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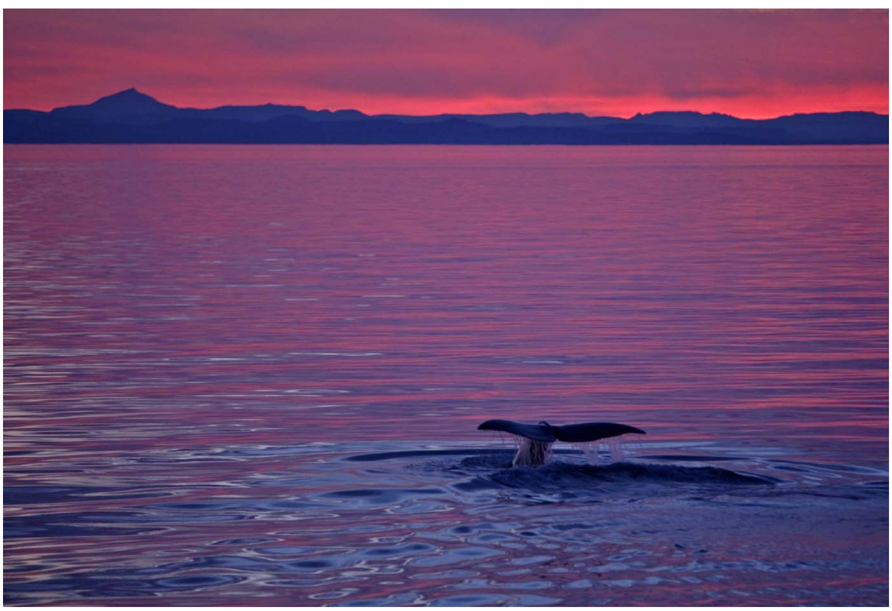
4 October 2009

The Peak Oil Market

Price dynamics at the end of the oil age



FITT Research

Fundamental, Industry, Thematic, Thought Leading
Deutsche Bank Company Research's Research Product Committee has deemed this work F.I.T.T. for investors seeking differentiated ideas. Here our Oil & Gas team extends its ongoing series of thought pieces on the peak of oil demand and supply.

Fundamental: Efficiency will drive the long-term future of oil

Industry: Price volatility will reign in the medium term

Thematic: Government distortions = chronic underinvestment

Thought leading: The end is nigh for the Age of Oil

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Fundamental: Efficiency will drive the long-term future of oil
Building on our February 2008 note "The 100mb/d peak oil market", we have refined and deepened our global demand/supply model, and extended it out to 2030 to capture the game-changing emergence of a powerful disruptive technology, the electric car. Our gasoline model focuses on the major (200% +) efficiency gains flowing from the new era in transportation. Unburdened by the conflicted forecasting agendas of government agencies, oil companies, or auto makers, we forecast a game change. US and then global oil demand will fall dramatically once the high efficiency fleet hits critical mass; competing structurally cheaper natural gas will exacerbate the pace of demand decline. In our view global oil demand peaks in 2016, with oil prices, before a long, tandem, decline.

Industry: Price volatility will reign in the medium term
While the Street, governments, OPEC and the integrateds are all excessively focused on supply alone as the key factor for the future of oil, our analysis views the price-demand interaction as the linchpin in a supply-constrained world. We postulate that government-created distortions – not geology - prevent oil supply from responding to rising prices, and so demand must therefore be broken, by a price crisis. We conclude that medium-term volatility must increase, causing supply under-investment to become even more chronic, and the resulting price spike – implied to be to $175/bbl in 2016 - will drive a final stake into long-term oil demand. By contrast, natural gas supply responds to high prices, and will price at a major discount to oil priced to break demand.

Thematic: Government distortions = chronic underinvestment
Our theme-by-theme cost of supply curve finds the demand-clearing price of oil. We have developed price-demand elasticity curves and present a final supply-demand equilibrium price for a declining oil market to 2030 of around $100/bbl.

Thought leading: The end is nigh for the Age of Oil
This is the end of the 20th Century of Oil; we are entering the 21st Century of Electricity. We expect high volatility in both fuels as the baton is passed. Once the peak oil market is reached and demand begins its decline, there will be a real need for OPEC to reverse its strategy of under-supply, and pursue market share & lower prices. This shift will threaten the value of high cost un-developed oil such as ultra-deepwater (Brazil, Lower Tertiary, West Africa, and elsewhere) undeveloped Canadian heavy oil sands, and the companies that are adding rig capacity to service them. Refining is also directly and negatively threatened, as is the airline industry; we see peak aviation as a function of lack of oil supply, as prices fall below levels required to develop marginal oil. As base demand shrinks away led by gasoline, so global oil supply will shrink too. We strongly prefer oil-levered companies with low and flexible future capex intensity, short refining.

FITT Research

Top picks

ExxonMobil (XOM.N),USD66.58	Buy
Canadian Natural (CNQ.TO),CAD68.42	Buy
ConocoPhillips (COP.N),USD46.80	Hold
Chevron (CVX.N),USD68.14	Hold
Hess Corporation (HES.N),USD51.79	Hold

Companies featured

	2008A	2009E	2010E
ExxonMobil (XOM.N),USD66.58			**Buy**
EPS (USD)	8.47	4.17	4.84
P/E (x)	9.8	16.0	13.8
EV/EBITDA (x)	5.5	8.9	8.4
Canadian Natural (CNQ.TO),CAD68.42			**Buy**
EPS (CAD)	6.53	6.52	5.56
P/E (x)	11.3	10.5	12.3
EV/EBITDA (x)	7.0	5.9	5.6
ConocoPhillips (COP.N),USD46.80			**Hold**
EPS (USD)	10.61	3.79	4.20
P/E (x)	7.1	12.4	11.1
EV/EBITDA (x)	3.9	3.9	3.8
Chevron (CVX.N),USD68.14			**Hold**
EPS (USD)	11.18	4.52	5.41
P/E (x)	7.6	15.1	12.6
EV/EBITDA (x)	3.9	6.0	5.6
Hess Corporation (HES.N),USD51.79			**Hold**
EPS (USD)	7.28	1.74	1.49
P/E (x)	12.3	29.7	34.8
EV/EBITDA (x)	4.0	4.2	5.7
Marathon Oil (MRO.N),USD30.48			**Hold**
EPS (USD)	6.36	1.97	2.25
P/E (x)	6.8	15.5	13.6
EV/EBITDA (x)	3.8	4.4	4.4
Murphy Oil (MUR.N),USD55.57			**Sell**
EPS (USD)	8.52	3.40	2.48
P/E (x)	8.5	16.4	22.4
EV/EBITDA (x)	3.5	5.1	5.0
Occidental Petroleum (OXY.N),USD74.33			**Buy**
EPS (USD)	8.95	3.65	3.69
P/E (x)	8.0	20.4	20.1
EV/EBITDA (x)	4.2	7.3	6.2
Petro-Canada (PCA.TO),CAD45.50			**No**
EPS (CAD)	7.82	–	–
P/E (x)	5.6	–	–
EV/EBITDA (x)	3.0	–	–
Suncor Energy (SU.TO),CAD35.35			
EPS (CAD)	3.49	–	–
P/E (x)	13.7	–	–
EV/EBITDA (x)	10.2	–	–

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Executive Summary

The peak oil market: oil prices at the end of the oil era, macro

Peak oil analysis is excessively focused on supply, with insufficient analysis of demand, and price, and the price-demand interaction in a supply-constrained world. Our view is that oil will never run out, rather we will become more efficient. In the next century we will almost certainly use more electricity. We believe that falling oil demand will end the oil age, that price will be volatile and needs to break demand, but is under long-term downward pressure.

Figure 1: Peak Oil Market

"The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil." Sheikh Yamani, Saudi Oil Minister, 1962-1986.

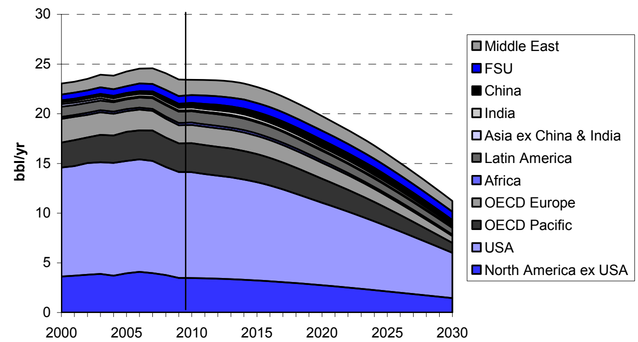
The current average vehicle fuel efficiency of the US vehicle fleet is 25mpg – only marginally better than the Model T Ford, first produced in 1908.

Source: Deutsche Bank

This note addresses three issues:

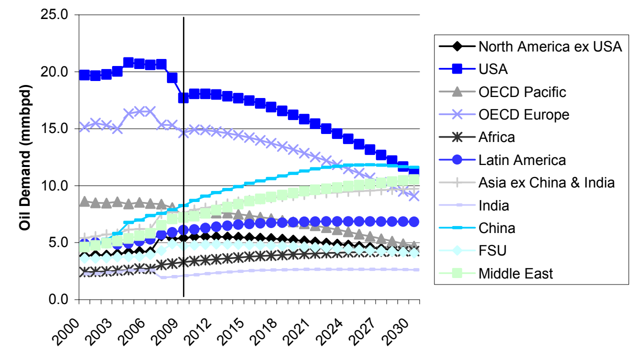
- **Supply:** we expect increasingly chronic under-investment in new oil supply capacity. We believe that concentration of remaining oil reserves into OPEC government hands will lead to under-investment in new supply and higher volatility in regulatory and fiscal regimes, and more volatile pricing. Consumer governments are adding to uncertainty with total lack of clarity on environmental legislation/regulation outcomes. That deep uncertainty in supply and demand will likely disincentivise private sector oil supply investment, exacerbating overall oil under-investment, and leading to peak oil supply within the next six years. We see market maximum capacity at 90mb/d in 2016 – just 5% above 2009.
- **Demand:** we now have a "disruptive technology" in the shape of the hybrid and electric car, that will very likely have a far greater positive impact on oil efficiency than the market currently expects. There are two major issues that lead us to believe that oil demand peaks with lack of available supply within six years:
    1. With reasonable assumptions, we find that by 2020 the global average MPG of newly purchased light vehicles will have increased by a bit more than 50% compared to 2009, from roughly 29 mpg to about 44 mpg. The impact will be concentrated in US gasoline, the largest single element of global oil demand (12%), and will be dramatic enough in its own right to cause the peak of global oil demand around 2016. We forecast US gasoline demand to fall to 4.9mb/d – about 46% from its 2009 level – by 2030.
    2. Also undermining oil demand is a switch to $30/boe natural gas. Unlike oil, natgas is abundant, accessible, and cheap to develop; huge current price discounts caused by OPEC and under-investment will cause major switching away from oil.

Figure 2: Remarkable gasoline demand/capita decline



Source: Deutsche Bank

Figure 3: World oil demand shifts hugely - downwards



Source: Deutsche Bank

- **Price dynamics**: as oil supply peaks, so oil demand will peak. But the fundamental mismatch in elasticities of supply & demand, time cycles of supply & demand and price mechanics of supply & demand will likely require a final upward price spiral that will serve to break US oil consumption short term, and shift it long term toward greater efficiency. US demand is the key. It is the last market-priced, oil inefficient, major oil consumer. We believe Obama's environmental agenda, the bankruptcy of the US auto industry, the war in Iraq, and global oil supply challenges have dovetailed to spell the end of the oil era.
- After a **final price peak implied at $175/bbl in 2016**, we forecast oil prices will be under fundamental long-term downward pressure. This pressure will be potentially exacerbated by a reversal in OPEC strategy, away from supply limits, towards market share gains. We suggest $70/bbl oil in 2030 in a market that has shrunk to around 79mb/d – 8% lower than its current level, and 40% below consensus (IEA/ExxonMobil/NPC) forecasts.

The peak oil market: corporate impacts

For specific corporate recommendations, risks, and valuations, please see the companion note to this piece "Peak Oil Market II: Corporate challenges at the end of the oil age".

On the supply side, we expect the under-investment cycle will greatly increase the value of oil that is currently in production, low decline, and low cost. Oil will remain a premium fuel as long as the price is set by the break point of US demand we believe – which is the case until around 2016.

Because of the current under-investment cycle, we expect oil will sustain a major premium over natural gas. Natural gas supply reacts to higher prices, and so we believe will continue to be priced by the marginal cost of supply, of around $5-$6 per mmbtu. However we forecast oil will spike over the coming half-dozen years to the marginal break point of US demand (the last major low-tax market-priced consumer), which is far higher, because of the inelasticity and low tax burden on US demand. Oil demand only breaks at around $4/gallon at the US pump, or $150/bbl. We envisage a spike towards the short-term breakpoint of 7.5% of GDP, in line with last year's price spike, which will represent $175/bbl in 2016, ***real 2009 US$***.

We expect a short-term period of low oil volatility, as Saudi controls the market around $70/bbl on the supply side and Chinese inventory-building supports the demand side up to, but not beyond around $70/bbl. (China has reduced inventory building at $70/bbl+ in late 2007-mid 2008). However as demand for oil enters its final growth phase, and supply under-investment is revealed, oil volatility should rapidly increase, with prices reaching a peak at the peak of the market, around 2016 in our view. We expect the value of oil storage will continue to rise, and rising inventories will not temper prices until the market is convinced that oil demand has peaked.

After the 2016 peak, we expect falling oil prices. The value of high capex intensity, long lead time, currently un-developed oil, such as undeveloped Canadian heavy oil sands, oil shales, and Brazilian pre-salt and other ultra-deepwater plays could be far lower than the market currently expects. Oil investors are fundamentally skewed towards a bullish stance on oil, based ultimately on a bullish long-term view of demand growth. We believe that growth ends in 2016, not 2050.

By contrast, relatively short-term, high capex flexibility oil projects have premium value and we believe will continue to do so. Companies that are relatively smaller, with lower costs of capital and stronger, more flexible managements should relatively outperform in a highly challenging world for corporate players.

There will be a competitive advantage to those companies that are prepared to plan on high oil prices in the medium term, in our view. Most advantageous would be to access near-term existing supply rather than long-term resource. At this stage we believe a high oil price planning assumption will be a competitive advantage – but this changes beyond 2016.

We believe refining is a twilight business that will struggle mightily in a world of ever-declining gasoline demand. Niche refiners may have a future, as oil demand is expected to remain a feature of agricultural, heavy transport and shipping markets. In the future we expect location to be more important than complexity in defining refinery values. We expect primary hydrocarbon-based industries – refining, petrochemicals – to relocate to the Middle East; global oil product trade will increase, global crude oil trade decline.

The peak oil market: government policy suggestions

In order to meet their energy security, long-term economic and environmental goals, consumer governments should – but probably will not –actively plan towards a shift towards hybrid and electric cars, through better grids, smarter electricity pricing, subsidies for switching to more efficient cars/ and taxes for not switching. They should stabilise consumer oil prices at higher levels through reactive taxes. For example the US government should first tax gasoline to better reflect its true cost (+50c gallon to pay for the war in Iraq alone). It should address excessive oil consumption and CO_2 emissions in a simple way: tax. Taxes could also be reduced or increased to mitigate the effect of the extreme volatility we are likely to see in oil and pump prices.

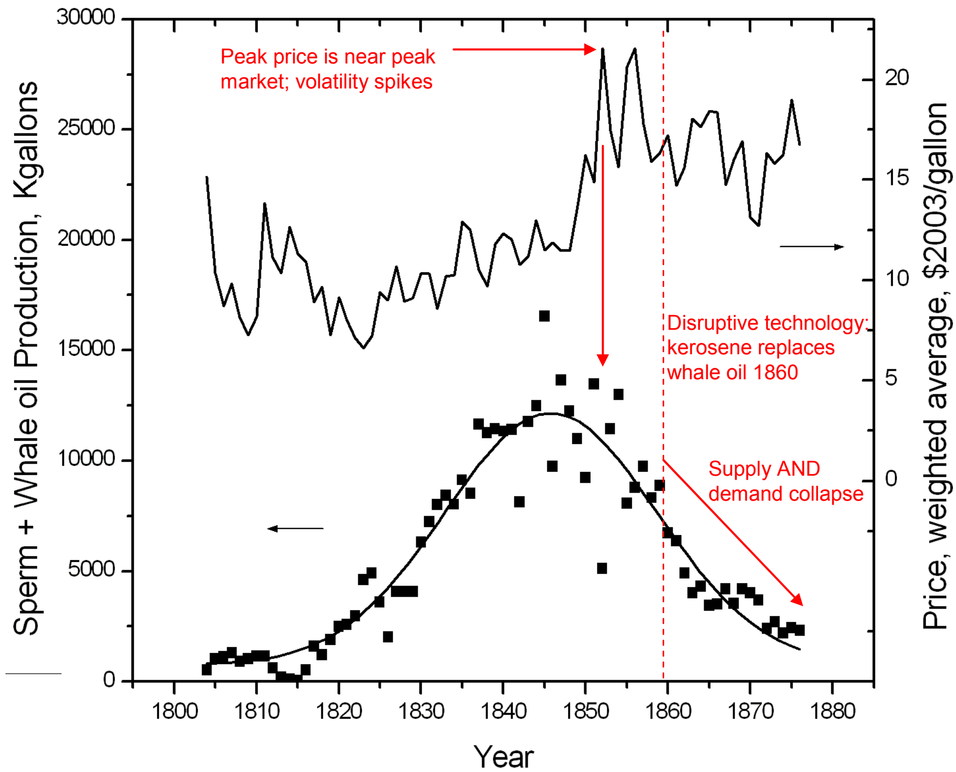
In our view, democracies tend to make for inconsistent and inefficient energy policy (see our note "The conspiracy of ignorance about oil", December 2007). But the major growth consumer of oil is centrally planned. China will therefore develop their energy market in a coherent manner – there is clear evidence they are doing this already. Through disruptive technology, like their jump from pen-written letters to 3G mobile phones, they will simply never use inefficient cars. They will develop natural gas supplies to replace oil use in industry and power generation. They are aggressively building inventories to mitigate risk; they are attempting to set the CO_2 agenda globally, throwing the gauntlet to the US. None of this is bullish for their future oil demand. Clearly Chinese oil demand growth is unavoidable over the coming decade, assuming strong GDP growth is to be sustained, but oil intensity of GDP growth will rapidly fall – it is a specific government target.

In order to maximize the value of their hydrocarbon assets, producer governments should – but probably will not – maintain highly stable, investment friendly fiscal and regulatory regimes, and by that simple measure move quickly to develop their oil through private capital investment. We believe, based on the history of the past decades, years, and months, that they will do the exact opposite. Thus ends the oil age.

Understanding peak oil price dynamics: whale oil 1800-1860

For the impact of the combination of tightening supply combined with disruptive technology, there is a clear example from the beginning of the oil age that illustrates how markets may act at the end of the oil age. Whale oil was the predominant fuel used for lighting in the period 1800-1880. Oil was discovered in Titusville, PA in 1860.

Figure 4: Whale oil supply vs price, 1800-1880



Note: Bardi uses the whale oil price example as evidence of the DIFFICULTY of transfer to alternate fuels, based on its extremely high relative price to kerosene ("rock oil"). Later in this note we illustrate that oil prices need only spike x2 to incentivise a wholescale shift in behaviour. Bardi also highlights that whale oil supply peaked before the alternate fuel became available. Again, we think that the alternate fuel is already available, in the shape of efficiency, and the hybrid car.
Source: Ugo Bardi Dipartimento di Chimica - Università di Firenze; Deutsche Bank estimates.

1. Whale oil suffered from a precipitous decline in supply as a function of the collapse of whale populations (its own "Hubbert's peak", illustrated in Figure 4) and
2. Its supply collapse occurred simultaneously with the birth of the oil industry and the aggressive substitution of whale oil in lighting, by hydrocarbon oil, in the form of kerosene, latterly known as a "disruptive technology".

The resulting price dynamic that resulted from the increasing substitution of kerosene for whale oil was a **huge jump to a peak price very shortly after peak supply, followed by a massive increase in volatility.** The all-time peak in price was shortly after supply peaked. Soon afterward, price peaked again at a similar level with extreme volatility, but never again achieved the highs of the peak of supply.

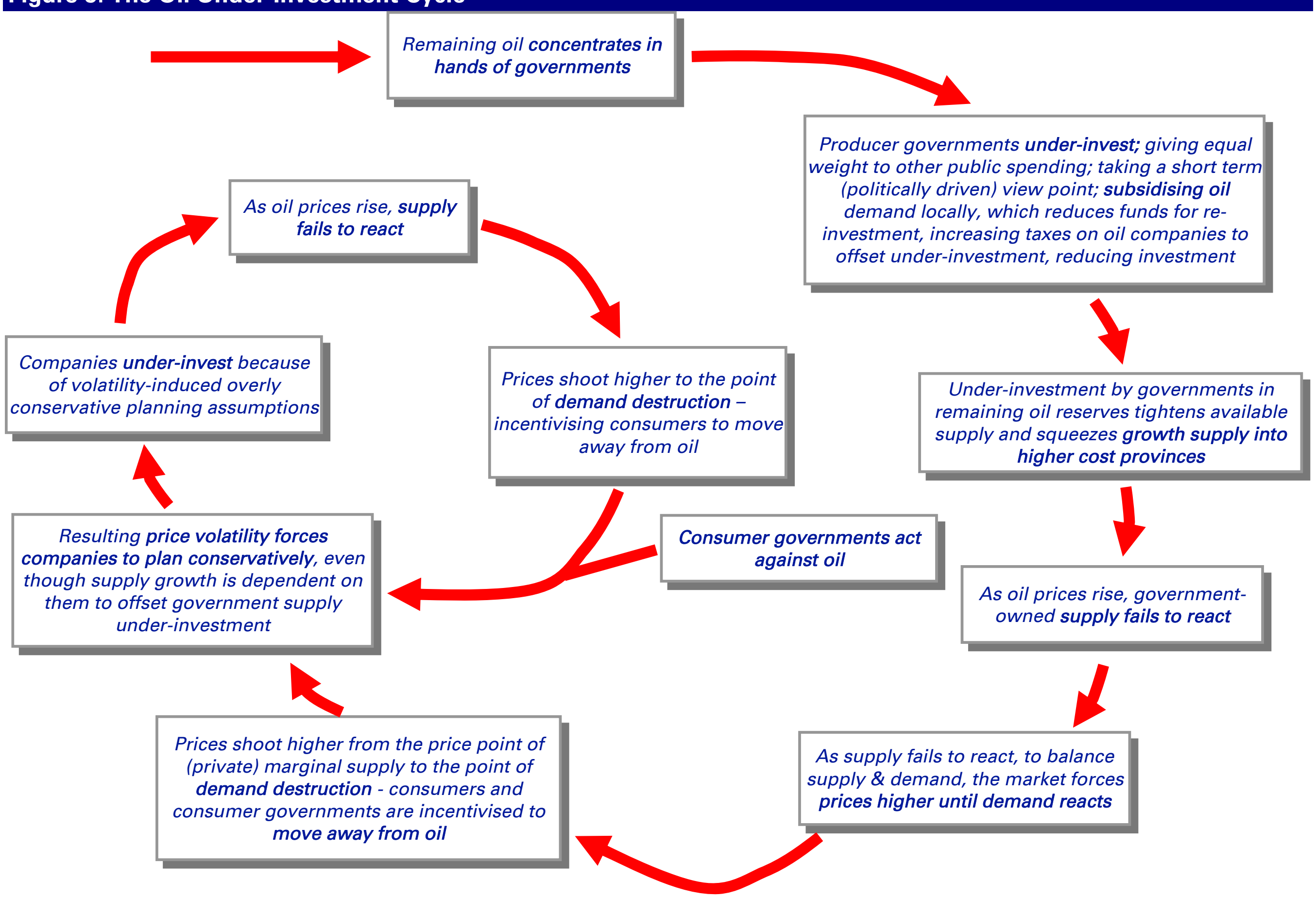
From the point of the introduction of kerosene, supply and demand fell equally quickly, as the market shifted towards a superior technology/product, in the shape of "rock oil."

Peak Oil Supply

The under-investment cycle

Under-investment in new oil supply will, in our view, become increasingly chronic, as reserves concentrate into the hands of financially, politically, and organizationally weak governments; which will exacerbate price volatility, and in turn challenge private sector investment in oil. The under-investment cycle is outlined here, illustrating how the concentration of oil into the hands of OPEC and other governments such as Russia, Mexico, and most recently Brazil, serves to exacerbate an oil under-investment cycle that is clearly already underway.

Figure 5: The Oil Under-Investment Cycle



Source: Deutsche Bank

Remaining oil reserves concentrate in the hands of governments

As reserves become concentrated into the hands of nationalist governments (beyond OPEC, the major reserves holders with no or very limited access are Mexico, Russia, and arguably Brazil), under-investment will likely become increasingly chronic.

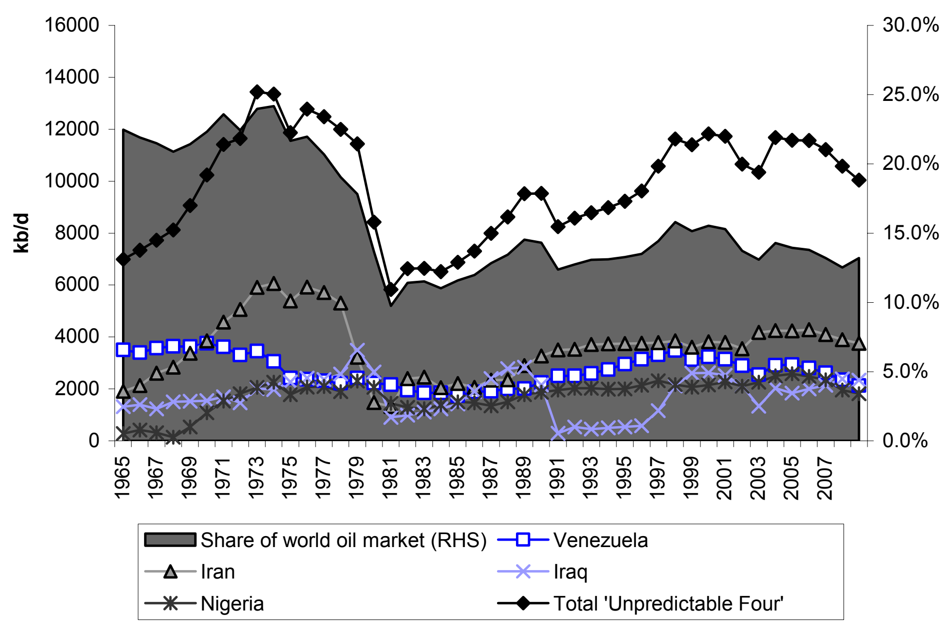
Figure 6: World remaining oil reserves, Bn bbls, Top 10

		Remaining Reserves	Share of total	Oil/Political Orthodoxy	Local oil prices
1	Saudi Arabia	264.1	21.0%	OPEC Islamic	Subsidised
2	Iran	137.6	10.9%	OPEC Islamic	Subsidised
3	Iraq	115.0	9.1%	OPEC Islamic	Subsidised
4	Kuwait	101.5	8.1%	OPEC Islamic	Subsidised
5	Venezuela	99.4	7.9%	Socialist	Subsidised
6	United Arab Emirates	97.8	7.8%	OPEC Islamic	Subsidised
7	Russian Federation	79.0	6.3%	Socialist	Subsidised
8	Libya	43.7	3.5%	OPEC Islamic	Subsidised
9	Kazakhstan	39.8	3.2%	Islamic Socialist	Subsidised
10	Nigeria	36.2	2.9%	OPEC Islamic/Xtian	Subsidised
	Top 10 Total	**1014.1**	**80.0%**		

Source: BP, Deutsche Bank

There is a particular issue with four major reserves holders, ex GCC, who are massively important in terms of remaining oil, but highly volatile in terms of supply reliability. They are Iran, Venezuela, Iraq and Nigeria. Between 2004 and 2008, supply from these countries declined in the face of all-time record total market growth. With the possible exception of Iraq, there is little prospect of any near-or medium-term growth from these massive reserves holders.

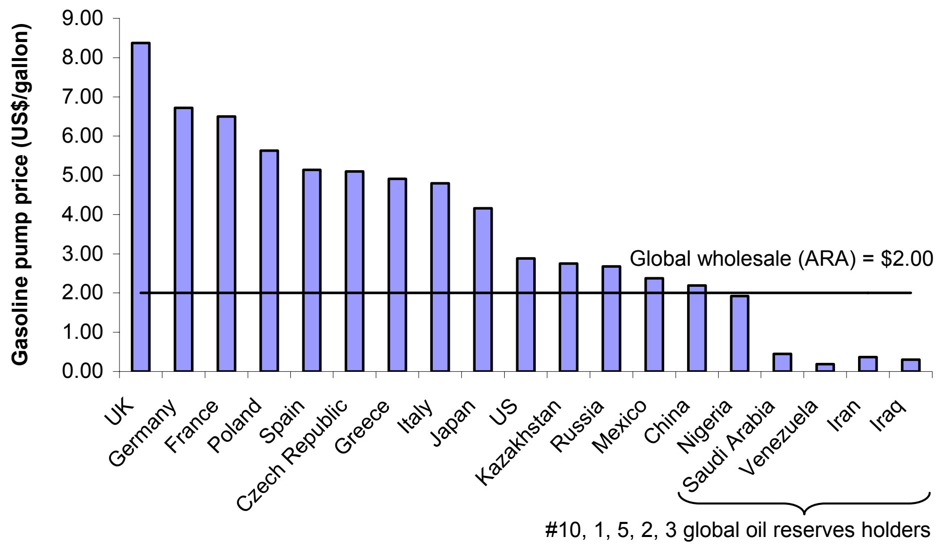
Figure 7: Oil production from key top 10 global oil reserves holders



Source: BP, Deutsche Bank

A key concern regarding the future availability of oil is that major remaining reserves holders subsidise their local oil markets, which are growing extremely rapidly, driven by high demographic growth. This subsidization is heavily loss-making against full cycle economics, and serves to starve the oil industry of re-investment funds. However, as shown in the past decade by Indonesia, it is extremely difficult indeed for a relatively high population, relatively poor per capita oil nation to remove oil subsidies. The oil investment cycle is now far longer than any election cycle, which undermines re-investment and economic rationale in the face of populist, short-term thinking and acting.

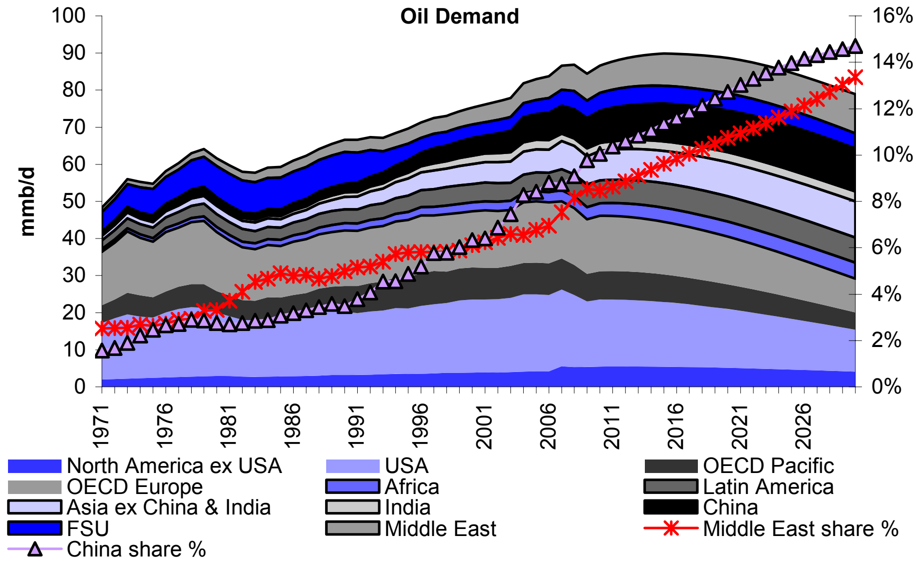
Figure 8: Gasoline prices are too low in oil producer nations = LT under-investment



Source: IMF, DOE, EIA, World Bank, PIW, Bloomberg, Deutsche Bank

In short, the world's remaining oil is concentrating in the hands of those who give it away for free. In a business with a natural decline that requires constant capital re-investment in new production to offset, that spells a major problem. In the demand section of this note, we explain more of the dynamics, but from a supply standpoint it suffices to say that we expect a major concentration of oil demand into the Middle East. Thus subsidised demand will form an ever-increasing share of the world oil market.

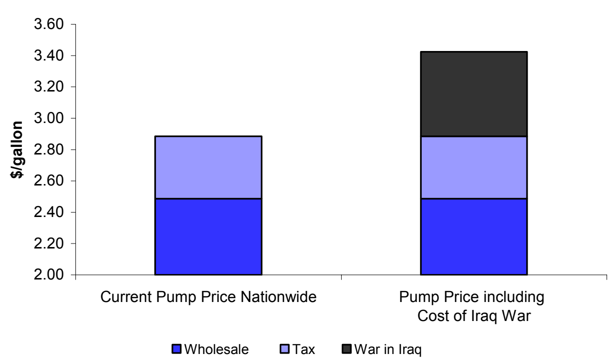
Figure 9: Share of the Middle East and China in Global Oil demand 1971-2030f



Source: Deutsche Bank

The US is arguably no more rational in respect to oil consumption policy. Although, as shown in figure 8, US gasoline prices are market-based, and at a premium to global wholesale prices, they are under-taxed, relative to the cost that huge scale and inefficient gasoline consumption exerts on the US economy/taxpayer.

Figure 10: Required US gasoline tax to pay for Iraq war



Source: DOE,CBO, WSJ, Joseph Stiglitz, Deutsche Bank estimates

Figure 11: Key assumptions

Cost of Iraq Gulf War II	1500 $ bn
Amortized over 20 years	75 $ bn / year
US gasoline consumption	9.1 mbbls / day
US gasoline consumption	381.2 m gallons / day
US gasoline consumption	139.1 bn gallons / year
Cost per gallon	0.54 cents per gallon

Source: DOE,CBO, WSJ, Joseph Stiglitz, Deutsche Bank estimates

If the US government taxed US gasoline consumers purely to reflect the financial cost of the war in Iraq, gasoline prices should be some 54c per gallon higher.

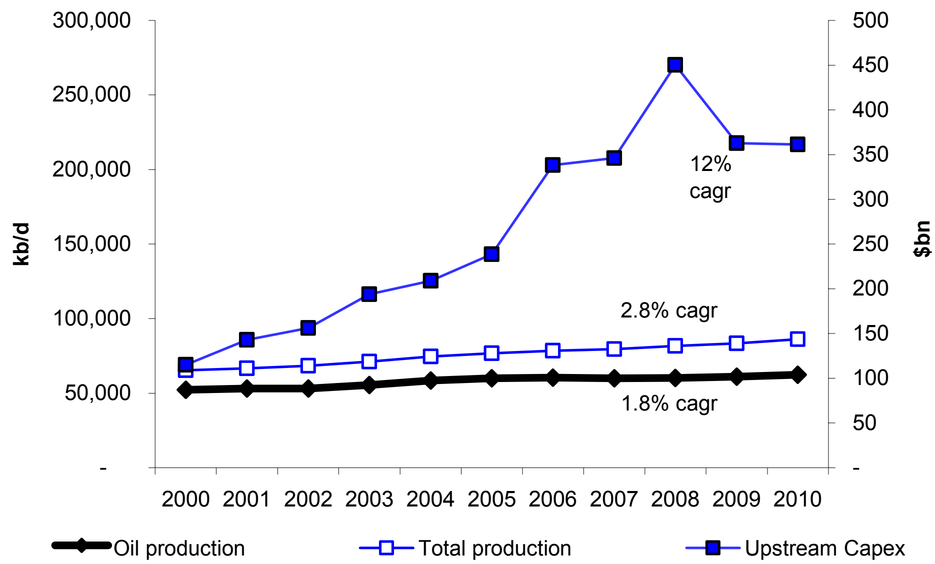
As oil prices rise, supply fails to react

We have highlighted capex cuts, but in reality, major oil companies, including national oil companies, have massively ramped their spending over the course of the past decade, as a break-out in oil prices has generated huge profits, particularly for OPEC members.

Global industry spending representing companies with some 60mb/d of oil production has risen from around $150bn annually in 2000, to around $360bn today, including a 2008 peak near $500bn, a compound annual growth rate of around 12% annually.

These companies' oil production during that time has risen just 1.8% annually. Even adding back current spare capacity takes that number to just 2.3%.

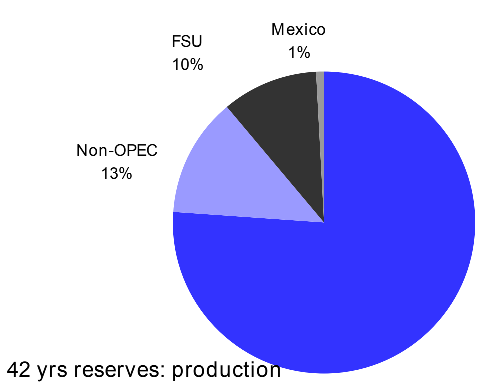
Figure 12: Oil production, total production, and capex spend by major oil companies*



*Source: DOE, EIA, IEA, Deutsche Bank *includes OPEC state companies*

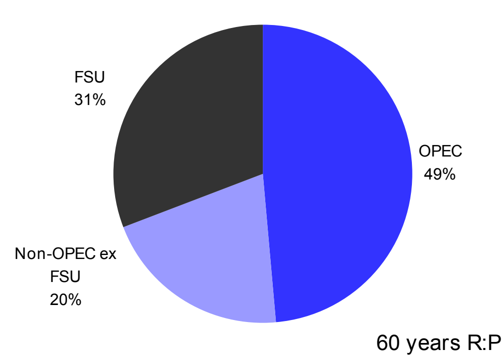
The story is different for natural gas. It is a hugely important related fact that natural gas supply **does** react to higher prices. First, natgas is more accessible, with a far higher proportion of overall reserves, longer reserves to production, and a far greater proportion of remaining natgas found in non-OPEC countries.

Figure 13: Global remaining oil reserves 1.2trn bbls



Source: BP

Figure 14: Natural gas – 6,000 TCF

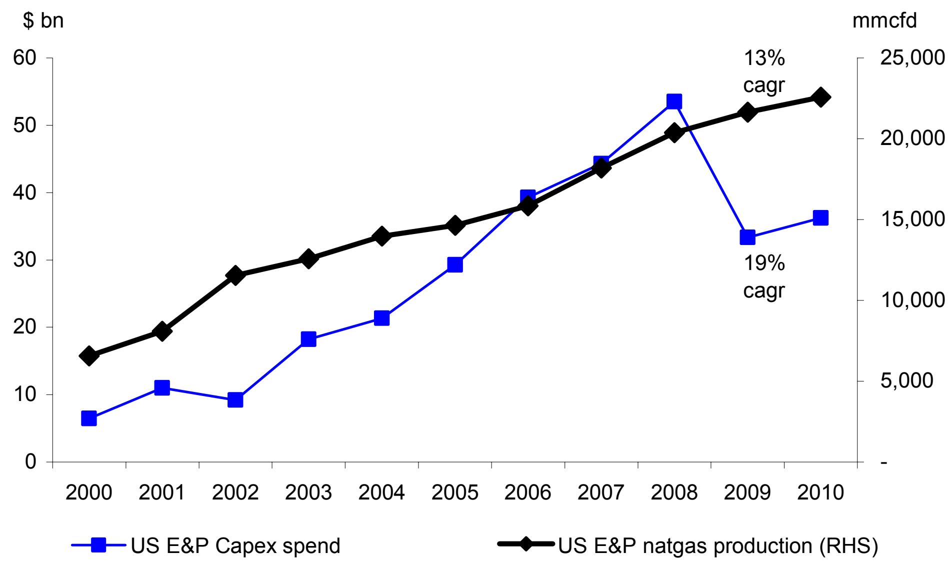


Source: BP

Second, natgas companies, particularly US E&P companies have proven themselves to be far more aggressive in terms of their willingness to invest. US E&P companies have increased their spending at 19% per annum over the period 2000-2009, even allowing for the major cut back in spending in 2009. At the same time, supply has reacted, with a 12% increase in output annually over the same period.

As discussed later this is clearly very important for fuel choice, consumption, and **prices of natgas relative to oil**, and effectively serves to accelerate the move towards electric cars. Basically, higher prices generate more natgas supply. Higher prices have little effect on increasing oil production, and in fact are probably only serving to stave off faster declines.

Figure 15: US natural gas supply reacts to higher prices and spending



Source: Deutsche Bank

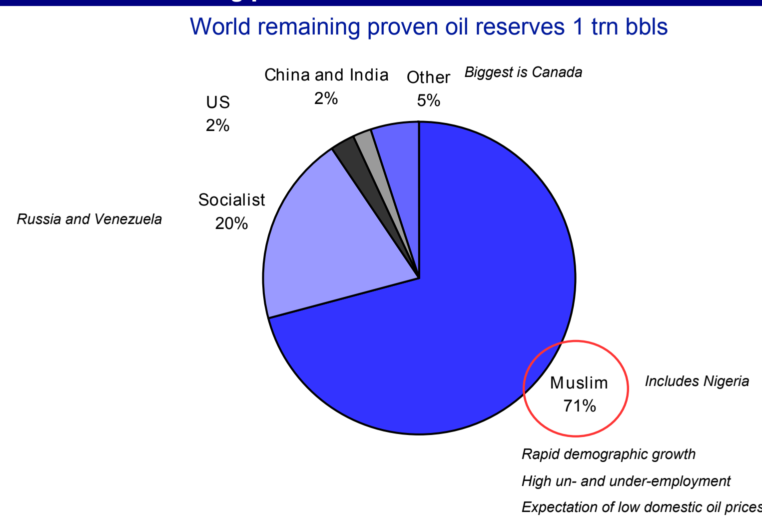
The long-term health of the US natural gas - and oil - industry is vital to the long term health of the US economy. It is by far the largest primary industry in the economy. US specific data is impossible to collect, but on a global basis, oil and gas is the largest single industry by capex, representing some 25% of global capex by MSCI classification. By extension, it is also fair to assume that US primary industry is dominated, at the capex level, by oil and gas investment. Our belief is that if the US is to recover its economic strength, then a strong US energy industry is of paramount importance. Arguably, the US should prioritise refining as a major export industry to address its current account deficit.

Private sector challenge 1: less available reserves, more volatility

We have argued in the past that, actually, high oil prices generate **less** oil supply, because the prices empower governments, increase nationalist sentiment, and enrage anti-oil company sentiment because of excess returns/profits. Governments respond by increasing taxes, nationalising, and taking control, and then under-investing.

Basically, governments typically do not invest, they spend. So the concept of IRR and full cycle economics, which are so vital to oil investment, are alien. Essentially a government will see oil investment alongside building schools, building roads, and paying doctors, as a discretionary expense, and will naturally under-invest in the spending with the longest payback. Typically that is education. In oil nations, it is also re-investment in more oil supply.

Figure 16: World remaining proven oil reserves



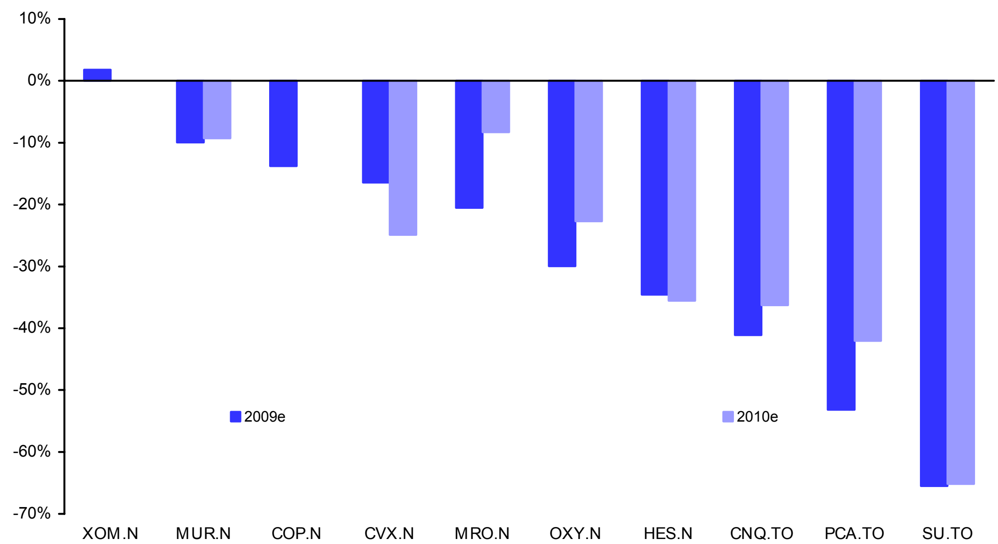
Source: BP, Wood MacKenzie, Deutsche Bank estimates

Additionally, governments crowd out private investment. As reserves concentrate into the hands of governments, and prices rise, the governments become more volatile in their rule-making, in terms of taxes, royalties, ownership/nationalisation and ease of doing business.

- Government volatility can come as a function of destabilisation from low prices, such as the accession to power of Hugo Chavez and change in Venezuela's oil policy away from major investment in growth and challenge to OPEC quotas, towards diversion of oil revenues into social programs. That occurred after the 1998 oil price low.
- Alternatively, super-high prices can cause harsh tax changes such as those seen in Russia as prices moved higher in the 2004-2008 boom. It has to be said that this massive tax increase has served to stabilize Russian production investment away from a boom-bust cycle. Russia is now the star non-OPEC performer, and despite the very low oil price excursion earlier this year, and heavy impact from the financial crisis on Russia's economy, investment has continued and so has growth. Russia and Iraq are the best hopes for the (few) oil supply bulls.
- It can also come as a paradoxical function of oil exploration success. Brazil's major new sub-salt play has generated a recent series of changes and proposed changes in a formerly very stable investment environment, as politicians quickly move to increase a nation's government stake in a given resource. Indeed, we believe that Brazilian sub-salt reserves are amongst the most challenged by the end of the oil age; it is imperative to commence production ramp up quickly, if our demand forecasts are correct, and re-invest in alternative fuel cars and industries, such as was done successfully in the past with ethanol in Brazil.

- Again, this issue is not limited to developing economies and oil-dependent economies. Arguably the biggest current problem in terms of investment challenges for major oil companies is the total lack of clarity and certainty over the outcome from major CO2 initiatives in Washington DC, the EU, and globally as we head into the Copenhagen summit late in 2009. There is simply no firm understanding of what kind of playing field and end demand environment we will be facing in major consumer countries. Again, the safest investment is lower carbon natural gas, the least safe, clearly Canadian heavy oil sands and other high capex, carbon-intense, oil recovery processes. It is these projects that are both at the margin of profitability at current prices, on a full cycle basis, and most needed if we are to continue to grow the oil market. Our simple conclusion is that we will not grow the oil market.

Figure 17: Capex cuts, April 2008 to May 2009



Source: Deutsche Bank

It is a simple fact that the most dramatic cuts in planned capex in the current downturn came from Canadian heavy oil sands plays Suncor, PetroCanada, and Canadian Natural, and that those cuts were huge, approaching 70% within months of the oil price downturn. Swift to cut, slow to increase, is the likely trend, especially with CO2 uncertainty, and a further effective reduction in overall spending from the merger/acquisition of Suncor and PetroCanada, two of the largest players in future development.

The ultimate result of the level of uncertainty on both the supply and demand sides of the equation is that oil companies have to have conservative price planning assumptions. By being conservative, they are aiming to be right, or rather, not wrong, on future prices. But by uniformly having conservative planning assumptions, the companies are effectively under-investing in future oil supply, and by extension, are putting more pressure on state (i.e., OPEC government) companies to provide marginal oil supply growth.

But those companies too are under-investing, because of instability (Nigeria, Iraq) sanctions (Iran), lack of population pressure/high per capita wealth (Libya, Qatar, Abu Dhabi), socialist policies (Venezuela) and ultimately excess capacity (Saudi). Of the top 10 remaining oil reserves holders, arguably only Saudi, Russia, Kazakhstan and possibly Iraq are investing sufficiently to allow for future oil demand growth.

If 60% of the remaining top reserves holders are under-investing, given declines in the rest of the oil world, we can agree with consensus that supply has a major problem. Our differentiated point is that demand will react.

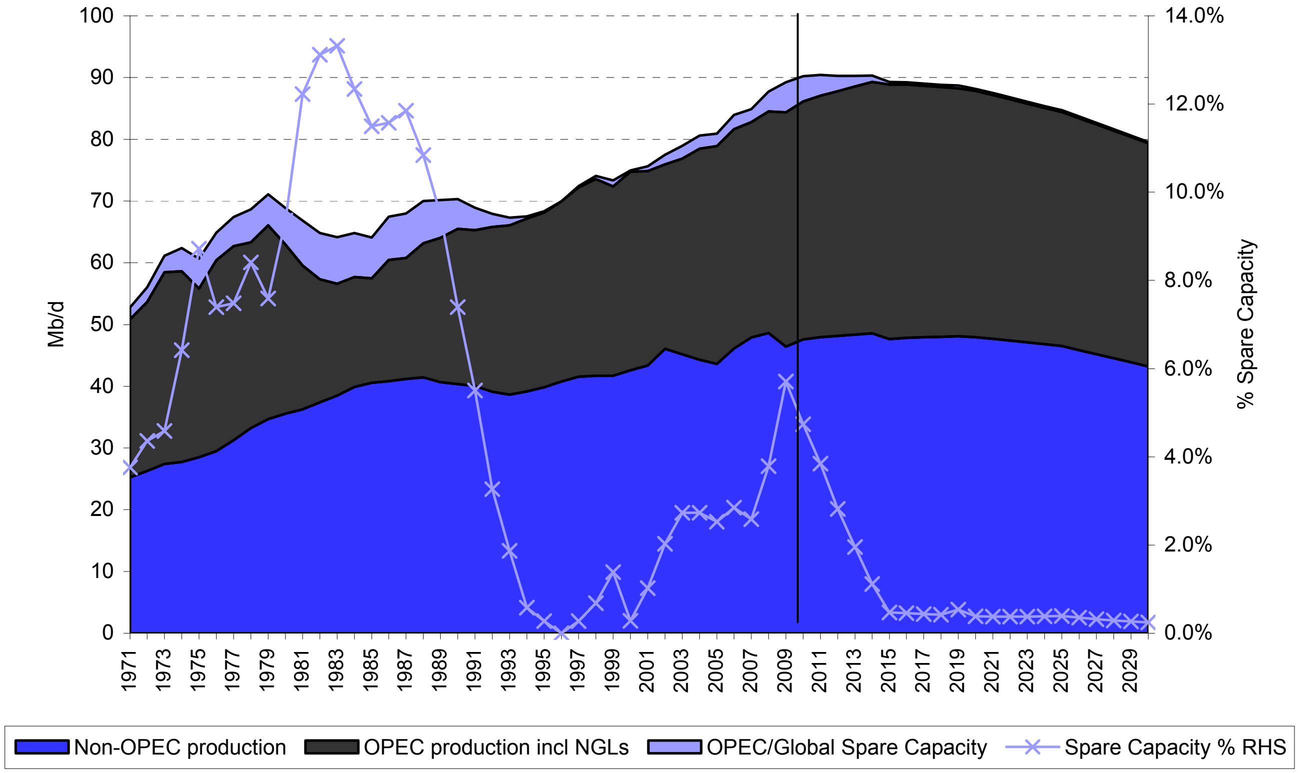
Private sector challenge 2: mismatched oil investment cycles

In our view, simple government involvement is not the only problem. Remaining *non-government* (non-OPEC) reserves are on a longer term investment cycle; (deeper water, larger projects to make returns, lower quality oils, more distant locations) that require a stable long term oil price planning assumption that is totally at odds with the extreme volatility that commences with changing government behaviour, feeds the under-investment cycle, adds to volatility, and causes oil companies to require a higher oil price planning assumption and return on capital to offset volatility.

We are under-taking a follow-on to this note, with a specific asset analysis of the Tahiti field, recently started by Chevron in the deepwater Gulf of Mexico. From first lease acquisition to first oil production was an 11 year process. This length of cycle for deepwater oil, which is clearly getting longer for mega-projects such as Kashagan, Brazilian sub-salt, and extreme deepwater Gulf of Mexico, where recent mega-discoveries have been made, is a key issue for price elasticity of supply. It requires a long-term planning assumption for oil that is by definition and by necessity of the massive capex requirement, conservative.

At the same time, we highlight that the oil cycle is fundamentally mismatched and opposing. Because of Saudi spare capacity, and its organisation of OPEC behaviour, the oil supply cycle is more price responsive than demand in the short term. By contrast in the long term, the demand cycle is more responsive. Later in this note we analyse what this means for actual prices, but the conclusion from a supply/under-investment cycle is that oil will tend towards short-term over-supply and long-term under-supply, again exacerbating volatility.

Figure 18: Oil spare capacity vs. demand – wafer thin margin that varies between tiny and not quite so tiny



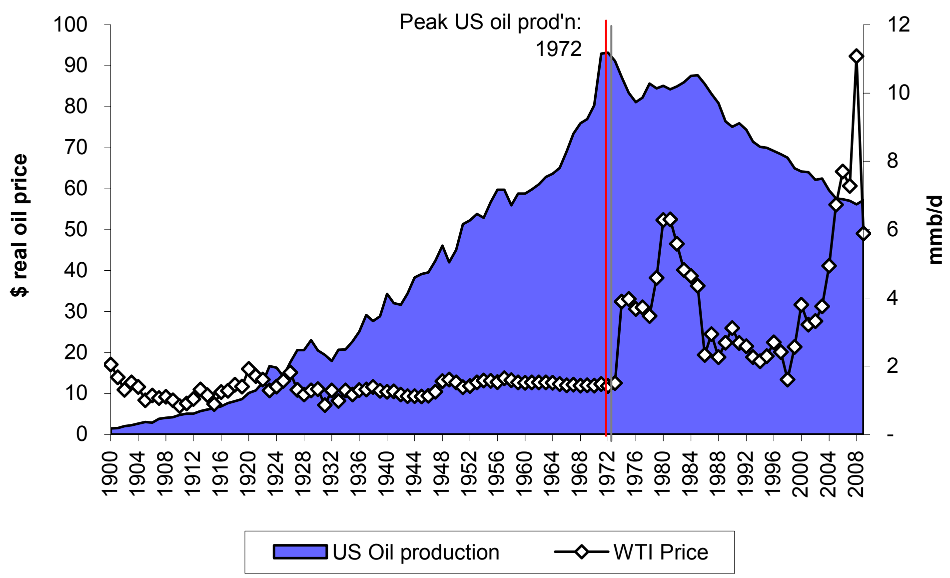
Source: Deutsche Bank

So major private oil companies are faced with projects that by their scale and challenges, require stable fiscal regimes and higher, sustained, oil prices, but they are faced with neither. This is the second leg of the under-investment cycle.

Private sector challenge 3: as supply tightens, more volatility

Examining peak supply points in historical oil markets shows that at key peak supply moments, both prices and volatility explode to the upside. We believe that ultimately there will be three phases to this – the peak of US supply (1972) the peak of Non-OPEC supply (around now) and the peak of OPEC/global supply (with under-investment, likely within the next six years). An illustration of price behaviour as markets peak was presented in the case of whale oil (Figure 4).

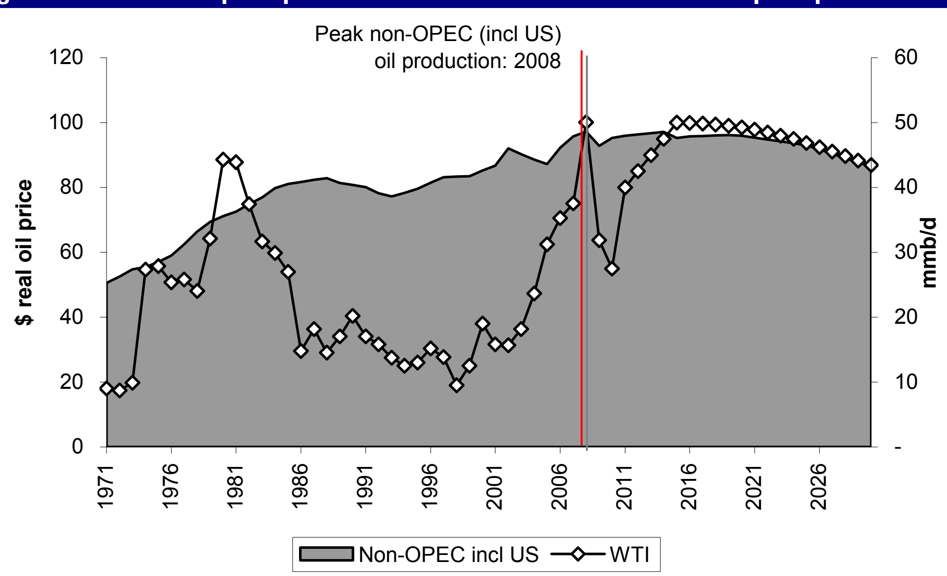
Figure 19: Peak US oil supply coincides with the first oil price shock



Source: IEA, Bloomberg, Deutsche Bank estimates

In 1972 as US oil supply peaked, we hit the first major price shock. OPEC governments were empowered by rising demand and peaking US domestic supply, and the result was major volatility.

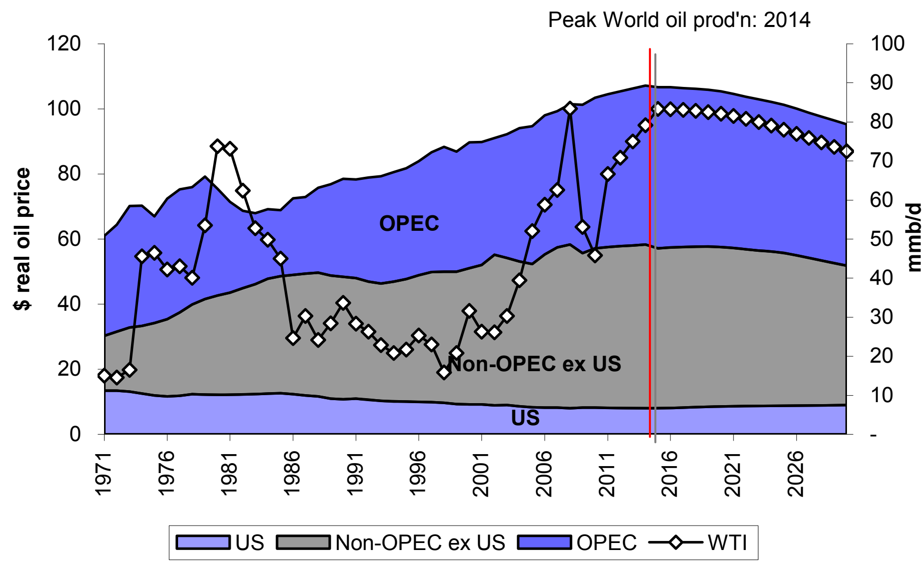
Figure 20: Non OPEC peak production in 2008? Coincides with 2008 peak price



Source: IEA, Bloomberg, Deutsche Bank estimates

Last year, Non-OPEC supply approached peak, with available supply severely challenged and the market more forward looking, prices again took a huge spike. The final spike, we believe, will come with the final peak, and will once again generate huge volatility that will ultimately, we believe, form the final peak oil market.

Figure 21: Peak world oil market coincides with peak oil price at $100/bbl real $2008



Source: IEA, Bloomberg, Deutsche Bank estimates

Certainly, it is difficult to believe that Non-OPEC production is not close to peak, which in turn should start to put serious stress on OPEC's ability to maintain market scale. If our view that OPEC ex Saudi and GCC is under-investing is correct, then demand pressure will quickly take care of spare capacity and drive us to a final price spiral. Again, that volatility will lead to less, not more, re-investment in a declining resource.

The price of future government-distorted oil supply

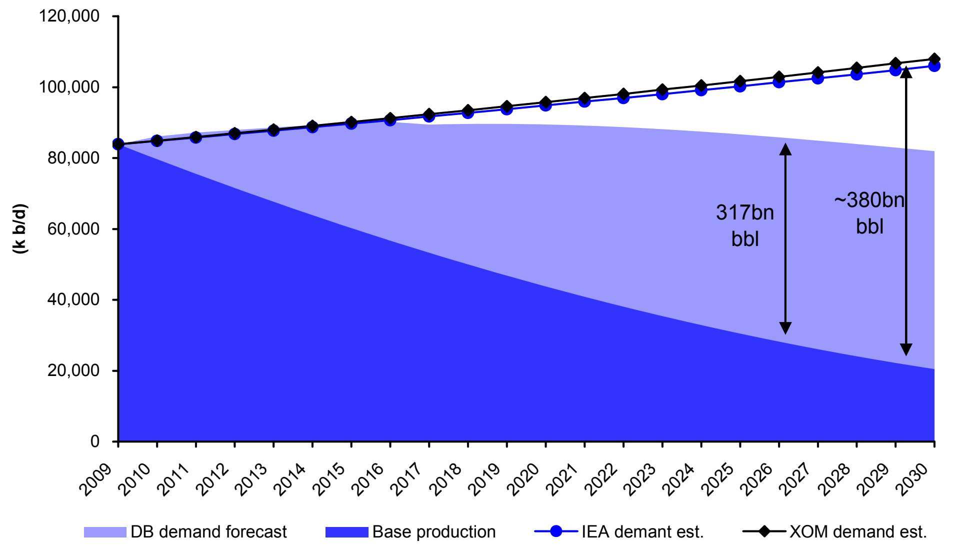
Based on simple arithmetic, over-layering a massively complex question, we can generate an investment requirement both in terms of barrels required for the future oil market, and in terms of new production developed to meet this demand, assuming given existing oil supply decline rates.

The most complete and thoughtful work on global oil supply decline rates comes from Fatih Birol and Olivier Rech at the IEA, and essentially expects an acceleration in global oil supply decline rates from existing fields from around 5% to around 8% annually by 2030. So, as remaining oil concentrates into tougher geologic, geopolitical, and geographic provinces, simultaneously the supply challenge accelerates.

We have a less aggressive demand forecast than major credible forecasters such as the IEA and ExxonMobil, who expect a global market of around 110 mb/d in 2030. We are all using similar GDP (IMF) and population (World Bank) forecasts. The key differentiator is efficiency gains from transport, and increasing substitution by natgas in non-transport, as analysed in the demand section below.

We are forecasting a peak oil market in 2016-17 and sustained declines beyond that, quite unlike the remarkably similar ExxonMobil and IEA long term oil demand forecasts. That still presents a massive investment challenge, requiring some 317bn bbl of oil development and production over the given period 2009-2030.

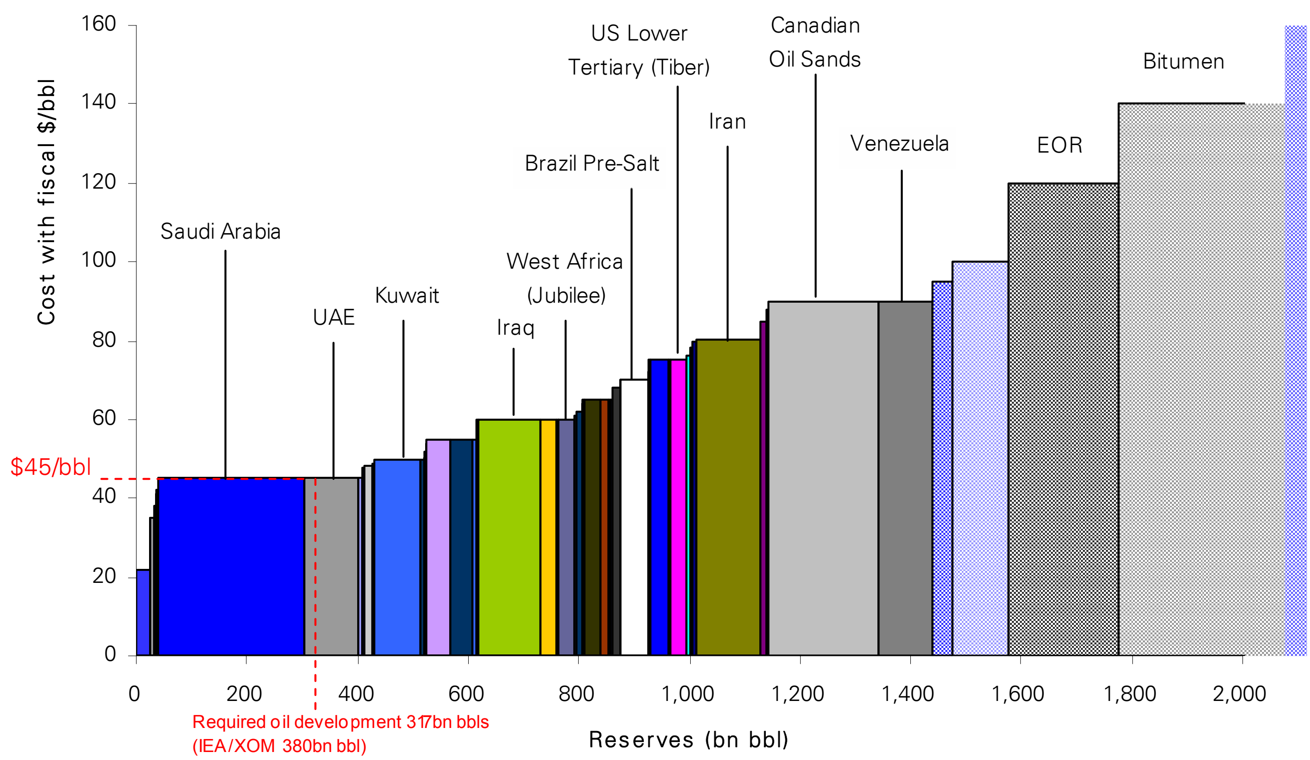
Figure 22: Required new barrels to meet forecast demand – DB vs XOM/IEA



Source: IEA, ExxonMobil, EIA, IDeutsche Bank

Looking at the full cost supply curve of major oil reserves, we can establish a supply price based on our 317bn bbl requirement.

Figure 23: Cost curve of future oil supply, assuming open access – available reserves at a given level of oil price

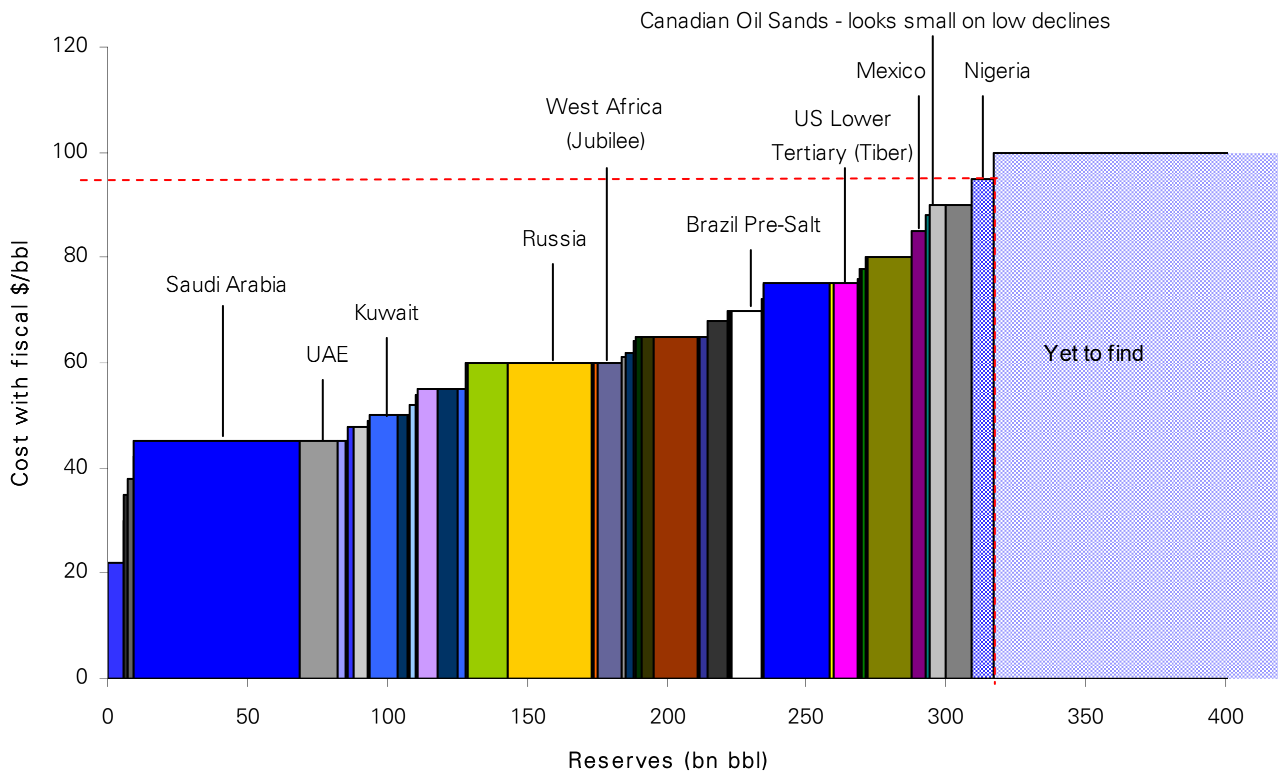


Source: IEA, Deutsche Bank

If the global reserves were exploited on a pure price basis, we could develop Qatar, UAE, Kuwait and above all Saudi reserves to the tune of the required 317bn barrels, which would imply a required price of around $45/bbl oil, even allowing for fiscal/social costs in those high demographic growth, government-spend-dominated economies.

However if we examine our own forecast of production growth, and the marginal cost of that production, the under-investment of major OPEC and government reserves holders will force the price of oil higher towards the marginal cost of the ~317bn bbl of realistically accessible resources. That immediately shifts the marginal cost of supply towards ~$100 per barrel.

Figure 24: Cost curve of future oil supply, allowing for expected access and forecast development



Source: IEA, Deutsche Bank

However, the price of oil has to be considerably higher than the full cycle development cost for a private company, made nervous by volatility and government risk, to invest. So whilst for certain government companies, such as Aramco, conviction on $50/bbl long term oil is enough to justify major investment in new capacity, for investors in Canadian oil sands, who require an $80/bbl long-term oil price to make a fair return (15% IRR), it would require a planning assumption/visible average oil price (i.e., average futures strip) of around $100/bbl for a major new investment to be sanctioned.

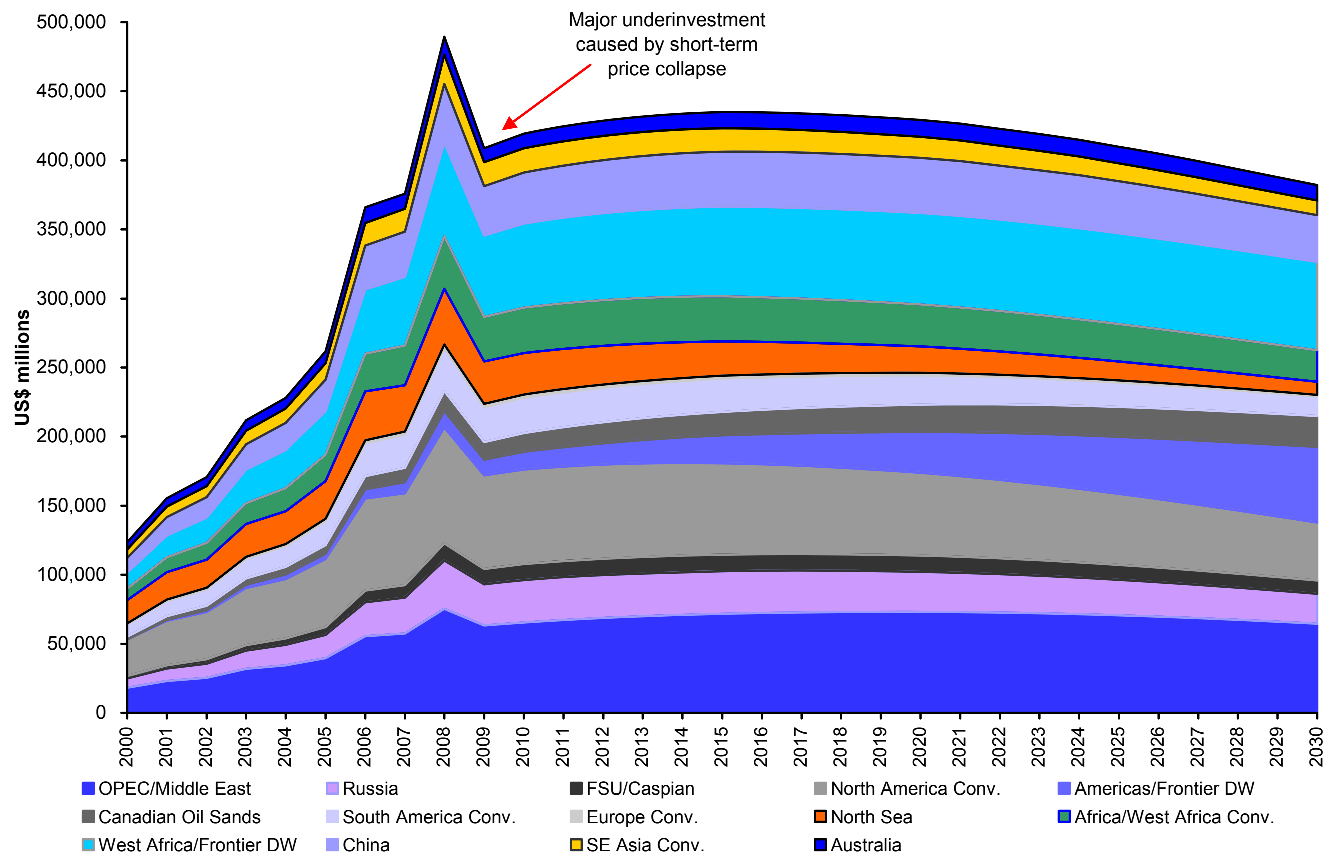
In short, the higher the oil price is forced by government intervention, the higher it must go to persuade volatility-nervous oil companies to risk capital.

The most obvious corollary of this function has been the rise of the buyback, whereby major oil companies in the oil price boom of 2004-2008, rather than chase rising costs and over-heated markets, focused instead on shrinking their capital employed by **buying back stock.** This is not as much under-investment as de-investment, but it could be argued to be the same thing; it certainly is in terms of its practical effect on physical oil supply.

Capex assumptions – are deepwater drillers refiners in disguise?

Based on our forecast and expected cost of developments, we can establish a capex requirement for the coming 20 years. The thematic implications of a squeeze on oil and ongoing and accelerating switch to natural gas would be supportive to the service providers (who get anywhere from 2x to 10x the revenue on a gas well vs. an oil well, with the high-end of that range being unconventional gas) and land drillers. Given price volatility, the difficulty of planning on high prices that goes with volatility, the high price planning assumption required for major deepwater drilling commitments, and finally growing deepwater rig supply, would be negative for deepwater services. Our medium-term support for oil and oil leverage is highly supportive of the group, and oil levered names within the group over the next six years.

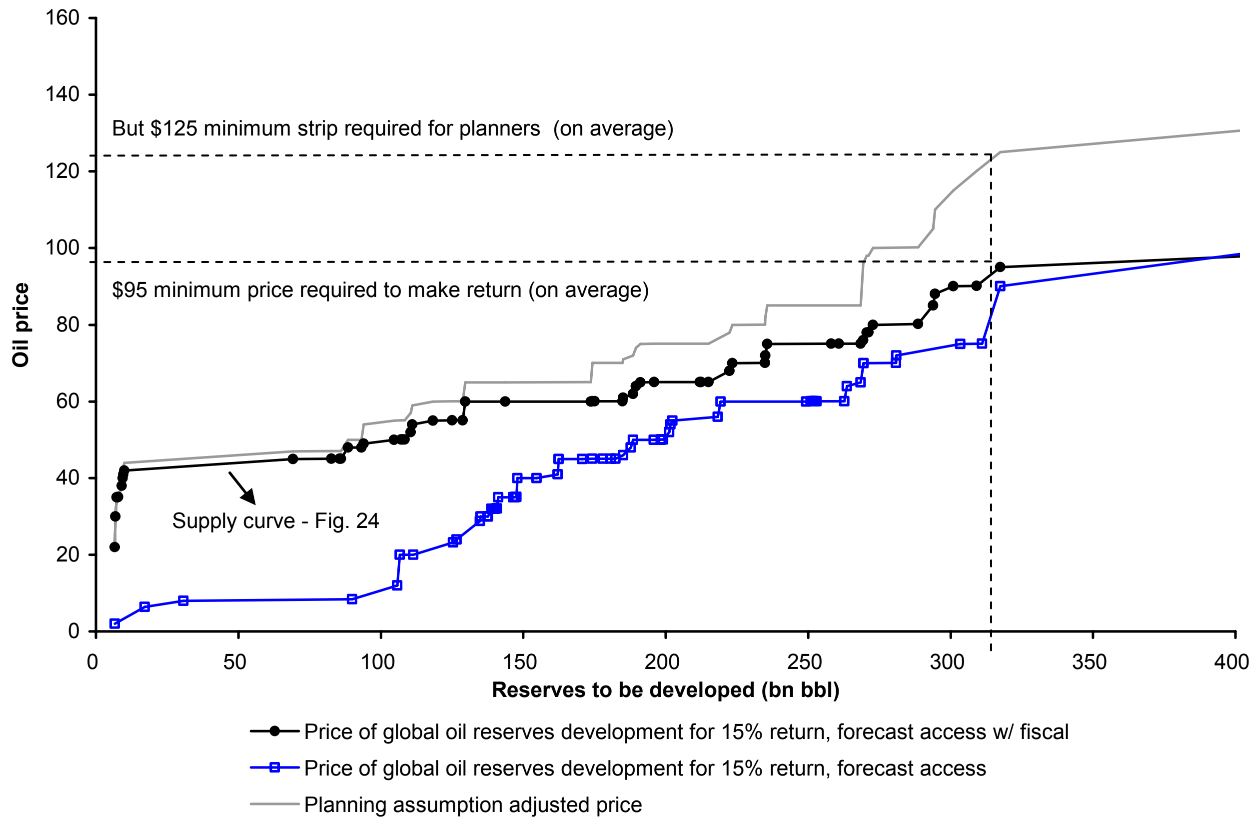
Figure 25: Forecast global oil industry capex by region, real US$2009



Source: Deutsche Bank

Planning assumptions requirements

Figure 26: Required oil price to generate planning assumption increase



Source: Deutsche Bank

If we take the line of economic break-even from Figures 23 and 24, we can show how governments force prices higher, by some $20/bbl on this chart, by under-investing in their own, lower cost resource (the difference between the lowest line's intersection with 317bn bbl requirement, and the middle line's intersection).

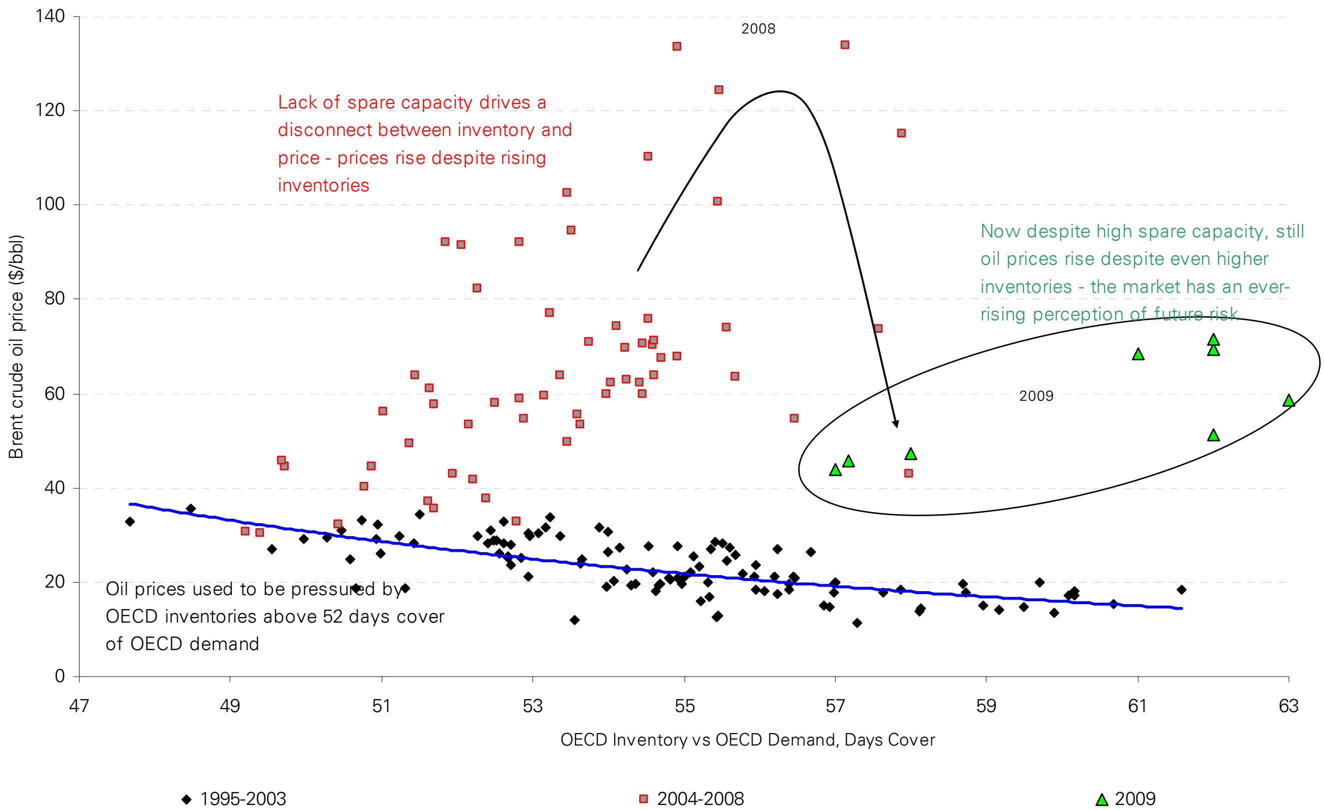
Again, there is an exponential effect, on planning assumptions, exacerbated by the higher the oil price the higher the volatility. Basically, a company will not invest in a project that requires a $100/bbl break even if the average oil price is $100/bbl. In fact, the company will require a degree of comfort, which we calculate here is around $25/bbl, to make an investment in a marginal project. So only with a visible and sustained strip price of $115/bbl, will oil companies invest in sufficient reserves to meet long-term oil supply needs sufficient to meet even a forecast declining demand profile for global oil.

For rising demand to 2030 (i.e., not our forecast but XOM/IEA), closer to $125/bbl is required, and the development of enhanced oil recovery, bitumen and oil shales becomes imperative. Additionally, as outlined in the demand section, we believe that in the short-term prices towards $175/bbl will be required to rationalise US demand sufficiently to offset inexorable controlled price and subsidised price oil demand growth, because the market will not - cannot - rationalise through more supply, but rather through less demand.

Market reaction to the supply problem: increase inventories

As long as the market remains convinced that, for real supply problem reasons, the oil price will be higher in the future, regardless of high inflation and a weak dollar, then it will likely continue to build inventory. The evidence is apparent in the market's systematic building of OECD inventory regardless of oil price.

Figure 27: Forecasters graveyard – how rising and historically high inventories of oil stopped affecting price



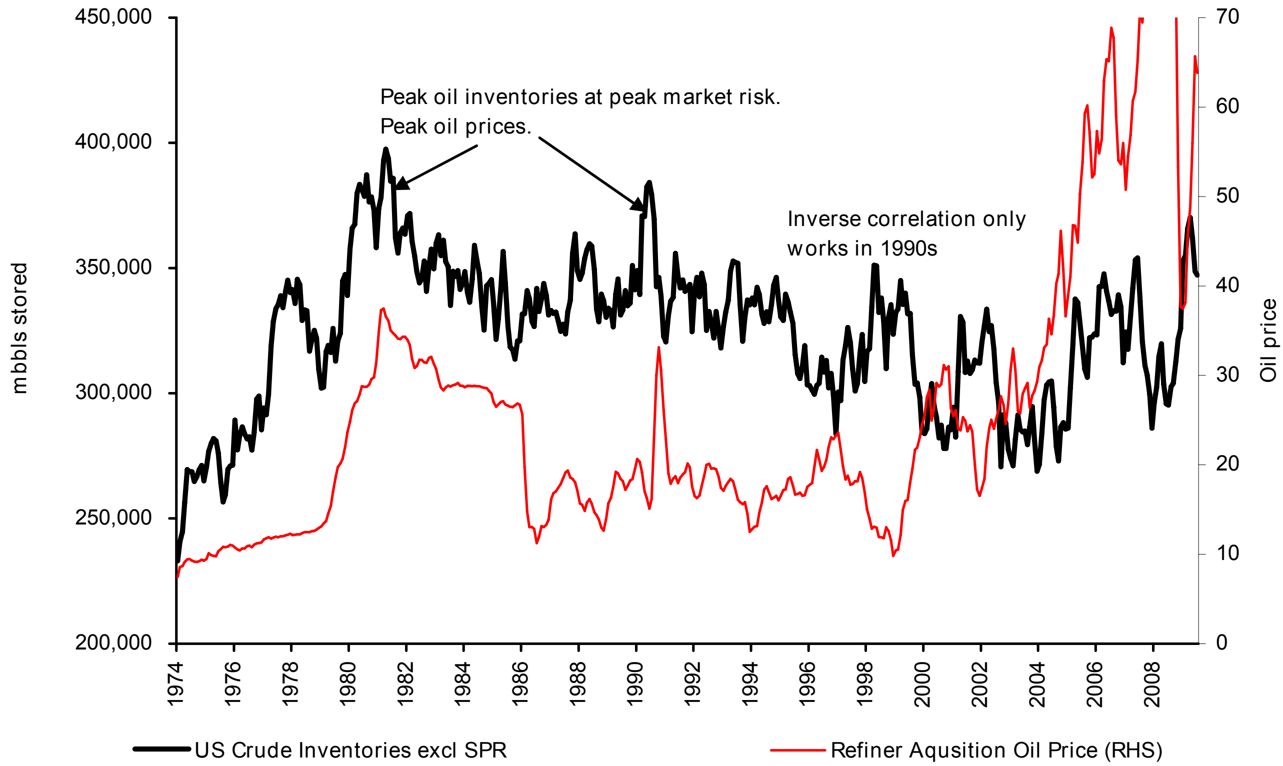
Source :IEA, Bloomberg, Deutsche Bank

Equally the market has sustained contango, or price incentivisation of storage based on future delivery prices trading above current delivery prices, even as inventories have continued to rise.

The key issue here is just how tight oil inventories are relative to the importance of the market in economic terms. The global oil industry has developed over time to run on extraordinarily low inventories, partly through efficiency and partly through two important functions that illustrate the problems we face:

1. In deciding to stock oil because of supply risk, OECD governments and notably the US government dis-incentivised commercial oil storage. Essentially, this again illustrates the point that governments crowd out private players. Led by China, other major consumers are joining the "hoarding."
2. In the past, the market may well have considered that un-produced oil was effectively oil in inventory. It is likely that the view increasingly held is that un-produced oil is dangerous oil, given the concentration of reserves into more-or-less hostile or unstable host governments. Effectively, the market seems to believe that, given oil is finite resource, "this time it's different." In other words, demand is now structurally higher, population keeps rising, but oil supply is getting tighter.

Figure 28: Inventories over the long term – correlate to high inventories at high price points – '09 inventories are low

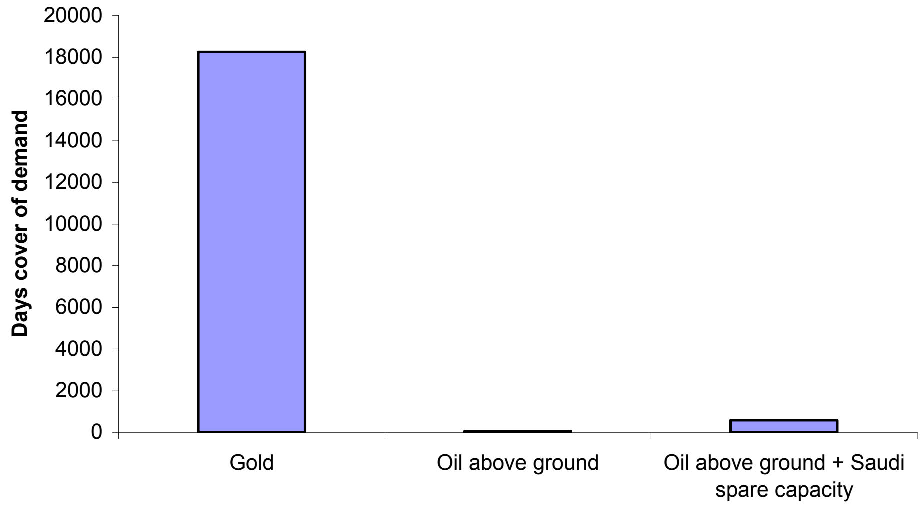


Source:IEA, Bloomberg, Deutsche Bank estimates

In fact, looking at a deep history of US oil inventories illustrates that the market will build inventories to the highest levels, at the highest point of risk, which would also be at the time of highest prices. All-time high US inventories were reached during the 1979 oil price shock. In retrospect, it was a tremendous time to sell inventories, but the market did the opposite. Arguably, oil inventories now remain low relative to price risk, keeping in mind that the graph above shows absolute inventory levels, as opposed to days of demand cover.

A further illustration of the low levels of inventory relative to other markets can be illustrated by gold, whereby a less economically important commodity, which is only a store of wealth by virtue of consensus and by dint of history, has far higher inventories than oil does in terms of days of demand cover.

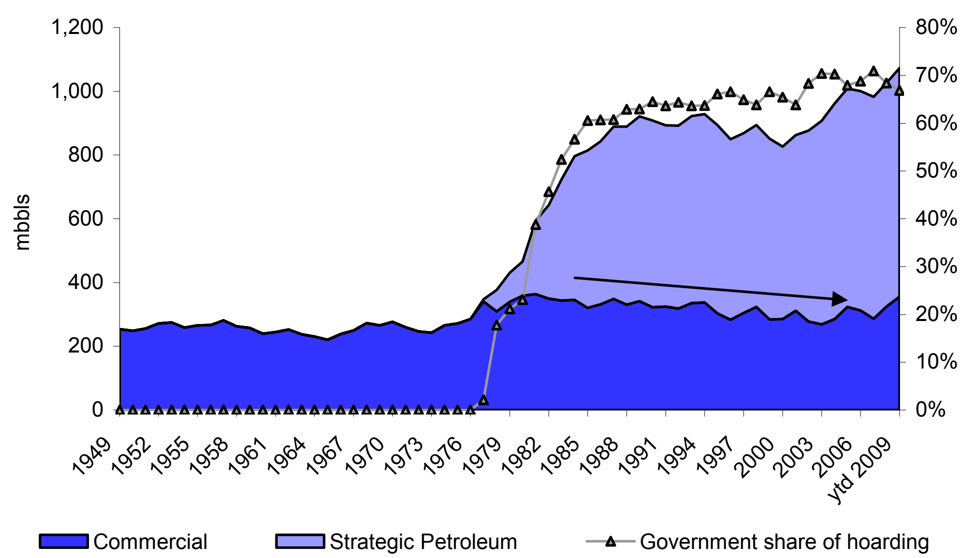
Figure 29: Oil inventory days forward cover of demand vs Gold, days forward cover



Source: Deutsche Bank

With risk, comes government intervention, so that we now have government distortion in supply (OPEC concentration), demand (CO2 legislation) and inventory – and price ex-US. The distorting effect of governments in storing oil exacerbates market fears over future oil markets. As OECD governments have massively increased their share of global oil storage, they have effectively removed oil from the market and distorted natural price swings, such as the market price of stored oil versus hurricane risk. That role is now essentially fulfilled by the US government, which willingly mitigates hurricane risk and effectively encourages the building of refineries in a hurricane zone – i.e., the Gulf of Mexico – by putting the burden of the cost of storage for a riskily located refinery onto the US taxpayer. As outlined above in the question of the mis-pricing by the US government of gasoline (to not include foreign oil war expenses), so the price of US gasoline should also reflect the cost to taxpayers of maintaining a massive oil storage effort. It does not. US oil companies now store less oil than they did in the 1970s.

Figure 30: US government drives down commercial inventory levels



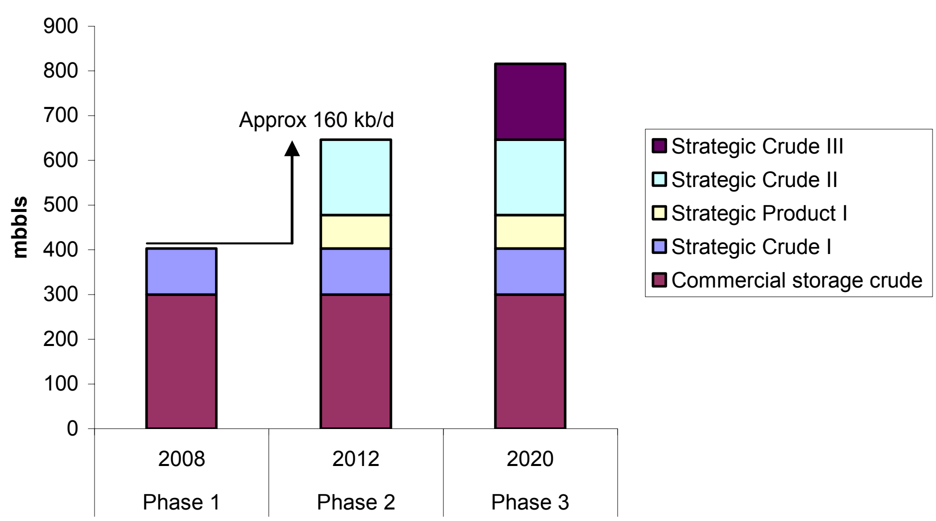
Source: EIA, Bloomberg, Deutsche Bank estimates

China is now undertaking the exact same pattern of intervention, both at a government level and at a majority government-owned company level. The single biggest area of marginal strength in global oil demand this year has been China inventory-building, probably accelerated by low oil prices.

We believe that, knowingly or not, the Chinese are moving into the position of becoming the largest marginal oil player in the world, as a function of the potential for their government to use their power at the margin of oil markets to control oil prices. If China was to reverse its inventory build over the past three years into an inventory drawdown, it would potentially exert a swing in demand of 4 mb/d (from 2mb/d build to 2 mb/d draw) – or the same market power as Saudi Arabia (currently 4 mb/d spare capacity). In the process they could crash oil prices, lower US and global inflation, and strengthen the US$, which might, given their creditor balance, be directly in their own interest if the US were to begin to suffer inflation that would inflate away debt and reduce the value through a weaker US$ of foreign creditor debts – of which China is the largest.

At this time, the precise strategy, and future plans of the Chinese government are totally obscure, but it is clearly in China's interest to increase oil inventories, both above ground and in oil reserves in the ground.

Figure 31: China strategic inventories



Source: Oil and Gas Journal, Bloomberg, Deutsche Bank estimates

This constant inventory build, given a market that is structurally willing to build inventory, should ultimately be resolved by a limit on inventory capacity. But we do not have that in oil on a long-term basis. Oil is not (fresh) fish. The idea that "rotting fish" as a model prevents excessive inventory build does not apply, as oil can be moved and held in the ground indefinitely. With single-hull tankers available to add to expanding oil storage capacity in global markets, notably the US and China, oil inventories can continue to grow despite high oil prices.

Market willingness to store oil has expanded to tankers. There are about 60m barrels of crude in floating storage at the moment, and another 70m barrels of product, with a majority of both off the shores of Europe. Freight rates are very depressed right now, with tanker utilization rates at or below 80% (slipping from 2Q's mid-80's%). More than 30 very large crude carriers (VLCC) are currently in use for storage, and about 65 smaller product tankers.

Figure 32: Approximate current tanker storage capacity

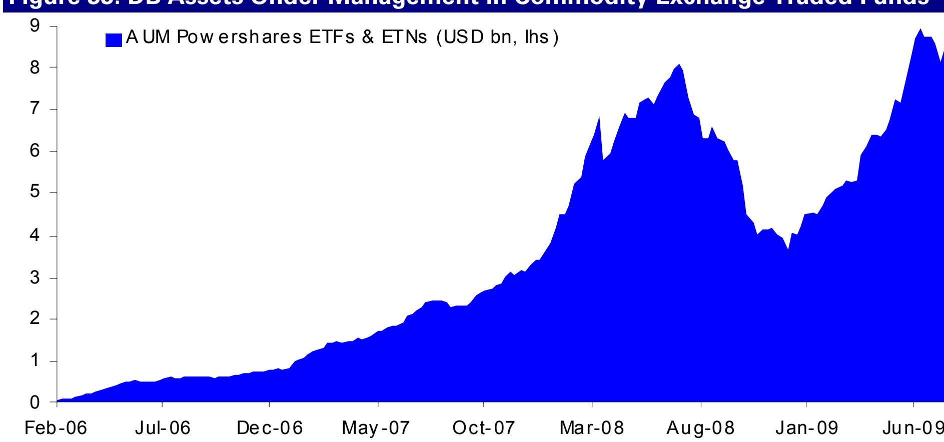
Vessel Class	Average Cap. (Mbbl)	World Fleet	Total Cap. (Mbbl)	Util. Rate %	Utilized Cap.	Avail. Cap. (max 92%)	Crude as % of Cap.	Available Capacity Crude	Available Capacity Product
VLCC	2.0	527	1,054	80%	843	126	100%	126	0
Suezmax	1.0	379	379	80%	303	45	100%	45	0
Aframax	0.6	792	475	80%	380	57	53%	30	27
Panamax	0.5	421	211	80%	168	25	60%	15	10
MR	0.3	804	241	80%	193	29	0%	0	29
Handysize	0.3	660	165	80%	132	20	40%	8	12
Sm. Handysize	0.2	359	54	80%	43	6	0%	0	6
Total	**0.7**	**3,942**	**2,579**	**80%**	**2,063**	**309**	**73%**	**225**	**84**
Crude/product currently in floating storage								60	70

Note: Tanker utilization rarely rises much above 90%, other than short-term spikes, so we've assumed a 92% effective maximum. The vessel count used here does not include the orderbook for the second half of 2009, so there are new tankers adding to capacity each month, and those ships are "clean", and thus can be used for either product or crude transport or storage.
Source: SSY, Clarkson's, DB Transportation Team, Deutsche Bank estimates

We believe there is considerable potential storage capacity remaining offshore, particularly for crude. Given current freight rates and demand levels, tanker supply does not appear to be an issue. Capacity constraints would likely require a demand catalyst to drive up rates and increase utilization dedicated to transport. Having said that, the remaining offshore capacity for product ("clean" vessels) is much lower than for crude, so given the recent inventory trends (slow decline in crude stocks, rising product inventories), a rise in offshore distillate stocks is a key reason for our short term bearish view on oil prices. This is essentially a seasonal call.

With governments signaling their concerns about future oil supply, either by holding oil off the market or by stocking it at taxpayer expense, not surprisingly, private players – who can easily envisage the same future problems – are moving into holding oil as an asset in its own right. As long as prices keep steadily rising, the cost of storage and rolling forward contracts is mitigated. The net effect exacerbates the government effect and serves to further increase oil storage.

Figure 33: DB Assets Under Management in Commodity Exchange Traded Funds



Source: Bloomberg, Deutsche Bank estimates

Oil producers sit on reserves, which amount to oil stocks. The market – led by governments - increasingly lacks confidence in the tangibility of these reserves, and so assumes that oil prices will be higher in the future. By paying more for oil in the futures market than the current price, the market causes contango, and incentivises stocking of oil, which serves to move oil from underground, risky places, to safe, local tanks, such as Cushing, Oklahoma or ships offshore; it also serves to remove oil from the open market and tighten physical supply. By increasing prices, governments then reduce demand. Again, given that inventory is not a real limit, one concludes that the solution to the oil problem will come through the end of oil demand.

Peak Oil Demand

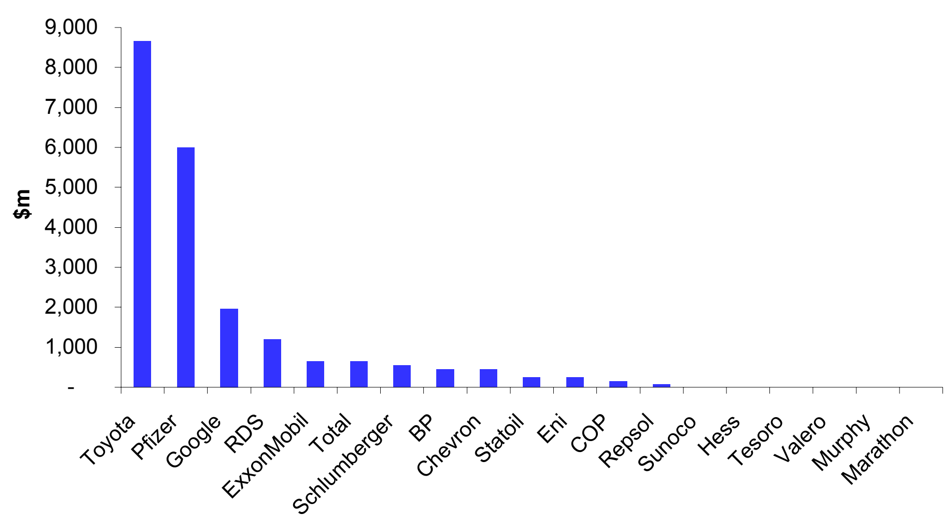
There's an oil supply problem, is that bullish for oil? No.

The oil supply challenge is more-or-less uncontroversial, a widely-held concern, particularly among oil specialists, even if the noisiest proponents of the oil supply problem, the Peakists, continue to pursue a bizarrely one-sided argument that oil supply is limited and mankind cannot change behaviour, even when prompted by high prices. We characterise the majority of Peak Oil analysis as the "stopped clock" school, right for one year and wrong for thirty. The majority of such analysis only covers one-third of the market dynamic: supply. The offsetting issues of price and demand are barely considered.

The fact is that after a century of low oil prices, it is **not** hard for us to improve efficiency, it is easy. There are tangible examples of highly successful economies that operate at $8 per gallon gasoline, without the end of economic activity as we know it; notably Germany and Japan have faced enormous oil import and energy import costs for many years, and yet have developed some of the highest per capita incomes and most stable economies globally.

Furthermore, there has been little attempt made to address the issue of energy, for example amongst the scientific community, having been disincentivised by low gasoline prices and a previous lack of concern about global warming. Now, the very best of the scientific community is turning its full attention towards oil and energy, and we believe the impact, based even on currently available technology, will be very large.

Figure 34: R&D Spend by Major Oil Companies vs. Toyota, Pfizer, Google – 2009e

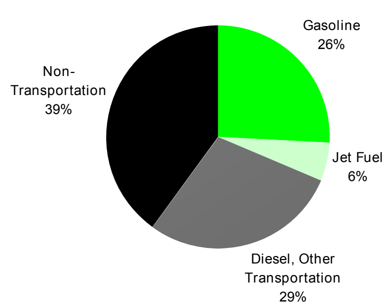


Source: Deutsche Bank

By far the biggest point is this. We see a surge in vehicle fuel efficiency that is in its nascent stages and that will accelerate and keep going. Efficiency is a net gain. Travelling from A to B in a more efficient car generates the same economic outcome for less cost. It is an outright productivity win, with attendant wider environmental and personal benefits.

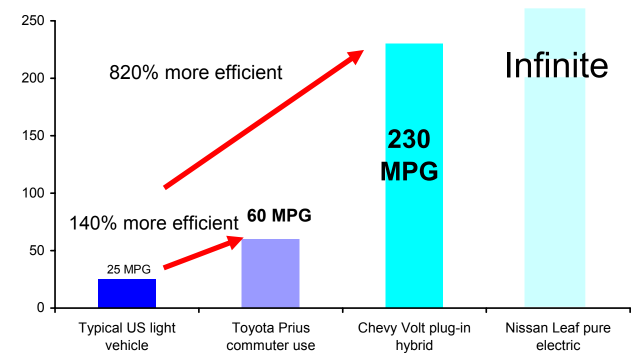
Improved transport efficiency will affect around 60% of global oil demand. That is widely known. Far less appreciated is the fact that a hybrid vehicle used in commuter or urban travel, which represents around 65% of global car use, achieves a 140% efficiency gain against a conventional gasoline car – currently. Electric/battery propulsion has high torque and strong acceleration with low friction, and is far better suited to stop-start driving than gasoline. We expect it will reverse the dynamics of world oil demand, and spell the end of the oil age.

Figure 35: Global oil use by sector



Source: IEA, Deutsche Bank estimates

Figure 36: Efficiency gain from hybrids/electric trade up



Note: According to the BTS, average 2006 MPG for US passenger cars and other two-axle, four tire vehicles was just over 20 MPG. The 2009 Toyota Prius hybrid is officially rated at 51 MPG for city driving, but with commuter driving (which accounts for well over 90% of car trips in the US, as per the Federal Highway Administration) the hybrid is likely to average closer to 60-70 MPG. A group of 28 journalists tested the car in March 2009 and averaged 70MPG driving on a 35 mile city course (http://www.hybridcars.com/mileage/hybridcarscom-gets-75-mpg-2010-toyota-prius-25680.html). GM's MPG estimates for the Chevy Volt were calculated using the average amount of driving for a cohort of urban commuter drivers, charging the battery daily. Nissan calculated an "MPG" of 376 for the Leaf, which uses zero gasoline, based on the petroleum equivalence factor for the amount of electrical power it consumed during a typical urban driving trip. Since we are primarily concerned here with the impact on gasoline and oil demand, rather than overall all-in power consumption, we consider the Leaf's gasoline efficiency to be infinitely better than combustion vehicles.
Source: Bureau of Transportation Statistics, US Department of Transportation, hybridcars.com, Toyota, General Motors, Nissan, Wall Street Journal, Deutsche Bank estimates

Transport change – big sector, with massive efficiency potential

We have modeled our view of vehicle efficiency gains and gasoline demand in association with the Deutsche Bank auto team, who helped us understand the sales and fuel efficiency dynamics of the industry. We've included key parts of the model in the appendix. In this section we will discuss the trends on a global scale, but given the importance of the world's largest market circa 2010, the United States, and the world's largest market circa 2030, China, we will break out some detail and commentary for those countries into a separate section.

Gasoline demand is essentially a function of three factors – the number of vehicles on the road (the "fleet" or "parc"), the average "vehicle miles travelled" ("VMT") and the average fuel efficiency (we've used miles per gallon, or "MPG") of the fleet. These factors neatly roll into the following formula for the demand delta:

$$\Delta\%\text{Demand} = \Delta\%\text{Fleet} + \Delta\%\text{VMT} - \Delta\%\text{MPG}$$

We've assumed VMT holds steady in our gasoline demand analysis, thus we've simplified our demand impact to the difference between average efficiency gains and growth in fleet size. Here are our basic assumptions for this analysis, keeping in mind that some key parts of the model are included in the appendix:

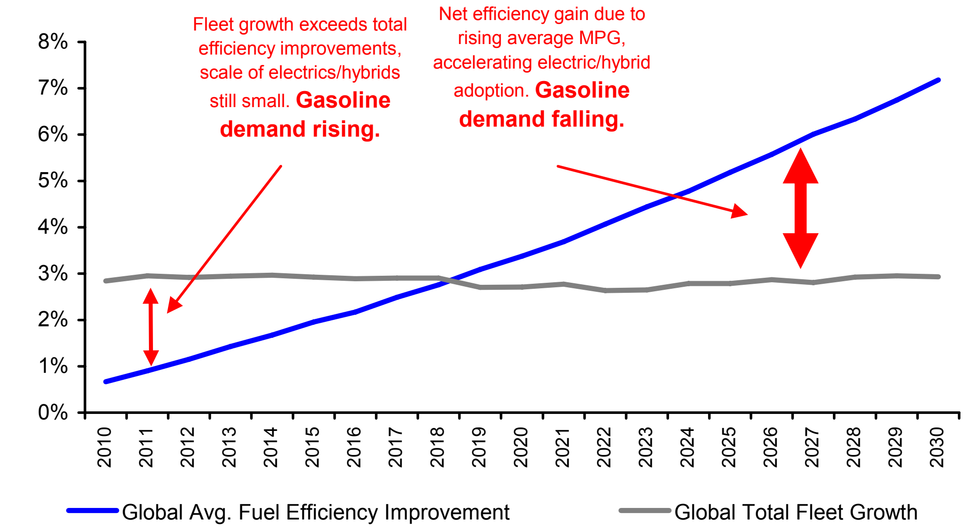
Figure 37: Key assumptions in our gasoline demand model

SALES & PARC GROWTH ASSUMPTIONS				
Light Vehicle Sales Growth (CAGR)	**2010-15**	**2016-20**	**2021-25**	**2026-30**
US	7.2%	1.5%	1.2%	1.5%
China	9.2%	6.2%	5.9%	5.5%
Global	7.1%	2.9%	3.0%	3.0%
Light Vehicle Parc Growth (CAGR)	**2010-15**	**2016-20**	**2021-25**	**2026-30**
US	1.2%	1.2%	1.2%	1.2%
China	11.9%	9.2%	8.7%	8.1%
Global	2.9%	2.8%	2.7%	2.9%
HYBRID/ELECTRIC PENETRATION ASSUMPTIONS				
Hybrids/Electrics as % of Total Sales	**2010**	**2015**	**2020**	**2030**
US	4.2%	10.2%	26.7%	75.8%
China	0.4%	7.7%	25.8%	78.3%
Global	1.7%	6.2%	19.9%	66.0%
Hybrids/Electrics as % of Total Light Vehicle Park	**2010**	**2015**	**2020**	**2030**
US	0.9%	3.0%	8.8%	39.8%
China	0.1%	3.5%	15.4%	63.1%
Global	0.3%	1.8%	6.6%	35.6%
FUEL EFFICIENCY ASSUMPTIONS				
New Light Vehicle MPG	**2010**	**2015**	**2020**	**2030**
US	26	31	42	95
China	27	33	45	106
Global	29	34	44	88
Light Vehicle Parc MPG	**2010**	**2015**	**2020**	**2030**
US	23	25	29	49
China	26	30	39	91
Global	28	30	34	57
Annual New Vehicle Fuel Efficiency Improvement	**2010-15**	**2016-20**	**2021-25**	**2026-30**
US	4.0%	5.9%	7.9%	9.1%
China	4.3%	6.3%	8.5%	9.3%
Global	3.4%	5.0%	6.7%	7.6%
Annual New Vehicle MPG Improvement by Class	**2010-15**	**2016-20**	**2021-25**	**2026-30**
Combustion Cars	3.0%	3.0%	3.0%	2.5%
Combustion Personal Light Trucks	3.2%	3.0%	3.0%	2.5%
Combustion Commercial Light Trucks	3.8%	3.0%	3.0%	2.3%
Hybrids	6.5%	3.5%	0.5%	0.5%
Plug-in Hybrids	9.2%	6.6%	5.2%	4.5%
Pure Electrics	∞	∞	∞	∞
Annual Miles Traveled Per Vehicle	12,000	12,000	12,000	12,000

Note: Light vehicles include cars, personal light trucks, commercial light trucks, hybrids, plug-in hybrids and pure electric vehicles. In our model we have sales, parc and mpg forecasts for the US, Europe, Japan, China and the Rest of the World. We've assumed 4-7% annual scrappage rates for the various regions over time, and assume that the oldest vehicles will be scrapped first, i.e., the vehicles with the lowest average MPG for each class of vehicle. New vehicle fuel efficiency improvement will be driven both by technical improvements (e.g., micro-hybrids, which have battery-driven motors that supply energy for all non-engine functions within a car, are included in the combustion car category), and by mix shifts within categories (e.g., a general shift towards more fuel efficient models). The striking jump in MPG between 2020 and 2030 is driven, of course, by the penetration of the electric vehicle, which essentially has infinite MPG with regards to gasoline.
Source: JD Power & Associates, US DOT, Bureau of Transportation Statistics, US Bureau of Economic Analysis, Deutsche Bank auto team, Deutsche Bank estimates

To get straight to the punch-line, we see overall efficiency gains (driven both by technological improvements and a mix shift in the global fleet towards high efficiency vehicles) overtaking the growth in the world fleet by the middle of the next decade, probably around 2016-17. From that point forward we believe gasoline demand will be on an inexorable and accelerating decline.

Figure 38: Efficiency vs. fleet growth – long-term decline of gasoline demand

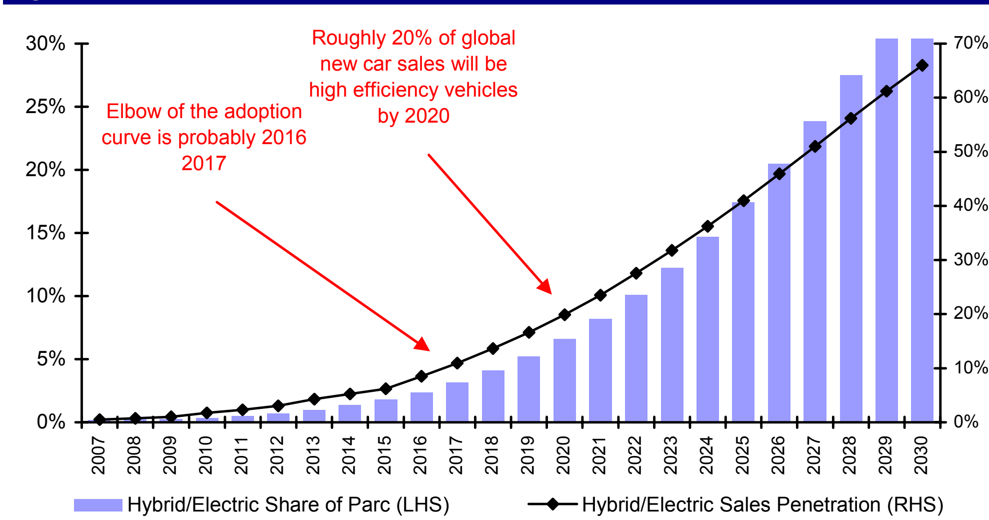


Source: IEA, JD Power & Associates, US Department of Transportation, DB Auto team, Deutsche Bank estimates

The central dynamic causing the (eventually) seismic change in gasoline demand is the adoption rate of high efficiency vehicles (both hybrids and electrics). The adoption curve will almost certainly take a classic "J" shape, an exponential function that will surprise the market when it hits the "elbow." We believe the elbow of the curve will be around 2016-17.

It is likely all downhill for gasoline demand after that inflection point is hit. We see this change as a "disruptive technology," a net superior product game-changer that is not threatened by the price collapse of the previous technology. An obvious recent example of this phenomenon has been the digital camera and the subsequent irrelevance of a collapse in the price of conventional film.

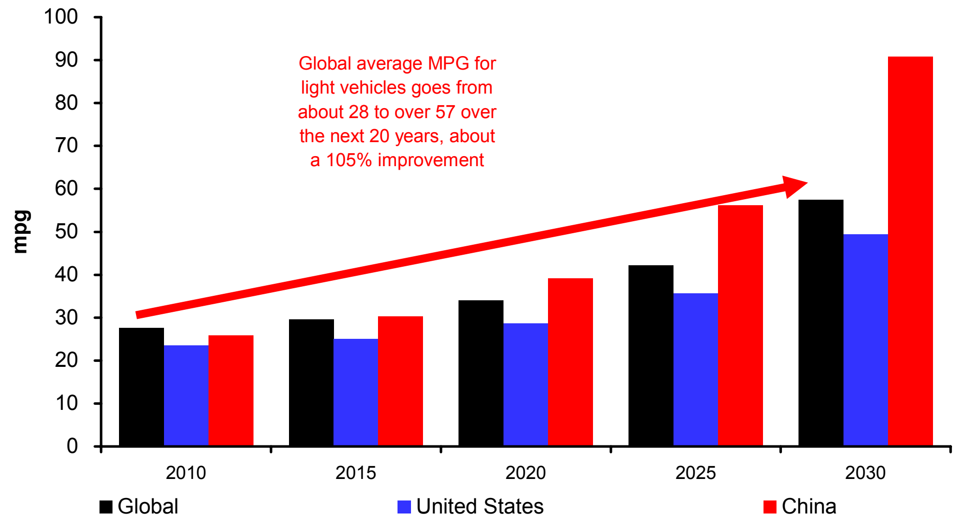
Figure 39: Estimated hybrid/electric share of vehicle sales and parc, 2007 to 2030



Source: IEA, JD Power & Associates, US Department of Transportation, DB Auto team, Deutsche Bank estimates

This is a recent change – 2009 marked its start, the Obama administration and the bankruptcy of the US auto industry. For the next half-decade, the high efficiency portion of the fleet lacks the scale to meaningfully move the needle in terms of overall fleet MPG. Mid-decade, however, scale should be sufficient to start to drive accelerating average MPG gains. **With reasonable assumptions, we find that by 2020 the global average MPG of newly sold cars will rise by a bit over 50% relative to 2009, from 29mpg to 44mpg, and the fuel economy of the global light vehicle parc will likely have risen by over 20%, from roughly 28mpg to about 34mpg.** From 2016 to 2030, the surge in hybrid/electric vehicle sales should drive close to a doubling of the fuel efficiency of the global light vehicle parc.

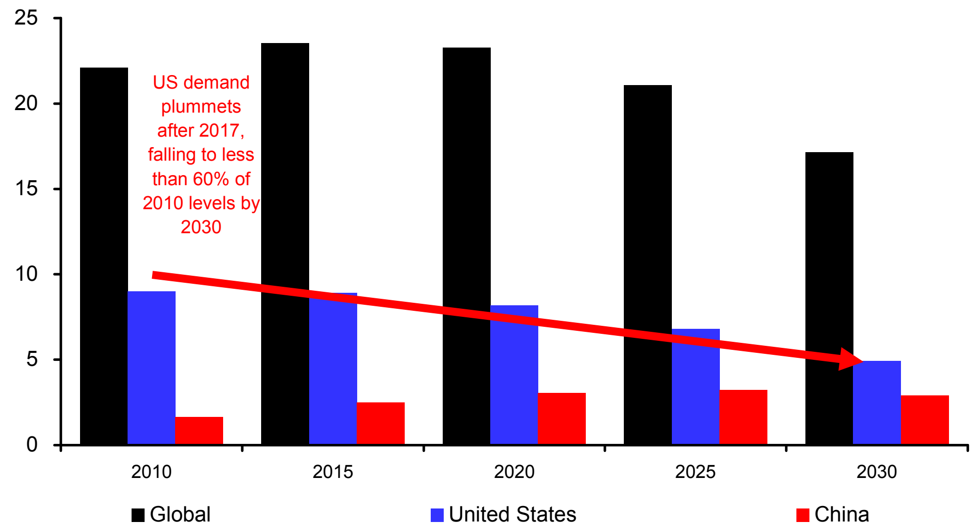
Figure 40: Average MPG for US, China and the world, 2010 to 2030



Source: IEA, JD Power & Associates, US Department of Transportation, DB Auto team, Deutsche Bank estimates

Despite the continued 2-3% annual global increase in total vehicles on the road, the impact on gasoline demand from the accelerating efficiency gains should be enormous. Essentially, after about 2016-17 gasoline demand will begin to fall, tumbling by 0.3Mb/d to over 1Mb/d each year for the next 15+ years. As we outlined in 2007 in our ethanol note "Food for oil," we believe US gasoline demand has peaked (at 9.3M/bd in 2007). From here, US demand should decline throughout the next decade (to about 8.2Mb/d in 2010, or about 9% below the 2009 level) **and will likely be less than 60% of 2009-10 levels in 2030**.

Figure 41: Gasoline demand (Mb/d), 2010 to 2030



Source: IEA, JD Power & Associates, US Department of Transportation, DB Auto team, Deutsche Bank estimates

We believe global gasoline demand will stand at 17Mb/d or less in 2030, versus the current 22Mb/d and a mid-2010's peak of perhaps 23.5Mb/d. A portion of the decrease across the next two decades will be from increasing ethanol substitution (approximately 0.7Mb/d), with the balance from effects related to efficiency (the mix shift towards hybrids/electrics, and across the board efficiency gains for both combustion and high efficiency vehicles). These are partially offset by growth in the total vehicle parc for the US.

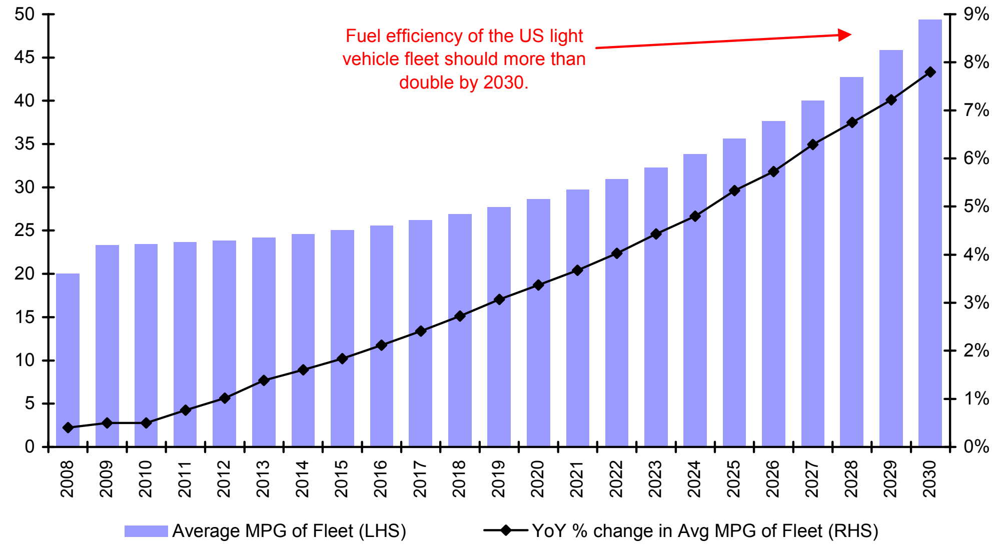
US focus – new standards and hybrid penetration

The US will almost certainly be the key market putting downward pressure on gasoline demand over the next two decades. The Obama administration has radically shifted government policy regarding vehicle emissions/efficiency, dramatically increasing fuel economy standards and putting pressure on the US auto industry (which the government effectively owns, ex-Ford, via the 1H09 collapse and managed bankruptcy of GM and Chrysler) to accelerate its ramp up of hybrids and electric vehicles.

US MPG standards had barely budged since 1990. The US vehicle fuel efficiency regime, implemented through the Corporate Average Fuel Economy (CAFE) standards, was created in 1973 to reduce consumption following the first oil crisis. CAFE standards are enforced at the level of individual manufacturers' new vehicle fleets, with different regulations for passenger cars and light duty trucks. The limit for passenger cars has been 27.5mpg since 1990, with only slight increases in the standards for "light duty trucks" (which include SUVs) from 20.0 mpg to 22.5 mpg. The stagnant standards, and persistently low fuel prices, disincentivised US automakers from developing more efficient vehicles, and incentivised them to push higher margin, but low efficiency, SUVs and cars.

This powerful trend towards heavier and more powerful trucks was a key contributor, alongside surging Chinese and Middle Eastern demand, of the global oil demand boom that eventually drove oil prices to $147/bbl… and paradoxically spelled the end of the SUV, the height of concern over oil availability, dependence, and volatility, and ultimately triggered the change that started with an SUV sales collapse, the bankruptcy of the US auto industry, and now we believe likely the demise of global gasoline demand.

Figure 42: Looking towards a more efficient future for the US vehicle fleet



Source: Federal Highway Administration, US DOT, DB Auto team, JD Power & Associates, Deutsche Bank estimates

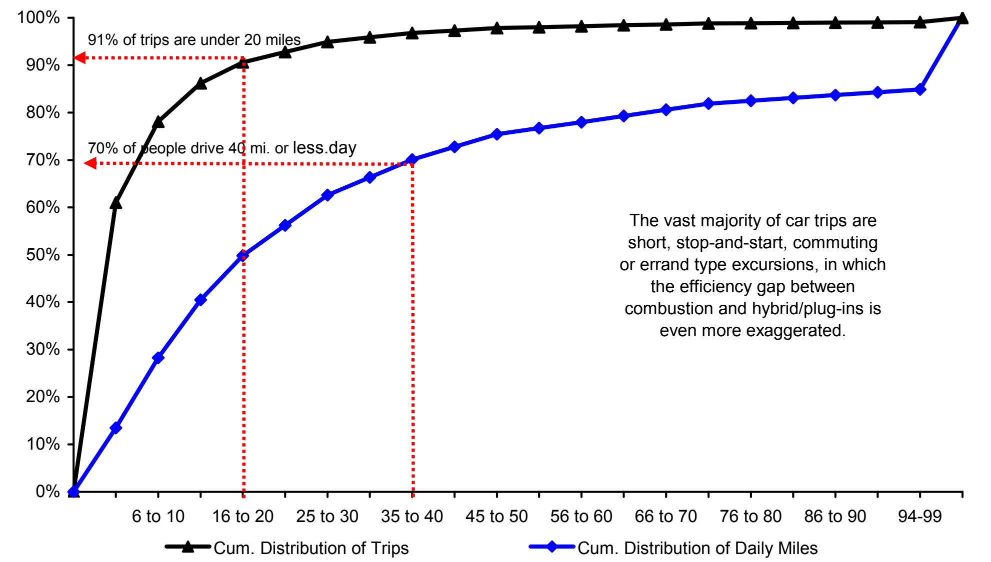
A brief recent history of the US government's approach to vehicle emissions and fuel efficiency sheds light on the significance of recent headlines. During the Bush administration, California proposed to the EPA a set of more stringent vehicle emission standards. EPA denied the proposal, and California then waged a long fight in the courts for the right to impose its own efficiency standards, which given the size of the state would essentially force automakers to build to California requirements. Federal agencies under Bush (EPA, DOT) acted to essentially freeze standards and resist California's efforts to move efficiency requirements higher.

Under Obama, the EPA recently granted the state the waiver it needed under the Clean Air Act to impose its own, more rigorous standards. Thirteen other states and the District of Columbia have already moved to adopt the California standards (and several others have indicated they will also follow). Though important, the EPA action may prove to be moot in the near term since in May 2009, President Obama made a surprise announcement (likely catching even the California Air Resources Board off guard) of a suite of new vehicle fuel efficiency standards, which essentially adopted the California requirements. Details were announced several months later, on September 14. The waiver granted by the EPA will allow the California Air Resources Board to essentially set the agenda starting in 2016, once the new CAFE standards expire.

The new rules will require automakers to produce new vehicle fleets that reach an average of 35.5 mpg by 2016, up from 27.3 mpg in 2011. Standards will start to rise with the 2012 models. The 2016 deadline was four years earlier than previously planned in the Energy Independence and Security Act of 2007. The standards also intend to reduce CO_2 emissions from new vehicles by 30% by 2016.

The more aggressive standards will have a disproportionate effect because of the nature of US transport trip miles. In the US, 97% of trips are under 40 miles in distance, 91% under 20 miles. Some 70% of people drive 40 miles or less a day. Trips of this length are typically congested and stop-start, a type of driving that exaggerates the efficiency gap between combustion and hybrid/plug-in electric vehicles. Informal studies suggest, for example, that the new Toyota Prius, rated 51 MPG in the city, may actually get 60-70 MPG under urban commuter usage (see the footnote for Figure 36 for a reference to one of these informal studies). So we believe that hybrids and plug-ins will likely get mileage better than their official MPG ratings, and efficiency gains will likely exceed expectations.

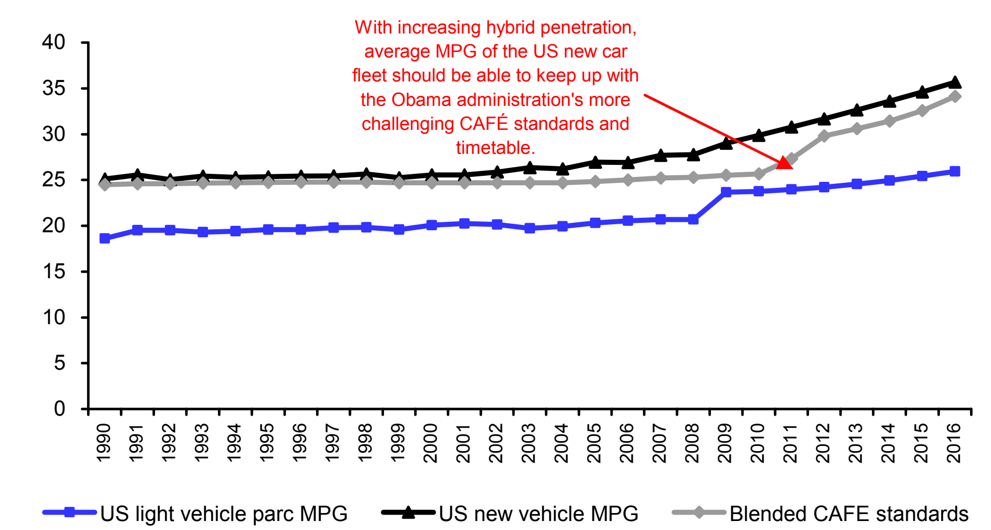
Figure 43: Cumulative distribution of trip miles and daily miles in the US



Source: National Household Travel Survey, Federal Highway Administration, US DOT, Deutsche Bank

Though the new standards will be a challenge for car manufacturers, we believe that US new vehicle efficiency gains will be able to keep pace with, and most likely exceed, the pace of rising CAFE standards, due to the increasing share of fleet for hybrids and plug-in electrics.

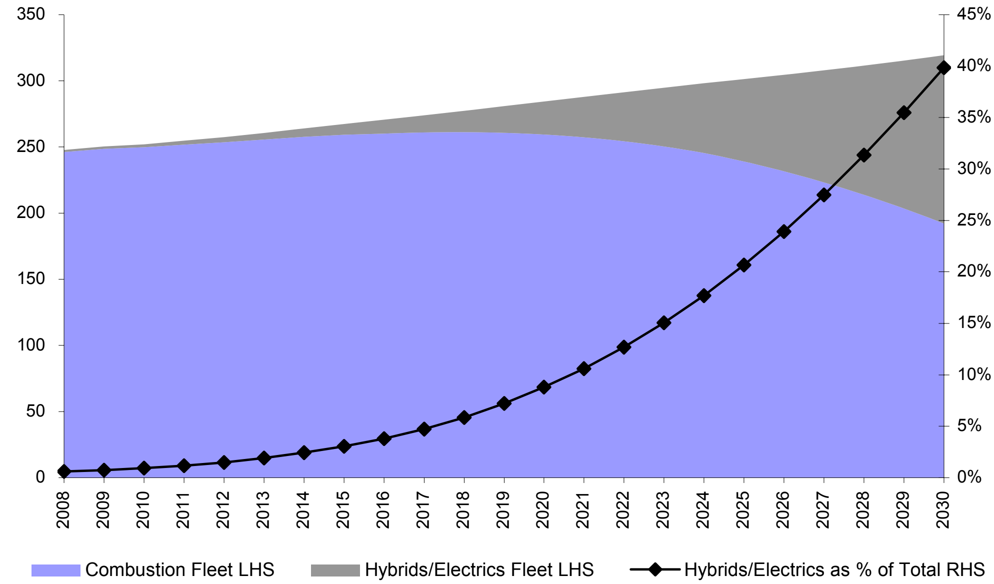
Figure 44: US average vehicle efficiency and the new proposed CAFE standards



Note: Blended CAFÉ standards are a proportionate mix of passenger car and light duty truck standards, using the DOT's fleet mix ratios.
Source: NHTSA,US DOT, Federal Highway Administration, Bureau of Transportation Statistics, JD Power & Associates, Deutsche Bank estimates

By 2020 we believe that hybrids and electrics will account for about 25% of new vehicle sales in the US, and 8-9% of the vehicles on the road. Over the following decade (2020-2030), the electrified portion of the US vehicle parc will jump to almost 40%.

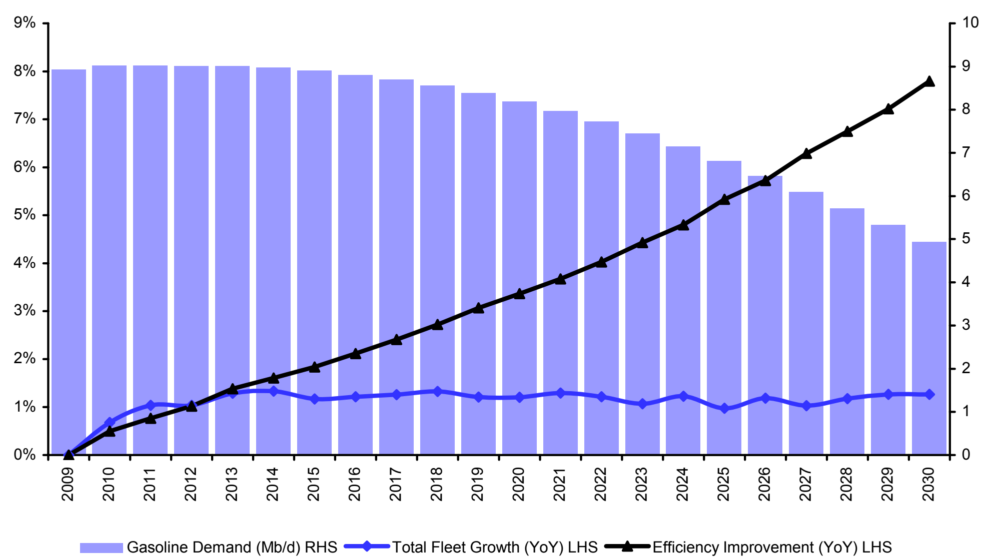
Figure 45: Long-term mix of the US vehicle fleet



Source: NHTSA,US DOT, Federal Highway Administration, Bureau of Transportation Statistics, JD Power & Associates, Deutsche Bank estimates

With the US's relatively low long-term fleet growth (1-2% a year on average), significant fuel efficiency gains will have a large and immediate impact on gasoline consumption. While emerging markets, such as China, will continue to see rising gasoline demand (due to persistent double digit growth in fleet), we believe US gasoline demand, relatively flat for the last few years (down YoY in 2009), will experience accelerating declines going forward. By the end of the decade it should feel like US gasoline demand is in free-fall. Figure 46 spells doom for US independent refiners in particular.

Figure 46: With low fleet growth, MPG gains wreak havoc on US gasoline demand

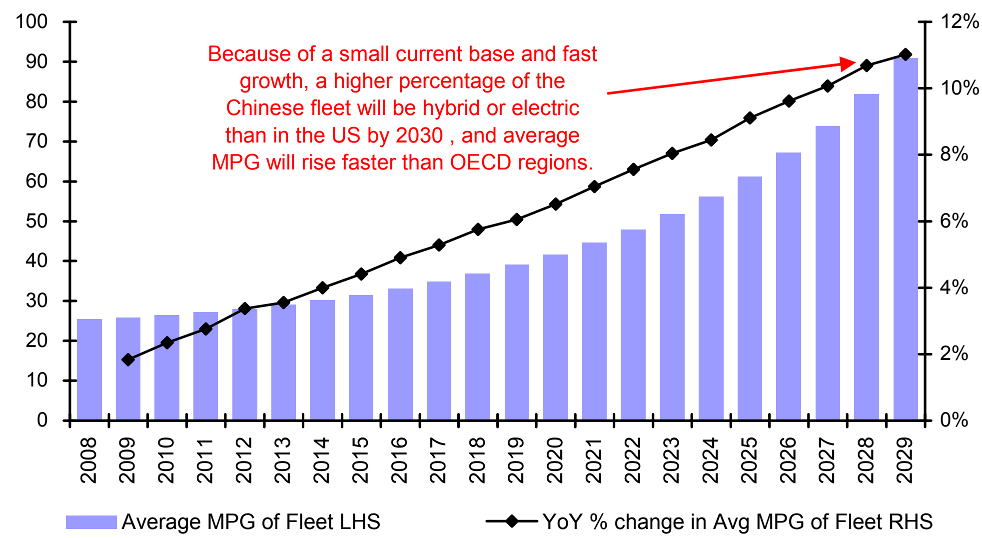


Source Federal Highway Administration, US DOT, DB Auto team, JD Power & Associates, Deutsche Bank estimates

China focus – disruptive technology and the Hummer bypass

The oil demand bull will look past the potential for accelerating demand destruction in the US and point to growth in China. However China's fuel economy standards are the third most stringent globally, behind only those of Europe and Japan. Putting Chinese and American standards on a comparable basis, An Feng, a leading architect of China's existing fuel economy regulations who is now the president of the Innovation Center for Energy and Transportation, estimates China's 2009 car fuel economy at 35.8 mpg. By extension, the new plan requires an increase to 42.2 mpg by 2015. This is much higher than the 35.5 mpg requirement by 2016 announced by President Obama in May this year. Because enforcement does not always match regulation in China, we're skeptical of those fuel efficiency averages, and have used more modest 34 mpg/40 mpg estimates for the Chinese car fleet for 2010/2015, but it is evident that China is as focused on efficiency as Japan, Europe and the US.

Figure 47: Improving efficiency in Chinese light vehicle fleet

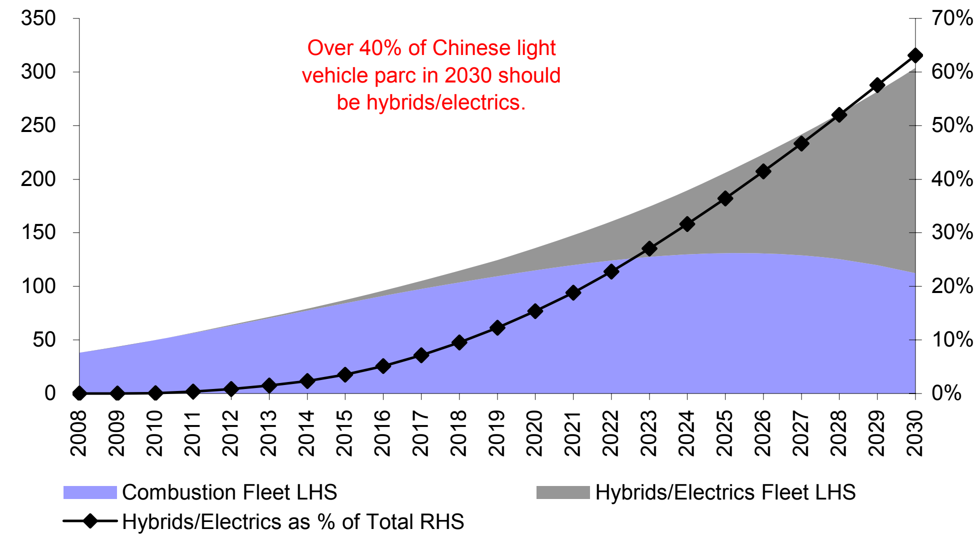


Note: These average MPGs include all light vehicles, including light commercial vehicles. Personal cars start out at around 30 mpg in 2008 in our analysis.
Source: JD Power & Associates, IMF, World Bank, DB Auto team, Deutsche Bank estimates

In addition to setting strict fuel economy standards, the Chinese government is raising subsidies for auto replacements from RMB 1bn to RMB 5bn for consumers who trade in small and mid-sized trucks and mid-sized passenger cars for new ones which are more fuel efficient, or sell vehicles that no longer meet emission standards but still have remaining life expectancy. The government also lowered the excise tax on small-engine vehicles and significantly raised the rate on larger-engine vehicles in March 2006, August 2008 and January 2009. It is worth noting, however, that in China only urban fuel economy is regulated; highway driving is not. Also, only domestically produced cars are regulated by the FES; imports are not.

At present, the market penetration of hybrids in China is very low (only ~0.01% of passenger car sales according to JD Power & Associates China). In fact BYD Co., the Chinese automaker part-owned by Warren Buffett's Berkshire Hathaway, only sold 31 F3DM plug-in's nationwide in the seven months after its launch in January 2009. While the F3DM can run 62 miles on a single charge and has a maximum speed of 100 mph, it is at least twice as expensive as a similar gasoline car.

Figure 48: Changing mix of the vehicle fleet in China



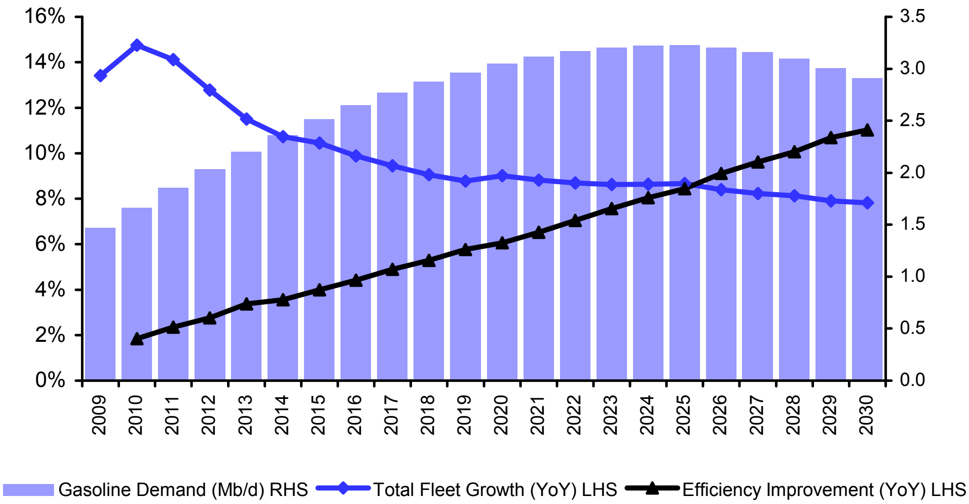
Source: DB Auto team, JD Power & Associates, Deutsche Bank estimates

This again brings government subsidies and policies into the picture. Back in January 2009, the Chinese government announced a 10 billion yuan ($1.5 billion) plan to boost alternative energy, stipulating a target of at least one green vehicle per car company by 2011. Also, the Ministry of Finance and Ministry of Science and Technology aim to put over 60,000 new-energy or energy-efficient buses, taxis, government sedans and postal trucks in use in 13 pilot cities (including Beijing and Shanghai) within four years.

Potentially more dramatic, however, is China's position in terms of vehicle science and disruptive technology. Accompanying the FES is the boom in electric bicycles (e-bikes) in China. While China fell behind international automakers in combustion technology (and still trails by a wide margin) it has charged ahead with electric vehicle technology. Eighteen years ago China made it an official technology goal to develop e-bikes. With hikes on gas-powered scooter licensing fees in cities like Shanghai, motorcycle bans in certain areas of Beijing and Shanghai, and downtown Guangzhou and Hangzhou, as well as special privileges for e-bikers (riding in the bicycle lanes, no licenses or helmets required), e-bikes have skyrocketed in popularity. In 1998, 40,000 e-bikes were sold; less than a decade later in 2005, annual sales reached 10 million. In comparison with autos, 21 million e-bikes were purchased in 2008 versus 9.4 million autos, and in mid-2009, there were 100 million e-bikes vs 25 million autos on the road.

Driven by its understanding of small scale electric transport technology, the growth of electric cars in China will be a major dynamic that will drive the efficiency of the entire world vehicle fleet. As market growth is so aggressive, net efficiency gains will be global in impact. China currently has 0.04 vehicles per capita (compared to 0.85 in the US, 0.52 in Europe, and 0.39 in the Middle East), and as the Chinese middle class continues to grow, the cars/capita should rise to 0.11 by 2020, and 0.18 by 2030. To a large extent, China will be skipping the combustion phase of its transportation development arc, and moving right to the electric era, much as it skipped the landline phase in its communication development and built out a modern wireless system over the course of 20 years. From a standing start (essentially no hybrids or electrics in 2009), we think about a quarter of new light vehicle sales in China will be high efficiency vehicles in 2020, and about two-thirds in 2030. Approximately half of all light vehicles on the road in China in 2030 will be electrics or hybrids.

Figure 49: Efficiency improvement overcomes fleet growth, demand falls



Source: IEA, JD Power & Associates, DB Auto team, Deutsche Bank estimates

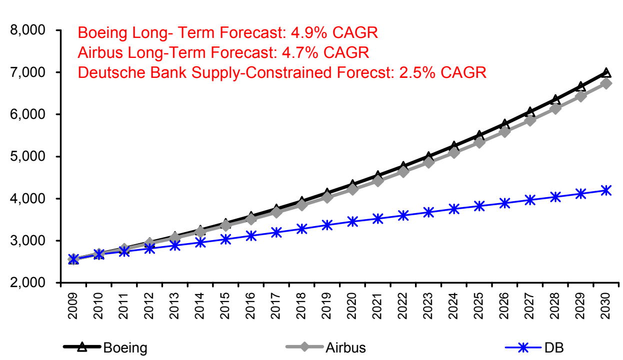
The net result of these trends (massive growth in the vehicle fleet, aggressive increases in total fuel efficiency) is a roughly 75% increase in gasoline demand through the end of the next decade, followed by a plateau through the first half of the second decade. We would anticipate a sharp decline thereafter driven by the ever-increasing electrification of the Chinese transportation system.

Peak aviation

Electrification will have minimal impact on airline travel for the foreseeable future, and we expect annual fuel efficiency gains for the industry to be along the lines of the long-term historical average of 2%. This is in line with the industry's stated aim of a 25% improvement in efficiency between 2009-2020.

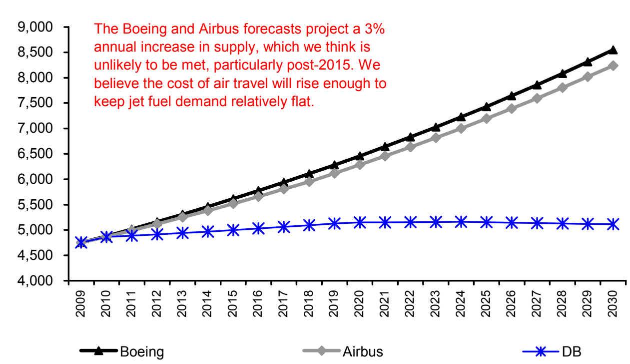
Both Boeing and Airbus have offered long-term air traffic forecasts (measured in units of revenue passenger miles – "RPM", and freight traffic miles – "FTM") in the range of 4.7% to 4.9%.

Figure 50: RPM* forecasts (Boeing, Airbus and us)



** Note: Revenue Passenger Miles. Boeing and Airbus each publish their forecasts in an annual statistical review*
Source: Boeing, Airbus, US Bureau of Transportation Statistics, IEA, IMF, Deutsche Bank estimates

Figure 51: Implied jet fuel supply/demand



Note: We've assumed a 2% annual fuel efficiency improvement, which is the long-term historical average for the industry.
Source: , Airbus, US Bureau of Transportation Statistics, IEA, IMF, Deutsche Bank estimates

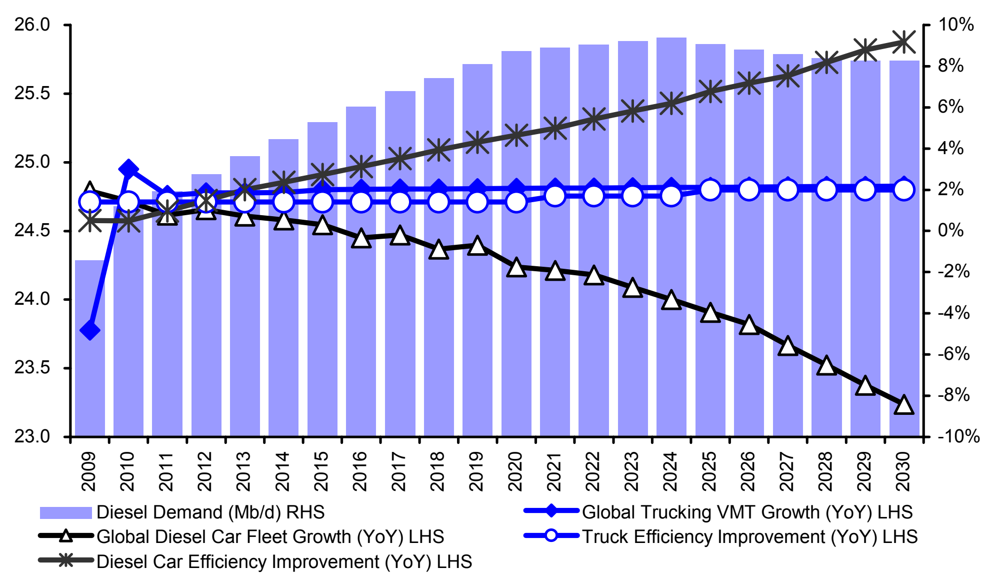
With an unconstrained fuel supply, we would have no issue with the manufacturers' bullish outlook for air transportation demand. In line with our view of constrained crude supply and falling or flat demand across the other products processed from a barrel of oil, we believe jet fuel will be kept in check via the price mechanism; the industry's emphasis on biofuels is symptomatic of the challenges it faces. Refining flexibility will accommodate some additional jet fuel supply, but with gasoline demand falling in an accelerating fashion after 2016, we believe jet fuel demand will rise only slightly over the next couple of decades. Our forecast is for 2.5% long-term growth in RPM, about a half a percent above the expected annual fuel efficiency gains; and around half the rate of growth that the industry envisages.

Diesel/non-gasoline transport: the tractor trailer sized battery

The power necessary to move an eighteen-wheeler truck a meaningful distance for freight would require a battery the size of an eighteen-wheeler. Very short hauls (less than 60 miles on a charge) are possible at low speeds (sub-40 mph), in other words, glorified fork-lifts, but we are a long-way from electrification having an impact on the heavy trucking industry. Heavy commercial trucking uses almost exclusively diesel for fuel, and this portion of the diesel market is relatively immune from battery-driven efficiency gains, at least for the foreseeable future.

Europe is the only region that has wholeheartedly embraced diesel for its passenger car fleet. Given somewhat better fuel efficiency characteristics, diesel cars have been stealing some market share from gasoline combustion in numerous other key markets, such as the US and parts of Asia, but off a very small base. Diesel claims just under 50% of the car parc in Europe, far higher than any other region. Though hybrids are off to a much lower start in Europe than in the US or Japan, we believe that diesel cars are susceptible to the same market share loss trends we foresee for gasoline vehicles, especially if prices are under upward pressure over the next five years.

Figure 52: Our long-term diesel/non-gasoline transport demand expectation



Source: IEA, EIA, World Bank, IMF, Deutsche Bank estimates

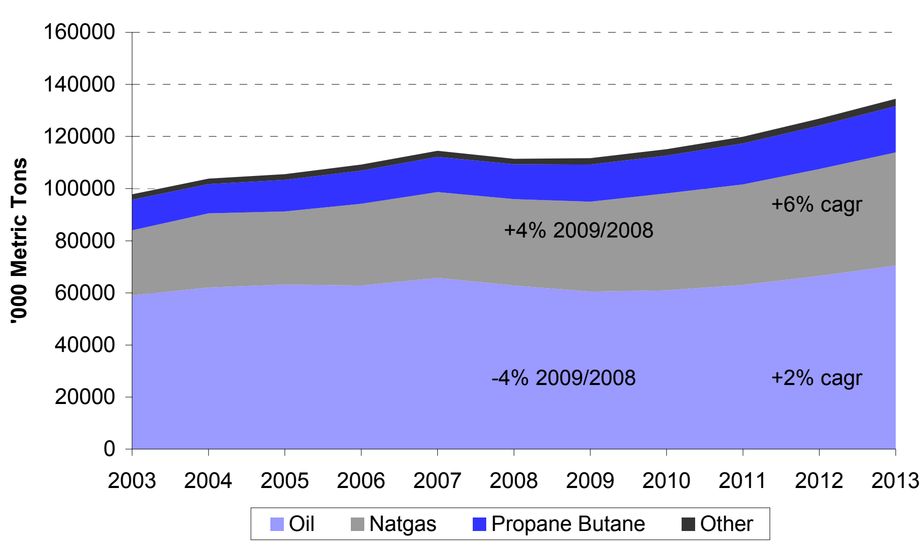
Thus at a simplified level, the two primary factors driving diesel demand are global trucking, which will continue to moderately increase fuel demand, and European passenger vehicles, which will drive a slight increase in demand in the near term, but which will meaningfully undermine diesel demand over the long term due to fleet electrification. There will also be some substitution of bio-diesel for diesel, which we've factored into the model, though the numbers there are quite small. The net impact of these factors is a modest rise in non-gasoline demand for the next decade, followed by a plateau or slight decline to 2030. If electric transportation technology starts to impact heavy truck fuel efficiency, the decline next decade could be greater even than we currently anticipate.

Non-transport oil demand and the impact of cheap natural gas

We see a continued abundance of natural gas availability globally, as outlined in the supply section, and attendant much lower and less volatile prices, per calorie, for natgas. Whereas oil will price towards the break point of marginal demand, beyond $150/bbl, natgas will be priced by the marginal cost of supply, around $5-$6 per mmbtu, or closer to $30-$40/bbl.

We expect there to be sustained substitution of natgas for oil in petrochemicals, and to the extent that it is still used, in power generation, particularly, in both cases, in the Middle East. Basically we see the death of the oil feedstock chemical business as approaching, under-cut by cheap and abundant natgas. That is not reflected in current expectations for petrochemicals feedstocks in current market forecast, but we believe that the shift we have seen over the course of 2009 indicates a major shift towards gas-fired petrochemicals as a future source of supply, based in the Middle East.

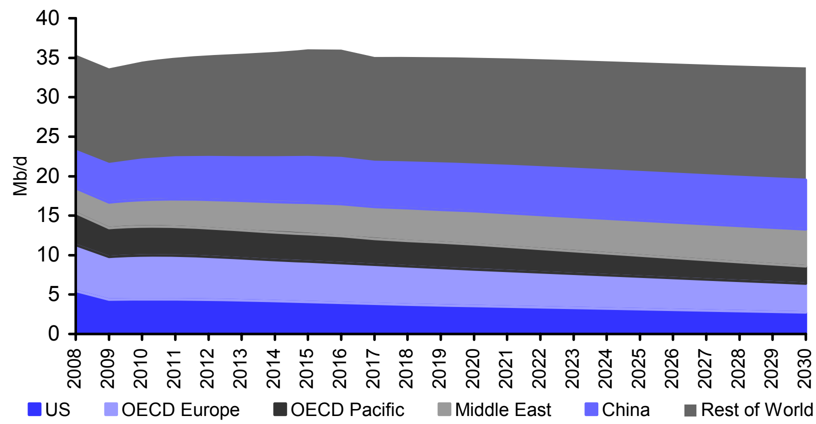
Figure 53: 8% shift in petrochemical feedstocks in 2009 to be reversed? We think not



Source: Petrochemical Association

Overall our non-transport forecast rises in the near term, before hitting a long plateau and gradual decline over the long-term. There is no powerful argument for growth in this sector, in oil use, going forward. We use DB and IMF forecasts for global economic growth and population, and do not see a constraint, owing to the availability of cheap natgas.

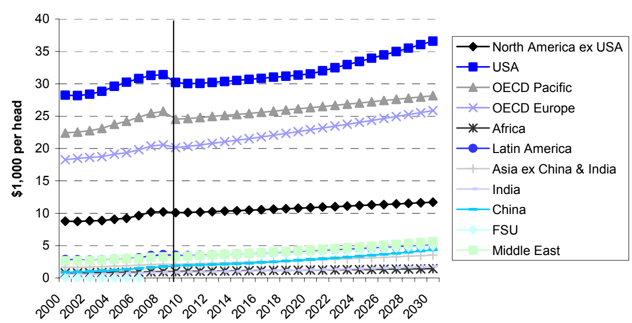
Figure 54: Non transport use of oil, DB forecast 2009-2030



Source: IEA, EIA, Deutsche Bank estimates

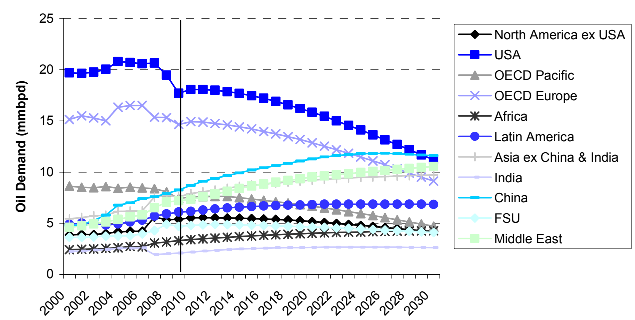
It is notable that we can forecast significant rises in global per capita wealth as well as dramatic declines in oil consumption in our outlook, without stretching our model. Again, the biggest single gain here is efficiency in car transport, a net economic gain.

Figure 55: GDP forecast per capita



Source: IMF, World Bank, Deutsche Bank estimates

Figure 56: Oil demand by region



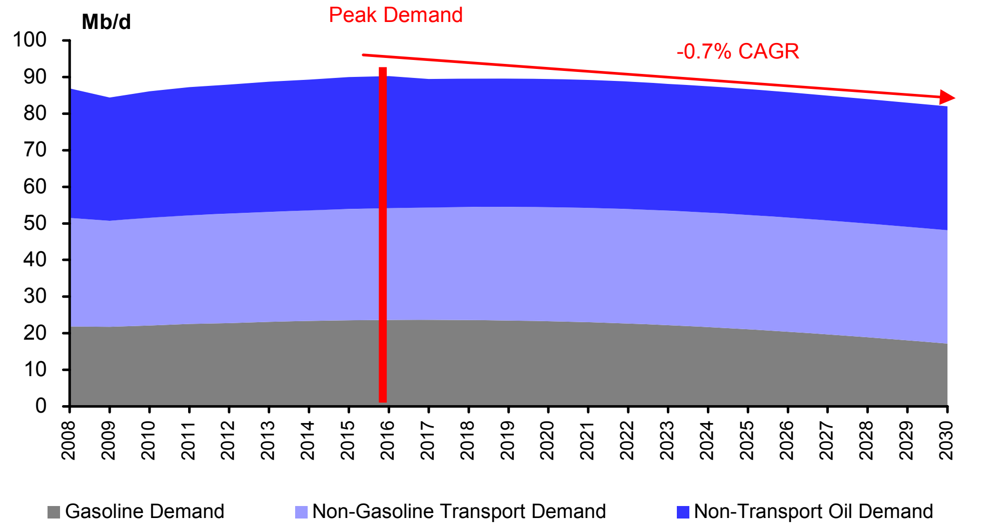
Source: IEA, Deutsche Bank estimates

Conclusion on future demand dynamics

A handful of factors have dovetailed to accelerate the global shift to an electrified transportation system: an aggressive new administration focused on emissions, rising concern over the environment, the war in Iraq, the bankruptcy of the US auto industry, $150/bbl oil in 2008. The trade-up from combustion to electric captures a massive gain in efficiency, and as an increasing proportion of the world fleet makes that trade each year, the pressure on gasoline demand will accelerate. This is current, available, and increasingly competitive technology that represents a disruptive technology – a direct shift away from historic behaviour patterns to a new world order.

The scale of the impact that we see is illustrated in combination below (Figure 57). In the near-term, economic recovery and growth in the worldwide vehicle fleet will more than offset efficiency gains from the nascent hybrid/electric vehicle growth, and gasoline/oil demand will be pushed higher. Beginning mid-decade, however, we believe that efficiency gains will offset, then exceed, fleet growth, and global gasoline demand (and oil demand with it) will likely decline in an accelerating fashion.

Figure 57: Shape of things to come – our oil demand outlook



Source: IEA, EIA, World Bank, IMF, Deutsche Bank estimates

Considerable skepticism remains regarding the electric car. Over the short term, technological trends are usually over-hyped, and the pace of change over-estimated, due both to wishful thinking and a tendency to leave out the details. Conversely, people tend to under-estimate the tempo of change over the long-term, due to a bias towards perceiving and projecting linear rather than exponential growth/adoption functions, and frustration with the recent slow rate of progress. The dovetailing of circumstances enumerated above have given the transportation electrification dynamic a helpful shove, and we now seek the tipping point that will destroy gasoline demand and mark the end of the age of oil.

Price Dynamics

Oil price elasticity and the current equilibrium price

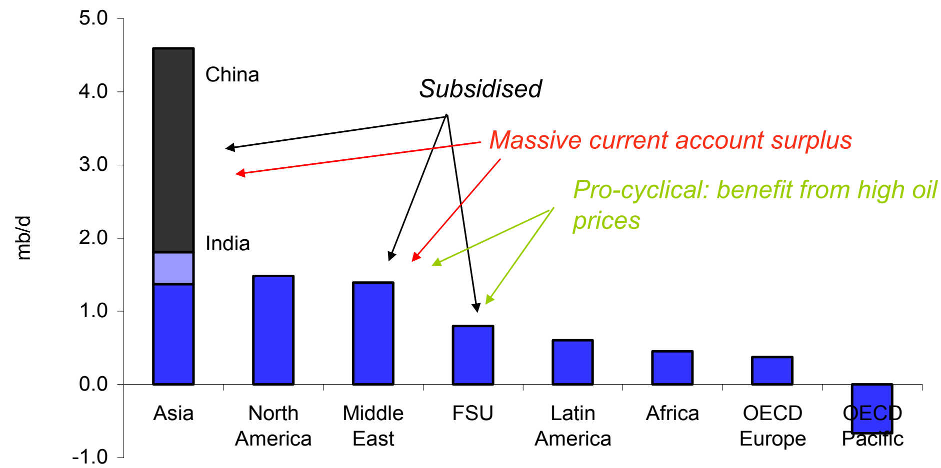
As outlined, oil supply has clearly proven to be inelastic to price – this is a vital point, because it sets the entire oil price dynamic. If supply does not react positively to high prices (we even argue that it reacts negatively, by encouraging even greater government intervention, ownership, and policy shifts, squeezing out private investment), then we know that **price must act on demand to balance the market**.

The dynamics are as follows: Short run **supply** elasticity is almost entirely set by the Saudis and selected Gulf Cooperation Council / core OPEC members that retain genuine discretionary spare oil supply capacity. There is very limited supply reaction in non-OPEC beyond US onshore stripper wells, marginal North Sea, Canadian and other mature oil production – but this requires $80/bbl+ prices and is a limited a short run response on marginal, mature production.

Demand is still highly inelastic for a number of important reasons:

- **Asymmetric elasticity**: as outlined in previous notes ("The 100mb/d Peak Oil Market") the previous oil price shocks, notably 1979/80 concentrated oil use into its staple use in transport. All substitutable oil – industry, power generation - was converted to natgas, coal, or other fuels. Therefore price elasticity of demand is now very limited, and essentially set by the transport sector. That is why the shift in transport efficiency and economics is so important. Additionally natgas continues to trade at a massive discount to oil, further under-mining non-transport oil demand price elasticity. There is some short run demand elasticity, but this is limited, as transport is a staple use and the car fleet is slow to turn over.
- **Reverse elasticity**: key oil market demand growth drivers, China, and the Middle East, have distorted or subsidised prices. China has an artificially weak currency (on PPP measures; imported oil therefore artificially expensive) but controlled prices that are only recently being market adjusted, and then with lags and distortions. In the Middle East, as illustrated in Figure 58, price is outright heavily subsidised, in some cases, to the point of major gasoline imports and government financial challenges (ie Iran).

Figure 58: Oil demand growth 2001-2008; heavily distorted by lack of price signals



Source: Deutsche Bank

On balance that allows Saudi in concert with GCC friends to set the oil price as long as demand does not fall below their threshold of market share tolerance, such as it did in 1986. In this latest price cycle, assuming things are getting better from here, we never reached that threshold. Practical Saudi spare capacity in this cycle reached around 50% - i.e., on 12 mb/d of capacity they were producing just 8mb/d. They lost tolerance in 1986 at below 3mb/d on 10mb/d of capacity. The Saudi stated target price for oil is $75/bbl, and they have done an excellent and impressive job of managing the market to that level. We do not believe that Saudi wants much higher prices, because they are at risk of damaging the global economy, further encouraging alternative fuel use, and making Canadian oil sands and other high cost major oil supply economic whilst they still hold a vast over-hang of their own spare capacity. Equally, at prices much lower than $75, they risk causing oil under-investment to be further exacerbated, adding to volatility and so undermining demand. **We think $75 is exactly the right number for Saudi too. But we believe that disruptive technology is in the process of taking away their market power, which is dependent on sustained demand for oil.**

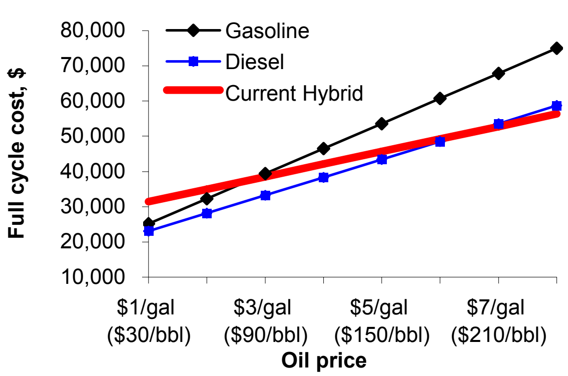
The hybrid disruptive technology & its impact demand elasticity

As outlined above, hybrid and electric cars will address the issue of low price elasticity of oil demand by providing a far more efficient means of mass transport.

Figure 59 shows the full lifecycle cost of a current hybrid vs a current gasoline or diesel vehicle. As illustrated, at this time, with pump prices around $2.50/gallon, both gasoline and diesel cars are more economically attractive to the purely-price sensitive consumer. Only at around $2.75/gallon does the hybrid begin to make sense vs a gasoline car, and then it is a neutral choice (same price) with a higher up-front cost. In short, current gasoline prices are not high enough in the US to justify a hybrid car, and it would only be outright attractive in terms of economics towards $3.50/gallon. Of course fashion, environmentalism, and political leaning now make hybrids attractive to buyers for non-economic reasons.

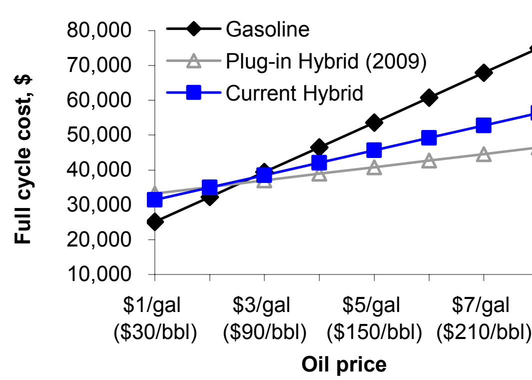
As illustrated in Figure 60, the next generation of plug-in hybrids offer similar low-priced economics to current hybrids with greater efficiency gains as oil prices rise. All data apply to US markets, which are the break point of global oil demand.

Figure 59: Full cycle economics of current car fuel choice



Source: Deutsche Bank
Assumes 15,000 miles per year (over 9.5 years vehicle life) at 20 mpg for gasoline car, 28 mpg for diesel car, and 40 mpg for current hybrid. Vehicle cost: $18,000 gasoline and diesel car vs $25,000 current hybrid. Battery cost: $2,850 current hybrid.

Figure 60: Full cycle economics of current car fuel choice



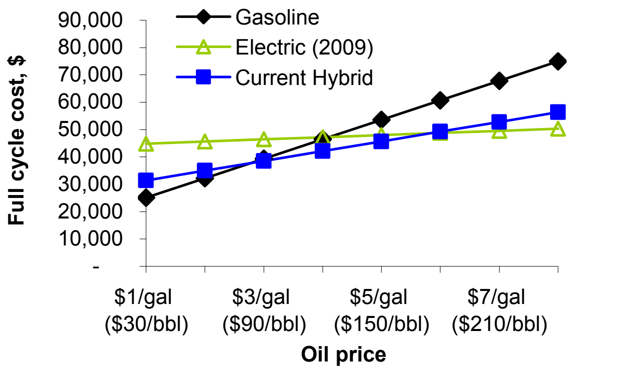
Source: Deutsche Bank
Assumes 15,000 miles per year (over 9.5 years vehicle life) at 20 mpg for gasoline car, 40 mpg for plug-in and current hybrids, and 5 miles per kWh for plug-in. Vehicle cost: $18,000 gasoline car vs $25,000 current hybrid vs $32,000 plug-in hybrid. Battery cost: $2,850 current hybrid vs $8,000 plug-in.

As illustrated in Figure 61, the price signal is not there for a transfer to an electric car, at current cost. We need oil at $4/gallon at the pump, or around $125/bbl WTI, in order to encourage that shift, though over time and increased scale, that threshold will fall.

The calculation shifts depending on vehicle use. Obviously a high intensity car user, for example a taxi, driven 75,000 miles per year rather than the 15,000 we assume for the average car, has a different economic break point regarding gasoline costs.

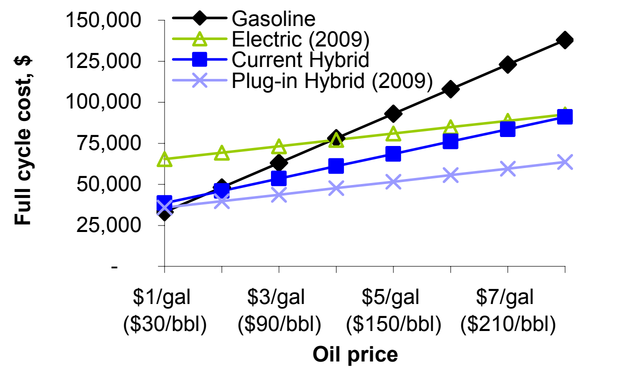
As illustrated in Figure 62, intensive car users are currently incentivised to switch to a hybrid, as the economics are advantageous as low as $1/gallon at the pump. At $3/gallon, the taxi driver is saving over $100,000 over the decade-long lifetime of the vehicle, by choosing a current technology hybrid rather than a conventional gasoline car.

Figure 61: Full cycle economics electric at 15,000 mpy



Source: Deutsche Bank
Assumes 15,000 miles per year (over 9.5 years vehicle life) at 20 mpg for gasoline car, 40 mpg for current hybrid, and 5 miles per kWh for electric cars. Vehicle cost: $18,000 gasoline car vs $25,000 current hybrid vs $40,000 electric cars. Battery cost: $2,850 current hybrid vs $11,000 electric car.

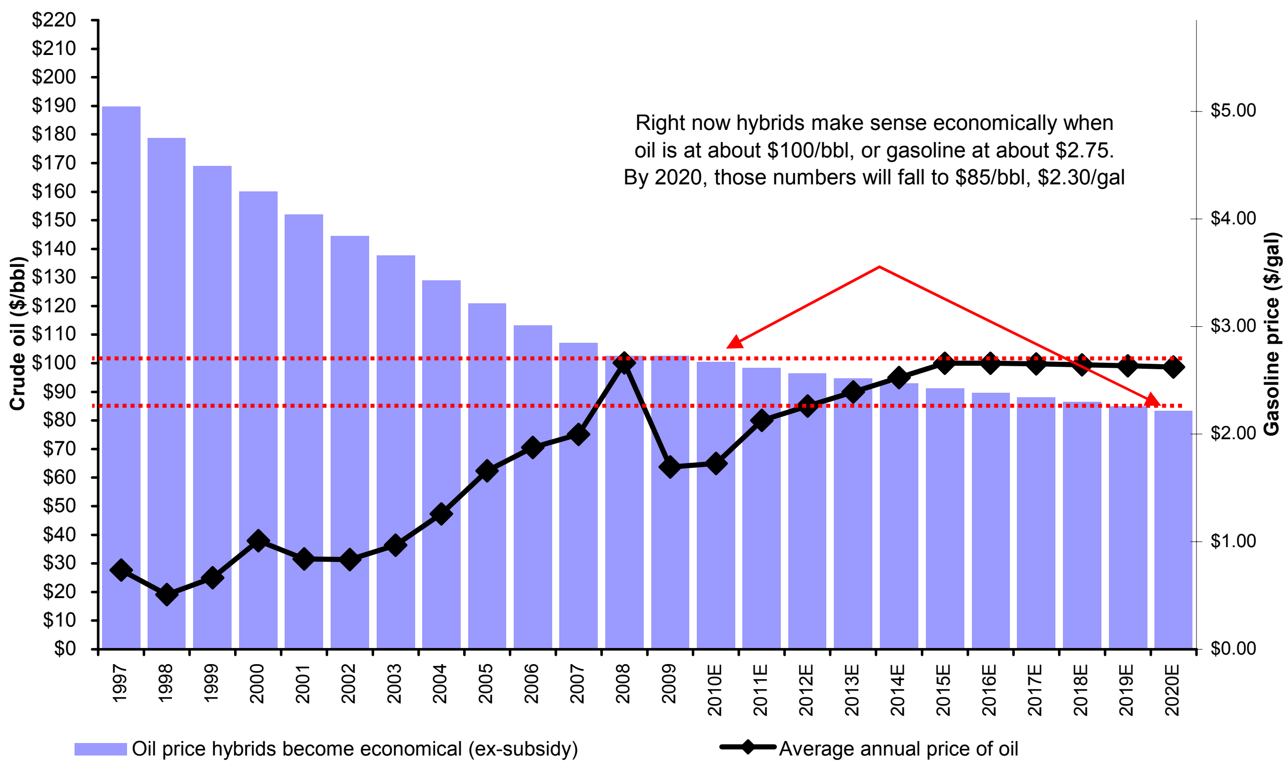
Figure 62: Full cycle economics electric at 75,000 mpy



Source: Deutsche Bank
Assumes 75,000 miles per year (over 4 years vehicle life) at 20 mpg for gasoline car, 40 mpg for current and plug-in hybrids, and 5 miles per kWh for electric cars and plug-in hybrid. Vehicle cost: $18,000 gasoline car vs $25,000 current hybrid vs $32,000 plug-in hybrid vs $40,000 electric cars. Battery cost: $2,850 current hybrid vs $8,000 plug-in vs $11,000 electric car.

Of course over time the cost of hybrids, plug in hybrids and electric cars will fall, lowering the marginal price at which consumers decide to switch away from oil.

Figure 63: Break points for US consumers to switch to hybrid cars

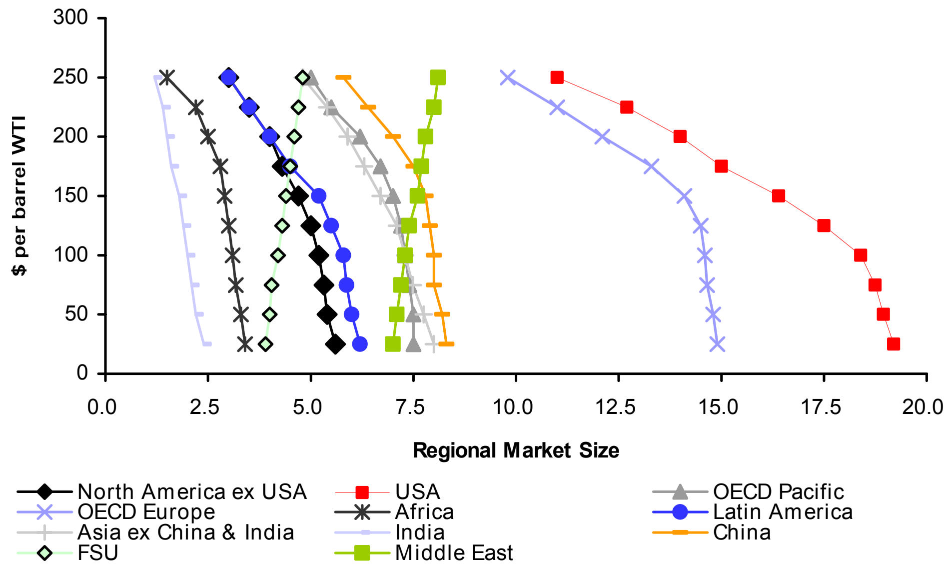


Source: Deutsche Bank

Price elasticity of future oil demand

We believe that over time oil demand will become structurally lower, increasingly responsive to high prices, and greatly less responsive to low price. In fact, we believe that over time, oil demand will be un-altered by price changes in a low price range ($20-$75/bbl) whereby prices at the lower end of the range will not encourage any greater oil use – we see this as applying the counter effect of disruptive technologies on market demand.

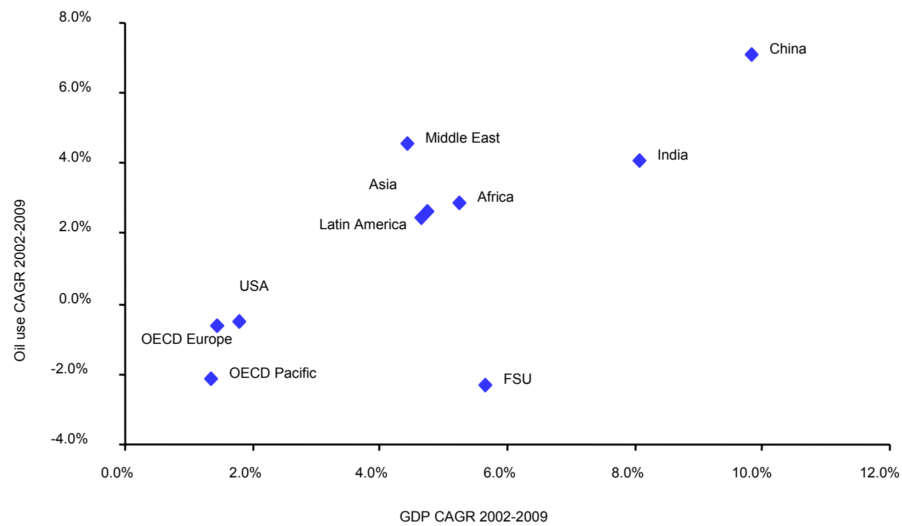
Figure 64: Elasticity of 2009E crude demand (mmb/d) at price intervals (US$)



Source: Deutsche Bank

The current estimated elasticities of demand for global regions are shown above. Clearly, this is a best estimate that does pertain to actual price elasticities observed in the US and OECD markets over the past three years, as well as certain inferred elasticities, notably in the Middle East and FSU, where we take the view that higher oil prices = higher GDP price = higher local subsidised oil demand. Mexico also serves to distort North America ex USA.

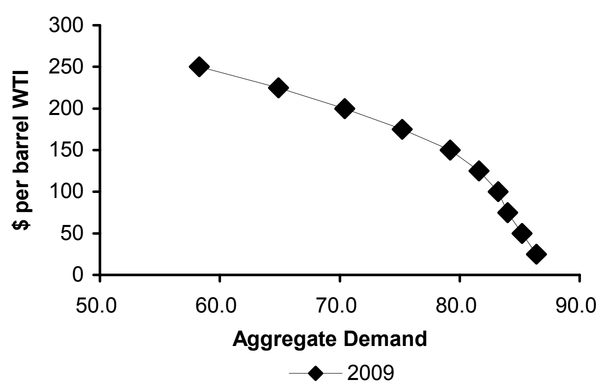
Figure 65: GDP intensity of global oil demand growth



Source: IEA, IMR, Deutsche Bank

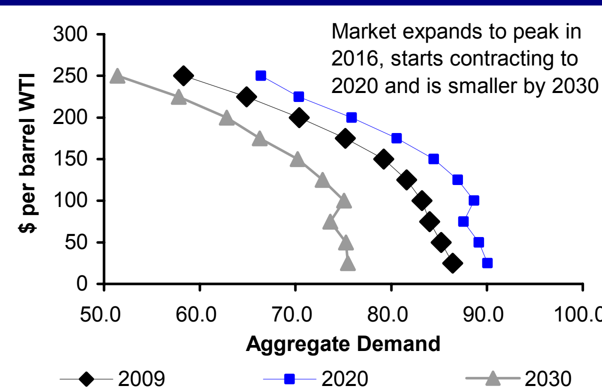
If we aggregate on a weighted average basis the demand curve, we get the elasticity presented in Figure 66. Generating a series of regional elasticities over time, and aggregating them produces the series of elasticities in Figure 67.

Figure 66: Global average 2009 estimated oil demand price elasticity (aggregate of Figure 64)



Source: Deutsche Bank

Figure 67: Shifts in price elasticity over time, from 2009, to 2020, to 2030



Source: Deutsche Bank

By designating a line of price-elasticity, we are in position to infer the required reserves to meet future oil market demand at a given price. That leads us to an overall supply and demand equilibrium price.

In the future, lower oil prices will not encourage demand

A key conclusion from our estimated elasticities is that the line of demand growth becomes increasingly steep over time, essentially implying that there is increasingly little price elasticity of demand at low prices. This is a fundamental concept related to "disruptive technology," whereby a move to a superior (more efficient) product is not reversed by the collapse in price of the former product. We believe that hybrid cars will be superior to combustion-only vehicles and consumers will be reluctant to switch back because of price volatility – i.e., they will fear, even if prices are low, that prices will rise again in the future.

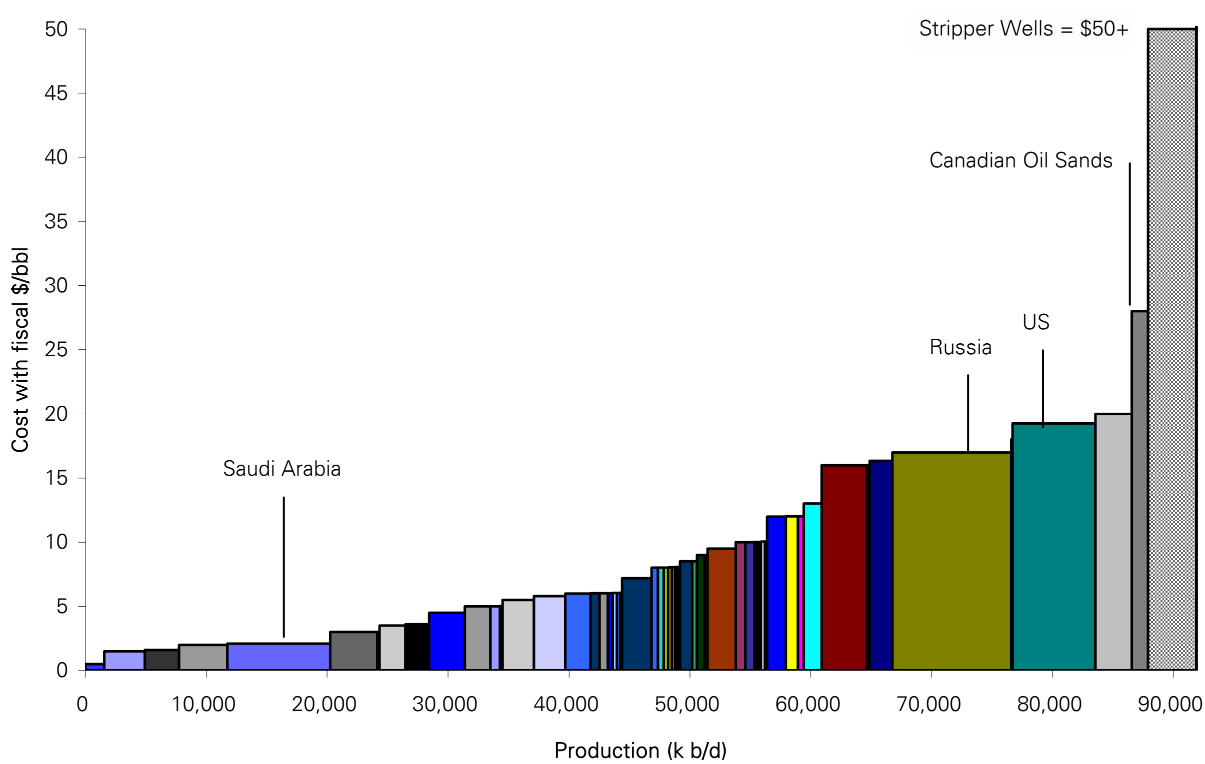
Government policy will tend to enforce this reluctance to move back to oil-intense consumption, especially as a function of dissuading hydrocarbon/CO2 intense behaviour, rather than electricity-generated energy demand which is easier to control in terms of emissions; oil consumer governments will also continue to incentivise less oil demand regardless of price in order to avoid the negative geopolitical issues that excessive oil dependence brings.

The point here is that when the oil market breaks, the downward pressure on prices from a realisation that the market is contracting regardless of price, and abundant undeveloped oil preserves in major oil dependent producer economies, will exert further downward pressure on oil prices as the market contracts.

Bottom end of the price range is set by the cash cost of supply

Although we expect upside skew in volatility over the coming six years as the market peaks, there will also be drops to the bottom end of the price range as demand falls away just as supply rises, such as we saw in early 2009, when WTI hit a low of $33/bbl. The bottom of that range will be set by the cash cost of marginal oil supply, which is essentially cash operating cost. Interestingly there was little or no evidence of production shutdowns at $33/bbl – partly because the US$ simultaneously strengthened, improving marginal economics of Canadian heavy oil producers (US$ revenues, CAD$ costs) and partly because oil was only very briefly at those levels. We believe that oil would need to be below operating costs for at least a month before operators took the decision to shut.

Figure 68: Cash cost of oil production is very low – around $30/bbl for Canadian oil sands



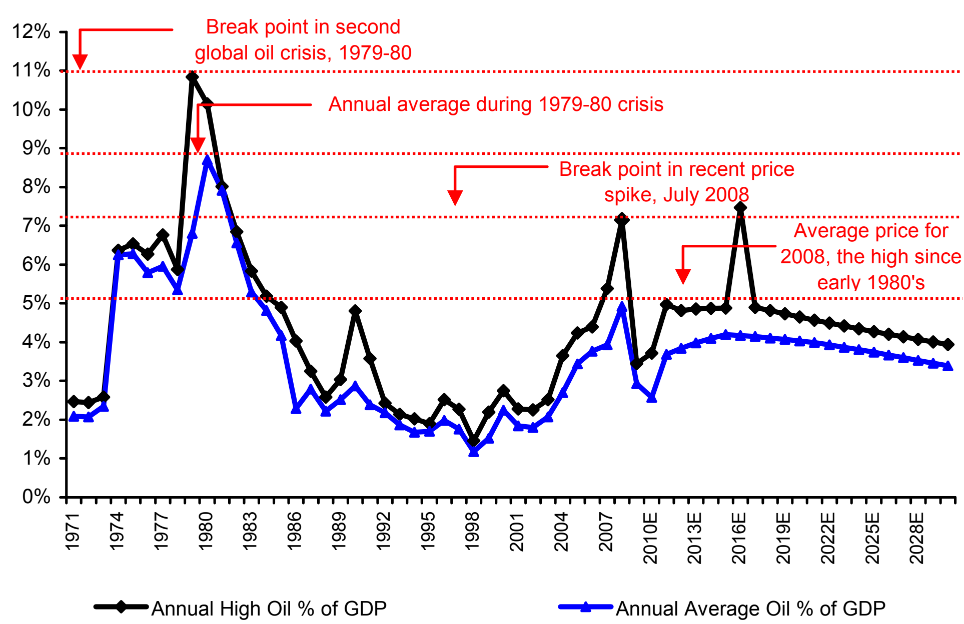
Source: Deutsche Bank

Upper end of price range set by the price of demand destruction

As we've discussed in previous notes ("The 100mb/d Peak Oil Market", February 2008), each country seems to have a threshold percentage of national income at which crude pricing meets stern resistance and demand is broken. As outlined, we consider the marginal price-sensitive major market to be the United States.

For the United States that threshold was hit at about 11% for a short-term peak, and 9% for a more sustained period (annual average). The price peak in the 1979-80 surge pushed oil spend to just under 11% of GDP on an annualized basis. For the full year 1980, average prices pushed oil to almost 9% of GDP. That level has not been tested since, though the recent peak of $147 in summer 2008 rose to 7.2%.

Figure 69: Oil as % of US GDP, implied by annual highs and full-year averages

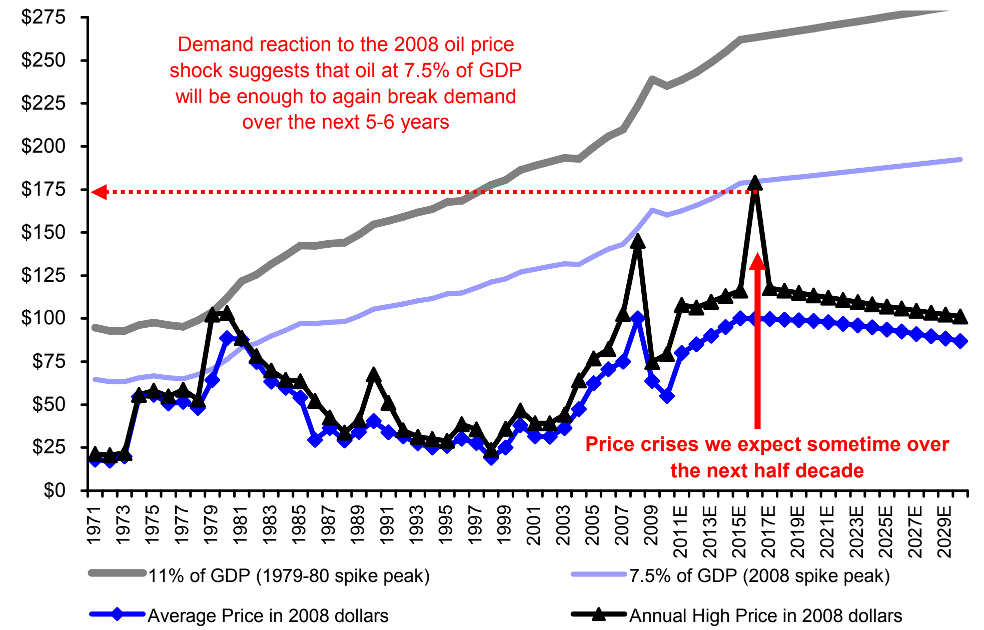


Source: EIA, IMF, US Bureau of Economic Analysis, IEA, JD Power & Associates, DB Auto team, Deutsche Bank estimates

For the reasons outlined at the start of this section, we believe that the US will once again be the key marginal breakpoint of demand. Given the US consumers' reaction to the 2008 price shock, we don't think it will take a surge to 11% or even 9% of GDP to again break demand. The oil crises of the 1970's compelled massive permanent substitution away from oil in the power and industrial sectors, thus involving a much wider swath of the economy. The 2008 spike, and future crises, will be about transportation, and natgas. The natgas shift is already there, but marginal.

Thus in all likelihood a surge in price towards the 7.5% oil/GDP threshold that was tested in 2008 will be enough to provoke a decisive demand reaction from American drivers. Our GDP growth forecast (1.5% per annum), coupled with a 7.5% threshold, suggests the critical price of oil will be somewhere around $175/bbl within the next six years.

Figure 70: Maximum price threshold derived from oil % of US GDP



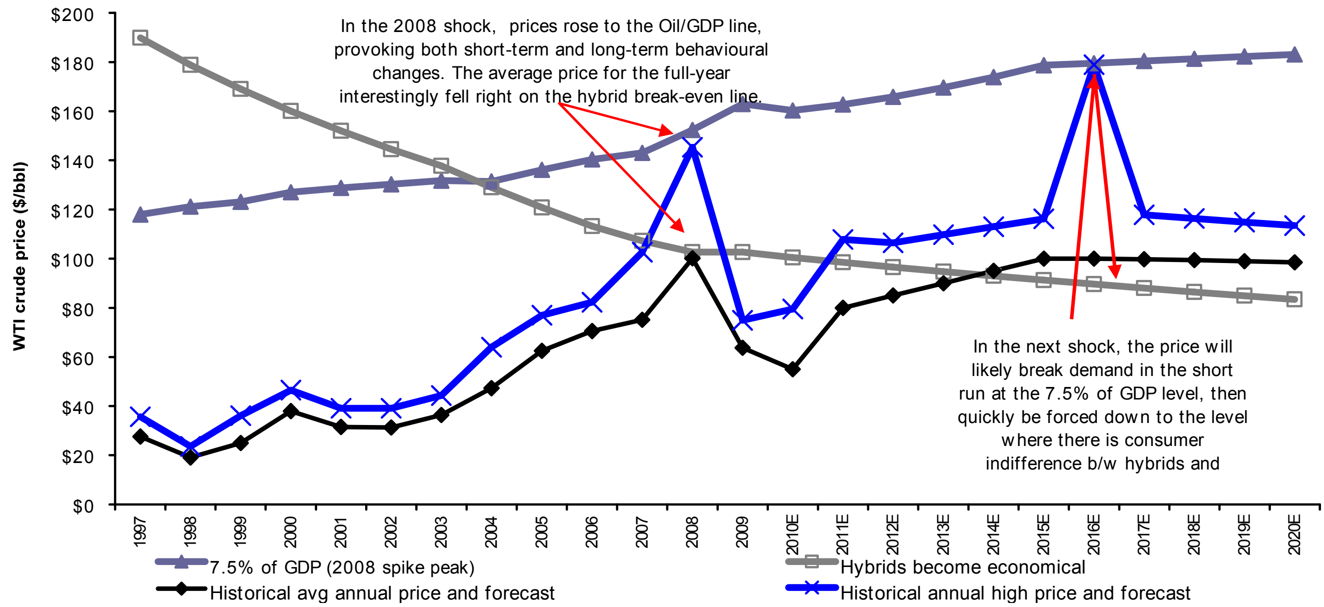
Source: IEA, US Bureau of Economic Analysis, EIA, Bloomberg, Deutsche Bank estimates

Another key factor will lower the breakpoint further. Electric hybrids become economically advantaged when gasoline prices at the pump rise above about $2.76 per gallon. With a falling hybrid price gap relative to combustion vehicles and improving fuel efficiency, that threshold is falling by a few cents each year (we calculate it will be $2.44 in 2016). Those gasoline prices translate to oil prices in the $95/bbl to $100/bbl range. Once that oil price level is crossed, we expect rapidly accelerating adoption of hybrids (and soon, even more efficient plug-in electrics), which will further undercut demand.

So to summarize, the 7.5% threshold of oil as a portion of national income likely represents the tolerance limit for the American consumer, and we expect demand to break decisively when the price of crude next tests that threshold, likely within the next half dozen years. We need higher prices to cause the shift.

Perhaps even more likely, any future crude price crisis is likely to rise above the level that makes hybrids (and plug-ins) a rational economic choice versus the traditional combustion engine. Short-run consumer behaviour, such as the choice to drive to work or take the subway, will dramatically change when the GDP threshold is tested. Car purchase behaviour will likely be altered if the price of oil rises above the hybrid break-even level for a meaningful period of time, perhaps measured in months. Figure 71 below shows how the annual average and high oil price trends match-up with the two thresholds historically, and going forward.

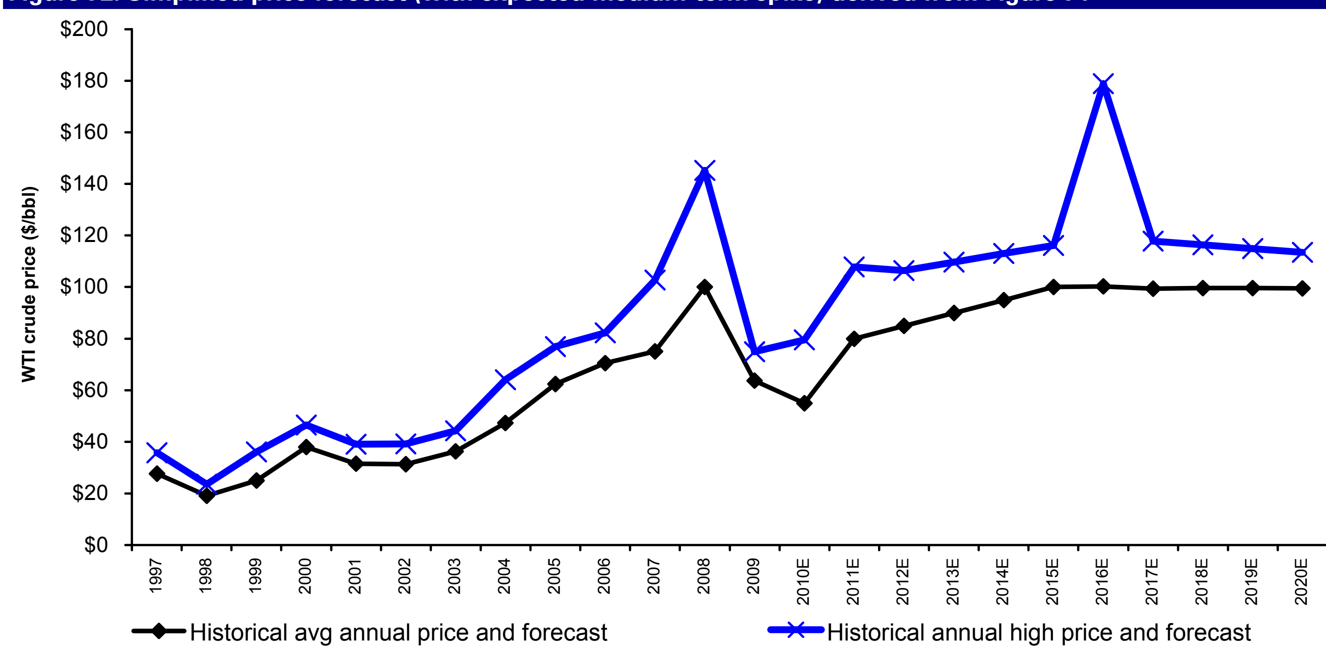
Figure 71: The upper end limit to oil prices story in a nutshell



Source: IEA, US Bureau of Economic Analysis, JD Power & Associates, IMF, Deutsche Bank Auto Team, Deutsche Bank estimates

In Figure 73, which simply shows our crude oil annual average and high price forecast, with the demand-destroying price spike we expect in the next half-dozen years modelled for 2016.

Figure 72: Simplified price forecast (with expected medium-term spike) derived from Figure 71



Source: EIA, IMF, US Bureau of Economic Analysis, IEA, JD Power & Associates, DB Auto team, Deutsche Bank estimates

As the chart illustrates, over the medium-term, we anticipate high price volatility similar to what we experienced in 2007 and 2008, though in the very near term we foresee a period of relatively low volatility, as both the marginal supplier (Saudi Arabia) and consumer (China, as it builds its strategic reserve) seek $70 oil. The table below lays out the crude forecast numbers, and adds the Deutsche Bank natural gas outlook. Note that all estimates are in real terms.

Figure 73: Crude oil and natural gas annual price forecasts, with intra-year high price for crude

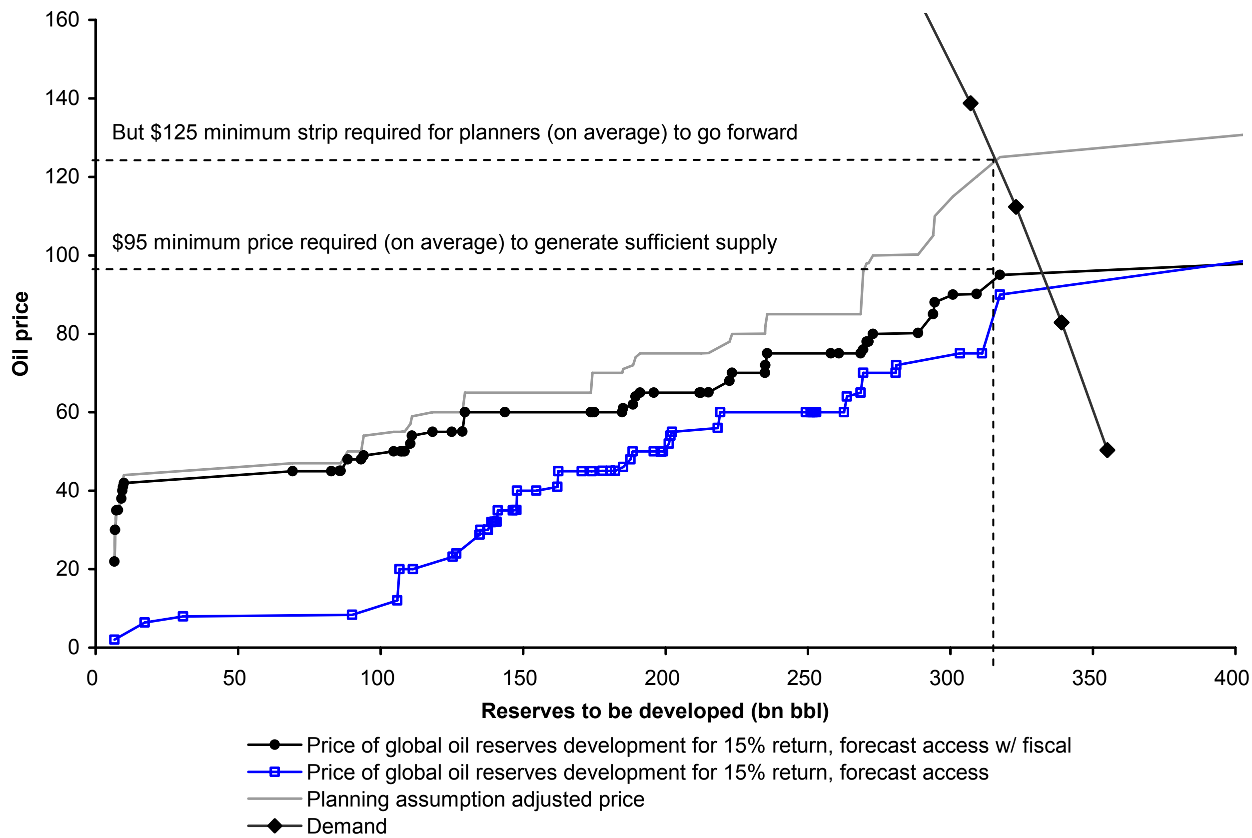
	2006	2007	2008	2009	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E	2019E	2020E
Average annual oil price/bbl	$70.54	$75.09	$100.07	**$63.73**	$65.00	$80.00	$85.00	$90.00	$95.00	$100.00	$100.28	$99.44	$99.59	$99.57	$99.47
Intra-year high oil price/bbl	$82.27	$102.68	$145.29	**$74.37**	$79.52	$107.85	$106.39	$109.75	$113.02	$116.20	**$178.95**	$117.80	$116.33	$114.89	$113.50
Natural gas price/mmbtu	$7.45	$7.39	$8.90	**$4.12**	$5.96	$7.84	$8.22	$8.59	$8.95	$9.30	$9.64	$9.97	$10.29	$10.61	$10.91

Note: All prices are real using 2009-chained dollars. As we've highlighted in this note, we believe we'll get one more demand-destroying crude price crisis within the next half dozen years, which we've modelled here in 2016.
Source: IEA, EIA, Bloomberg, Deutsche Bank estimates

Bringing supply and demand together to equilibrium price

If we finally combine the break point in demand with the curves of available, expected available, and price-planning-required supply against our view of price elasticity, we have a conclusion, being a supply versus demand price curve for oil 2009-2030. The answer is $125 average oil price strips through 2016, with extreme upside price volatility, followed by post 2016 pressure to the downside on prices towards the $40/bbl long run marginal cost of supply.

Figure 74: Supply and Demand equilibrium price for 2009-2030 global oil markets



Source: Deutsche Bank

Wider Impacts

Inflation and the weaker dollar

We are not convinced over time that the shift in the global energy market away from oil is negative for the dollar, given the abundance of natural gas to fire electricity power generation. Equally the position of China as the marginal driver of oil demand exerting active government control may well mitigate any major future dollar weakness.

Non-oil commodity pressure from electric cars

The shift in transport will be from a low capex / high opex model conventional car, towards a high capex / low opex hybrid, and eventually the electric car.

There is a positive implied requirement for upfront capital, shifting financing power away from the oil industry towards the auto industry.

The shift that will take pressure off oil, and will put pressure on raw material inputs, particularly those used in the production of high-cost batteries and other specialty electronics used in the new breeds of vehicles. Soaring global demand for batteries used in mobile phones, digital cameras and laptop computers has already strained the availability of inputs such as lithium. Also becoming increasingly in short supply are rare earth metals such as neodymium, lanthanum, terbium and dysprosium which are used in the magnets for the lightweight hybrid motors. While the jury is still out on the dominate battery technology (e.g., lithium-ion vs other nickel and/or cobalt-based batteries), we defer to our auto team, and the auto industry's view of the potential of their hybrid plans to source the required raw materials. At this stage, our auto team is optimistic that lithium, rare metals and other required resources will be sufficient to meet the massive implied demand in this shift.

Why no natgas vehicles? A dinosaur invents a meteorite?

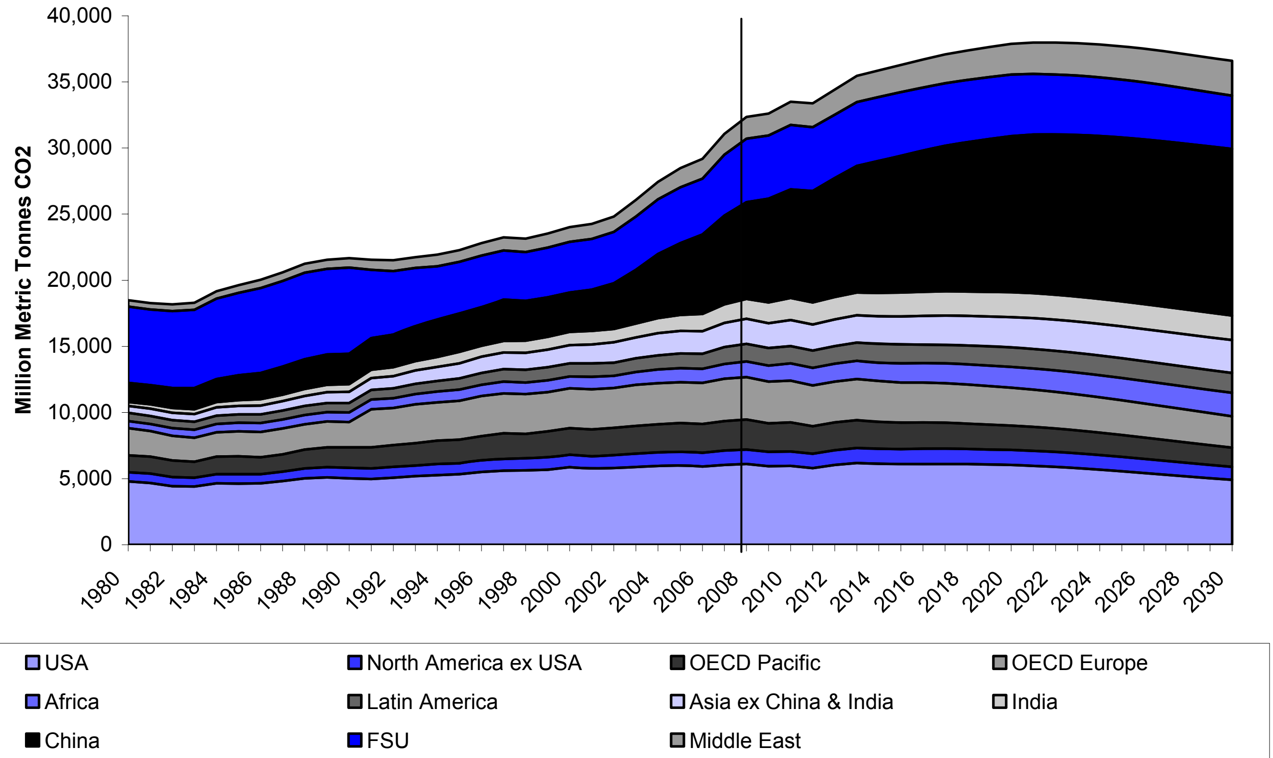
Quite simply, our auto team, reflecting auto industry trends, see little significant penetration of natgas vehicles over the forecast period. The infrastructure required is excessively costly and time consuming to construct, the cost of that construction falls to energy supply companies who cannot develop the cars to use it, and the benefits in terms of efficiency are too little to attract consumers. Natgas vehicles are a red herring, in our opinion.

CO2

We believe that CO2 limitations will be too economically challenging to fully progress globally. As major non-US oil consumers and producers such as the Middle East and Russia essentially resist CO2 control, US consumer appetitive to support a somewhat vaguely-evidenced, or at least controversial in the minds of voters, phenomenon that undermines relative competitiveness at a direct cost to consumers will be hard.

However much legislation struggles, it is important to recognise that the EU is regulating aggressively, and the likelihood is that in the absence of US legislation, then the Supreme Court-backed EPA will regulate too. The big loser is clearly, at this stage, the refining industry, further adding to pump prices of gasoline, and further accelerating the shift away from gasoline. Indeed, the general move towards limiting CO2 emissions is highly supportive of a shift away from oil and towards electricity. More efficiency is also highly beneficial in this regard.

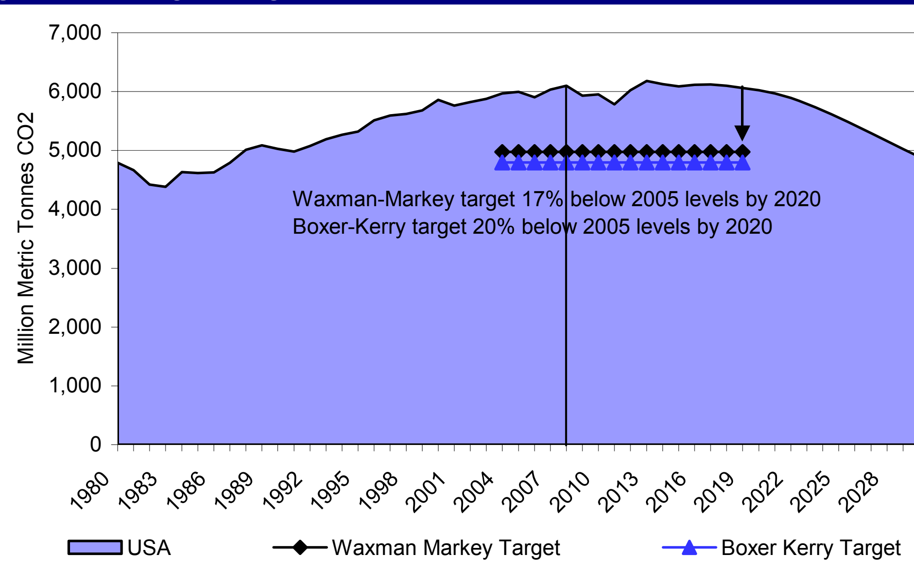
Figure 75: Global CO2 emissions history and model-implied forecast



Source: EIA Deutsche Bank

Even with our negative long term view of demand, CO2 emissions targets under current, unclear, US legislation cannot be met.

Figure 76: Missing the target on our numbers – Waxman Markey aims vs forecast CO2



Source: Deutsche Bank

Valuation and Risks

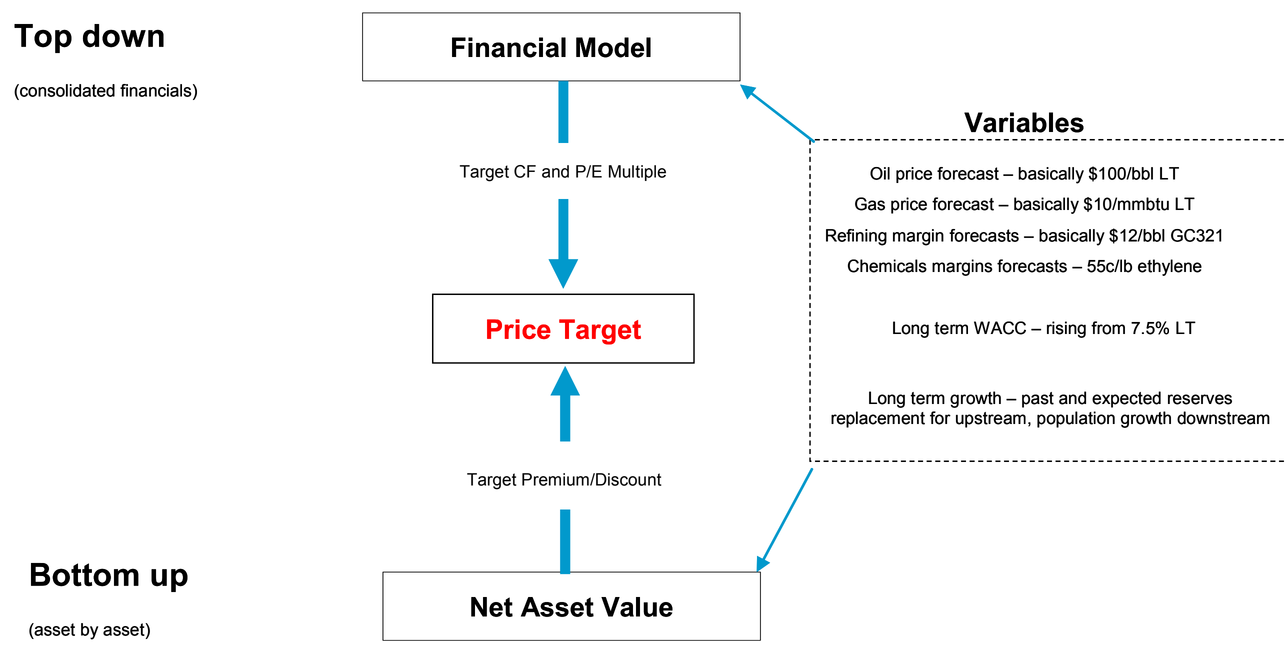
Valuation and Risks: Integrated Oils

We have taken a two pronged approach to valuation of the integrated oil sector.

- Top down: taking financial performance from quarterly results and SEC filings, we can calculate the classic ROCE / WACC model (ROIC/WACC = EV/IC; etc.). This states that returns above the cost of capital will enhance equity value.
- Bottom up: we can cross check our valuation on an asset-by-asset basis. The value of an asset is the **present value of the future free cashflow, net of debt**, or net asset value (NAV). The sum of all the assets is the equity value.

The two approaches above both should theoretically generate the same result.

Figure 77: Arriving at a price target



Source: Deutsche Bank

In the process of developing a top down/bottom up valuation matrix, several other important valuation comparisons emerge, from both financial model and net asset value. These are outlined in this report, including reserves, reserves replacement, growth, management value, cost containment, free cashflow generation and cash return to shareholders.

In terms of risks, the oils can have massive costly accidents that are impossible to predict, but hugely damaging to shareholder value. Think not only of Exxon Valdez, but also BP at Texas City. It is a fact of the scale and intensity of the business that accidents will likely occur again. Chevron is currently facing a massive lawsuit in Ecuador, which may lead to a $27bn negative judgement, which the company intends to fight.

The potential for government policy change in Washington DC is a major risk for the "big 5" oils, ExxonMobil, Shell, BP, CVX and COP. However, regulatory or fiscal change could affect almost any oil mentioned in this report, to the significant detriment of value. They all have exposure in risky regimes that see Big Oil as much as an enemy as a friend.

The biggest overall risk is oil and gas demand. We really have no idea how 30 years of credit driven consumption growth in the US, and the development of export oriented growth economies around the world to serve that demand will translate if the US consumer is forced to de-lever, and that is clearly what is happening. US consumption is 72% of US GDP and 18% of world GDP – be warned that consumption in the US has arguably been excessive – the wrong-headed view of that consumption was that it would continue for ever; the right-headed view is that American consumers are going to change their behaviour.

Our valuations are forward looking, but management can make acquisitions or disposals that totally change the shape of their companies and alter the investment case. Other risks include the oil price, refining margins, and management turnover.

Valuation and Risks: Refiners

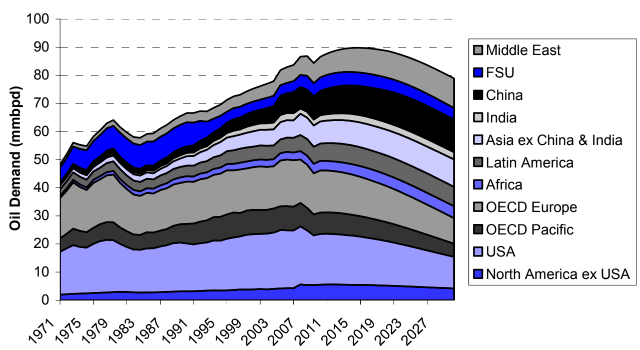
We value refiners through a combination of our bottom-up net asset value (NAV) and a top-down forward earnings and multiples basis. Our NAV serves to produce more of a mid-cycle valuation, using our mid-cycle crack spread to produce a cash margin for each refinery (or group of refineries) and, in turn, a valuation for the company. However, we acknowledge that forward earnings and multiples are more helpful in looking at short-term moves in the stocks and employ this top-down approach to derive our price targets.

In terms of risks, the forces of demand and supply constitute both upside and downside risks to our theses. Better-than-expected economic growth, recovering demand, and lower supply through poor refinery utilization could drive sustained and considerably higher crack spreads, earnings and hence equity value. Within the group, Valero is the bellwether in the case of stronger-than-expected demand for oil.

On the contrary, lower demand in the form of recession, natural disaster or geopolitical risks would have the opposite effects. We note that all the refiners are exposed to volatile crude input prices and volatile refined product prices. Lower supply resulting from accidents or explosion would also destroy earnings now and into the future, especially for the small-cap refiners with few assets. Other risks include refinery sales and business spin-off.

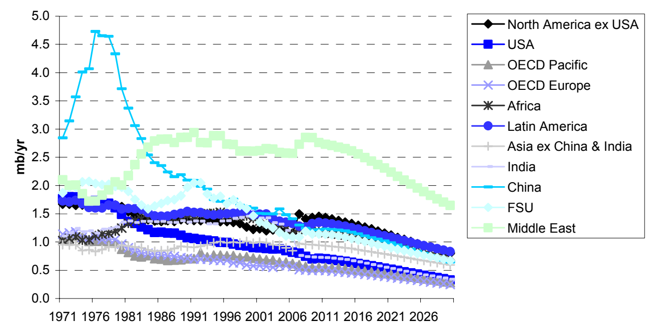
Appendix

Figure 78: Oil demand



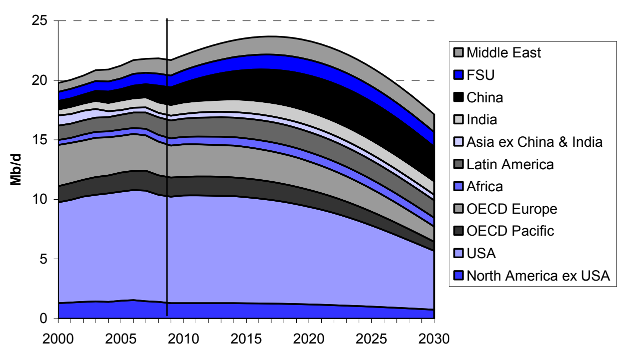
Source: IEA, EIA, Deutsche Bank estimates

Figure 79: Oil demand per $1,000 GDP



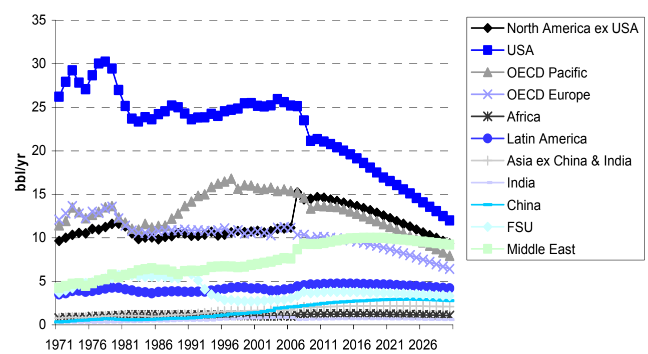
Source: IEA, EIA, Deutsche Bank estimates

Figure 80: Gasoline demand



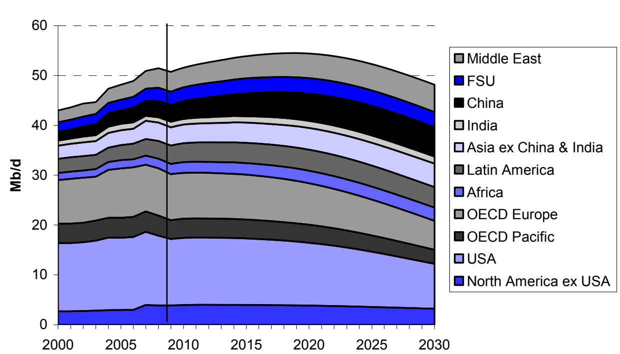
Source: IEA, EIA, Deutsche Bank estimates

Figure 81: Oil demand per capita



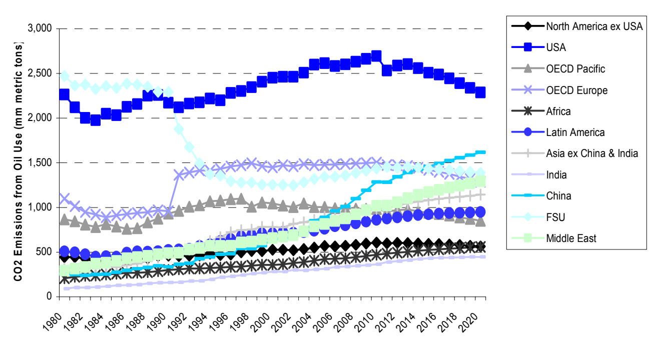
Source: IEA, EIA, Deutsche Bank estimates

Figure 82: Transport oil demand



Source: IEA, EIA, Deutsche Bank estimates

Figure 83: CO2 emissions from oil use



Source: IEA, EIA, Deutsche Bank estimates

Figure 84: DB gasoline demand model – New light vehicle sales and sales mix

	2010	2015	2020	2025	2030
UNITED STATES					
Combustion Cars	5,777	7,498	5,992	4,145	2,112
Combustion Personal Light Trucks	4,508	6,043	5,657	4,127	2,102
Combustion Commercial Light Trucks	873	1,263	1,369	1,151	714
Hybrids	460	1,273	2,406	4,354	7,267
Plug-in Hybrids	13	287	1,438	3,092	4,844
Pure Electrics	13	127	753	1,706	2,771
Total Sales	**11,644**	**16,492**	**17,614**	**18,575**	**19,809**
Light Vehicle Sales Mix %					
Combustion Cars	49.6%	45.5%	34.0%	22.3%	10.7%
Combustion Personal Light Trucks	38.7%	36.6%	32.1%	22.2%	10.6%
Combustion Commercial Light Trucks	7.5%	7.7%	7.8%	6.2%	3.6%
Hybrids	4.0%	7.7%	13.7%	23.4%	36.7%
Plug-in Hybrids	0.1%	1.7%	8.2%	16.6%	24.5%
Pure Electrics	0.1%	0.8%	4.3%	9.2%	14.0%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
OECD EUROPE					
Combustion Cars	11,210	14,322	11,316	7,744	3,900
Combustion Commercial Light Trucks	1,254	2,014	2,345	2,369	2,066
Hybrids	115	566	1,497	2,454	3,377
Plug-in Hybrids	12	446	2,970	6,016	9,254
Pure Electrics	12	86	742	1,974	3,854
Total Sales	**12,602**	**17,434**	**18,871**	**20,556**	**22,451**
Light Vehicle Sales Mix %					
Combustion Cars	89.0%	82.2%	60.0%	37.7%	17.4%
Combustion Commercial Light Trucks	10.0%	11.6%	12.4%	11.5%	9.2%
Hybrids	0.9%	3.2%	7.9%	11.9%	15.0%
Plug-in Hybrids	0.1%	2.6%	15.7%	29.3%	41.2%
Pure Electrics	0.1%	0.5%	3.9%	9.6%	17.2%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
JAPAN					
Combustion Cars	3,620	3,720	2,952	1,841	816
Combustion Commercial Light Trucks	715	824	807	729	659
Hybrids	167	480	883	1,296	1,702
Plug-in Hybrids	5	10	228	681	1,105
Pure Electrics	5	10	228	681	1,105
Total Sales	**4,512**	**5,044**	**5,099**	**5,228**	**5,386**
Light Vehicle Sales Mix %					
Combustion Cars	80.2%	73.7%	57.9%	35.2%	15.1%
Combustion Commercial Light Trucks	15.8%	16.3%	15.8%	14.0%	12.2%
Hybrids	3.7%	9.5%	17.3%	24.8%	31.6%
Plug-in Hybrids	0.1%	0.2%	4.5%	13.0%	20.5%
Pure Electrics	0.1%	0.2%	4.5%	13.0%	20.5%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
CHINA					
Combustion Cars	7,310	10,606	11,479	9,701	5,781
Combustion Commercial Light Trucks	2,950	4,152	4,560	3,994	2,380
Hybrids	40	647	2,662	7,186	14,197
Plug-in Hybrids	0	231	1,164	3,142	6,099
Pure Electrics	0	347	1,746	4,713	9,149
Total Sales	**10,300**	**15,983**	**21,612**	**28,736**	**37,606**
Light Vehicle Sales Mix %					
Combustion Cars	71.0%	66.4%	53.1%	33.8%	15.4%
Combustion Commercial Light Trucks	28.6%	26.0%	21.1%	13.9%	6.3%
Hybrids	0.4%	4.0%	12.3%	25.0%	37.8%
Plug-in Hybrids	0.0%	1.4%	5.4%	10.9%	16.2%
Pure Electrics	0.0%	2.2%	8.1%	16.4%	24.3%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
REST OF WORLD					
Combustion Cars	18,511	25,420	27,408	26,591	20,564
Combustion Commercial Light Trucks	2,953	4,281	5,098	5,020	3,882
Hybrids	209	630	1,620	6,288	16,142
Plug-in Hybrids	3	94	692	1,838	3,730
Pure Electrics	3	56	410	1,090	2,210
Total Sales	**21,678**	**30,481**	**35,228**	**40,827**	**46,528**
Light Vehicle Sales Mix %					
Combustion Cars	85.4%	83.4%	77.8%	65.1%	44.2%
Combustion Commercial Light Trucks	13.6%	14.0%	14.5%	12.3%	8.3%
Hybrids	1.0%	2.1%	4.6%	15.4%	34.7%
Plug-in Hybrids	0.0%	0.3%	2.0%	4.5%	8.0%
Pure Electrics	0.0%	0.2%	1.2%	2.7%	4.8%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
GLOBAL					
Combustion Cars	46,428	61,566	59,148	50,023	33,173
US Combustion Personal Light Trucks	4,508	6,043	5,657	4,127	2,102
Combustion Commercial Light Trucks	8,745	12,534	14,179	13,263	9,701
Hybrids	991	3,597	9,068	21,578	42,685
Plug-in Hybrids	31	1,067	6,492	14,769	25,031
Pure Electrics	31	626	3,880	10,163	19,089
Total Sales	**60,736**	**85,434**	**98,424**	**113,922**	**131,781**
Light Vehicle Sales Mix %					
Combustion Cars	76.4%	72.1%	60.1%	43.9%	25.2%
US Combustion Personal Light Trucks	7.4%	7.1%	5.7%	3.6%	1.6%
Combustion Commercial Light Trucks	14.4%	14.7%	14.4%	11.6%	7.4%
Hybrids	1.6%	4.2%	9.2%	18.9%	32.4%
Plug-in Hybrids	0.1%	1.2%	6.6%	13.0%	19.0%
Pure Electrics	0.1%	0.7%	3.9%	8.9%	14.5%
Total Sales	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: JD Power & Associates, US DOT, Bureau of Transportation Statistics, Deutsche Bank auto team, The Economist, GreenCar.com, Deutsche Bank estimates

Figure 85: DB gasoline demand model – light vehicle park mix by region & segment

	2010	2015	2020	2025	2030
UNITED STATES					
Combustion Cars	55.6%	53.2%	48.6%	41.0%	30.6%
Combustion Personal Light Trucks	39.7%	39.0%	37.2%	33.0%	25.3%
Combustion Commercial Light Trucks	3.8%	4.8%	5.5%	5.7%	4.9%
Hybrids	0.9%	2.6%	5.7%	11.3%	20.3%
Plug-in Hybrids	0.0%	0.3%	2.0%	5.9%	12.1%
Pure Electrics	0.0%	0.1%	1.0%	3.1%	6.7%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.9%	3.0%	8.7%	20.3%	39.2%
OECD EUROPE					
Combustion Cars	91.6%	89.6%	81.9%	67.1%	45.3%
Combustion Commercial Light Trucks	8.3%	8.9%	9.9%	10.1%	8.8%
Hybrids	0.1%	0.8%	3.0%	6.6%	11.4%
Plug-in Hybrids	0.0%	0.5%	4.2%	12.7%	25.7%
Pure Electrics	0.0%	0.1%	1.1%	3.5%	8.8%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.1%	1.5%	8.2%	22.8%	45.9%
JAPAN					
Combustion Cars	85.7%	82.5%	75.9%	62.9%	44.0%
Combustion Commercial Light Trucks	13.5%	14.2%	14.5%	13.9%	11.9%
Hybrids	0.8%	3.2%	7.9%	15.1%	24.3%
Plug-in Hybrids	0.0%	0.1%	0.8%	4.0%	9.9%
Pure Electrics	0.0%	0.1%	0.8%	4.0%	9.9%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.8%	3.3%	9.5%	23.2%	44.1%
CHINA					
Combustion Cars	74.9%	70.2%	61.1%	45.5%	26.3%
Combustion Commercial Light Trucks	25.0%	26.3%	23.6%	18.1%	10.6%
Hybrids	0.1%	1.9%	7.7%	17.6%	30.4%
Plug-in Hybrids	0.0%	0.7%	3.1%	7.5%	13.1%
Pure Electrics	0.0%	1.0%	4.6%	11.3%	19.6%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.1%	3.5%	15.4%	36.4%	63.1%
REST OF WORLD					
Combustion Cars	89.3%	88.1%	85.7%	80.9%	71.4%
Combustion Commercial Light Trucks	10.6%	11.3%	12.2%	12.4%	11.4%
Hybrids	0.1%	0.6%	1.4%	4.4%	12.1%
Plug-in Hybrids	0.0%	0.1%	0.4%	1.4%	3.2%
Pure Electrics	0.0%	0.0%	0.2%	0.8%	1.9%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.1%	0.6%	2.1%	6.7%	17.2%
GLOBAL					
Combustion Cars & Light Trucks	80.2%	78.5%	73.7%	64.5%	50.2%
US Combustion Personal Light Trucks	10.2%	9.2%	8.1%	6.6%	4.7%
Combustion Commercial Light Trucks	9.2%	10.6%	11.6%	11.5%	9.7%
Hybrids	0.3%	1.4%	3.7%	8.6%	17.3%
Plug-in Hybrids	0.0%	0.3%	1.8%	5.4%	10.7%
Pure Electrics	0.0%	0.2%	1.1%	3.4%	7.5%
Total Light Vehicle Parc	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total High Efficiency Vehicles	0.3%	1.8%	6.6%	17.4%	35.5%

Source: JD Power & Associates, US DOT, Bureau of Transportation Statistics, Deutsche Bank auto team, The Economist, GreenCar.com, Deutsche Bank estimates

Figure 86: DB gasoline demand model – average fuel efficiency for light vehicle parc

Average MPG by region and segment	2010	2015	2020	2025	2030
UNITED STATES					
Combustion Cars	27	29	31	35	40
Combustion Personal Light Trucks	20	21	23	26	31
Combustion Commercial Light Trucks	17	19	22	26	31
Hybrids	45	56	68	75	79
Plug-in Hybrids	121	167	224	279	335
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**23**	**25**	**29**	**35**	**49**
Personal Vehicle MPG					
5 yr CAGR %					
Combustion Cars		1.0%	1.7%	2.2%	2.8%
Combustion Personal Light Trucks		1.1%	2.0%	2.5%	3.0%
Combustion Commercial Light Trucks		2.3%	2.8%	3.2%	3.8%
Hybrids		4.4%	4.1%	1.9%	1.0%
Plug-in Hybrids		6.7%	6.0%	4.5%	3.7%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**1.3%**	**2.7%**	**4.4%**	**6.6%**
Personal Vehicle MPG					
OECD EUROPE					
Combustion Cars	32	35	39	44	53
Combustion Commercial Light Trucks	17	19	21	25	30
Hybrids	47	60	72	78	80
Plug-in Hybrids	121	171	228	280	335
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**30**	**33**	**38**	**49**	**74**
5 yr CAGR					
Combustion Cars		1.4%	2.2%	2.8%	3.8%
Combustion Commercial Light Trucks		1.8%	2.4%	3.0%	4.2%
Hybrids		4.8%	3.8%	1.5%	0.7%
Plug-in Hybrids		7.1%	5.9%	4.2%	3.6%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**1.5%**	**3.0%**	**5.2%**	**8.7%**
JAPAN					
Combustion Cars	32	34	38	45	54
Combustion Commercial Light Trucks	17	19	22	26	33
Hybrids	47	57	69	75	78
Plug-in Hybrids	121	159	235	292	347
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**29**	**31**	**36**	**46**	**66**
5 yr CAGR					
Combustion Cars		1.3%	2.3%	3.0%	4.0%
Combustion Commercial Light Trucks		1.9%	2.8%	3.6%	4.7%
Hybrids		4.1%	3.8%	1.6%	0.8%
Plug-in Hybrids		5.6%	8.1%	4.4%	3.5%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**1.6%**	**3.0%**	**5.0%**	**7.3%**
CHINA					
Combustion Cars	31	36	43	52	66
Combustion Commercial Light Trucks	17	20	23	28	36
Hybrids	51	65	76	80	82
Plug-in Hybrids	110	186	247	310	376
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**26**	**30**	**39**	**56**	**91**
5 yr CAGR					
Combustion Cars		3.2%	3.5%	3.8%	5.1%
Combustion Commercial Light Trucks		2.7%	3.2%	3.6%	5.2%
Hybrids		4.9%	3.3%	1.0%	0.5%
Plug-in Hybrids		11.1%	5.9%	4.6%	4.0%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**3.2%**	**5.3%**	**7.5%**	**10.1%**
REST OF WORLD					
Combustion Cars	32	34	37	41	47
Combustion Commercial Light Trucks	17	18	21	24	27
Hybrids	49	59	71	79	83
Plug-in Hybrids	121	169	229	286	347
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**29**	**31**	**34**	**39**	**47**
5 yr CAGR					
Combustion Cars		0.9%	1.7%	2.3%	2.5%
Combustion Commercial Light Trucks		1.4%	2.3%	2.7%	2.8%
Hybrids		3.8%	3.6%	2.3%	0.9%
Plug-in Hybrids		6.9%	6.2%	4.5%	3.9%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**1.0%**	**1.9%**	**2.9%**	**3.9%**
GLOBAL					
Combustion Cars	31	33	37	42	49
US Combustion Personal Light Trucks	20	21	23	26	31
Combustion Commercial Light Trucks	17	19	22	25	30
Hybrids	46	58	71	78	81
Plug-in Hybrids	121	172	231	287	346
Pure Electrics	∞	∞	∞	∞	∞
Total Light Vehicle Parc	**28**	**30**	**34**	**42**	**57**
5 yr CAGR					
Combustion Cars		1.3%	2.1%	2.7%	3.1%
US Combustion Personal Light Trucks		1.1%	2.0%	2.5%	3.0%
Combustion Commercial Light Trucks		1.9%	2.6%	3.1%	3.6%
Hybrids		4.9%	4.1%	1.8%	0.9%
Plug-in Hybrids		7.3%	6.0%	4.4%	3.8%
Pure Electrics		na	na	na	na
Total Light Vehicle Parc		**1.4%**	**2.8%**	**4.4%**	**6.3%**

Source: JD Power & Associates, US DOT, Bureau of Transportation Statistics, Deutsche Bank auto team, The Economist, GreenCar.com, Deutsche Bank estimates

Appendix 1

Important Disclosures

Additional information available upon request

For disclosures pertaining to recommendations or estimates made on a security mentioned in this report, please see the most recently published company report or visit our global disclosure look-up page on our website at http://gm.db.com/ger/disclosure/DisclosureDirectory.eqsr**.**

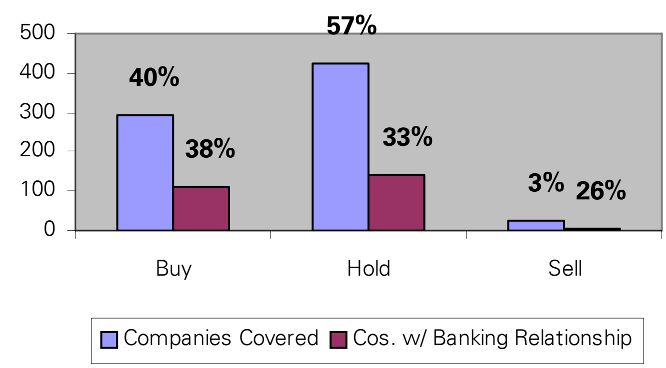
Analyst Certification

The views expressed in this report accurately reflect the personal views of the undersigned lead analyst about the subject issuers and the securities of those issuers. In addition, the undersigned lead analyst has not and will not receive any compensation for providing a specific recommendation or view in this report. Paul Sankey

Equity rating key

Buy: Based on a current 12- month view of total share-holder return (TSR = percentage change in share price from current price to projected target price plus projected dividend yield) , we recommend that investors buy the stock.
Sell: Based on a current 12-month view of total share-holder return, we recommend that investors sell the stock
Hold: We take a neutral view on the stock 12-months out and, based on this time horizon, do not recommend either a Buy or Sell.
Notes:
1. Newly issued research recommendations and target prices always supersede previously published research.
2. Ratings definitions prior to 27 January, 2007 were:
    Buy: Expected total return (including dividends) of 10% or more over a 12-month period
    Hold: Expected total return (including dividends) between -10% and 10% over a 12-month period
    Sell: Expected total return (including dividends) of -10% or worse over a 12-month period

Equity rating dispersion and banking relationships



North American Universe

Regulatory Disclosures

1. Important Additional Conflict Disclosures

Aside from within this report, important conflict disclosures can also be found at https://gm.db.com/equities under the "Disclosures Lookup" and "Legal" tabs. Investors are strongly encouraged to review this information before investing.

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