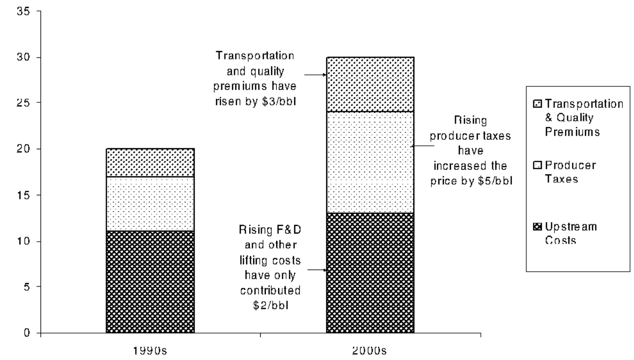
Exhibit 9: Capex has increased but will likely need to double from current levels over the next decade
US$ mn



Source: Goldman Sachs Commodity Research.

Exhibit 10: The equilibrium oil price has increased by $10/bbl over the last decade
$/bbl



Source: Goldman Sachs Commodity Research.

We believe three main reasons explain why spending needs to be significantly higher during the 2000s than in the past, supporting a higher oil price.

- A significant shift in government policies has taken place, from subsidizing to taxing energy production and deliverability through increased environmental regulations, larger royalty payments on production leases and increased revenue taxes for both sovereign and corporate companies. We estimate that this shift in government policies will alone increase the equilibrium oil price by $5.00/bbl, as the total tax bill will likely increase by $1.8 trn over the next decade relative to the prior decade.

- The exhaustion of substantial low-cost capacity in transportation, refining and other core infrastructure, which was built with the help of governments during the 1970s, requires significant investment in next-generation infrastructure. Building this infrastructure without the help of governments will require $150 bn for transportation and $300 bn for refining over the next ten years, including upgrading units to process increasingly poorer quality crude oil production. This spending is nearly double the level of spending that occurred during the 1990s. As a result, we estimate the delivery premium for high quality, gasoline-rich crude oils such as WTI, which can partially substitute for inadequate refining capacity, will likely add an additional $3.00/bbl on to the equilibrium oil price over the next five to ten years.

- Existing production basins are declining much faster than in the past, requiring more capital to just keep production flat, and substantially more to displace them. Total upstream expenditures on oil over the next ten years will likely need to exceed $2.0 trn to meet trend demand, and $2.2 trn to offset the older more expensive production, which is nearly triple the level of the previous decade. This has resulted in a modest, but temporary, increase in finding, development and production costs, which will likely add another $2.00/bbl on to the equilibrium price of oil.

This argument for a higher equilibrium price of oil is not dependent upon rising finding and development costs, which have only increased modestly, nor is it a statement that the industry is running out of oil (rather, infrastructure has been exhausted). Instead, the

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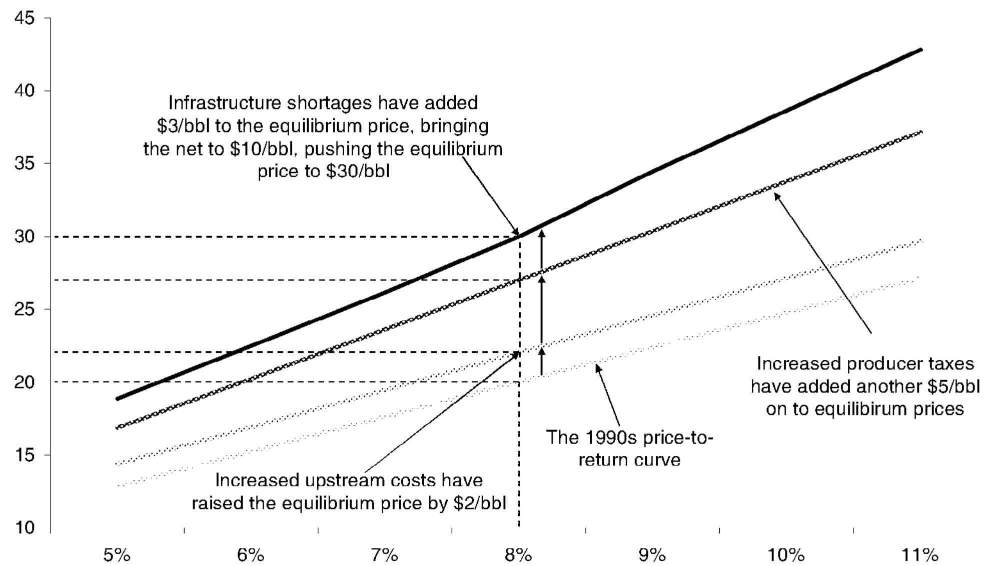
argument is dependent upon the requirement for higher prices to keep older supplies cost effective while funding a substantial increase in spending by the industry resulting from the need to build new infrastructure without government subsidies just as there has been a sharp rise in host government production taxes.

To attract and maintain the higher level of spending required to build next-generation infrastructure without government assistance, oil prices need to stay at a level where cash flows are sufficient to (1) at least break even relative to fourth quartile costs on the older supply sources until the supply curve has shifted out far enough to not need the older supplies (see Exhibit 8) and (2) for some companies in the bottom two cost quartiles to earn a rate of return on capital invested that is at least equal to the cost of capital, accounting for all costs including taxes (see Exhibit 11).

Exhibit 11: Oil prices need to average at least $30/bbl to keep the returns of marginal high cost companies, which will have to do some of the capital spending, above 8%
$/bbl (vertical axis); % cost of capital (horizontal axis)



Source: Goldman Sachs Commodity Research.

While the super majors are likely to generate higher returns on investment, and do not require prices this high, the same cannot be said for almost all of the rest of industry including the sovereign oil companies (once an analysis of social spending is included), which is why for the industry overall we see the need for a $30/bbl WTI oil price. Once next-generation projects are completed and new production comes online, prices will likely decline as the new production displaces the older, more expensive fields that are currently supporting prices at the margin.

Although the entire industry will likely be able to finance this spending through internal cash flows and avoid the external capital markets, the required rate of return must still be the industry's weighted average cost of capital, which is currently around 8.0%. This return is required because companies will remain concerned about their stock price

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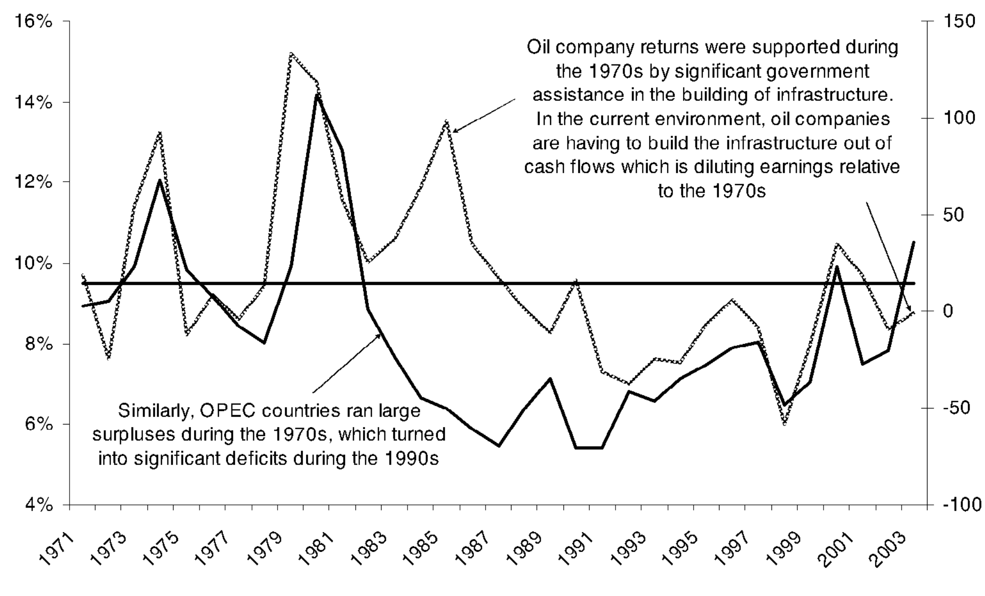
performance, which will continue to be driven by their overall financial performance. Furthermore, debt holders will still require companies, both private and sovereign, to have an adequate debt rating. Our spending estimates are derived from the following assumptions on government taxation policies, the need for infrastructure projects and upstream developments over the next ten years.

Government policies have shifted from subsidizing to taxing

During the 1970s, the returns on capital in commodity sectors were much better as the governments essentially paid for the infrastructure (see Exhibit 12) while the companies and OPEC countries benefited from the infrastructure once it was put into place. In the current environment, however, governments – both OPEC and non-OPEC – are unlikely to provide financial assistance as they did during the 1970s and early 1980s. In the West, governments will likely be hesitant to provide significant subsidies that cross national borders as they will be unlikely to fully capture the benefits of those subsidies given the global nature of the oil market.

Exhibit 12: Government aid to build infrastructure resulted in high returns in the 1970s while OPEC countries had free cash flow that generated high savings rates
% cash return on cash invested (left axis); million riyals (right axis)



Source: Compustat and Goldman Sachs Equity Research.

Furthermore, the shift has actually gone one step farther away from government assistance to increased government taxation. Any measure of the long-term equilibrium oil price is extremely sensitive to the underlying assumptions on the tax rates levied on producers, with a 100 bp increase in the tax on production leading to a $0.50/bbl increase in the equilibrium price of oil (see Exhibit 13). During the 1990s, producer willingness to sell away the upside to host governments under the belief that oil prices would unlikely exceed $25/bbl, combined with increasing demands by the host governments to gain a larger share of oil revenues as prices continued to climb, led to a sharp rise in host government taxes.

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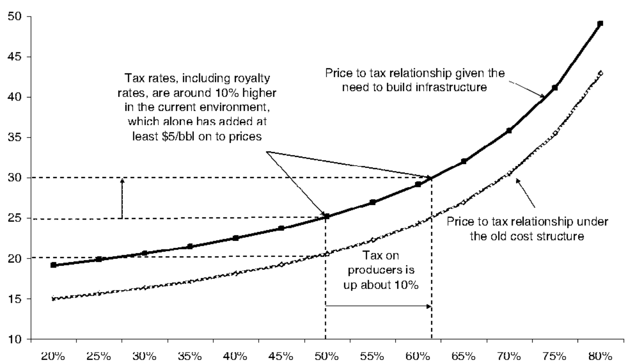
Currently, we believe that the marginal tax rate is about 10% higher at 60% than during the 1990s, which will likely increase the producer tax bill by $1.8 trn over the next decade. Much of this increase is being driven by emerging market governments, with Russia, the largest producer in the world, having substantially raised taxes over the last decade (see Exhibit 14). The higher expected tax expenditures create a $5/bbl incremental increase in the equilibrium price, which is the largest component, pushing the equilibrium price to $25/bbl with no delivery, quality, or increased cost premiums added. Going forward, tax expenditures represent a significant upside risk to costs should host governments try to extract more of the producers' revenues. If prices drop, these host governments will likely want to maintain revenues by increasing taxes, and should prices rise further, these same governments would likely want to extract more of the rise in revenues.

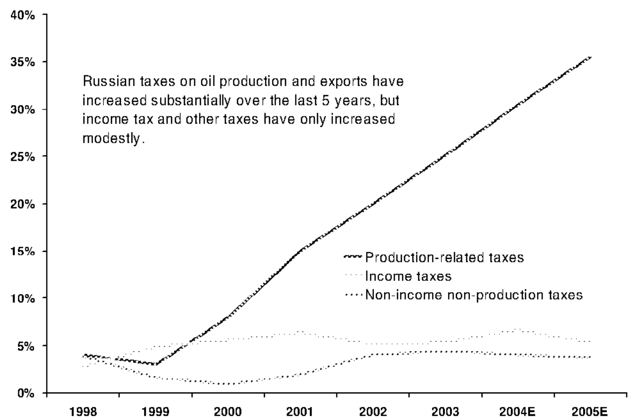
This shift in government policy can also be viewed in the context of OPEC countries. During the 1970s, these countries saved a large share of the revenues they received (25% savings rate in Saudi Arabia). However, by the 1980/90s these countries started to run significant deficits, averaging 45% of revenues in Saudi Arabia over the last two decades, which pushed debt to extremely high levels (see Exhibit 15). Going forward, these countries will need to re-direct a large share of cash flow generation into government spending programs to support a rapidly growing population and pay down past debt, leaving very little free cash flow to be invested into the industry.

Exhibit 13: The equilibrium oil price is very sensitive to the producer tax rate
$/bbl (vertical axis); % producer tax (horizontal axis)



Source: Goldman Sachs Commodity Research.

Exhibit 14: Russian oil-related taxes have increased substantially in recent years as a percent of revenues
% tax rate (left axis)



Source: Goldman Sachs Commodity Research.

For example, if the population in Saudi Arabia continues to grow at 3.0% year over year over the next five years, the price of oil will need to average at least $30/bbl to keep per capita expenditures flat over this time period (see Exhibit 15). A similar calculation for OPEC as whole suggests a volume weighted average price for oil of $31.00/bbl to maintain spending programs (see Exhibit 16), with countries like Venezuela in a critically unstable situation.

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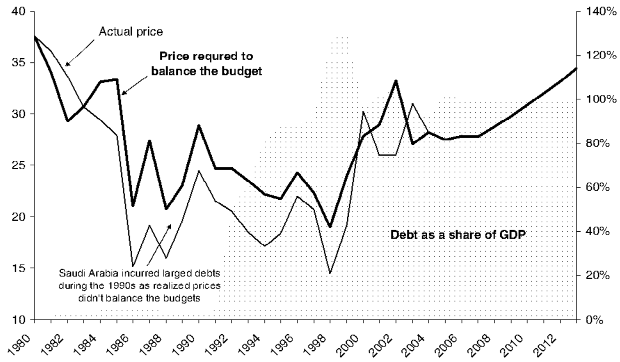
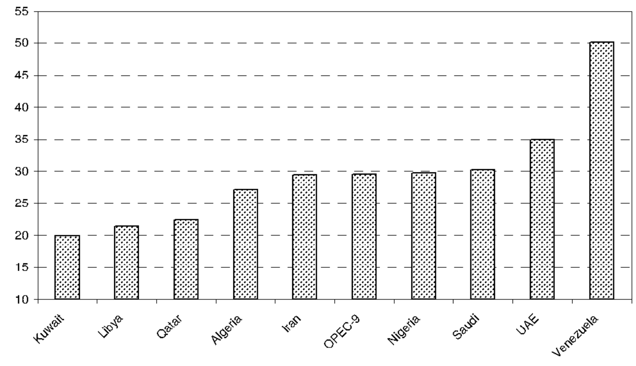
Exhibit 15: Saudi Arabia needs on average $30/bbl to balance the budget over the next ten years
$/bbl (left axis); % GDP (right axis)



Source: Goldman Sachs Commodity Research, IMF and IEA.

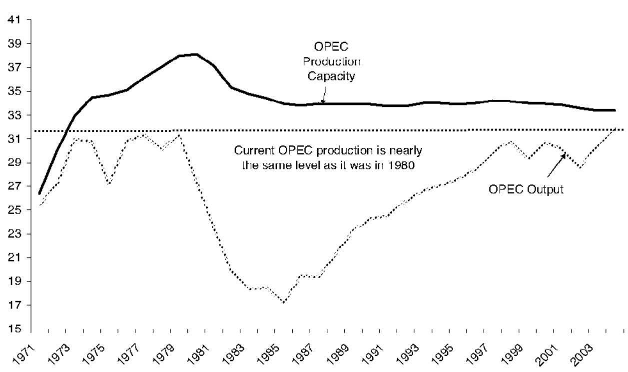
Exhibit 16: On average, over the next decade OPEC countries need a $31/bbl price to avoid budget deficits
$/bbl



Source: Goldman Sachs Commodity Research, IMF and IEA.

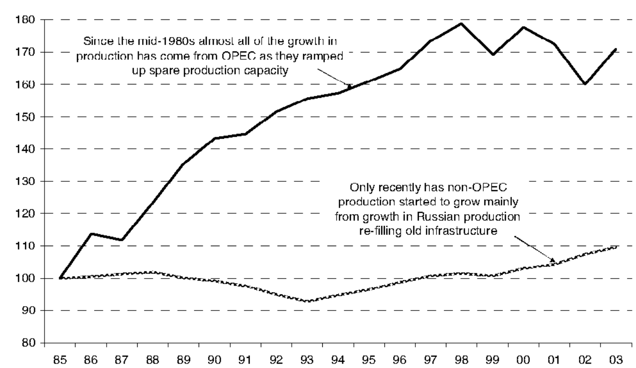
The situation in many of the OPEC countries has become much more acute today than in the past because OPEC supply growth, as elsewhere in the world, is restricted by infrastructure constraints that limit the ability to grow revenues through volume growth (see Exhibits 17 and 18). As a result, barring substantial investments in new infrastructure to grow the supply base, revenue growth will have to be met through price appreciation. Furthermore, any surpluses will likely be absorbed by increasing demands for revenues to fund social programs, which suggests that the social programs will float up to a higher oil price relatively quickly, as evidenced by recent announcements from several OPEC countries that the required price to balance their budgets has already increased significantly.

Exhibit 17:OPEC countries have not invested to expand oil production capacity
million b/d



Source: IEA and Goldman Sachs Commodity Research.

Exhibit 18: Production growth was achieved through OPEC spare capacity, not new fields
Index 1985=100



Source: IEA and Goldman Sachs Commodity Research.

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The need for next-generation infrastructure projects

The lack of investment in infrastructure projects for more than 20 years has finally caught up with the market, necessitating investment in new next-generation projects to enable further oil demand growth. Almost all of the growth in supply was achieved by bringing online existing production capacity that was installed decades ago (see Exhibit 18). The seeds of this current infrastructure problem were sown more than 30 years ago. The low investment rates and poor rates of return on energy-related assets can be traced back to (1) a global regulatory environment during the 1970s that incentivized overinvestment in transportation, refining and other core capacity, creating a "commodity investment bubble", (2) increased environmental-related regulation and taxation, and (3) "deregulation" of the industry that increased the risks and delayed investments in energy infrastructure. Even in the current environment characterized by high energy prices, rates of return have not significantly improved, as these concerns continue to create a hostile environment for energy infrastructure investments. Net, the regulatory pendulum swung too far to the left during the 1970s and created overinvestment and a capacity bubble, while today it has swung too far to the right and created an environment that is not conducive to investment.

Commodities bubble of the 1970s depressed prices in the 1980s & 1990s

The regulatory environment and economic institutions of the 1970s created an environment that generated massive overinvestment in commodity-related infrastructure. The resulting overinvestment was wide spread, particularly in the planned economies, where giant state monopolies built large-scale infrastructure projects. As many of these projects were built to maximize reliability, with an emphasis on excess capacity and redundancy rather than market economics or efficiency, replicating these projects under anything other than a large-scale government spending program would be exceedingly challenging.

In 1981, the global commodity investment boom ended. On a global basis, oil drilling, transportation and refining capacity all reached a peak that year (see Exhibits 19, 20 and 21). This timing corresponded to the beginning of the deregulation era. Even in the former Soviet Union, investment stopped in the early 1980s (see Exhibit 22). However, the legacy of this era was an infrastructure bubble that provided years of demand growth with little investment.

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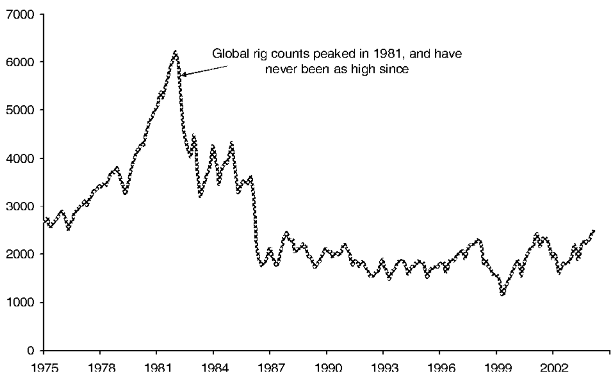
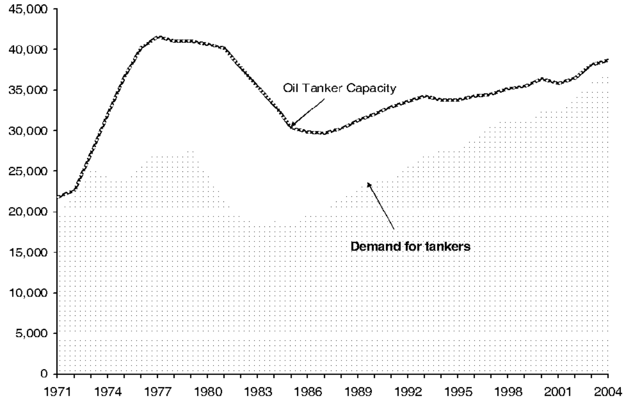
Exhibit 19: Global rig counts peaked in 1981…
number of rigs



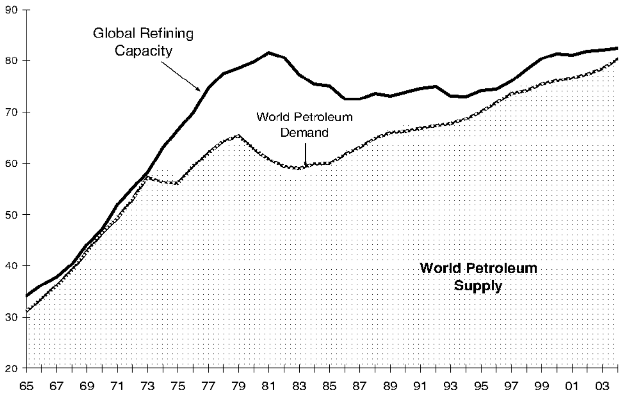
Source: Baker Hughes.

Exhibit 20: …as well as oil tanker capacity…
thousand b/d



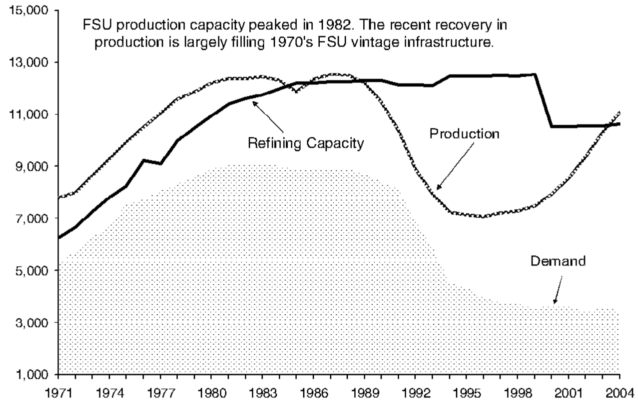
Source: Clarkson and Goldman Sachs Commodity Research.

Exhibit 21:…and oil refining capacity
million b/d



Source: IEA and Goldman Sachs Commodity Research.

Exhibit 22: Soviet investment also stopped after 1981
thousand b/d



Source: IEA and Goldman Sachs Commodity Research.

Increased environmental regulations pushed up costs

During the 1980s and 1990s, energy producing companies were not only facing downward pressure on revenues due to overcapacity, but also were facing rising costs due to increasingly more challenging environmental regulations. These regulations spanned the entire energy complex. On the upstream side, increased difficulties in obtaining drilling permits increased project times and costs while on the downstream side refineries were forced not only to produce more environmentally friendly fuels but also to reduce emissions. This regulatory shift significantly raised costs globally during the 1990s, as clean air became extremely important to nearly all of the industrialized nations.

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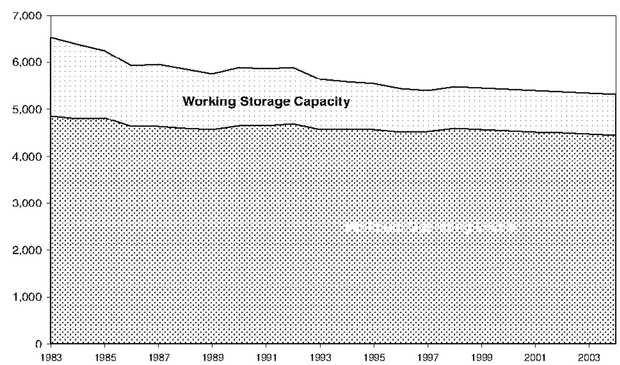
"Deregulation" increased risk, price volatility, and delayed investment

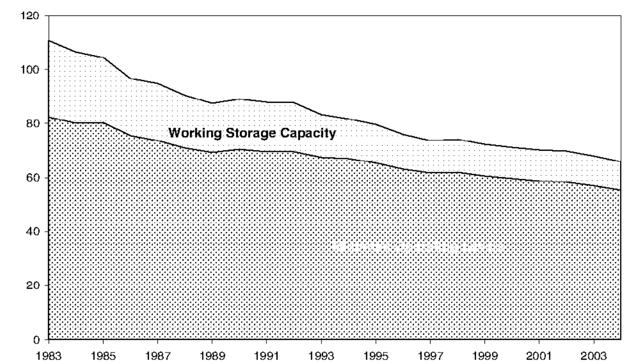
Deregulation during the 1990s significantly increased the risks associated with these low return energy projects. The market emphasis shifted toward unbundling the supply chain and the use of spot prices, which provided welcomed transparency to both consumers and producers. Although spot price transparency is very effective in providing market signals for efficient drilling and consumption patterns, which are relatively low-capital intensive activities, for more capital intensive and longer lead-time activities, such as building infrastructure, a spot market price signal is a lagging indicator of an investment that should have already been made. Instead, forward contracts of sufficiently long duration are needed to internalize the risks and induce the needed investment in advance of shortages. Further, the industry shifted from reliability to efficiency, for example, through the elimination of excess capacity. This shift was apparent in the decline in spare storage capacity that was deemed "excess" during the 1990s (see Exhibits 23 and 24), which ultimately increased price volatility in the market.

Exhibit 23: Global petroleum storage capacity has been declining
million bbl



Source: Regional governments sources.

Exhibit 24: Relative to demand growth, this decline has been even more pronounced
days of forward consumption



Source: Regional governments sources and IEA.

Calculation of the downstream spending requirements

Accordingly, we estimate that the industry needs to spend $450 bn over the next ten years (or $45 bn per year) on the development of downstream infrastructure, both transportation and refining. Approximately $300 bn of this amount will need to be directed towards refining. This level of spending on refining is derived by calculating the increase in refined product supply required to meet trend demand over the next ten years, which suggests that the industry will need to add over 14 million b/d of refining capacity, 15% of which will need to have expensive upgrading capacity added to process lower quality crude oils. We estimate that a barrel of capacity costs $20,000, which leads to the estimated $300 bn spend on refining infrastructure. To attract this necessary downstream capital, US Gulf Coast (USGC) refining margins will likely need to average near $4.25/bbl, $2.25/bbl higher than during the 1990s, to keep returns above 10% (note that refineries have a significantly higher cost of capital than producers).

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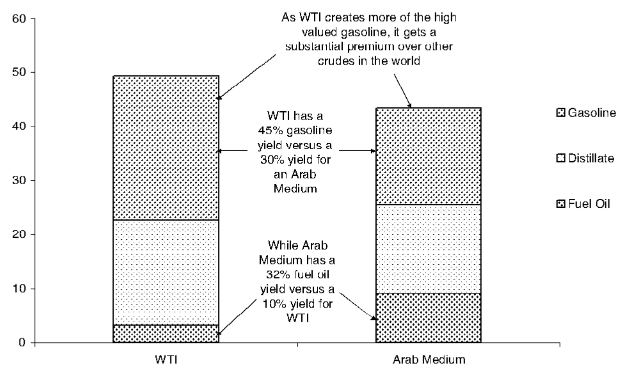
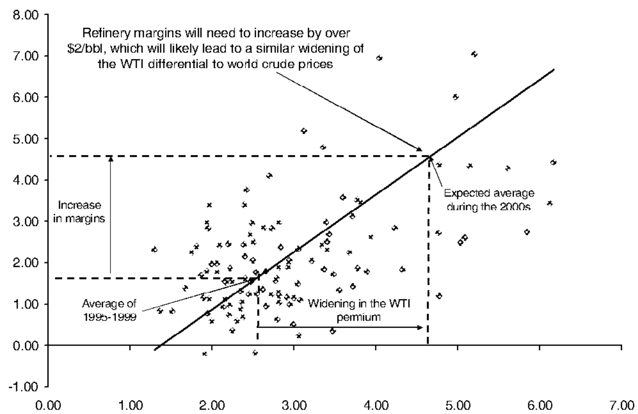
The higher refinery margin will widen the differential that WTI receives relative to the world oil price (a global-production-weighted-average crude oil price). This is because not all crude oil is equal. There are significant quality differences, which are primarily measured in terms of the product yields. A "good quality" crude oil usually has a high gasoline yield and a low fuel oil yield. WTI is considered a high quality crude as it has a large gasoline yield relative to other crude oils, and accordingly receives a significant premium to other crude oils (see Exhibit 25). The need for higher gasoline prices to generate an increase in refining margins that is necessary to motivate the industry to build new refineries suggests that the differential of WTI to the world oil price will need to widen by $2/bbl (see Exhibit 26), further boosting the equilibrium WTI price.

Exhibit 25: WTI has higher gasoline yield and a higher intrinsic value than other crude oils
Gross product value in $/bbl



Source: Goldman Sachs Commodity Research.

Exhibit 26: Refinery margins will likely support a gasoline-driven WTI premium
$/bbl premium (horizontal axis); $/bbl margin (vertical axis)



Source: Goldman Sachs Commodity Research.

The additional $150 bn of downstream infrastructure spend will need to be directed toward transportation. Due to the need to scrap older vessels at rate of 6% per year, we believe that the industry will need to add 300 million Dwt over the next ten years, of which only 150 million Dwt will be incremental capacity. The rest will be to replace scrapped vessels that are aging. To generate this spending, freight rates will likely have to maintain a $1.00/bbl premium, which is mostly priced into rates. WTI crude oil is in a position to capture this premium because it is produced as close as possible to the largest consumer in the world, the US. In sum, the WTI differential has already widened to reflect both refining and transportation by a total of $3/bbl (see Exhibit 27).

Thus far, this exercise has been from the perspective of the producer, not the consumer, who instead of consuming raw crude oil, is exposed to the final refined product price which includes the increase in refining margins. From the consumer perspective, the increase in the equilibrium price is not from $20/bbl to $30/bbl, but rather from $22/bbl to $34/bbl when factoring in the increase in refining margins. This, however, would be reflective of the average product price, as gasoline and jet fuel prices would be significantly higher than this average while fuel oil prices would be significantly lower. Further, given the extremely high utilization rates in refining, the upside risks in gasoline and jet fuel prices are very high, as it takes only a modest refinery disruption to create significant upside price spikes.

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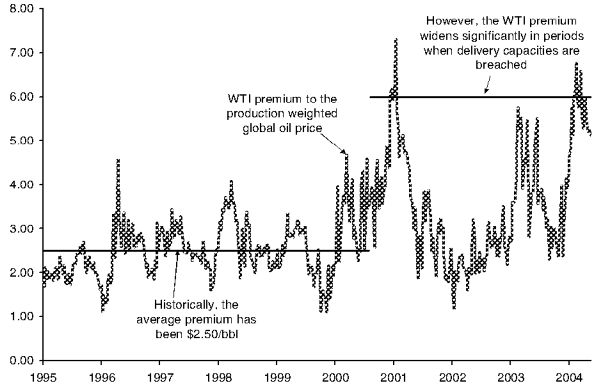
Exhibit 27: Average global crude oil production prices are reflecting a widening in the quality and delivery premium for WTI
$/bbl discount



Source: Goldman Sachs Commodity Research.

Accelerating exploitation costs also increases the need to spend more on "secondary" production and replace higher cost fields over the next decade

Since revenues for the industry as a whole were largely out of the control of companies (particularly for those that did not hedge) and environmental regulations were an increasing cost of operation, the focus in the 1990s shifted to the costs that companies could control. This focus on cost cutting created the mega-mergers of the 1990s and large investments in technological advances aimed at increasing production without large scale infrastructure investments. On the upstream side, this technology included 3D seismic, horizontal drilling and fractionation techniques that allowed producers to extract more oil, more quickly from a well. The cost of such technologies, however, was steeper decline rates in the future, which are now beginning to create problems for producers in trying to simply keep secondary production levels flat, let alone grow them (see Exhibit 28).

The result is that existing production basins are declining much faster than in the past, requiring more capital to just keep production flat. So the use of technology that was lowering costs in the 1990s is actually beginning to raise costs in the 2000s. The only way to reverse this "aging" is to build infrastructure into less mature basins and start the process all over again, i.e. create new producing basins that have lower decline rates (see Exhibit 29). Currently, we estimate that the average age of the producing fields is 36 years and they are all concentrated around infrastructure that was built during the "bubble" era of the 1970s.

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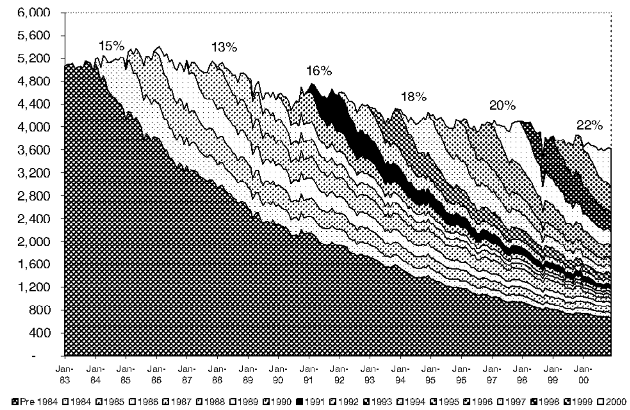
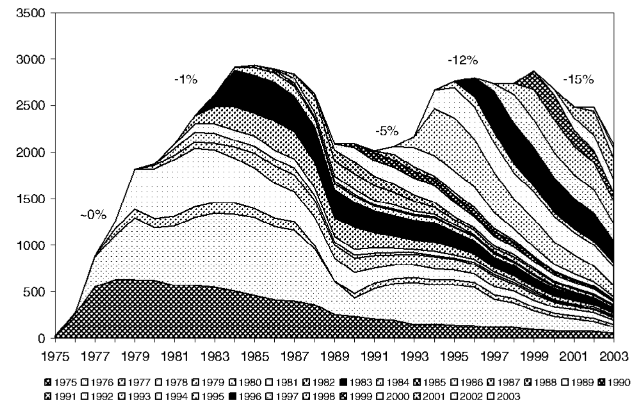
Exhibit 28: Decline rates in US oil output have been accelerating
thousand b/d



Source: IHS and Goldman Sachs Commodity Research.

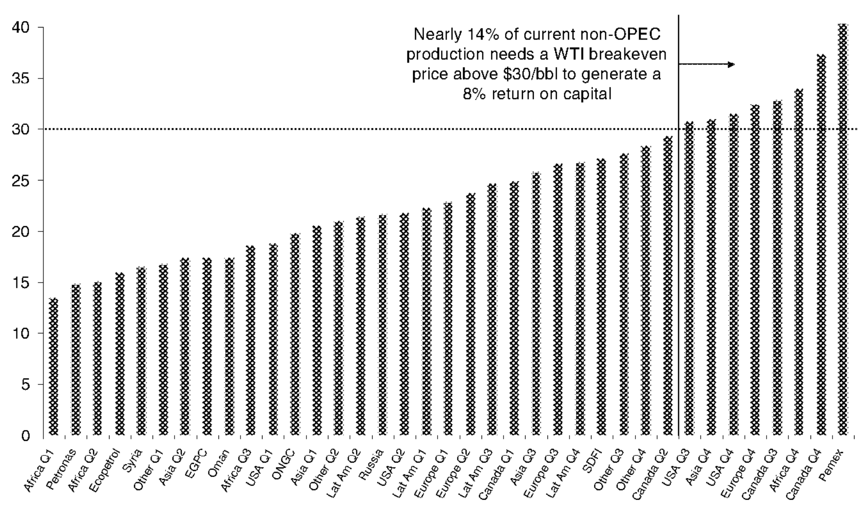
Exhibit 29: UK output history shows the life cycle of production decline rates
thousand b/d



Source: UK Department of Trade & Industry.

Many companies are forced to operate in these older secondary basins, as there is a very large barrier to entry in the form of capital outlays to build the infrastructure required to develop less mature basins. We estimate that as much as 14% of non-OPEC production (or 7 million b/d) now has a breakeven cost that exceeds $30/bbl due the rising costs associated with these secondary basins. Most of these companies are smaller fourth quartile producers in Europe and North America (see Exhibit 30). It is important to reiterate that once the next-generation infrastructure is completed, the market will no longer need this higher cost production and costs will come down once again, as these companies will likely enter the new-generation infrastructure once the large-scale producers begin to sell interests.

Exhibit 30: Breakeven WTI prices for non-OPEC producers exceed $30/bbl for 14% of production (or near 7 million b/d)
$/bbl



Source: Goldman Sachs Equity Research.

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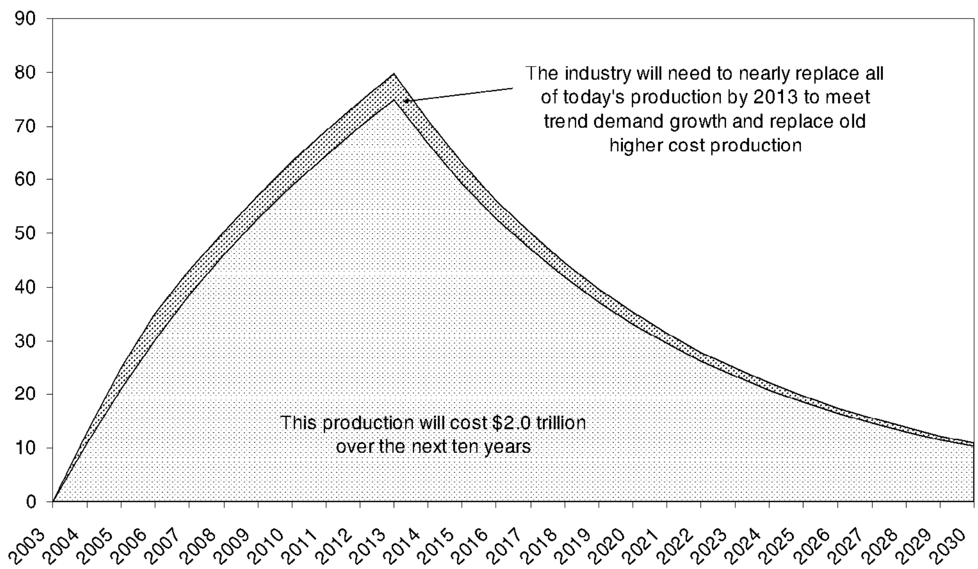
Calculation of the upstream spending requirements

We believe the industry will need to spend $2.0 trn over the next ten years (or $200 bn each year) to meet trend demand and $150 bn (or $15 bn each year) to offset existing older high cost production basins. This number is derived by calculating the cost of finding and developing (including upstream infrastructure) the amount of supply required to meet global oil demand growth of 2% per annum. We also add on 2% spare capacity to deal with system shocks, which brings the total required increase to 14 million b/d over the next ten years. To offset the 7 million b/d of existing high cost production, the increase in new production would need to expand by another 5 million b/d (not the entire 7 million b/d, as natural decline rates will remove much of this oil from service). These assumptions, however, still create a very tight supply situation, which is why we view this as a lower bound on spending. This is just enough supply to "get by" if demand continues to grow as it has in the past. Furthermore, it is assumed that the supply base declines at 11% per annum, with newer fields exhibiting initial decline rates of 15% per annum. These are relatively conservative estimates when viewed in the context of the US and UK supply bases. Altogether, the industry will need to completely replace the current supply base over the next decade (see Exhibit 31).

Exhibit 31: The industry will need to replace the entire current supply base over the next decade which will cost $2.0 trn on conservative cost estimates
million b/d



Source: Goldman Sachs Equity Research.

The underlying industry average finding and development (F&D) cost estimate is $5.00/bbl, which is based on a sample of public and sovereign oil companies representing 90% of all production. On the margin, however, we estimate the F&D cost rises to $9/bbl, more than a $2/bbl increase over the 1990s level of $6.50. We have used the average of the bottom two quartile companies as representative of the margin, which is the relevant cost measure in terms of determining the price level. Furthermore, we assume that 25% of the required capital expenditures will have to come from this group,

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with the remaining 75% coming from the top-half low cost producers. On the margin, the increase in F&D and production costs will likely add $2/bbl on to the equilibrium price. This increase is represented by a $2/bbl upward shift in the price-to-return curve over the historical relationship at an 8.0% cost of capital (see Exhibit 11).

Increased spending has already begun to dilute company returns

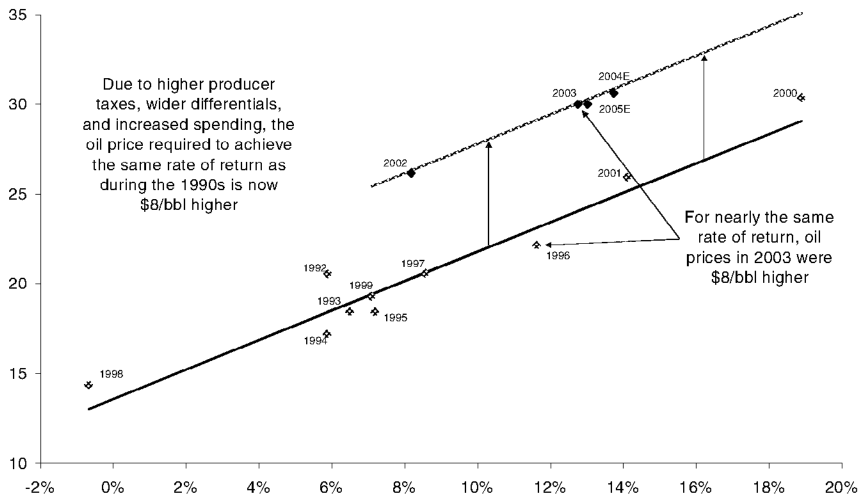
The analysis above suggests that current price levels and refining margins are just beginning to incentivize the spending required by the industry over the next decade. Although some of the required investment on next-generation projects has already started, the industry still needs to significantly ramp up spending. Our estimates suggest that the industry spent $113 bn last year on upstream oil-related projects, which is nearly half of the $200 bn per year we estimate is required over the next ten years. On the downstream side, however, the industry spent about $30 bn last year, which is only modestly short of the $45 bn per year that we believe is required.

Current prices and margins, which are above the levels needed to support spending, are being supported by a combination of higher breakeven oil prices for both OPEC producers and high-cost non-OPEC producers. Although it is unclear which group is on the margin, it is clear that both groups currently support oil prices at or above $30/bbl, and will likely continue to do so until the next-generation infrastructure is completed and new supplies can begin to displace the older higher-cost supplies. The sustainability of these price levels, however, is a critical factor in attracting the necessary capital to rebuild the infrastructure, as many in this group of producers that are currently supporting prices due to higher costs do not have the capacity to make the large-scale investments required to grow the supply base.

For the large integrated oils, the increased spending on next-generation projects, higher tax rates on production and the need to rebuild infrastructure are already beginning to be reflected in the financial performance of energy companies relative to the price of oil. This increased spending has substantially diluted the earnings of energy companies and hence the returns on investment relative to the price of WTI. The returns that major integrated oil companies generated in 2003 at $30/bbl oil were the same as those generated in 1996 at $22/bbl oil (see Exhibit 32). We estimate that $4/bbl of that rise resulted from increased production taxes, $1.50/bbl resulted from a wider differential, while the rest resulted from the capitalization of the required increase in spending.

The key is that the industry must increase spending from current levels. A large number of projects are both under development and planned. However, it is important that industry returns continue to support the completion of these projects, as there is little margin for error. Although the industry could concentrate the spending over a shorter period of time at higher near-term prices, this would unlikely speed up the time required before the industry can enter a new exploitation phase as there are physical constraints on how fast these projects can be completed, which is five to ten years.

Exhibit 32: Higher prices do not necessarily mean higher returns
$/bbl basis WTI (vertical axis); % return on capital employed (horizontal axis)



Source: Goldman Sachs Equity Research.

Risks to $30/bbl oil prices are skewed to the upside

The key downside risk to sustainable higher oil prices is the potential for longer-term demand rationing should prices rise too high. Hybrid automobile sales are already beginning to gain momentum and sustainable prices above $40/bbl would likely begin to attract alternative energy sources. Gas-to-liquids may also become an attractive alternative should the technology improve. However, the slow pace of these adjustments suggests the potential for significant demand declines presents only a modest downside risk to this view.

It is important to distinguish the current demand mix of oil from the demand mix of the late-1970s when there was a significant drop in demand in response to rising prices. During the 1970s, nearly 30% of oil demand was consumed for the purpose of power generation, which is the most demand-elastic energy consumer, as generators can easily substitute less expensive fuels, as was done during the early 1980s. In the current environment, demand is much more transportation intensive, which suggests a much more inelastic demand, as cars, trucks, jets, and trains can only run off of petroleum, which substantially reduces the ability to switch fuels and the risk of a significant drop in demand as witnessed during the early 1980s. Even so, we still expect to see cyclicality in oil demand and oil prices over the current investment phase. For example, a sufficiently large negative demand shock like an economic crisis in a major consuming region could temporarily push prices far below $30/bbl.

In contrast, upside risks are more numerous and more likely to occur. The risks of cost overruns are very real, as the industry has already encountered steel shortages in places such as the Gulf of Mexico. Furthermore, recent projects in Canada have experienced such large cost overruns that contractors are refusing to accept turnkey agreements, while operators in the emerging world face political risk from the host countries demanding better lease terms as oil prices rise. While the large projects of the 1970s were located in places such as Alaska and the North Sea, the next-generation projects of the 2000s are located in places such as Africa, the Caspian Sea and Siberia, which increases the likelihood of cost overruns, delays and political risk. Equally important is the risk of increasing costs for capital. It is important to remember that last year the environment for access to capital was very accommodative as interest rates were extremely low. These risks all underscore that $30/bbl likely represents a lower bound on equilibrium prices with a significant probability that prices average much higher.

We are not running out of oil

The industry is not running out of oil – reserves are large and continue to grow. What the industry is running out of is the ability to access this oil. To develop these reserves, massive infrastructure projects need to be completed, even within the OPEC countries. In Iraq, there is a very significant amount of oil reserves, but the existing infrastructure, which was built in the early 1970s, is old, inadequate and cannot be expanded without significant investment and, more importantly, time. Energy infrastructure is rapidly becoming a major limiting factor on growth. If the core infrastructure does not improve, energy crises are likely to become progressively more frequent, more severe and more disruptive of economic activity.

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