18 November 2013 | 79 pages

Global

Commodities Inflection Point – Energy Section

Still Cyclical, But Not So Super – 2014 Annual Market Outlook

- **Macroeconomic factors should continue to mute global demand for commodities for at least another year, so Citi's outlook for 2014 remains neutral to bearish commodities,** even if conditions improve slightly in both advanced economies and emerging markets. However, seasonal and tail risk factors could potentially push prices up.
- **Of profound importance is whether and when market conditions could tighten and if this would spell a continuation of the commodity super cycle of the last decade.** While Citi Commodities Research has pushed the 'Super Cycle Sunset' theme, others argue that Malthusian conditions (more people, higher urbanization and per capita income) will again lead to shortages and upward correlated prices and higher volatility, repeating the recent past.
- **What's happening in energy, however, looks increasingly likely to make a long-term difference, pointing to lower energy prices possibly for decades ahead.** Propelled not just by the shale revolution, which leaves OECD countries on the supply offensive but opening up (at higher than historical prices) significant, super abundant, reasonably low-cost resources to market participants at low entry costs amid scalable renewable resources and distributed energy that undermine many assumptions about King Coal's sway in the decades ahead.
- **Lower cost energy also carries significant implications for other commodities, virtually all of which are energy-intensive, even if metals and mining conditions look to be tighter three to five years out.**
- **We have lowered our oil price forecasts and kept our gas price forecasts constant since our September quarterly**. Citi lowered its 2014 Brent price forecast to $98/bbl from $108/bbl and proceeding prices as the previous price forecasts had been made under the assumptions of a US-led strike on Syria. Citi's WTI price forecasts lowered as a result of lower Brent price forecasts and marginally wider WTI-Brent forecasts. Our US Henry Hub natural gas price forecasts have remained unchanged for 2014/15.

■ Commodities

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Commodities still cyclical but no so super - twists and “re-”turns ahead

While global growth faces headwinds, is the super cycle making a comeback? Coping with 9 billion people

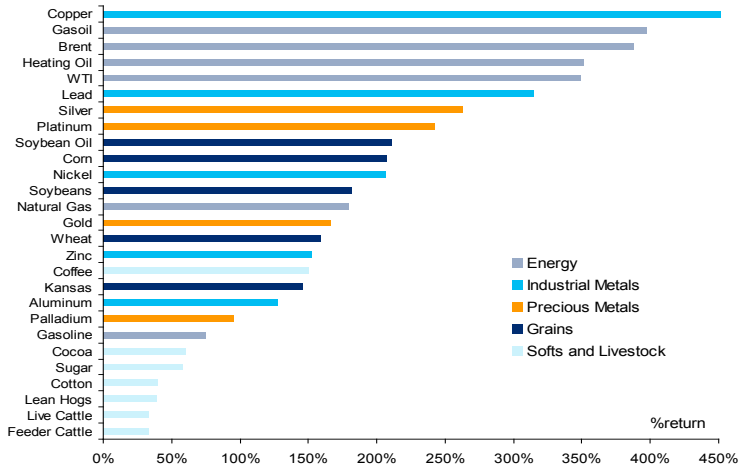
- **Two commodity super cycle theories have been lingering on, awaiting for a return to the heady days of the last decade, one based on difficult to prove long-term factors and the other based on Malthusian gloom** that the world's finite resources cannot accommodate an additional 2-million people, let alone bringing 4 billion people up to a higher standard of living

- **The return of the super cycle is superficially compelling as a theory**. Proponents point out that commodities prices remain high by historical standards, that commodities prices remain tightly correlated, that most supply costs are still increasing, that the era of low cost sources have dwindled and cost curves keep rising in many commodities, that food and non-food soft commodities are confronting fall growth in yield, all in the face of rising populations and rising incomes. (See: McKinsey Global Institute, *Resource Revolution: Tracking Global Commodity Markets, Trend Survey 2013* [September 2013]).

- **It's also compelling from an investment perspective, in the quest for the return of yield volatility**. Tight markets set the stage of high price volatility as well as volatility of returns. That's because when demand growth smacks into a supply limit, prices need to rise dramatically to balance markets; and once demand falls off due to price impacts or once limited supply relief is found from new sources, the price consequence is also volatility. Tight markets produce and sustain volatility and the return of the former predictably will lead to the latter.

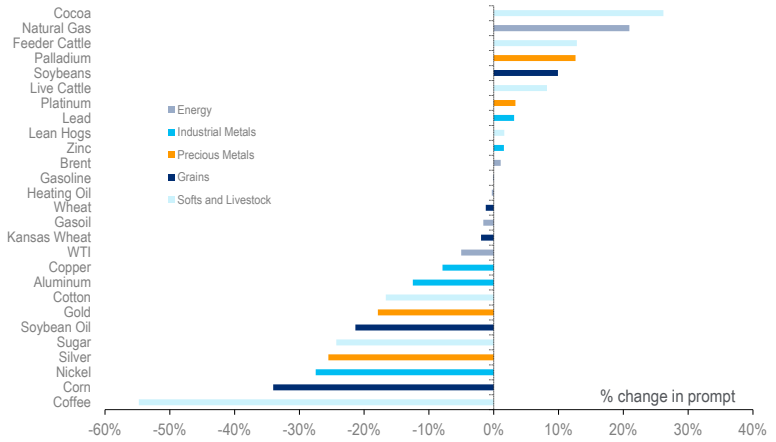
- **But the return of the super cycle hinges on three not so obvious assumptions: (1) the continued correlation of commodity** prices across main commodity sectors, which we think has no empirical basis; **(2) a fundamental change to historical drivers which have on the supply side led to herd behavior of over-investment and under-investment**, which is far too premature to believe has occurred; and (**3) an end to historical experience of efficiency gains swamping** supply constraints.

Figure 1. 2003 to mid-2008 Nominal Commodity Price Returns (Super cycle Birth/Maturity)



Source: Bloomberg, Citi Research

Figure 2. 2012- 2013 YTD* Nominal Commodity Price Returns (Unicycles)

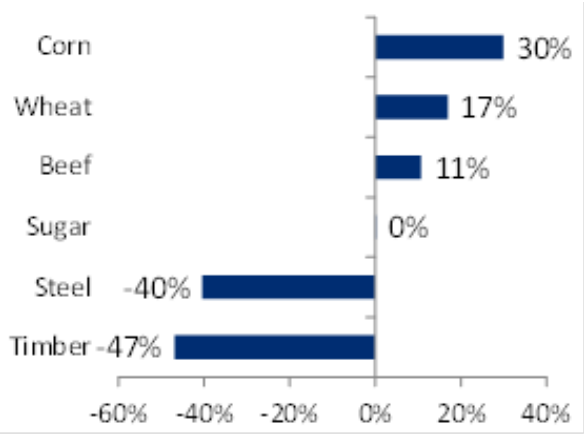


Source: Bloomberg, Citi Research, *through 14th November

Energy is a key to a super cycle return

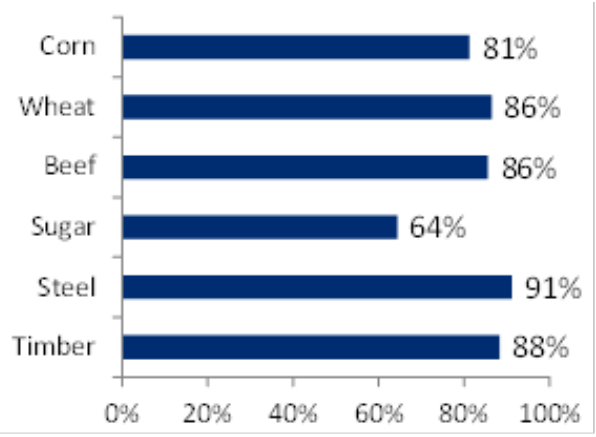
- **During the last cyclical trough (1981-97) there was a random correlation between oil and other commodity prices**, a trend that has re-emerged after 2010. In "normal" times there are multiple season and sector-based factors at work defining cross correlations.
- **During the height of the last cycle, correlations between energy and other commodities were high** including not just steel, but copper, aluminum and other energy intensive commodities.
- **Probably the most critical factor in the recent past was that energy and non-energy commodities reached the same condition at the same time for largely unrelated reasons.** Across commodities due to lack of investment in the years if not decades before 2002, inventories of potentially producing properties were depleting under the weight of low prices and lack of incentives to deploy capex. And under the weights of high prices and complacency inventories of above the ground stockpiles were likewise depleted. Agricultural inventories fell as lobbyists in the US and Europe found a way to foster biofuel use.
- **Petroleum prices surged the greatest of all commodities from 2003-08,** lifting the prices of all commodities, which are to one or another degree energy intensive, thus forcing an effectively tight correlation across commodities and raising the costs and therefore the prices of highly energy intensive commodities like copper the most.
- **For commodities to be correlated tightly again, their investment cycles will have to be simultaneous or energy prices will have to rise.**

Figure 3. Correlation with Oil Prices - Q1'81 - Q4'97



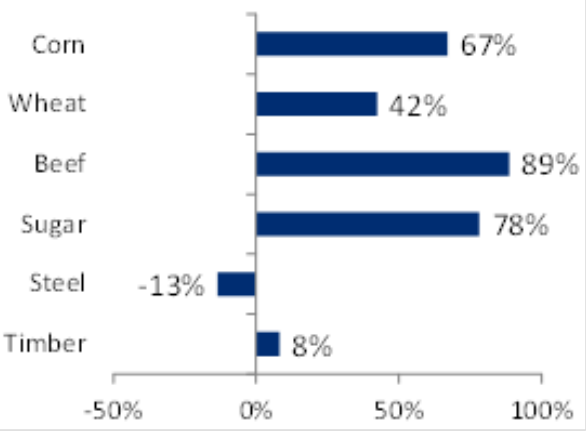
Source: Citi Research

Figure 4. Correlation with Oil Prices - Q1'98 - Q4'08



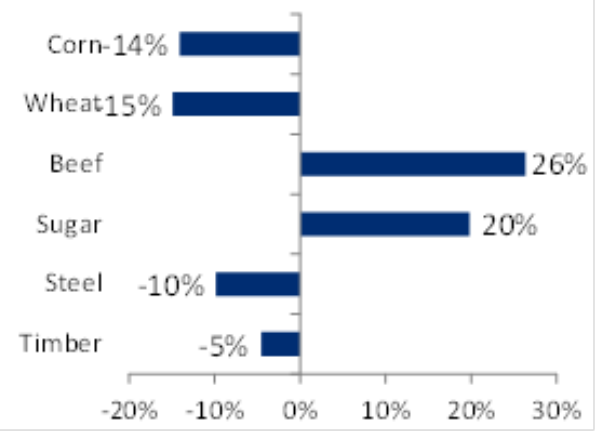
Source: Citi Research

Figure 5. Correlation with Oil Prices - Q1'09 - Q1'11



Source: Citi Research

Figure 6. Correlation with Oil Prices - Q2' 11 - Q3'13*



Source: Citi Research

For significant volatility to return to commodity markets, demand will likely have to reach supply limits once again

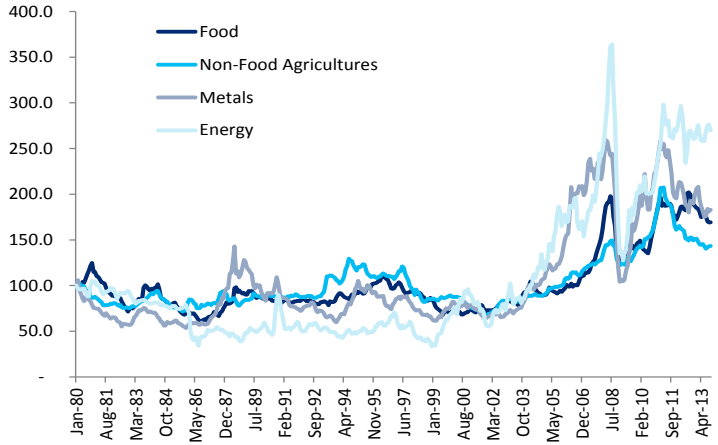
- **Just as all commodity prices were correlated during 2003-2008, they also showed increased volatility.** That's largely a function of their simultaneously hitting capacity constraints on the supply side, driven in part of extraordinary demand growth from China and other emerging markets, but also reflecting several decades of under-investment in investing in new production capacity and bringing new supply to market.

- **Given the rigidity of the supply function in commodities, once demand erodes both available inventories and production capacity, prices inevitably surge and become more volatile.** A surge in prices is an inevitable consequence of supply constraints, as with rigidities in the supply function, due to long investment lead times that can be a decade or longer, when demand hits supply limits prices must surge to balance demand with supply.

- **The most important of the surprising supply constraints in the 2000s was oil, and the constraints were almost entirely within OPEC.** Oil prices reached their lowest levels in 1998-99, falling below $10/bbl (nominal) for both Brent and WTI, and even lower for most OPEC crude streams. Investments in new production capacity outside of OPEC lagged with low prices; and within OPEC they lagged as a result of concerns by major producers such as Saudi Aramco that four countries – Iran, Iraq, Nigeria and Venezuela were planning to implement investment programs to raise their combined capacities by 9 million b/d over the decade 1998-2008. But in 2003 it became apparent that their capacities were collectively stagnating or falling and both deferred and prompt prices started to increase after two decades of range-bound trading and persistently lower prompt prices.

- **Energy prices led the charge in volatility, as demand reached and bounced off of supply constraints repeatedly from 2003 to 2008.** Given the energy intensity of virtually all commodities, volatility in oil prices was transmitted to other commodities and both raised their prices and increased their volatility as well.

Figure 7. Commodity prices indexed to 1980



Source: World Bank, Citi Research *Indexed to 100 at 1980

Figure 8. Commodity Nominal Price Changes and Volatility*

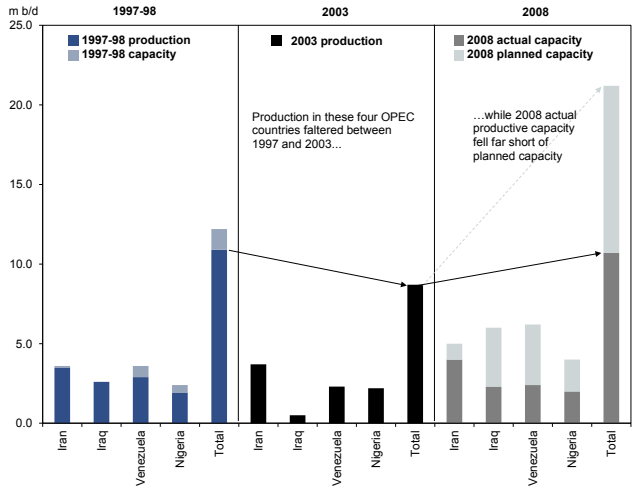
Nominal Price Change (%)	Q1'81 - Q4'97	Q1'98 - Q2'08	Q1'03 - Q2'08	Q1'09 - Q1'11	Q2'11 - Q3'13
Food	-19%	115%	138%	41%	-11%
Non-Food Agricultures	8%	66%	76%	63%	-31%
Metals	1%	228%	240%	135%	-29%
Energy	-51%	687%	297%	103%	-7%
Volatility (%)					
Food	13%	28%	27%	13%	5%
Non-Food Agricultures	15%	20%	17%	16%	12%
Metals	22%	53%	41%	25%	11%
Energy	27%	58%	39%	19%	5%

Source: World Bank, Citi Research *Annualized monthly return volatility

Commodities and the alignment of planets – how the super cycle began despite different supply investment horizons

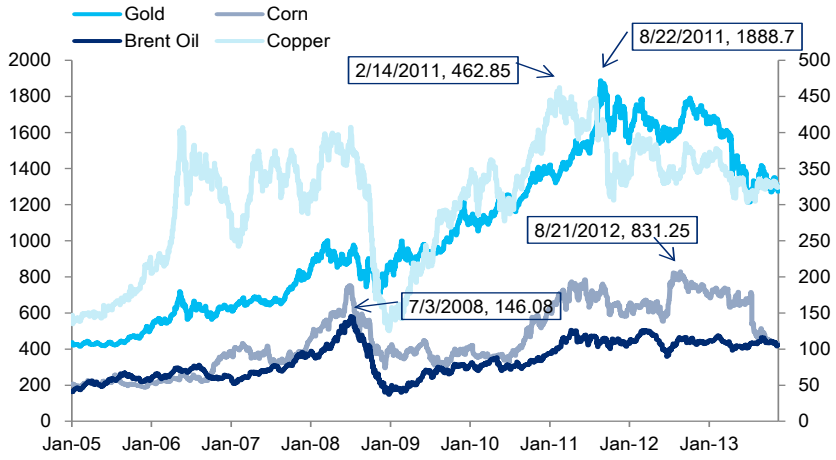
- **2003 can be seen as a rare but inevitable statistical event.** No overriding "super cycle" was at work but different commodity cycles unfolded at the same time. Specifically they reached a cyclical trough around the turn of the century and were poised for a significant upturn in prices accompanied by a cyclical upturn in capital expenditures.
- **It was as though** the planets in the solar system, each in its own orbit, traveling at different speeds, suddenly were distributed in a straight-line from the sun. 1998-2003 bracketed a period when:
  - global grain inventories had been drawn down, setting the stage for rising prices;
  - producible industrial metals reached the limits of capacity growth and required higher prices to stir on new investment
  - a set of OPEC countries, expected to see surging growth in a period of exceptionally low prices, encountered failure in their production capacity, catching the GCC countries and the major oil companies off guard, setting the stage for surging prices.
- **But the mobilization of capital unfolds at a different pace across different commodity classes** and the supply responses are uneven and cross different time spans.
- **The period ahead should see the planets in disarray, again moving at their own speeds,** individually impacted by their own inherent conditions and specific accidental factors that can affect the supply side.

Figure 9. OPEC supply disappointed in the 2000s



Source: EIG, Citi Research

Figure 10. Cyclical peak of different commodities

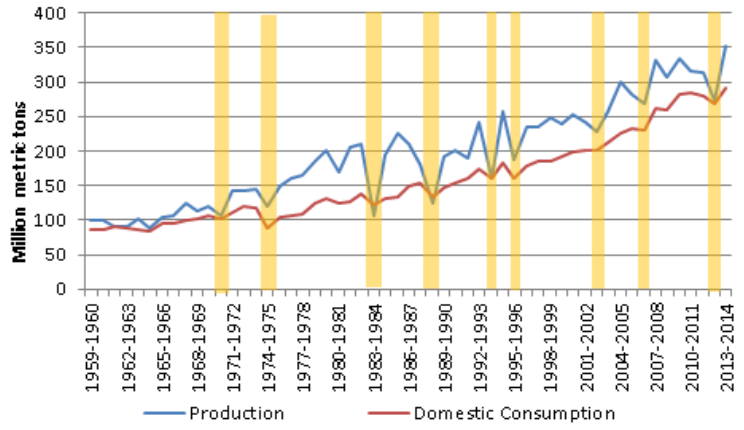


Source: Citi Research

Ten years later, what's moving the supply side in the medium-term ahead?

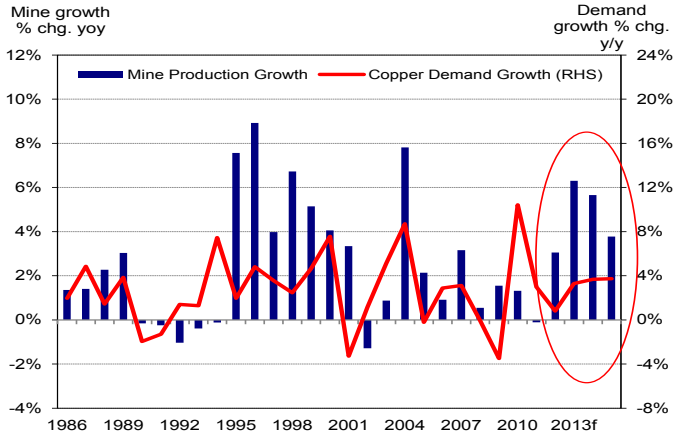
- **Agricultural and soft commodity cycles are the briefest** with the shortest lead times, depending on the weather gods, but we believe inventories can be rebuilt over a 1 to 3 year period. The sector responds rapidly to changes in prices by moving acreage in and out of cultivation and by switching from less remunerative to higher payout crops as feasible.
- **Industrial metals are somewhat stickier and can take a half-decade or longer to incentivize investors** to build out new capacity. In theory, it should take not much more than five years to gain access to new mining sites and build out capacity. But a host of factors in emerging markets, where by and large industrial metals and bulk commodities are located, can increase and delay the supply response.
- **Oil and gas historically took significantly longer to mobilize capital**, in part because the structure of rentier states, historically having least-cost production capacity, but impeding private capital deployment delays efficient capital mobilization.
- **But the unconventional revolution – harnessing shale resources plus deepwater and oil sands – is different in two significant respects: It's occurring in OECD countries, with few market impediments compared to resource nationalism emerging markets; and its unleashing a new low-cost supply that is fairly ubiquitous globally, setting the stage potentially for a long period of relatively low cost resources**
- **Some commodities are particularly lumpy in their concentration in a limited number of places and see tighter market conditions ahead.** This is the essential story of previous metals and the PGM group, with sustainable demand in gold and silver requiring relatively high cost production to meet the new demand, and with platinum and palladium required for industrial uses including especially in catalytic conversion in refining and transportation.
- **This history of commodity cycles is that they are supply-side-based, with investors, following a herd mentality, oscillating between over-investment and too much supply, under-investment and too little supply, with not much evidence that historical patterns are changing.**

Figure 11. On the one hand, agricultural cycles are the briefest due to weather (i.e. US corn) and ability to adjust planting intentions each marketing year



Source: USDA, Citi Research
Note: Shaded areas denote troughs of cycles as production disappointed, in most cases due to weather

Figure 12.On the other hand, metals cycles are lumpier: Copper mine production and demand growth proceeded in successive waves

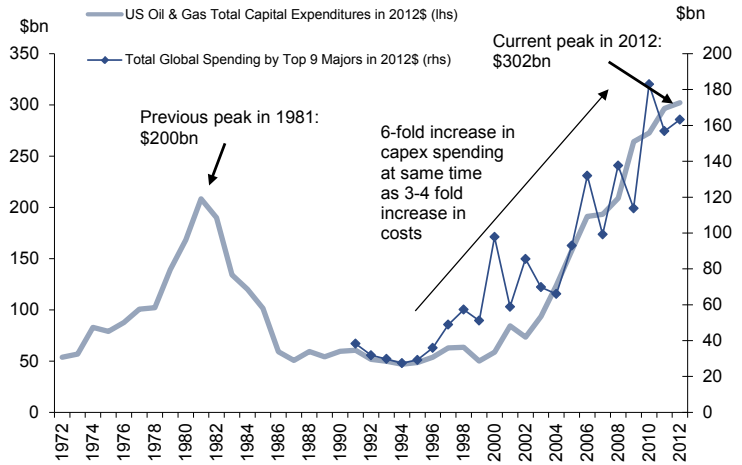


Source: IHS Herold, Citi Research

Across commodities, different historical capex cycles are differentiating timing of supply responses

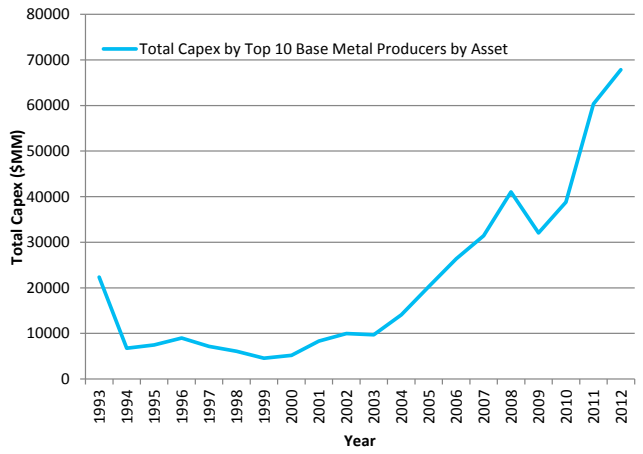
- **For oil and gas, the recent surge in US liquids output is part of a long-term cyclical pattern that encompasses the global petroleum sector, but the pattern could be altered somewhat going forward due to shale, deep water and oil sands.** Historically OPEC production led supply growth, particularly in the 1970s, but has essentially stagnated ever since. OPEC production today is marginally higher than it was in 1980. High prices in the 1970s led to a total growth of ~15-m b/d from new source production in the Soviet Union, Mexico, the North Sea and the North Slope of Alaska. This surge was the result of a sharp rise in capex. But the surge in reserves led to weak prices for nearly two decades, and with weak prices came a collapse in upstream capex after 1981.
- **Fast-forward to the last decade. Higher prices then, like higher prices in the 1970s, have led to the resurgence in exploration** and have unleashed technological revolutions. The growth of US shale oil and gas has been preceded by the technological revolutions facilitating the tapping of vast non-commercial resources in deep water and shale gas plays. Now the US is on course to become the largest liquid producer globally, already overtaking Russia and Saudi Arabia.
- **Unlike prior boom-bust cycles in exploration, and unlike unconventional deep water and oil sands, shale oil and gas drilling in the US is much less capital intensive,** with short lead times, enabling investment to respond rapidly to demand and price changes, smoothing out the large cycles in the sector.
- **For metals and mining, many major supply projects still require large capex for site-preparation and the building of infrastructure for future production.** Given the scale and complexity, it often takes years before a project comes online. But the investment decision would have to be made when demand and prices have risen for some time already, with relatively strong conviction on the demand trajectory. This process similarly applies to large-scale oil and gas (LNG) projects. By the time the project becomes operational, the demand and price environment could be different, as witness in the cancellation of capex in some major coal mines in Australia. However, new technology could be changing part of the mining complex.

Figure 13. Total US and global oil and gas capex 1972-present



Source: Company filings, Citi Research

Figure 14. Total Capex by 10 Largest Listed Base Metals Producers by Assets 1993-2012

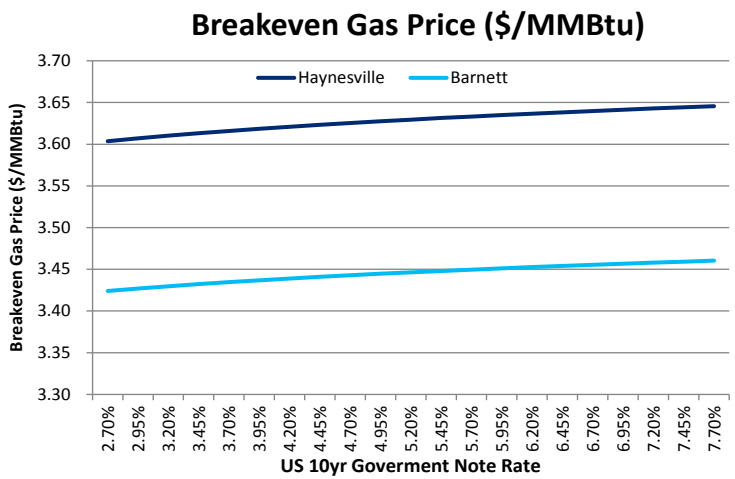


Source: Company Filings, Citi Research

Moreover, short term macro shocks (interest rates, project economics) may not elicit the same reaction on supply-side investments either

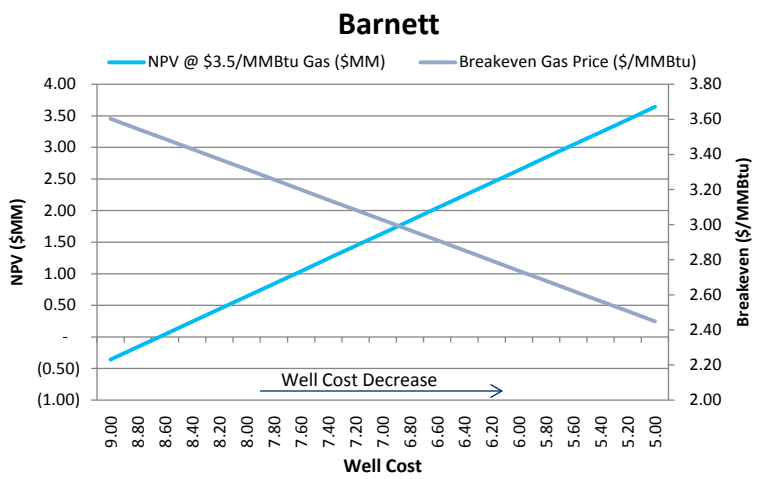
- **At first glance, higher interest rates should raise the capex hurdle rate, adversely affecting project economics**. This is the case for large capital projects on the supply side with relatively steady output in the life of the project. But shale oil and gas production, which has been driving oil and gas output growth, is different.
- **Interest rate changes should not have a major impact on shale oil and gas production**, which has been driven by very high returns on the oil side and continued efficiency gains on the gas side. Due to very high initial decline rates of shale production, the bulk of the cash flow should come in the first couple of years, so that the net present value would not be affected as much by rates as when production and cash flow are more backend loaded. Citi's detailed field analysis shows that a rise in the 10-year treasury (as a benchmark, which flows through to WACC) may only raise breakeven gas prices for these marginally.
- **The impact of rate increases also looks likely to be more than offset by lower production costs**. Well costs have been falling and efficiency gains increasing under the pressures of technology and market forces. Supplier services are moving to oversupply. Innovation and learning-by-doing should also drive costs down.
- **Data are overwhelmingly convincing so far that deepwater costs have stabilized considerably and shale exploitation costs are under downward price pressures.** To be sure, there are short-term inconveniences impacting prices, including temporary or one off increases in costs associated with regulation; but there is no evidence that the 20-50% annual increases in drilling efficiency – the ability to extract more hydrocarbons with less effort – is ready to tail off. To the contrary, the efficiency gains appear to be increasing and maybe even accelerating.

Figure 15. Interest Rate Impact in Breakeven Gas Price in Haynesville and Barnett



Source: Citi Research

Figure 16. Well Cost Decrease Can Offset Interest Rate Impact-Haynesville

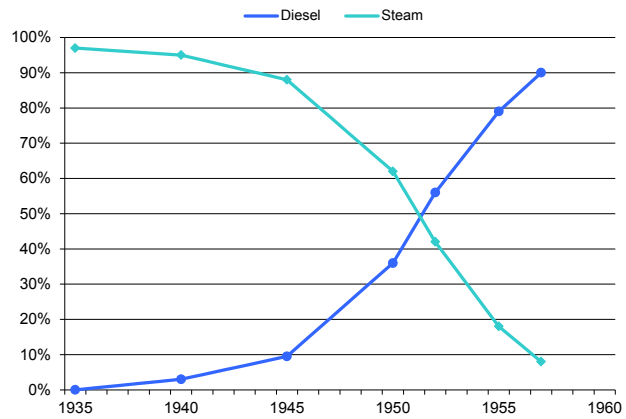


Source: Citi Research

In the oil and gas sector, short-term response to bursts of innovations are leading to longer term transformations

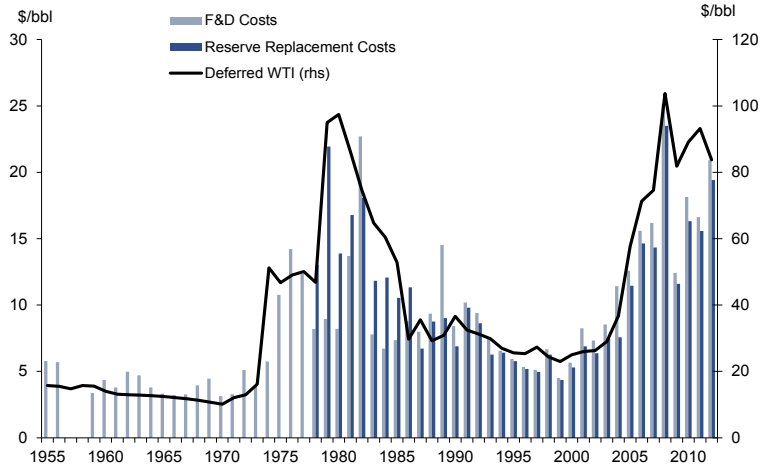
- **Although the search for new energy sources involve vastly more sophisticated techniques, the need to build new infrastructure, particularly in locations with geopolitical instability, has raised the risk of supply and transit disruptions**. Even so, a number of developments are making both the demand and supply sides more efficient:
- **Demand side innovations: higher prices promote efficiency and substitution allows users to optimize their energy sources.** Technological change and sustained price divergence between energy sources (e.g. oil and gas) are motivating increasing substitution between fuel supplies just as higher prices foster conservation. Under the circumstances, elevated prices have been hard to sustain. The gas-for-oil substitution in power generation in the 1960s and 1970s is being repeated in also is playing out in the transport sector, but hybrids, electric vehicles and other fuel efficiency technologies should also have an impact.
- **Supply side innovations: technological advancement and increased availability of supply are lowering costs.** Shale and deep water unconventional reasons are being tapped into because of high prices. High prices in turn trigger technological change and diffusion, increasing efficiency and lowering costs. The rise in supply also breaks apart long-standing oligopolies and reduces their market power.
- **Sector level innovations: the notion that "small is beautiful" is revolutionary in the energy space**. Costs of entry are very low for shale drilling for both oil and gas, and the installation of solar and other new energy sources substantially lower the barrier to entry in power gen.
- **Unlike energy, metals and mining should still be reliant on large-scale projects with substantial capex, even as there are new ways to reduce costs.** Citi expects continue downward pressure on oil and gas costs and prices, but renewed upward pressure on most metals. Even so, with energy effectively "opting out" of much of the long-term oil investment cycle, at least for the time being, we expected a moderation of the commodities cycle going forward, with metals probably outperforming energy.

Figure 17. Incremental fuel-substitution in the rail industry from coal-steam to diesel turned into a wholesale transformation of the sector, helped by technological improvement and infrastructure improvement in both supply and demand – similar cycle applies to other sectors



Source: Citi Research

Figure 18. The interplay of the oil capex and price cycles



Source: Citi Research

In addition to innovations, the oil and gas upstream capex cycle remains at the core of the overall supply cycle

- **Upstream capital markets is a tale of 6 discrete market activities each of which has its own balance of supply, demand and inventories**

  1. Acquiring/relinquishing acreage
  2. Acquiring an inventory of seismic knowledge
  3. Exploratory drilling-designed to find new resources
  4. Delineation drilling – designed to prove up reserves
  5. Development – huge capital deployment to bring proved reserves to market
  6. Deciding on whether to extend the life of producing properties, or whether to prematurely abandon them.

- **In an expansionary phase, inventories are built in each of these markets:**

  1. Companies bid up acreage in order to have an inventory to explore,
  2. Firms increase their inventory of seismic data,
  3. They increase exploration and delineation drilling to build an inventory of proven, producible properties,
  4. Producers deploy capital for development (the lion's share of expenses), and
  5. Companies invest to prolong field lives.

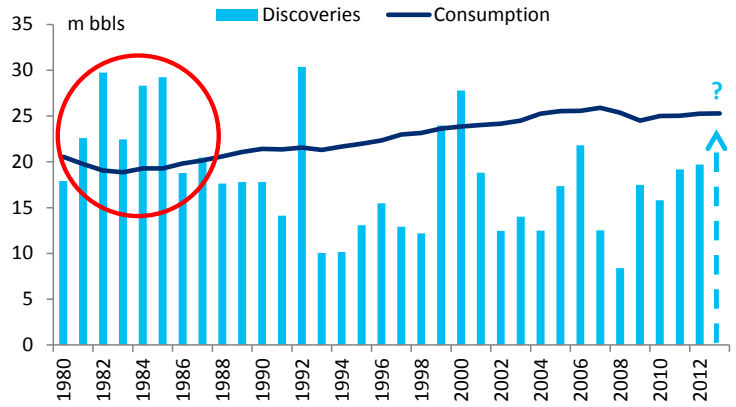
- **In a contractionary phase (e.g 1981-2003), firms deplete these inventories**, as buying oil on wall street (M&A) is cheaper than finding and developing it, services costs decline. In addition, with early abandonment of fields, depletion rates rise (buttressing the idea of "peak oil"); capex in turn focuses on development (or sale) of proved reserves

- **For the next 5-10 years – or longer, capex globally is likely to focus on these areas of proved reserves**, but focusing on capital efficiency, therefore ignoring higher cost projects and focusing on lower cost projects – shale gas and tight oil should be in this category

Going forward, with a burst of new discoveries, oil/gas spending to focus on further development of these areas

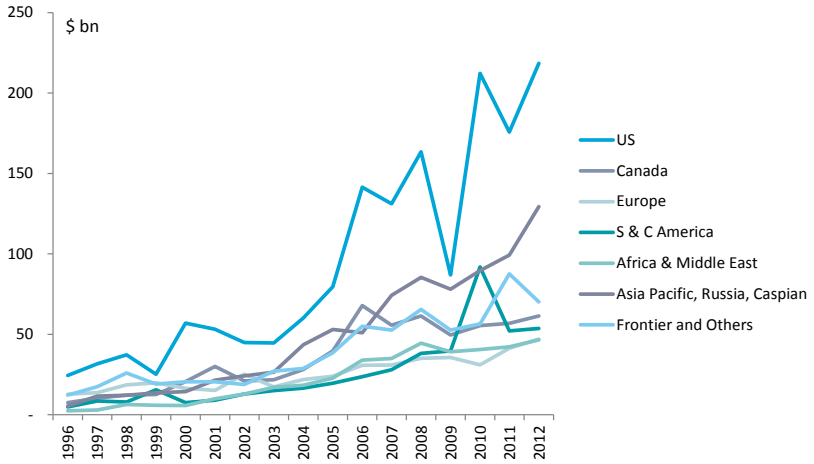
- **Resources discovered and reserves proved up over the past few years should see continued development, particularly shale and deepwater, even though spending on large-scale, offshore LNG should slow.** The outlook could mirror the late 1970s to early 1980s, when a capital spending surge boosted global oil/gas discoveries. Reserves in and around these discoveries were proved up over time, providing the world with low-cost hydrocarbons for nearly two decades.
- **Similarly, strong US spending on shale and other unconventionals should continue going forward, while incremental technological improvements and technological transfer could open up shale and unconventional developments globally**. Argentina, despite its regulatory regime, is seeing further exploration and production in its vast shale resources. Spending on shale or onshore tight formations in Australia, China and Saudi Arabia, among others, should accelerate.
- **Spending in Australian LNG could have peaked in 2013 and could fall off sharply by 2016, as liquefaction projects come online**. The expected surged in LNG supply after the middle of this decade should loosen the global LNG supply-demand balance and has reduced the appetite for expensive new projects amid reluctance from LNG importers to pay oil-indexed prices for LNG. However, if floating LNG proves to be successful, then the cost of offshore LNG could fall sharply, reaccelerating upstream/midstream developments. Lower costs and lower prices should boost demand, raising the need for more incremental spending on supply.
- **Spending on deep water projects should continue to rise in various locations: Angola, Australia, Brazil, Nigeria and the Gulf of Mexico**. Seismic and exploratory drilling have proved up some fields, with production beginning, that further development of these deep water basins should surge.
- **Critical in this analysis is the deceleration or even reversal of cost inflation as a driver of capital spending**. The reasons for possible cost moderation include: (1) depreciation of many producing countries' currencies, (2) the easing of equipment and labor shortage, particularly as some new capital projects are canceled or put on hold, and (3) lower commodity prices from steel and metals to energy reducing the overall cost.

Figure 19. Strong capital spending in the late 1970s boosted global oil discoveries* in the early 1980s and the world lived off from these new discoveries for nearly the next two decades; the world could be on the cusp of entering such a phase again



Source: IEA, IHS Herold, Citi Research (* Discoveries, revisions, extensions and improved recovery)

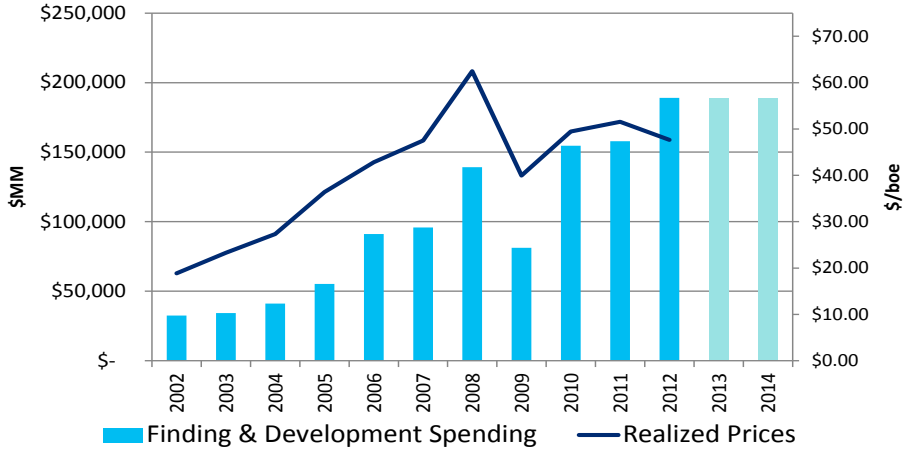
Figure 20. Global capex by region – the global total has surged to over $600bn since the 2000s ($ bn), driven by North America, Asia Pacific, Russia and the Caspian, and others



Source: IHS Herold, Citi Research

US oil and gas capex has been robust on existing areas, but is negative cash flow recently a problem? Probably not...

Figure 21. Capital spending surged in 2012 but growth looks softer in 2013-2014



Source: IHS Herold, Citi Research

Figure 22. Total US oil and gas operations ($ millions) – negative free cash flow has resulted

	2008	2009	2010	2011	2012	'11 - '12 % change
Oil & gas revenue (a)	$211,357	$149,757	$190,391	$204,388	$202,787	-1%
Lifting costs	$51,007	$41,924	$55,716	$56,298	$62,145	10%
Exploration expenses	$6,023	$5,836	$5,423	$6,130	$7,610	24%
DD&A (Incl. write-downs/impairment)	$89,854	$88,952	$58,797	$60,523	$95,997	59%
(Write-downs/impairment) incl. above	$45,673	$40,568	$6,357	$7,326	$28,918	295%
Other expenses/(income)	$4,704	$3,685	$3,251	$4,163	$326	-92%
Pre-tax profit	**$59,770**	**$9,360**	**$67,203**	**$77,273**	**$36,710**	-52%
Income tax/(benefit)	$23,301	$2,659	$22,598	$28,861	$13,062	-55%
Net income (b)	**$36,469**	**$6,701**	**$44,605**	**$48,412**	**$23,648**	-51%
Cash flow	**$134,533**	**$102,319**	**$109,599**	**$116,124**	**$128,046**	10%
Free cash flow	**($4,653)**	**$21,125**	**($45,074)**	**($41,814)**	**($60,975)**	46%

Source: IHS Herold, Citi Research

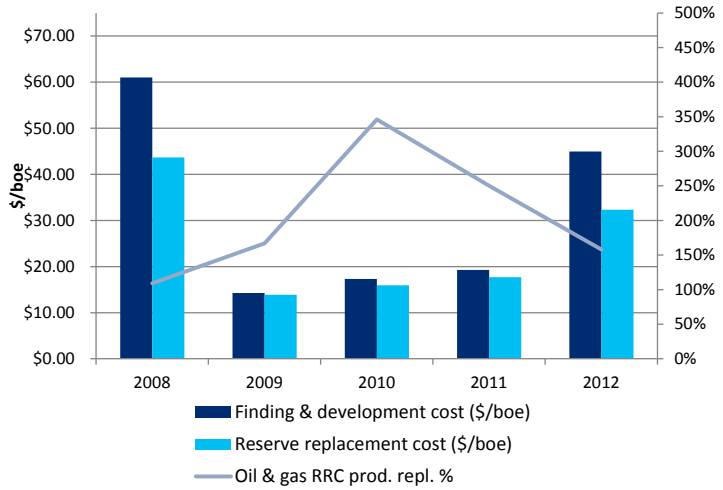
Despite negative cash flow in recent years, the oil and gas industry should begin to reap benefits

- **The land grab significantly skewed results on two levels; the land grab phase is in many cases being replaced by more efficient operations**: (See Robert Morris, "Chesapeake Energy Corp (CHK)" Citi Equities Research, 24 October 2013, for a solid case study of this process)

  Until 2012, much of capex was on acreage acquisition. Much of the funding was via joint ventures (often with foreign companies) or VPPS, or sale of non-core acreage. In addition to high and rising per acre acquisition costs, work requirements were fulfilled at minimum levels as the land grab continued and as minimum spending was need to hold acreage and meet minimal obligations; this process masked underlying efficiency gains, and understated the pace of technological growth. Lower-than-expected natural gas prices reduced cash flow against expectations and often firms turned to oil directional from natural gas directional drillings. Only now as a more mature phase of development is entered should cash flows in some plays start to exceed capex. Companies with extensive resource bases should start seeing solid cash flow growth, with output increases potentially accelerating.

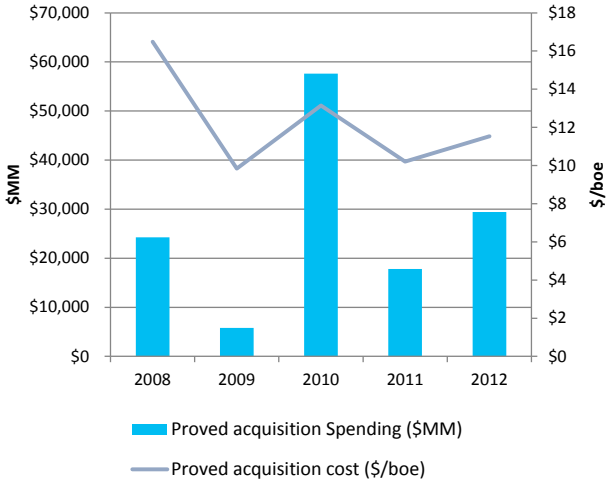
- **However, growing evidence of profitability and sustainability is on the horizon**. Multiple matrices are pointing to future profitability, sustainable at significantly higher production levels than today's level. Undoubtedly the oil and gas industry is under great pressure to improve capital efficiency, which means avoiding high-cost plays in favor of lower-cost areas. Intensive drilling to hold leases is being replaced by greater diligence on project execution. The drive for efficiencies is resulting in shorter drilling times, higher productivity from more selective drilling and greater efficiencies. So far the efficiencies are being led by faster drilling, more sophisticated geological understanding, 24/7 operations, multi-wells pads. Services costs are likely to become more competitive over time. Cost curves are likely to continue to see downward pressure. High and sustainable oil and natural gas production at plateau levels significantly above today's are in the cards.

Figure 23. Natural gas write-downs crush reserve replacement metrics



Source: IHS Herold, Citi Research

Figure 24. Rising proved acquisition spending pushes prices higher

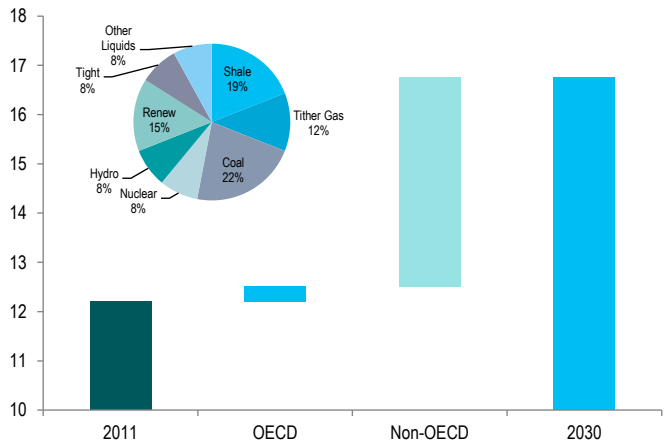


Source: IHS Herold, Citi Research

More broadly, a further transformation of the energy industry is at hand: small is beautiful…

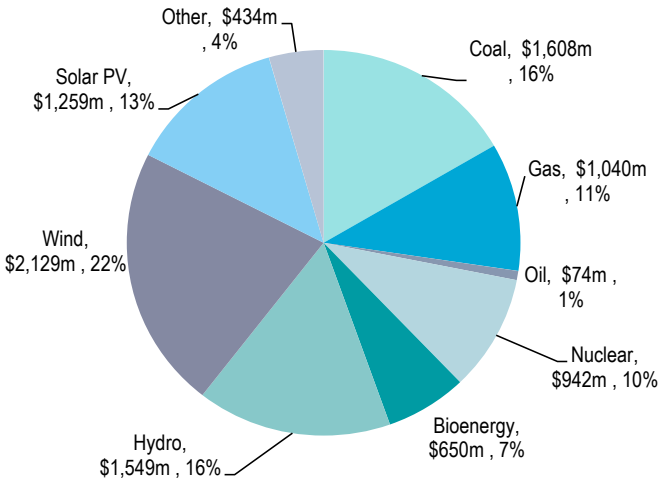
- **A series of transformative forces are increasingly asserting their influence on the global power mix**. Disruptive changes in technology costs and fuel markets are now set to ensure that the next ten years look little like the last twenty. US shale oil and gas are just the beginning.
- **"Small is beautiful" is a characteristic that is common across these disruptive changes. This characteristic is revolutionary in the energy space.** Much lower capital requirements for shale drilling on the oil and gas, and the installation of solar and other new energy sources substantially lower the barrier to entry.
- **In a "David vs. Goliath" fashion, this "smallness" is encroaching into the turf of the energy establishment in both coal and oil**:
  1. **Renewables are taking market share away from conventional generation amid very lackluster demand in developed markets**. Different geographies are undergoing different changes in their energy mix. The voracious appetite for power in emerging markets is being met not just with conventional generation, but renewables as well in a way where EM countries could leapfrog an entire generation of technology in the electricity sector. See Citi's GPS report "Energy Darwinism" (Oct 1, 2013) for details.
  2. **For the last decade, one of the most unassailable assumptions in global energy markets has been the ever-increasing trajectory of thermal coal demand. But changes in the power mix and economic structure could instead call for a peaking of coal demand!** The consensus outlook for China's coal demand, accounting for more than 50% of global demand, has been so strong that the IEA called for coal to surpass oil as the leading global fuel before 2030. See Citi's [Must C] report "The Unimaginable: Peak Coal in China" (Sept 4, 2013) for details.
  3. **Gas-for-oil substitution is also cutting down on oil demand growth amid wide divergence between oil and gas prices. The belief that oil demand will rise into the future as far as the eye can see has come to a crude awakening.** The change is happening, like the others above, in massive number of seemingly small adoptions – one power plant/one engine at a time. See Citi's GPS report "Energy 2020: Truck Trains and Automobiles" (Jun 4, 2013) for details.

Figure 25. Energy demand growth will be dominated by non-OECD countries, but the split of fuels/ technology will be relatively even split



Source: IEA, Citi Research

Figure 26. Split of $9.7trn global investment in power generation by technology



Source: IEA, Citi Research

…with a reversal of runaway demand growth amid the rise of renewables

- **Long term electricity consumption growth could be limited by development in three different areas**: (1) the wider use of demand management and load response, (2) improvements in energy efficiency standards and (3) behavioral changes across sectors. With much smaller or non-existent demand growth in a number of locations, the need for new large-scale, convention coal or nuclear generation should fall.

- **In place of new large-scale generation, small items are collectively making a big impact.** On peak demand periods on a hot summer day, for example, the additional consumption over normal demand could largely be provided by both demand reduction by industrial or commercial facilities, solar generation or potentially energy storage.

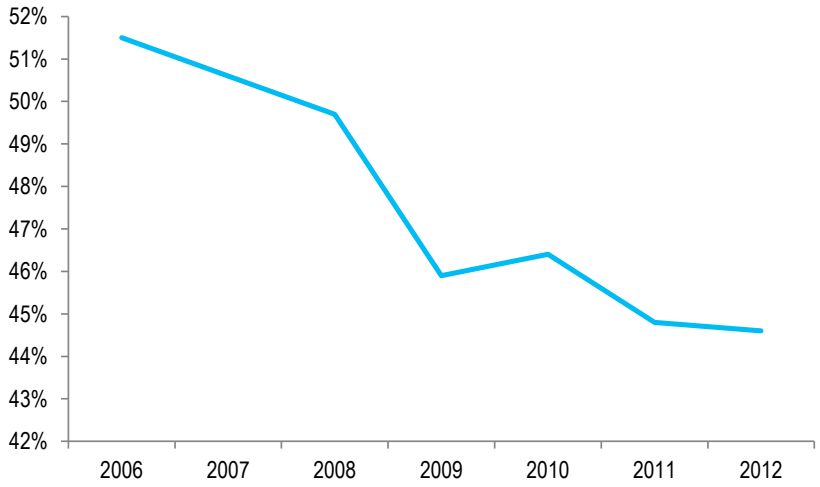
  1. Peak demand hours on a hot summer day is typically the most 'valuable' part of the curve to supply, as electricity prices are highest. While solar generates only a relatively small amount of units of energy per unit of capacity, it is the time of day at which it generates those units which causes the biggest headache for utilities.

  2. Given its modular nature, solar works well as a distributed (local) generation source.

  3. If storage facilitates the next renewables boom and becomes broadly adopted in markets worldwide, the electricity load curves could once again change dramatically causing more uncertainty for utilities and more disruption to fuel markets.

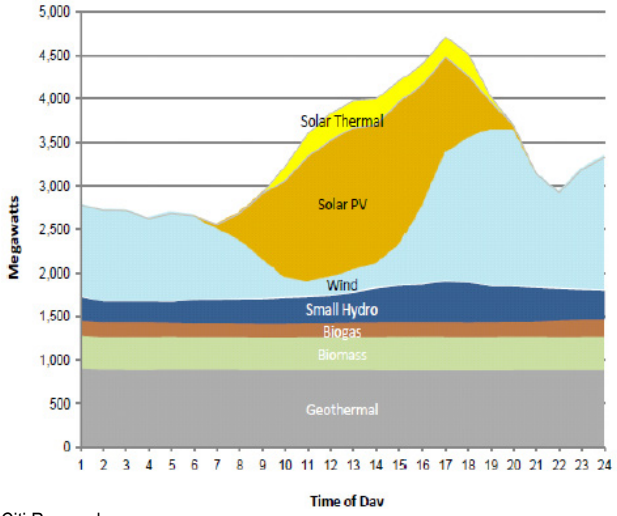
- The rest of this report examines how various supply drivers, capex and changes in demand expectation for individual commodities affect their outlooks and positions within the commodity cycle.

Figure 27. Load factor of traditional technologies has been steadily declining in Europe



Source: TSOs, Citi Research

Figure 28. Summer workday in California – with renewables supplying peaking electricity

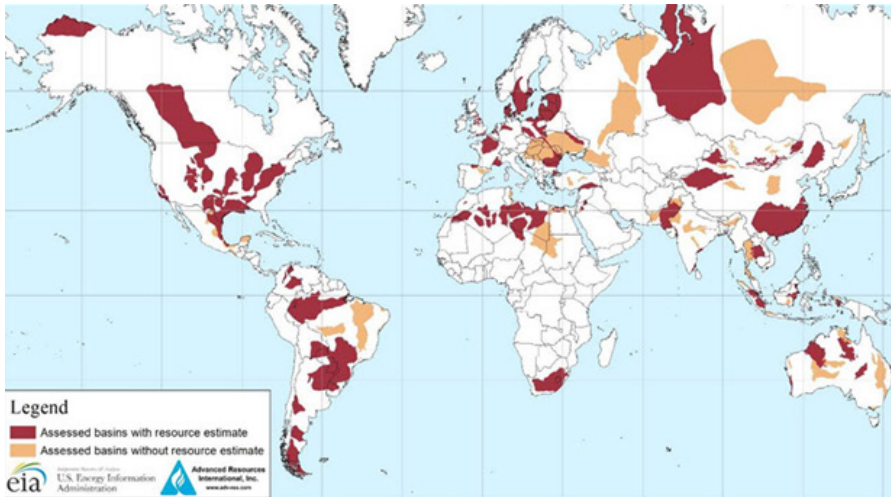


Source: CAISO, Citi Research

The transformation also impacts geopolitics: the global spread of the shale revolution could have unexpected geopolitical consequences – a turn away from resource nationalism?

- If shale resources are indeed as geologically commonplace as a cursory look at a global map suggests, there could be a rush to develop these domestically in many countries, in order to secure hydrocarbon production within one's borders.
- The shale revolution should be sustainable and could spread. North America is the major producer of shale oil and gas for now, but US shale resources are only ~15% of technically recoverable reserves globally. In the near-term, North Africa and Ukraine look to be making steps forward. Other major shale resource holders include Mexico, Argentina, Russia, Saudi Arabia, China; Mexico and Argentina could be among the earlier movers.
- While this development may be slow to come given the rare confluence of factors in the US that supported its recent meteoric rise, this could cause a widespread fall in the reliance on foreign sources of supply, changing global crude trade flows and the geopolitics of oil.
- The spread of shale production could make net oil importers more self-sufficient, and the imperative for this could catch on like wildfire. The structural implications of this would be more stable global oil prices with downward pressure. Already, the US and Canadian supply surge alone was able to offset a massive rise in global supply disruptions in the world – from ~500-k b/d globally prior to January 2011 to ~3.5-m b/d since summer 2013 – keeping Brent prices range-bound at the $110 level.

Figure 29. Global map of shale resources



Source: EIA

Figure 30. Major global oil transit chokepoints, with some 17-m b/d through Hormuz, 15-m b/d through Malacca, and 3.8-m b/d of crude and products through Suez and SUMED in 2011

Source: EIA

Energy

Figure 31. Citi Energy Commodity Price Forecast

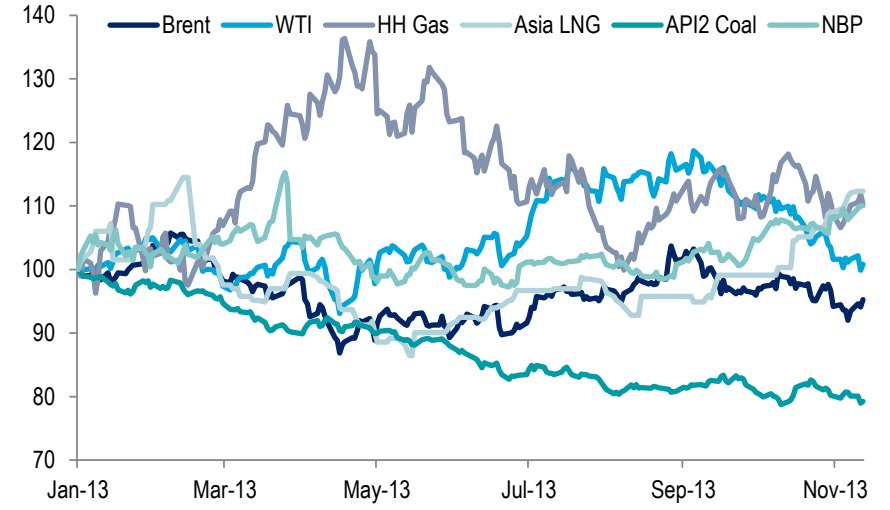
		Point Prices																	
		0-3m	6-12 m		Q3 2013	Q4 2013E	Q1 2014E	Q2 2014E	Q3 2014E	Q4 2014E	Q1 2015E	Q2 2015E	Q3 2015E	Q4 2015E	2012	2013E	2014E	2015E	2016E	2017E	2018E
Energy				5Y Cyclical																	
NYMEX WTI	USD/bbl	97.0	92.5	81.0	108.0	99.0	97.0	89.0	97.0	88.0	91.0	83.0	90.0	81.0	94.1	98.9	92.8	86.3	83.0	78.0	80.0
ICE Brent	USD/bbl	100.0	97.5	85.0	112.0	105.0	100.0	95.0	100.0	95.0	95.0	90.0	95.0	90.0	111.7	108.2	97.5	92.5	90.0	85.0	85.0
Henry Hub Natural Gas	USD/MMBtu	3.7	3.8	N/A	3.55	3.60	3.70	3.60	3.70	3.90	4.20	4.50	4.50	4.80	2.75	3.70	3.70	4.50	4.90	4.90	5.50

Source: Citi Research

Energy overview: Cycles persist, but secular trends are clear

- **The previous decade's bull run in energy was driven by fundamentals, specifically robust demand growth and consistent disappointments on supply. Citi's big picture view of energy is that those have now flipped**, and that the outlook for supply on a global basis is now robust, while it is demand growth that is set to disappoint. The US shale revolution, coming on top of the maturation of deep-water production, paints a robust supply picture. In oil we are seeing ramp ups underway in Brazil, Iraq and the Caspian, while the US continues to surge, and Mexico's reforms may mean that the country is close to turning a corner. Global LNG markets are tight but once US exports take-off in 2015/2016, along with another surge in supply from Australia and East Africa, those markets are expected to loosen.
- **The demand side of the equation also looks very different this decade as compared to the last** due to a long list of factors: a slower rate of global economic growth, a change in the composition of that economic growth – namely more from the less energy intensive developed markets (DMs) and less from the more energy intensive emerging markets (EMs). Even within the EMs, the shifting focus away from energy intensive export-driven heavy industry and onto consumption/services points to less energy-intensive GDP growth going forward.

Figure 32. Indexed Rolling Front Month Energy Prices (1/1/2013 = 1) (YTD)



Source: Bloomberg, Citi Research

- **Finally, the increasing focus on energy efficiency, and natural gas substituting for oil while renewables substitute for coal and gas, all point to a less hydrocarbon intensive future than was assumed previously.** These secular trends are all already clearly visible in the global energy markets: the changing power generation mix in Europe, the surge in solar installations in Japan and China, Shell's agreement with TravelCenters of America to install LNG fuel lanes at up to 100 of its US interstate truck stops; UPS and FedEx both trialing LNG as a long-haul fuel; Saudi Arabia committing to use its own shale gas reserves to back out oil burned for power generation; the list goes on and on.

Infrastructure requirements complicate the commodity cycle

- **Oil is thought of as a global fungible commodity, yet the US is swimming in oil while Asia is tight, similarly US natural gas prices have collapsed under the weight of the shale supply surge while prices in Europe and Asia are markedly higher.** These geographic discrepancies reflect the huge infrastructure requirements for the energy industry to move their products around the world, as well as the complex web of regulations that govern the industry as is the case with US crude exports. The US had spare refining and coal export capacity, so the first way that surplus BTUs escaped the oversupplied US market was via a surge in refined product and coal exports, with decidedly bearish results in both of these markets. Global LNG markets are still very strong, but this is because the US for now has no ability to export LNG. This will change once the US export ramp up begins in 2015/2016 once the necessary infrastructure is put in place. The petrochemical industry will face a similar challenge later this decade once the massive petrochemical build out in the US comes on line. The huge volatility in the Brent-WTI spread in 2013 reflects the nature of infrastructure additions; they tend to be lumpy and unpredictable in the timing of their market impact. Yet what is clear to us is that the infrastructure, and the market impact, is coming.

Potential surprises in the energy space in 2014

- **US LNG Export Facility Approvals** – The US has so far approved four LNG export projects, totaling 6.4-Bcf/d. The rate of project approvals has been increasing to one every two months. Citi expects more approvals to be coming before year-end. The DOE-commissioned analysis earlier this year concluded that between 6- to 12-Bcf/d of exports would have net benefits for the US economy. This same analysis also concluded that unlimited exports would have even more of a net benefit. The market has been assuming that 12-Bcf/d was the cap on export approvals, but at the current rate of approvals that level will be hit in 1H14.

- **Movement on US Crude Exports –** The frequent gluts of light, sweet crude on the Gulf Coast are expected to drive a surge in export license applications for crude. Contrary to public opinion and debate, US law does not have to be changed to facilitate crude oil exports – the President retains considerable discretionary power and certainly enough authority to make a major difference. And an expected increase in applications appealing to these authorities might slowly lift the barriers to crude exports – by stealth, and on a case-by-case basis. See Hydrocarbons Surge to Top of US Export List

- **Iran –** Meaningful progress in negotiations between the West and Iran over the country's nuclear program would be bearish oil as it would start the process of bringing missing Iranian barrels back to the market, but it could also be extremely disruptive to natural gas markets later in the decade. Iran appears to be another Qatar in terms of its gas reserves; it shares the North Dome/South Pars field, the world's biggest, with Qatar.

- **Venezuela –** Probably the biggest bull risk to the oil market in 2014 outside of the MENA region. The current regime is looking increasingly unstable, with rampant inflation, shortages of food and other basics. In the event of a coup the country's production could collapse as it did back in 2002

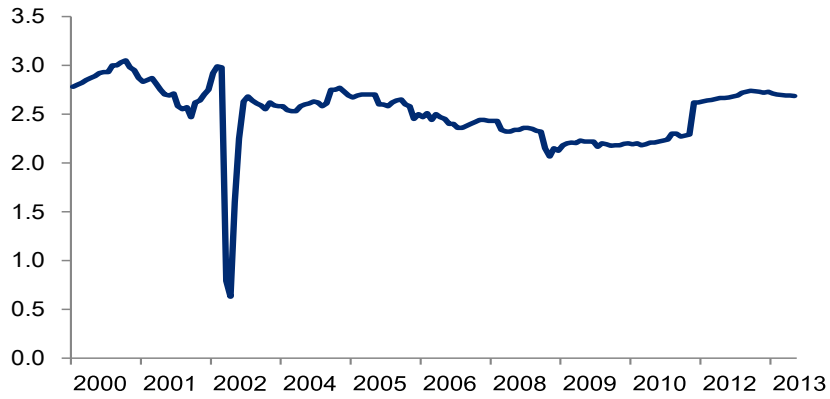
Figure 33. US, Iran & Venezuela Oil & Gas Reserves (2002 & 2012)

Proven Oil Reserves (bln barrerls)		
	As of 2002	As of 2012
US	30.7	35.0
Venezuela	77.3	297.6
Iran	130.7	157.0

Proven Gas Reserves (tcm)		
	As of 2002	As of 2012
US	5.3	8.5
Venezuela	4.2	5.6
Iran	26.7	33.6

Source: BP, Citi Research

Figure 34. Venezuelan Crude Production (m b/d) (2000-2013)



Source: Bloomberg, Citi Research

Is the US shale oil surge setting the stage for another supply crunch? We think not

- **The IEA has been vocal recently that the capex restraint in the Middle East, a direct result of the US shale oil supply surge and the resulting market uncertainty**, **may be setting the stage for another supply crunch in the decades to come**. This argument is based on two assumptions: that the shale supply surge is ephemeral and will run out of steam and that demand will continue to grow unabated. Citi thinks both of these assumptions are misplaced.

- **The notion that the shale supply surge will prove ephemeral still has many boosters**. The parabolic decline rates of individual shale wells continue to persuade many that production growth from these plays are unsustainable. The problem with this analysis is that it stands in stark contradiction to what has actually been observed in the US over the last 10 years; despite prices collapsing and rig counts falling by 70%, production continues to climb. Yes the liquids being produced are subsidizing the gas, but what matters for this argument is that production continues to climb; improving technology coupled with capex spend can trump the parabolic declines. Extrapolating 10 or even 20 years into the future is a fool's errand, but as the EIA's well productivity report **(US Oil and Gas Drilling Productivity)** showed, there is as yet no sign of production rolling over. The opposite is in fact occurring, with IP rates growing significantly for both oil and gas shale plays.

- **There are three key variables that drive a well's production profile: total recoverable reserves, recovery and decline rates.** Companies can do little about the 1st, but they can do a lot about the other two. Recent experience in the Marcellus shows how companies can improve their shale reservoir management techniques to reduce the decline rates, or rather to have production plateau sooner and at higher levels. The next area with potentially game changing impact is on the recovery factor. The EIA has estimated recovery rates in 28 significant shale plays in the US, weighting these by their estimate of oil in place gives a recovery factor of 3.2%, with a range of 1% to 9%. With conventional fields seeing recovery rates in the 60% range, there is clearly scope for improvement in shale plays. Current technological options to achieve this include: optimal well spacing; longer laterals and more frac stages; completion of higher proportions of the vertical pay section and developing the less-productive parts of each play.

- **Another flaw in the argument is the assumption that the shale revolution will remain a North American phenomenon**. The surging interest in shale and the widespread nature of the resource makes this untenable in our view. It will take time to happen and many countries/basins are likely to disappoint, but many will not. Shale production outside North America is not expected to have much of an impact this decade, but by next decade, especially if the US is starting to show its age, things will likely look very different. The incentives to chase shale are more than just economic, as there are growing incentives to develop indigenous energy resources for "energy security" purposes. This is driving countries to adjust their tax systems to attract companies and capital, which will in turn make for a less resource nationalist system, one that even OPEC countries will have to adapt to.

- **Furthermore, the notion that there is in fact a substantial pullback in hydrocarbon investment in the Middle East seems to be entirely founded on the pullback in Saudi Arabia's planned capacity expansion to 15 m-b/d from its current level of 12.5 m-b/d**. There is no shortage of recent newsflow indicating robust investment in the region: Abu Dhabi's $52bn expansion aimed at raising capacity from 2.9 to 3.5 m-b/d by 2017; Saudi Arabia's shale gas production program, Kuwait confirming its own capacity expansion program.

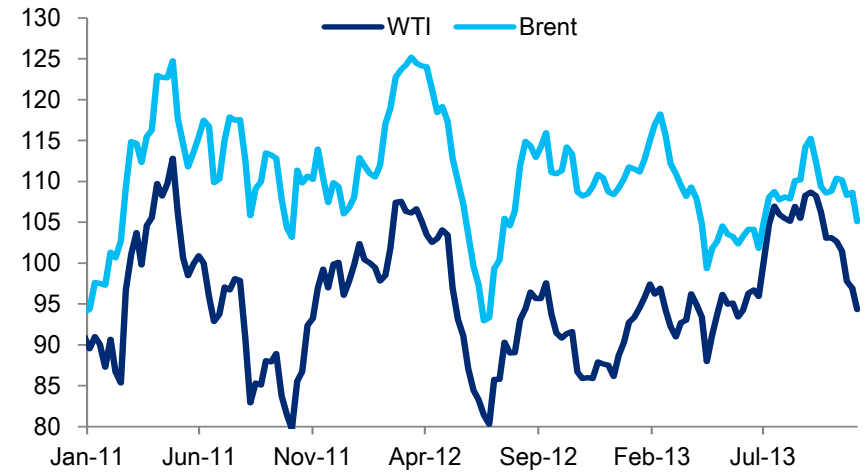
- **On the demand side of the equation, the IEA continues to underestimate the impact of gas for oil substitution in our view.** The IEA does continue to rein in its projections of oil demand growth; having dropped its estimate of 2030 global oil demand from over 120 m-b/d in 2004 to just under 100 m-b/d in their report last week. Citi thinks that gas substituting for oil in the transportation sector is the next stage of the energy revolution the world is living through, and oil demand will surprise to the downside as a result.

Oil in 2014 – déjà vu all over again?

- **2014 looks like a year in which OPEC will have to cut. Non-OPEC supply growth looks robust and demand growth remains underwhelming.** This leaves balances looking distinctly bearish. The US supply surge continues and it is now being joined by Kashagan in the Caspian, Brazil and Iraq. Emerging markets are bearing the brunt of the prospect of US Fed tapering which is taking a toll on demand. The problem with this view is that if we go back 12 months this is exactly what market expectations were for 2013, yet far from Saudi cutting production to balance the market the Kingdom instead went to record levels of production of over 10-m b/d over the summer as an unprecedented level of supply disruptions left a huge hole to fill. With 3.5-m b/d of oil offline, the obvious question is: how much worse can it get? Iranian and Libyan production are already so reduced that the risks are of more rather than less oil coming to market from both of these countries.

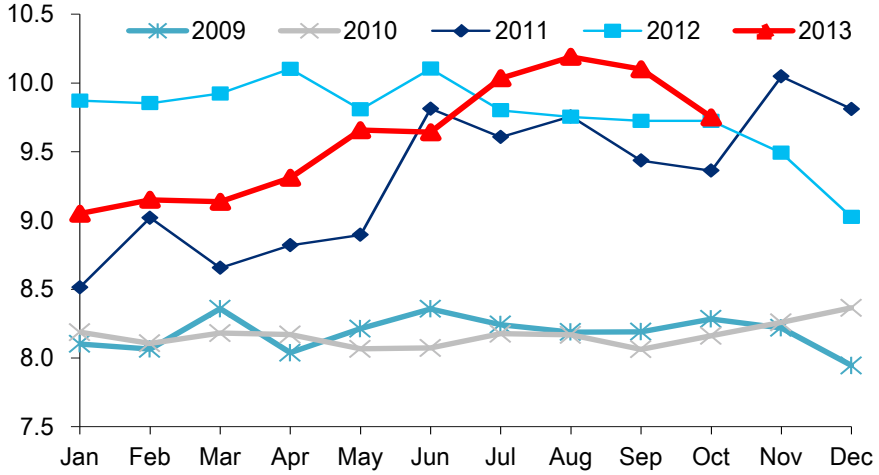
- **Prices started 2013 with a bang on the back of a flood of new money into commodities, spurred on by a surprise Saudi cut.** The lackluster performance of commodities this year - especially versus equity markets - makes the first factor look unlikely, but it cannot be ruled out. Neither can the prospect of an aggressive Saudi cutback in production. The kingdom has significantly more flexibility to cut back crude production over the winter months as their need for associated gas for summer power generation needs is less acute. Furthermore, the ramp-up in the Jubail refinery should result in lower crude exports, and the 4Q start up at Yanbu, another 400-k b/d, should further curtail exports even absent any production pullback.

Figure 35. Brent and WTI Rolling Front Month Prices ($/bbl) (2011-2013)



Source: Bloomberg, Citi Research

Figure 36. Saudi Crude Production (m b/d) (2009-2013)



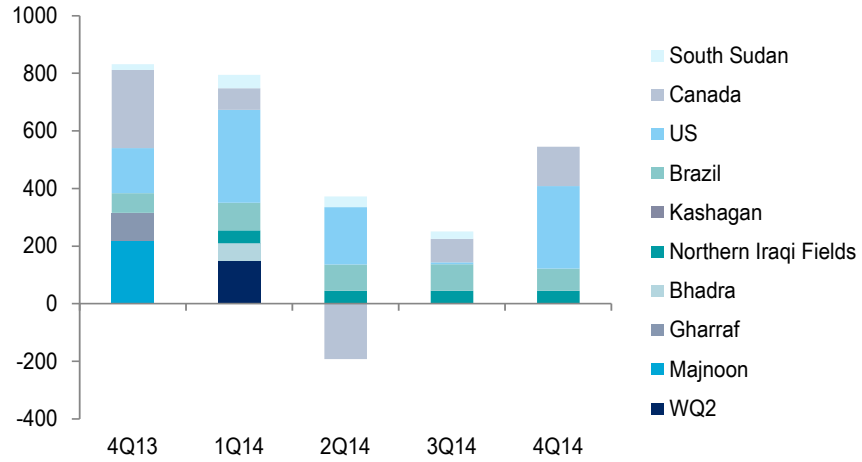
Source: JODI, Argus, Citi Research

2014 – This time really is different

- **The surge in supply is happening now. Brazil and Kashagan, both long delayed, are finally seeing the ramp-up in production get underway.** The ongoing US production surge and resulting weakness across the US market, including WTI timespreads, threatens to become a dead-weight on the oil market. WTI rallied hard against Brent in 2013 on a massive infrastructure build-out. More pipelines are starting up in 2014, but the Gulf Coast has already weakened materially against global markets as a glut of light, sweet crude starts to weigh on the region.

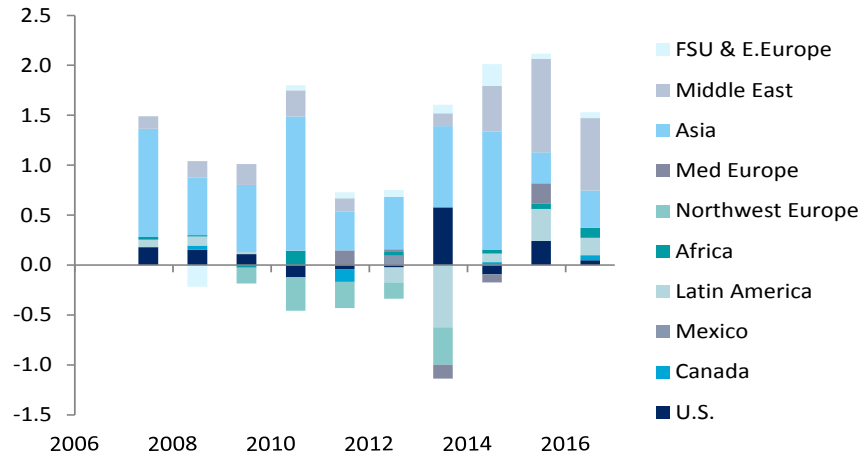
- **Citi raised its oil price forecast when it looked all but certain that the US was about to attack Syria. Given the radical departure from script that has ensued, along with the progress towards a deal over the Iranian nuclear program, Citi is rescinding its increase in oil price expectations**, and is reverting to its previous forecast, with $105 for Brent in 4Q'13 and $98 for 2014. The bearish pressures on the oil market are growing and looking less likely to be derailed by supply disruptions in 2014, given the already-high levels impacting the market. Venezuela is the best candidate for a potential bullish geopolitical surprise, but overall the odds favor a softer market in 2014 as compared to 2013, with balances pointing to oversupplied crude and product markets.

Figure 37. Key Incremental Q/Q Oil Supplies in 2014 (k b/d) (2013-2014)



Source: Company Reports, EIG, IEA, Citi Research

Figure 38. Global Refinery Additions (m b/d) (2007-2017)



Source: ESAI, Citi Research

Global oil supply-demand balances

- **Citi expects non-OPEC supply to continue outpacing global oil demand, increasing spare crude capacity and hence our bearish outlook on prices for 2014 onwards.**

- **Citi expects global oil demand to grow 1-m b/d y/y in 2014** as improving global GDP growth is offset by less oil-intensive growth and continued gas-for-oil substitution resulting in a similar growth level to 2013. Growth is driven by non-OECD oil demand which is expected to grow 1.30-m b/d. Demand growth in China of 0.36-m b/d will likely remain the largest of any single country whilst Latin American and Middle Eastern oil demand combined should also grow 0.36-m b/d. Oil demand is expect to continue dropping in OECD countries, led by OECD Europe where a drop of 0.14-m b/d is expected y/y in 2014.

- **Non-OPEC supply is expected to grow 1.71-m b/d y/y in 2014 driven unconventional and deep-water production.** North American supply growth of 1.14-m b/d makes up the bulk of the increase. The start-up of commercial production at Kashagan should boost FSU output, while Brazilian supply is expected to reverse output declines. (See further discussion on this later on.)

- **The "Call on OPEC crude" could drop to 29-m b/d in 2014** as non-OPEC supply growth continues to overshadow oil demand increases. This is a 1.11-m b/d fall from the 2013 level of 30.1-m b/d.

Figure 39. Citi Global Oil Supply/Demand Balances (m b/d)

Demand	1Q12	2Q12	3Q12	4Q12	1Q13	2Q13	3Q13	4Q13	1Q14	2Q14	3Q14	4Q14	2012	2013	2014	2015	12/13 YoY	13/14 Y/Y	14/15 Y/Y
OECD Americas	23.4	23.6	23.7	23.8	23.7	23.7	23.9	23.7	23.7	23.8	23.8	23.7	23.6	23.8	23.7	-	0.13	-0.03	-
OECD Europe	13.7	13.8	13.8	13.7	13.2	13.8	13.8	13.4	13.1	13.3	13.7	13.5	13.7	13.5	13.4	-	-0.20	-0.14	-
OECD Asia	9.2	8.1	8.3	8.8	8.9	7.9	8.2	8.6	8.8	7.7	8.0	8.5	8.6	8.4	8.3	-	-0.19	-0.13	-
OECD Demand	**46.3**	**45.5**	**45.9**	**46.2**	**45.8**	**45.4**	**45.8**	**45.7**	**45.6**	**44.9**	**45.5**	**45.6**	**46.0**	**45.7**	**45.4**	**45.2**	**-0.26**	**-0.30**	**-0.30**
China	9.5	9.6	9.8	10.3	9.9	10.0	10.2	10.4	10.3	10.3	10.4	10.8	9.8	10.1	10.5	-	0.35	0.36	-
India	3.4	3.4	3.2	3.4	3.4	3.5	3.2	3.6	3.6	3.6	3.4	3.6	3.3	3.4	3.5	-	0.09	0.11	-
Other Asia	7.9	8.0	7.9	8.1	8.2	8.2	8.1	8.2	8.3	8.4	8.3	8.4	8.0	8.2	8.3	-	0.20	0.17	-
Africa	3.6	3.6	3.6	3.7	3.8	3.8	3.8	3.9	3.9	4.0	3.9	4.0	3.7	3.8	4.0	-	0.13	0.17	-
Non-OECD Europe	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	-	0.00	0.01	-
FSU	4.3	4.4	4.6	4.6	4.3	4.5	4.8	4.8	4.4	4.6	4.9	4.9	4.5	4.6	4.7	-	0.11	0.12	-
Latin America	6.2	6.4	6.5	6.6	6.4	6.6	6.7	6.6	6.4	6.7	6.9	6.8	6.4	6.6	6.7	-	0.16	0.14	-
Middle East	7.3	7.8	8.2	7.5	7.5	7.8	8.4	7.7	7.6	8.1	8.6	8.0	7.7	7.8	8.1	-	0.17	0.22	-
Non-OECD Demand	**42.7**	**43.9**	**44.5**	**44.8**	**44.1**	**45.0**	**45.8**	**45.8**	**45.3**	**46.4**	**47.1**	**47.2**	**44.0**	**45.2**	**46.5**	**47.8**	**1.21**	**1.30**	**1.35**
Total Demand	**89.0**	**89.4**	**90.4**	**91.1**	**89.9**	**90.5**	**91.6**	**91.6**	**90.9**	**91.2**	**92.6**	**92.9**	**89.9**	**90.9**	**91.9**	**92.9**	**0.95**	**1.00**	**1.05**

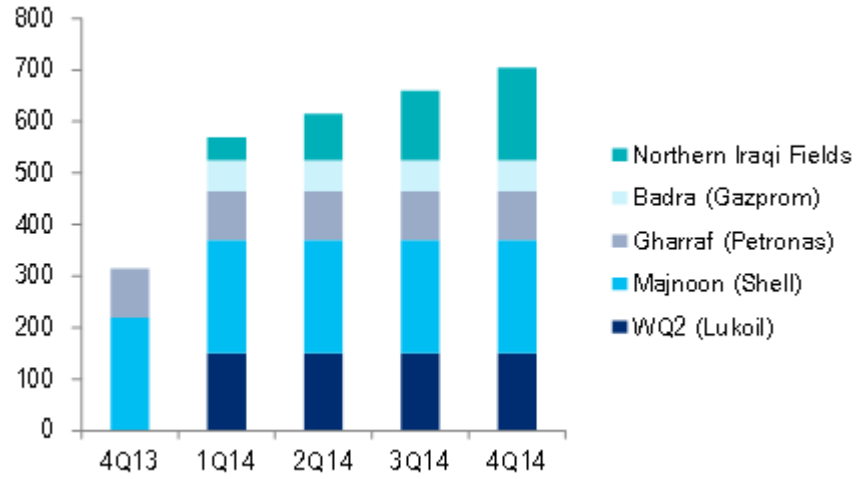
Supply	1Q12	2Q12	3Q12	4Q12	1Q13	2Q13	3Q13	4Q13	1Q14	2Q14	3Q14	4Q14	2012	2013	2014	2015	12/13 YoY	13/14 Y/Y	14/15 Y/Y
North Sea	3.4	3.2	2.8	2.9	3.0	2.9	2.7	3.0	3.0	2.8	2.6	2.9	3.1	2.9	2.8	-	-0.19	-0.07	-
FSU	13.7	13.6	13.6	13.7	13.8	13.8	13.8	13.8	13.9	14.0	14.0	14.0	13.6	13.8	14.0	-	0.17	0.16	-
United States	8.9	8.9	9.1	9.8	9.8	10.1	10.4	10.5	10.9	11.0	11.1	11.3	9.2	10.2	11.1	-	1.02	0.88	-
Canada	3.8	3.6	3.6	3.9	4.0	3.8	4.0	4.3	4.3	4.1	4.2	4.4	3.8	4.0	4.3	-	0.26	0.26	-
Mexico	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	-	-0.04	0.00	-
Brazil	2.3	2.1	2.1	2.2	2.1	2.1	2.1	2.2	2.3	2.3	2.3	2.4	2.2	2.1	2.3	-	-0.05	0.22	-
Total non-OPEC Oil	**49.8**	**48.9**	**48.7**	**50.2**	**50.2**	**50.1**	**50.2**	**51.3**	**52.0**	**52.0**	**51.9**	**52.7**	**49.4**	**50.4**	**52.2**	**54.0**	**1.04**	**1.71**	**1.85**
Iraq	2.7	2.9	3.1	3.1	3.0	3.2	3.0	3.2	3.1	3.4	3.6	3.7	3.0	3.1	3.4	-	0.13	0.34	-
Iran	3.4	3.1	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	3.0	2.7	2.7	-	-0.32	-0.01	-
OPEC Crude	**31.3**	**31.7**	**31.5**	**30.7**	**30.4**	**30.8**	**30.6**	**30.3**	**30.2**	**30.5**	**30.5**	**30.5**	**31.3**	**30.5**	**30.4**	**30.5**	**-0.78**	**-0.13**	**0.10**
OPEC NGL	6.0	6.0	6.1	6.1	6.1	6.2	6.3	6.3	6.4	6.4	6.5	6.5	6.1	6.2	6.5	6.7	0.16	0.24	0.24
Processing Gains	2.1	2.1	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.2	2.2	2.2	0.04	0.04	0.04
Global Biofuels	1.5	1.9	2.1	1.9	1.5	2.0	2.3	2.1	1.7	2.1	2.4	2.1	1.9	2.0	2.1	2.2	0.11	0.13	0.13
Total Supply	**90.8**	**90.6**	**90.6**	**91.1**	**90.4**	**91.2**	**91.6**	**92.1**	**92.6**	**93.2**	**93.6**	**94.0**	**90.8**	**91.3**	**93.3**	**95.7**	**0.58**	**1.99**	**2.35**
Call on OPEC Crude	**29.5**	**30.4**	**31.2**	**30.7**	**29.9**	**30.1**	**30.6**	**29.7**	**28.6**	**28.5**	**29.5**	**29.3**	**30.5**	**30.1**	**29.0**	**27.8**	**-0.41**	**-1.11**	**-1.20**
Implied Stock Build	**1.8**	**1.3**	**0.2**	**0.0**	**0.5**	**0.8**	**0.0**	**0.5**	**1.7**	**1.9**	**1.0**	**1.2**	**0.8**	**0.4**	**1.4**	**2.7**	**-0.37**	**0.99**	**1.30**

Source: Citi Research

The supply keeps coming on the long wave of high upstream capex… driven by North America, but also Iraq, Kazakhstan, Brazil…

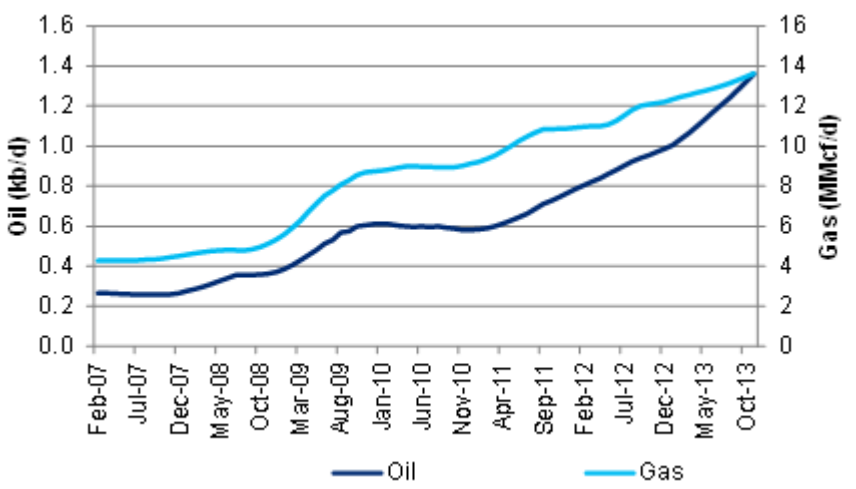
- **2014 looks set to be another strong year for global oil supply growth**. Non-OPEC supply growth is expected to grow 1.7-m b/d led by rampant North American production. North American growth should continue its rampant pace driven by improvements in productivity, efficiency and drilling techniques (see charts below right and overleaf). The Bakken, Eagle Ford and Permian Basin plays should continue to drive US growth but growth in smaller plays such as those in Oklahoma and Colorado add further barrels. In Canada, growth in dilbit (diluted bitumen) production of ~0.2-m b/d should make up the bulk of output growth. Producers remain committed to oil sands production, highlighted by the recent commissioning of the Fort Hills project which is close to the top of the global cost curve.
- **Outside of North America, Iraq is set for the largest y/y growth in output**. The start-up of several new fields in 4Q'13/1Q'14 in both the south and the north could add ~700-k b/d of incremental new supply by end-2014 whilst existing southern fields West Qurna-1, Zubair and Rumaila could further ramp-up. Y/Y production increases will likely be lower however due to maturing field declines, infrastructure problems, KRG political issues and probable pipeline attacks. Iraq's official growth estimate for 2014 is 0.5-m b/d but a more realistic base case is ~0.3-m b/d. Iraq could offset Libyan production where disruptions are expected to persist.
- **Following initial teething problems at the Kashagan oil field, the ramp-up in output will likely be pushed into 1Q'14** which could see the field producing around 100-k b/d. In 2014, output is expected to reach 180-k b/d, but this may only be reached on a sustainable basis in 2H'14, given the field's previous difficulties.
- **Brazilian production could reverse its recent stagnation as several new projects come online in 4Q'13.** Petrobras continues to invest strongly despite high debt levels, and new platforms are to be installed at Roncador in 2013 and 2014. Attractiveness in Brazil's pre-salt fields appears to have diminished however, highlighted by this year's auction of Libra, where only one consortium bid the minimum amount. Improved regulation is likely needed to further entice IOCs to Brazil.

Figure 40. Cumulative New Field Output in Iraq (k b/d) (2013-2014)



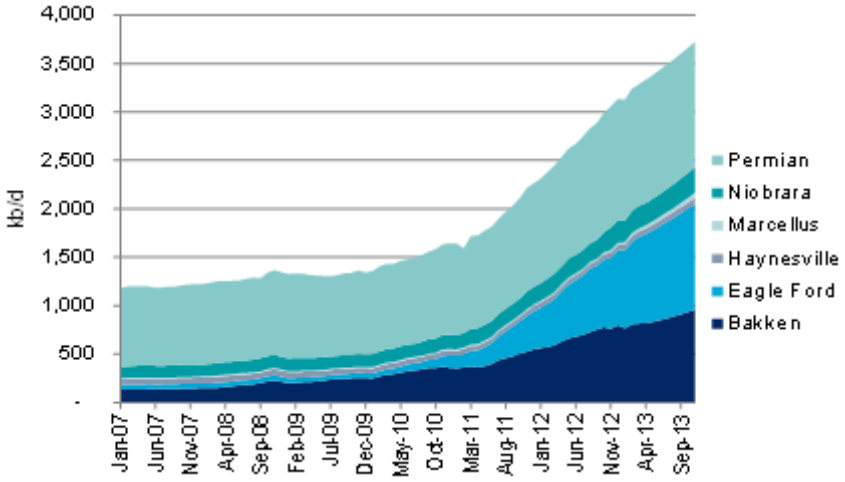
Source: Company Reports, Energy Intelligence, Citi Research

Figure 41. First Month Oil/Liquids and Gas Production Per Rig (2007-Present)



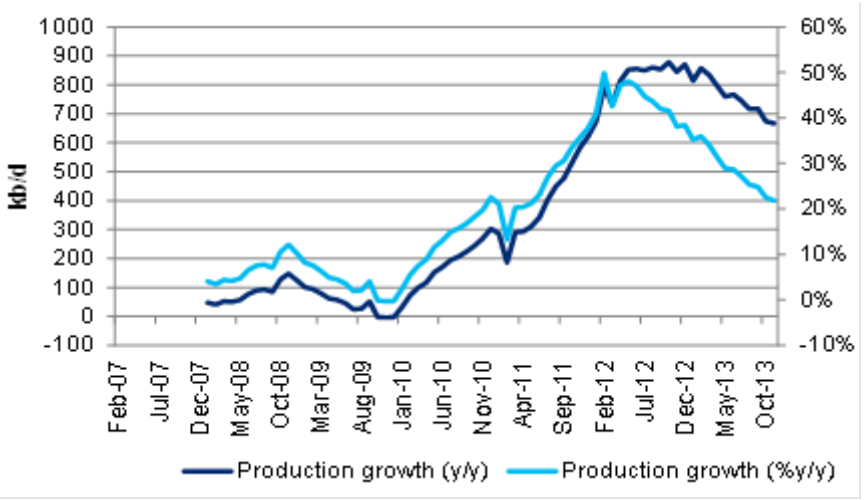
Source: EIA, Citi Research

Figure 42. US Oil/Liquids production began surging in late 2010…



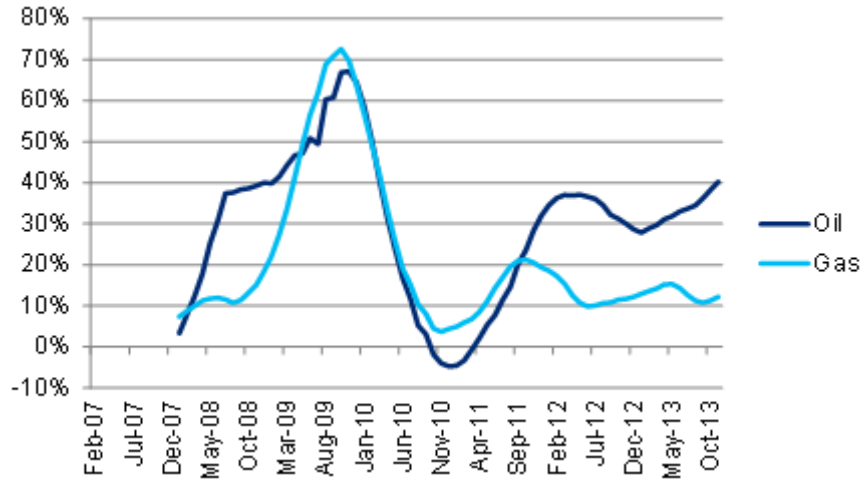
Source: EIA, Citi Research

Figure 43. Y/Y production growth reached 50% at its peak



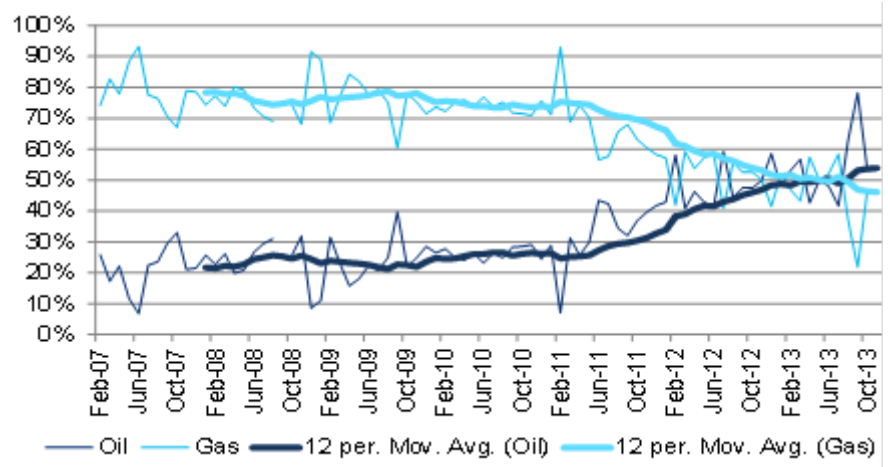
Source: EIA, Citi Research

Figure 44. Leading to continued productivity gains (y/y change in productivity per rig)



Source: EIA, Citi Research

Figure 45. And the wide price differences between oil/liquids and gas have finally boosted new liquids output above gas



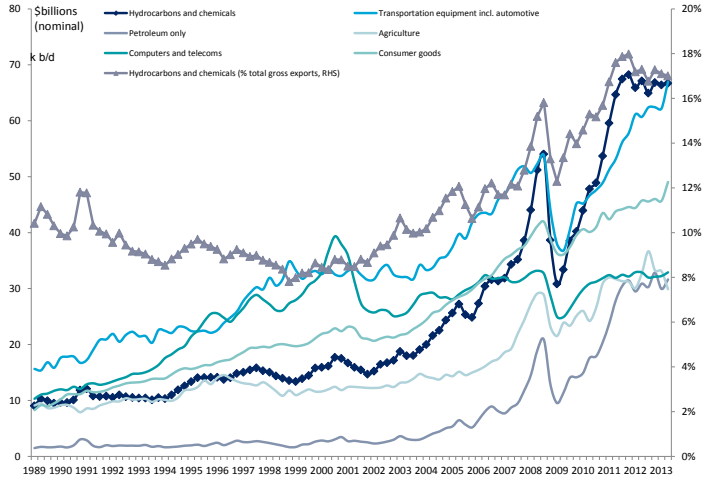
Source: EIA, Citi Research

Hydrocarbons surge to the top of the US export list

- **After surging ahead of agricultural commodities, the combination of petroleum products, LPGs, pipeline natural gas and coal is now running neck and neck against transportation equipment to the top of US gross exports, and accounting for a sixth of total gross exports.** While it remains the case that the US is a large net importer of crude oil, even as rising production and stagnant demand cut the country back to number two at times in 2013 against China, the US has already become a global powerhouse in energy markets.

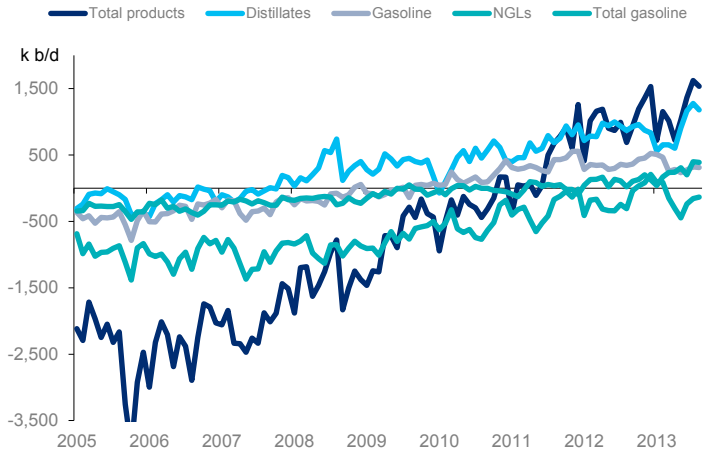
- **By this time next year the US will likely become the largest net exporter of petroleum products**, rising ahead of Russia and transforming the role of the country in global markets. The increasingly well-known petroleum product story has transformed the US from the largest net and gross importer to the largest gross exporter and second largest net exporter behind Russia. The numbers game should continue over the next few years as the US outpaces Saudi Arabia as the major supplier of LPGs to global markets including Asia.

Figure 46. Major categories of US gross exports (1989-Present)



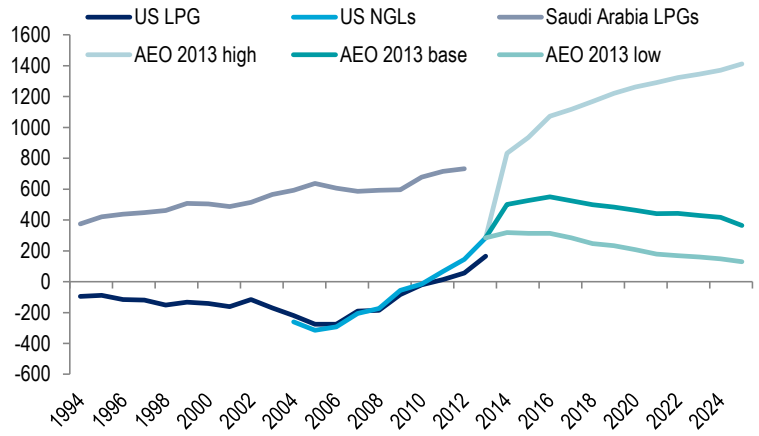
Source: US Census, Citi Research

Figure 47. US Petroleum Net Exports (k b/d) (2005-Present)



Source: EIA, Citi Research

Figure 48. LPG/NGL net exports in the US versus Saudi Arabia LPG exports; US net export projections from EIA's AEO 2013



Source: Saudi Aramco, EIA, Citi Research

Shale developments are beginning outside the US, though very slowly for now…

- **North America is currently the only meaningful producer of shale oil and gas yet the US accounts for only ~15% of technically recoverable global reserves**. Geology alone is not sufficient to generate a US-style revolution as correct legal framework, a developed oil infrastructure and services industry and accommodating credit conditions are all needed yet. Outside of North America progress remains slow but developments are progressing nonetheless.

- **Chinese policy is becoming more accommodating to help develop their shale resources that rank top 3 globally for both oil and gas.** The National Energy Administration recently unveiled its first shale gas policy which pushed for increased financial assistance though subsidies at local and state level and tax breaks as well as encouraging technological advancements through "exhibition / demonstration areas". The national target of 6.5-bcm of shale gas output by 2015 seems optimistic given 2013 output is estimated to be 0.2-bcm but a more progressive policy definitely brings the realization of that target closer.

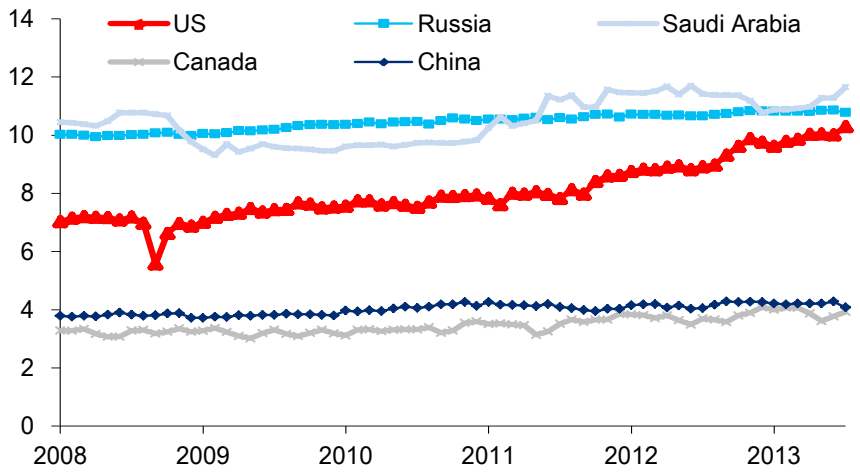
- **Russia like China has abundant shale resources but could additionally benefit from an existing oil and gas infrastructure network**. Reliable legal and tax systems and technology are both cited as important factors yet these are both improving in Russia. Several industry players including Total and Statoil are keen to bring in their expertise in helping Russia develop its unconventional plays whilst the government recently announced new tax breaks that will provide a reduction between 20%-100% on the Mineral Extraction Tax (MET) for shale producers. Rosneft has praised these new tax breaks as they make unconventional resources more economically viable and are expecting to produce 200-k b/d of shale oil by 2020 aside from the giant Bazhenov field that they are yet to fully assess yet.

Figure 49. Top 10 Technically Recoverable Shale Oil & Gas Reserves

Technically Recovarable Reserves				
Shale Gas (Tcf)			Shale Oil (Bln Barrels)	
US	1161		Russia	75
China	1115		US	48
Argentina	802		China	32
Algeria	707		Argentina	27
Canada	573		Libya	26
Mexico	545		Australia	18
Australia	437		Venezuela	13
South Africa	390		Mexico	13
Russia	285		Pakistan	9
Brazil	245		Canada	9
Others	1536		Others	65

Source: EIA, Citi Research

Figure 50. US Moving Towards Being the World's Biggest Oil Producer (Oil Production m b/d)



Source: IEA, Citi Research

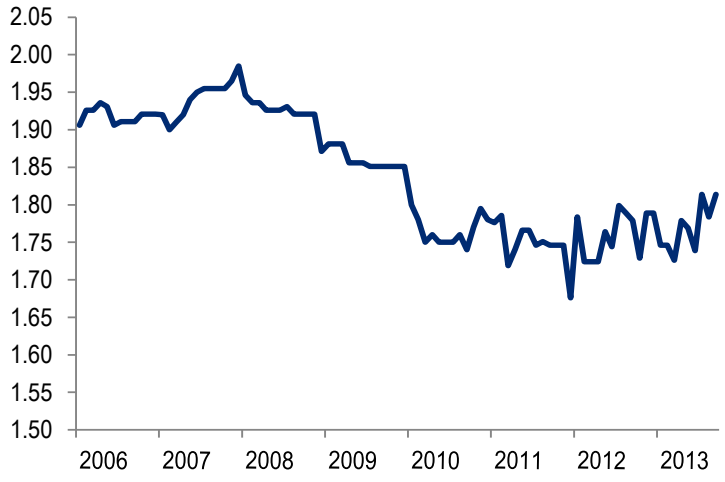
Avoiding production declines and protecting "Energy Security" are also prompting shale exploration

- **Algeria has moved to try and curb its dwindling gas reserves by taking its first steps into shale gas exploration**. During 2013, Sonatrach drilled two shale gas test wells and is rewriting legislation to accommodate shale gas exploration whilst also trying to bring in the expertise of several supermajors. IOCs are also showing interest in Morocco and Tunisia as they look to tap into North Africa's technically recoverable reserves of 38.1-bn bbls of shale oil and 971-Tcf of shale gas.

- **Argentinean shale resources are promising but better policies are needed to help attract foreign investors.** Argentina ranks in the top 5 for both oil and gas resources but nationalist policies and price caps have made it unattractive to foreign investors. Argentina's urgent need for gas to meet domestic demand could push the government into incentivizing foreign companies to invest. Attractiveness in Argentina could be increasing however after a relaxing of some price controls and new shale discoveries; Total recently announced its plan to spend $1bn developing the Vega Pleyade gas and condensate field.

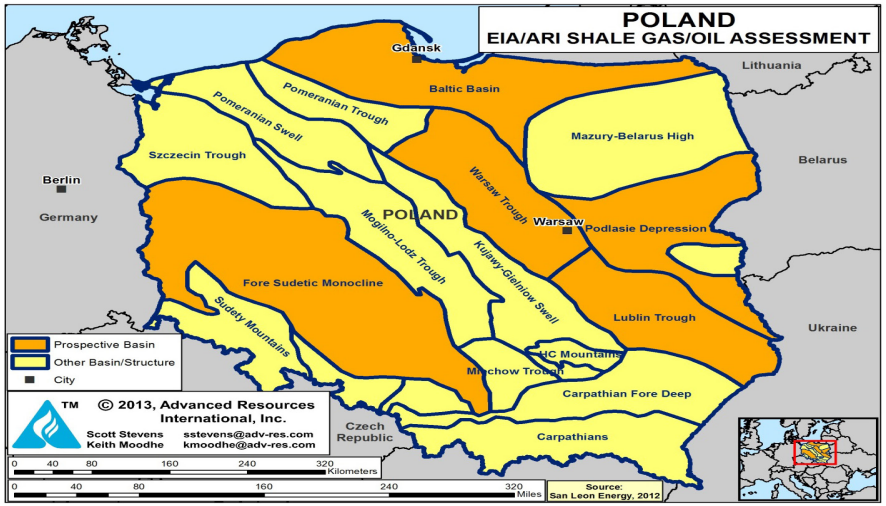
- **Ukraine's recent production sharing agreement (PSA) with Chevron for development of the 105-Tcf Olesska basin marks the country's second PSA deal with an IOC** in 2013 following its $10bn deal with Shell in January. Frequent disputes with Russia over contracted gas supplies is pushing Ukraine into developing its vast shale gas reserves as it looks to diversify away from the former Soviet nation. Elsewhere in Europe, developments have been slow; Poland, Europe's leader in shale exploration, has seen several IOCs pull out while policy continues to hamper progress. The European Commission is expected to issue a set of shale gas guidelines this year but public opinion remains skeptical towards hydraulic fracturing.

Figure 51. Algerian Oil Production (m b/d) (2006-Present)



Source: IEA, Citi Research

Figure 52. Favorable European policy is needed to help unlock Poland's shale potential



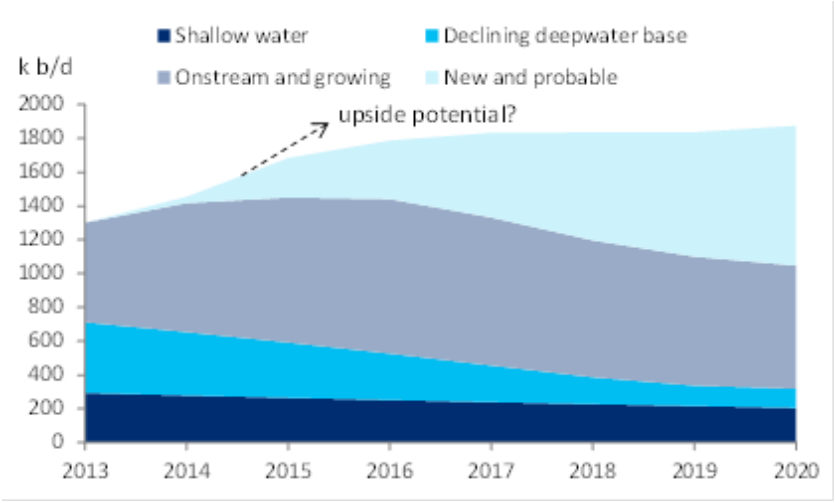
Source: EIA, Citi Research

Deep water too: US Gulf of Mexico begins to add meaningful volumes on top of shale; could Mexico also surprise?

- **The US Gulf of Mexico can begin adding production growth in earnest in 2014, adding to already fast growth in shale production.** At some 1.3-m b/d of production in 2013, this could rise to over 1.8-m b/d by 2016, or some ~150-k b/d each year for the next few years. 2014 could see growth from Atlantis, Auger, Caesar/Tonga, Cascade, Chinook, Na Kika, Tahiti, Thunder Horse, Who Dat, with potential new volumes from Big Foot, Dalmatian, Lucius, Tubular Bells.

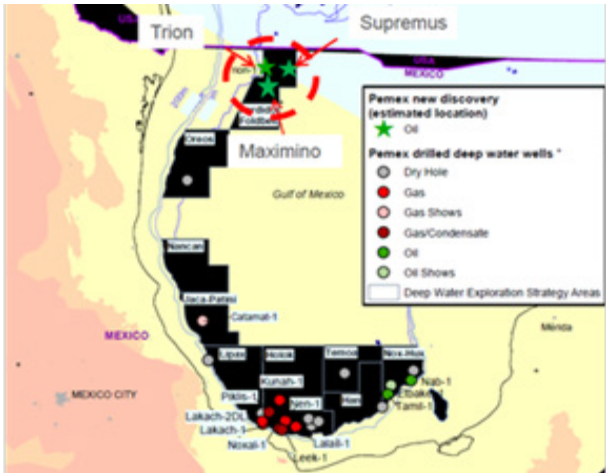
- **Mexico energy reforms could unlock near-term and long-term supply.** In the near-term, the Trion, Supremus and Maximino fields in the Perdido Basin, on the Mexican side of the Gulf of Mexico, could be producing quicker than expected if Mexican energy reforms proceed smoothly and these fields can be tied back to nearby US subsea lines through Pemex partnerships with IOCs that would be unlocked by the Mexican constitutional changes under proposal. In the longer term, onshore plays, including shale in the Burgos Basin, which is an extension of the same formation as the Eagle Ford in Texas, could also drive supply growth.

Figure 53 .The US Gulf of Mexico can begin to add significant production growth next year



Source: Woodmac, Citi Research

Figure 54. Mexico has seen significant discoveries in the Perdido Basin, close to viable production in the US Gulf of Mexico, which could be economic with cooperation with IOCs

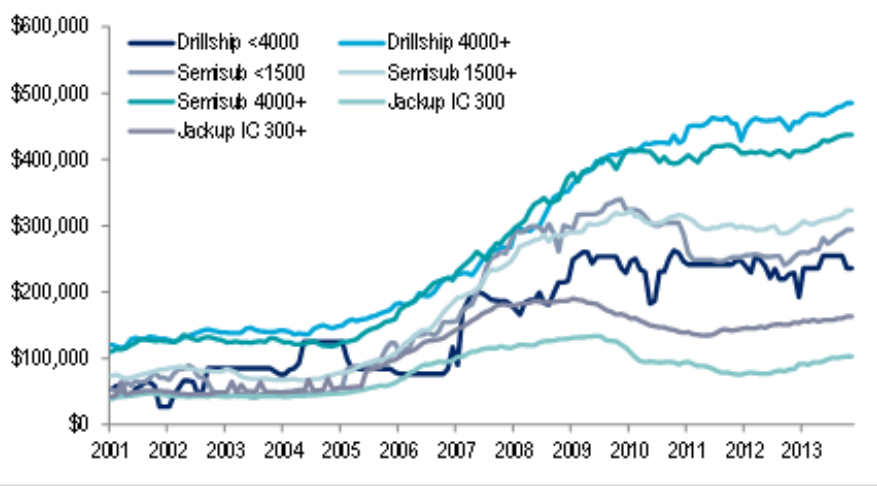


Source: EIA, Citi Research

Spread of deep water oil resources

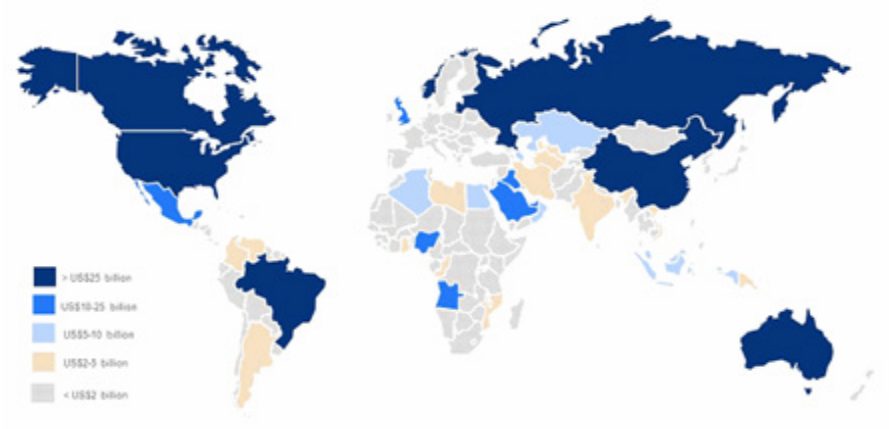
- Although shale has been present in popular news reporting, deep water supplies also represent massive growth potential, with some $70bn in development spending in 2013 surging to an estimated $100bn by 2016. Major activity is focused on Brazil, West Africa, Australia and the Gulf of Mexico, but East Africa, Indonesia and Israel hold great potential too.
- While the services sector has been loosening for US shale, it is still rather tight for deep water, even as it has loosened for shale. Deep water well demand looks to keep rig capacity utilization high even with new builds in the short-term, but this could plateau. New floating facilities and subsea tie-backs should keep service sector and construction demand robust.
- However, technological improvements for deep water oil has been reducing well costs, allowing smaller projects to be developed economically.
- Global deep water production accounts for some 5-m b/d today but could be as much as 9-m b/d by 2020.

Figure 55. Deep water rig day rates on the rise, with high utilization even with new builds



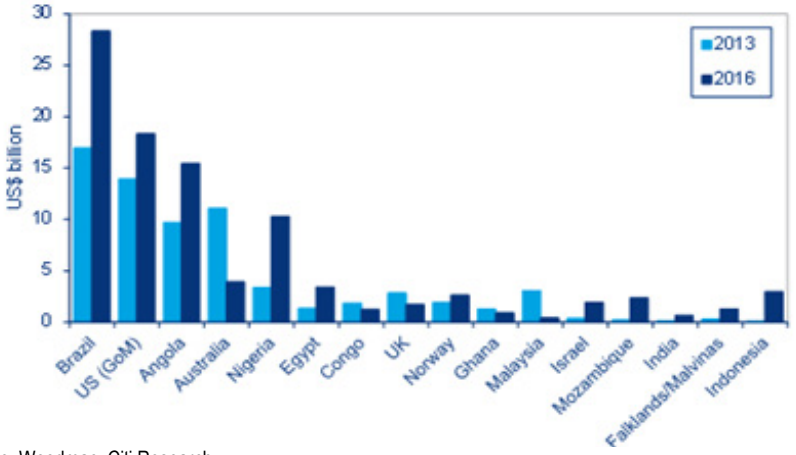
Source: Rigzone, Citi Research

Figure 56. Planned upstream development capex in 2013, focused on North America, Brazil, the FSU, Australia and China



Source: Woodmac, Citi Research

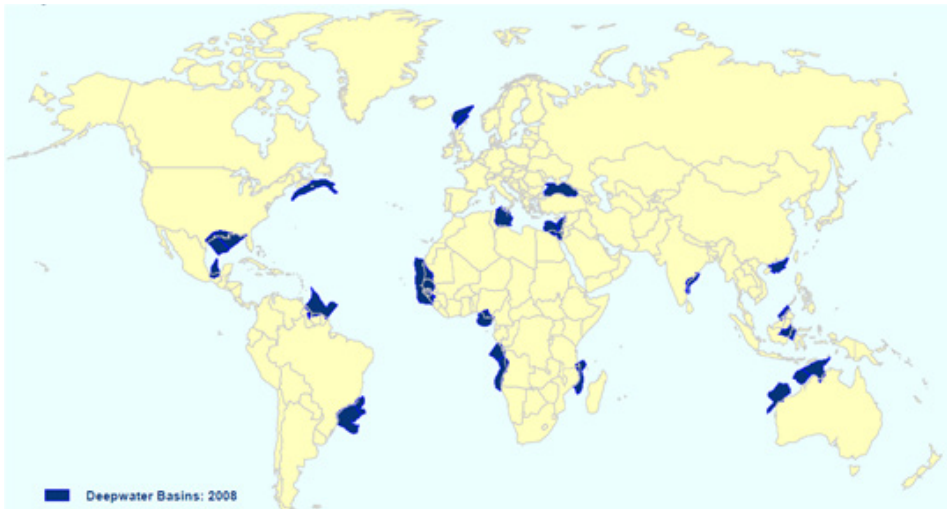
Figure 57. Development spending in deep water plays, 2013 and 2016E



Source: Woodmac, Citi Research

Deep water activity has expanded substantially and should continue to do so going forward…

Figure 58. Deep water drilling activity outlook in 2008…



Source: Wood Mackenzie, Citi Research

Figure 59. …expanded substantially to wide spread areas by 2012

Source: Wood Mackenzie, Citi Research

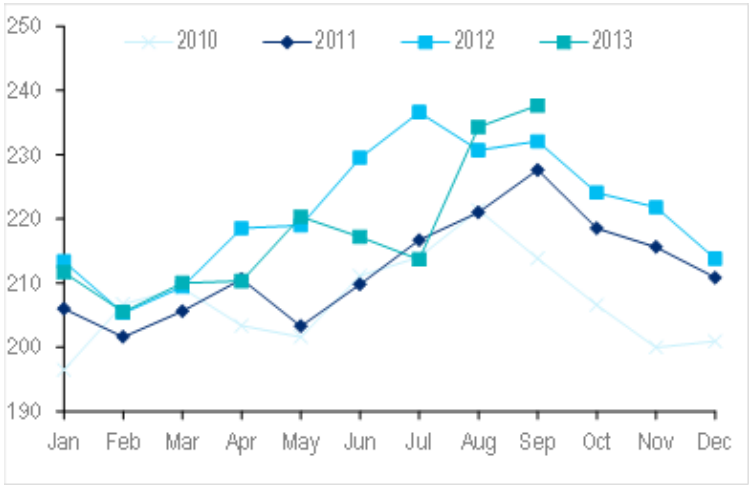
China's SPR stockpiling supports crude import demand, though timing may be opportunistic

- **Chinese strategic stocks come in two flavors: the Strategic Petroleum Reserve (SPR), as well as commercial stocks earmarked as "strategic". China does not look to have added SPR capacity since 2011**, when the two CNPC projects in Lanzhou, Gansu (18.9-m bbls) and Dushanzi, Xinjiang (18.9-m bbls) were completed; these were thought to be filled over 1H'12. Lanzhou and Dushanzi were the first of the SPR Phase 2, which as a total Phase represents a planned 207-m bbls. Phase I, with capacity of 103-m bbls, was completed back in 2008 and has been filled. That put the total SPR at ~141-m bbls filled by end-2012. Two Phase 2 projects expected this year did not transpire and look to be delayed into 2014. These include Sinopec's Zhanjiang, Guangdong (44-m bbls) and CNOOC's Huizhou, Guangdong facility (31-m bbls) – these seem unlikely to be ready until 2014. Thus, SPR fill has not been taking place since 2H'12, and is not expected to resume until later in 2014. But with another 207-m bbls added over 2014-2015, this could require some ~200-250-k b/d over that timeframe of one-off crude demand to fill storage if this is to be on track to be filled by end-2015. But timing could well be opportunistic during periods of lower oil prices, or delayed.

- **However, commercial storage is another story**; there were several storage facilities built in 2013. July saw Sinopec's Tieshan, Guangxi facility (15-m bbls) and September saw Sinopec's Tianjin facility (20-m bbls). 4Q'13 could see Sinochem's Quanzhou, Fujian (9.3-m bbls) and PetroChina's Qinzhou, Guangxi (36-m bbls). This would total 80-m bbls built over 2013. 2014-15 could see commercial capacity grow another 16-m bbls from Sinopec's Yangpu, Hainan facility (2H'14?) and 10-m bbls from Sinopec's Xuwei, Jiangxu facility. Filling this 96-m bbls over 2014-15 could mean an additional ~100-150-k b/d of one-off crude demand over two years.

- **China commercial crude storage capacity of 305-m bbls looks filled to ~78% at the last data point** – August 2013 saw a big surge in commercial crude stocks as reported by Xinhua China OGP, up 20-m bbls m/m to 234-m bbls, and another tick-up to 238-m bbls by September.

Figure 60. China's commercial crude stocks (m bbls)



Source: China OGP, Citi Research

Figure 61. China strategic petroleum reserve (SPR) capacity build-out

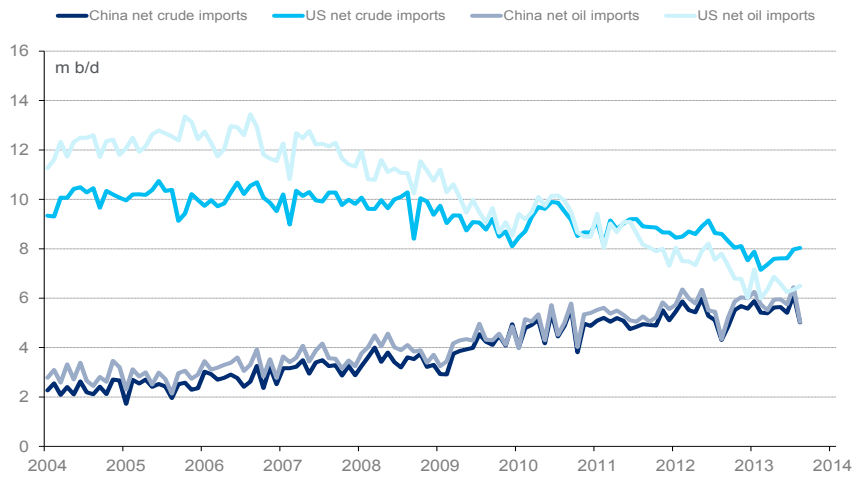
m bbls	Capacity	Completion	Company
Phase 1	103		
Zhenhai, Zhejiang	32.7	2006	Sinopec
Zhoushan, Zhejiang	31.4	2007	Sinochem
Huangdao, Shandong	20.1	2008	Sinopec
Dalian, Liaoning	18.9	2008	CNPC
Phase 2	245		
Lanzhou, Gansu	18.9	2011	CNPC
Dushanzi, Xinjiang	18.9	2011	CNPC
Tianjin Ph. 1	20.1	2013	Sinopec
Zhanjiang, Guangdong	44	2014	Sinopec
Huizhou, Guangdong	31.4	2014	CNOOC
Huangdao, Shandong	18.9	2014	Sinopec
Zhoushan, Zhejiang	19	2014	Sinopec
Jinzhou, Liaoning	18.9	2014-15	CNPC
Jintan, Jiangsu	15.7	2014-15	CNPC
Shanshan, Xinjiang	39	2014-15	CNPC
Phase 3	220-300		

Source: Company reports, Argus, EIG, IEA, Citi Research

China is on course to become the leading net oil importer in 2014…

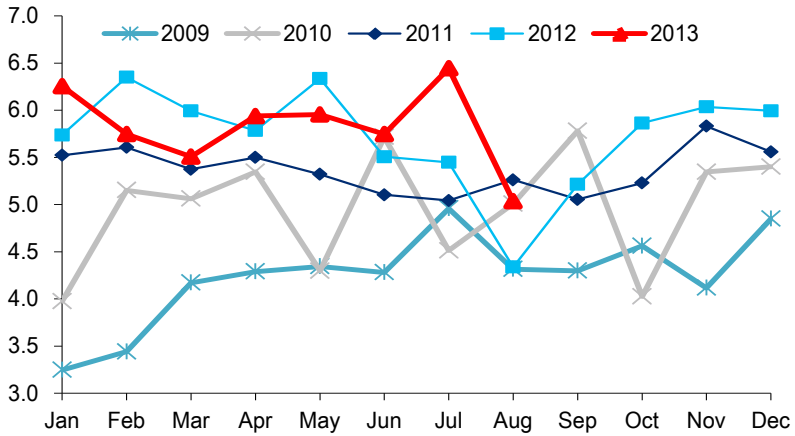
- **2014 marks a significant shift in global oil trade as China is set to topple the US to become the world's leading net oil importer.**
- **US net oil imports look set to decline** as production continues its rampant growth, crude imports continue to get backed out (although term contracts may prove sticky in the short-term) and cheap feedstock and gas provide the US a competitive advantage in refining products.
- **Chinese net oil imports should continue to rise** as oil demand continues to outpace growth in crude production. China is seeing growth in net product exports however (see chart below), a position it already holds for gasoline, diesel and kerosene.

Figure 62.Chinese and US Net Oil Imports (m b/d) (2004-2013)



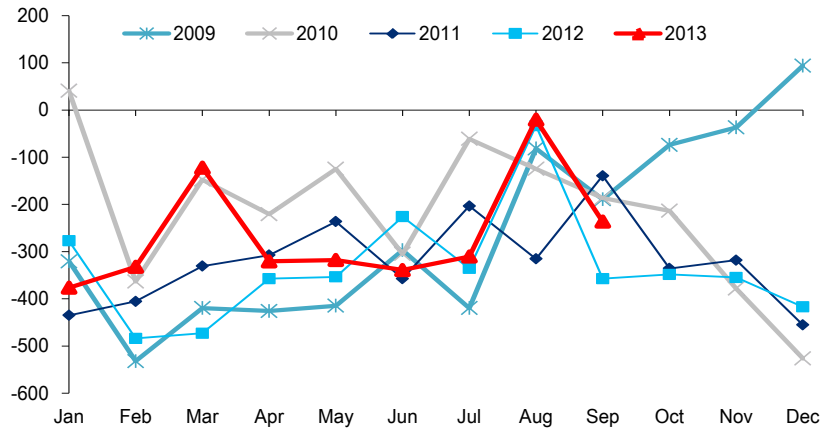
Source: Chinese Customs, EIA, Citi Research

Figure 63.Chinese Net Oil Imports Seasonal (m b/d) (2009-2013)



Source: Chinese Customs, Citi Research

Figure 64.Chinese Net Product Exports (k b/d) (2009-2013)

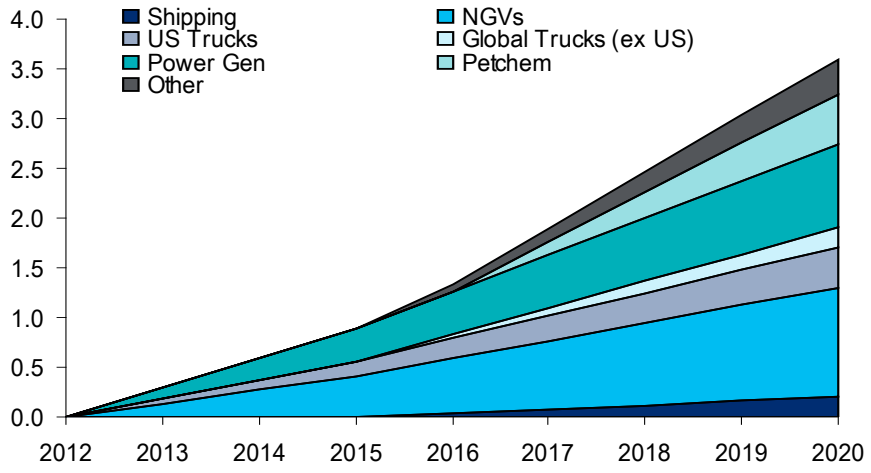


Source: Chinese Customs, Citi Research

Oil-to-gas substitution update

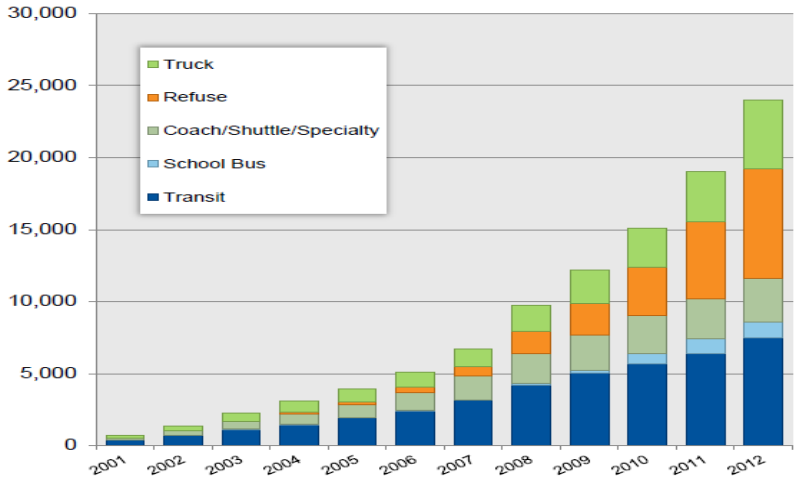
- **NGV's still make up a small percentage of road transportation but improvements are continually being made in infrastructure and technology globally.** In the US, GM recently announced its first NGV for sale in 2014 whilst heavy duty fleets continue to switch to CNG; Missouri city council recently voted to switch the city's fleet entirely to CNG. China continues its aggressive fueling station build out and in Germany, Gazprom is planning on adding another 10 refilling.
- **Marine bunker switching has been boosted by the first "small-scale" LNG reload in Europe.** This comes ahead of the 2015 EU regulation change that is expected to accelerate the use of LNG as a bunker fuel. Europe is also assisting small-scale LNG infrastructure though subsidization; Antwerp port received funding this year to build an LNG bunkering station for the city's barges.
- **Railroad switching to LNG and CNG could now capture a significant portion of the market as several companies announce plans.** BNSF announced earlier this year that it plans to start trialing LNG powered trains subject to US FRA approval. North of the border, Canadian National Railways are already running an LNG powered train and are awaiting the arrival of 4 more due from 4Q13 onwards.

Figure 65. Oil-to gas substitution should continue into 2014 before accelerating post 2015



Source: Citi Research

Figure 66. CWI Engines in North America by Segement (2001-2012)

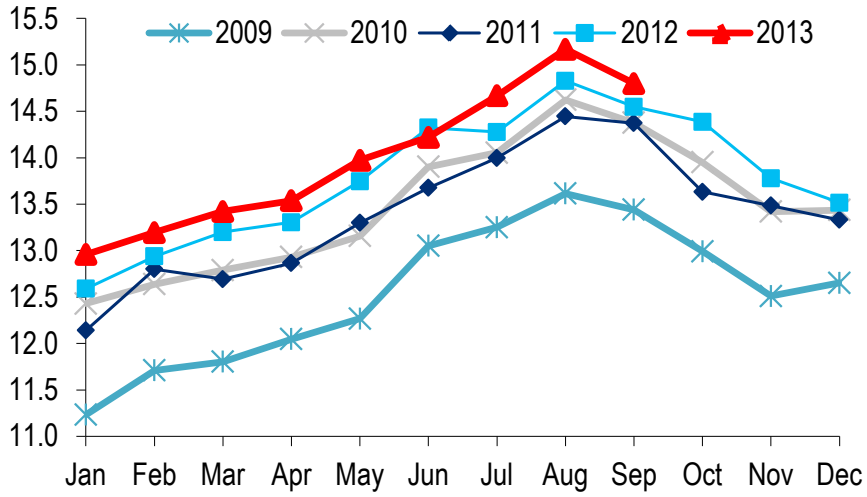


Source: Westport, Citi Research

Changing seasonality of oil markets, as Latam and Mid East demand takes on a larger share of the global pie

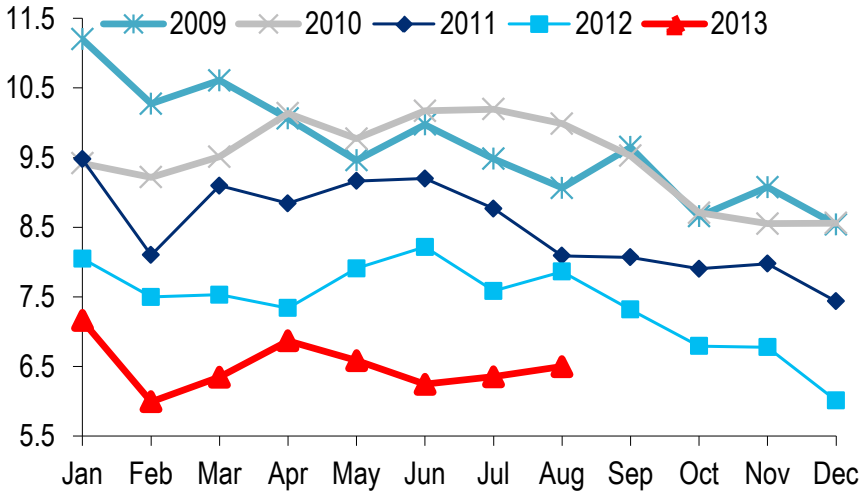
- The swing of power in oil demand from the OECD to the non-OECD and the US shale revolution are changing the seasonality historically seen in oil markets. These forces are altering the seasonal patterns previously seen in inventories, demand, flows and prices, and have particularly bearish implications for Q4.
- **As non-OECD demand overtakes OECD demand in 2014, the seasonality from the non-OECD world should start to dominate world oil demand dynamics**. Latin American oil demand usually peaks in Q3 due to winter heating demand and the Mid-East peaks at the same time as cooling demand is at its highest. These combine to give a highly seasonal demand pattern (see chart below) which drops off into Q4. As oil demand in these two regions grows as a proportion of global oil demand, this seasonality should start to overshadow the peak Q4 winter demand from OECD countries. Non-OECD Asian oil demand, which displays pretty consistent q/q growth, has helped keep the seasonal Q4 pop in global oil demand but with Asian economies forecasted for slower growth this could lead to a more pronounced effect from Middle East and Latam seasonality.
- **The seasonality in global oil inventories has also shifted.** Prior to 2008, stocks normally built in Q2 and Q3 and drew in Q1 and Q4. Since 2008, Q1 has switched to seasonally building, driven largely by US shale production and falling winter oil demand brining forward spring maintenance into Q1. Q3 pre-2008 stock builds have flipped to seasonal draws, helped by peaking oil demand in the Middle East during the quarter. OECD Asian seasonality has played an ever-increasing role while OECD infrastructure build-out has reduced seasonality in inventory management.
- **Spring and winter refinery maintenance used to have a greater seasonal effect on oil prices** (see chart overleaf), but since 2007, oil's correlation with other assets has muted seasonal effects. Oil's recent decoupling from other assets could lead to greater seasonal swings in oil prices, driven by refinery maintenance.
- **US Net Oil Imports also exhibit a large seasonal drop in Q4** as stocks are drawn down into year-end for tax purposes, adding further bearishness to the period.

Figure 67. Combined Middle Eastern and Latam Oil Demand (m b/d) (2009-2013)



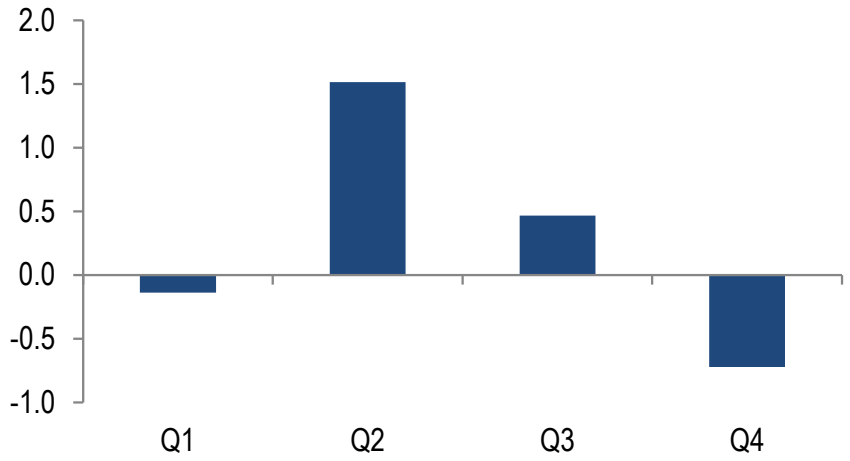
Source: EIG, Citi Research

Figure 68. US Net Oil Imports (m b/d) (2009-2013)



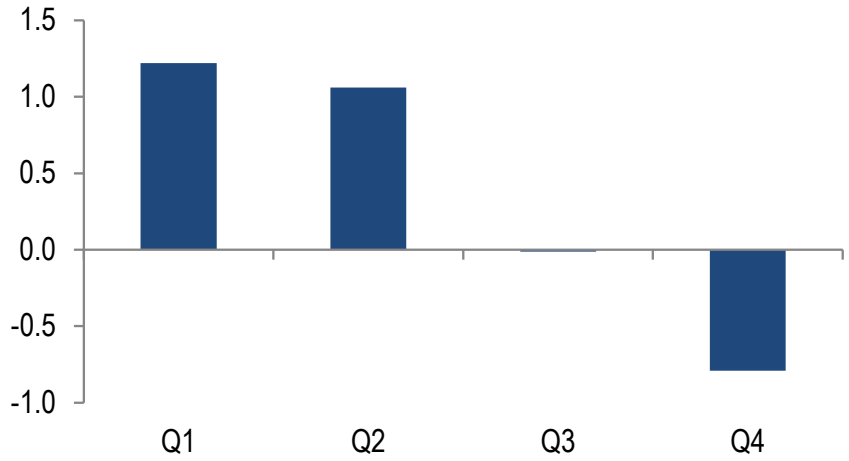
Source: EIA, Citi Research

Figure 69. Global Oil Stocks Average Q/Q Stock Change (m b/d) (2000-2007)



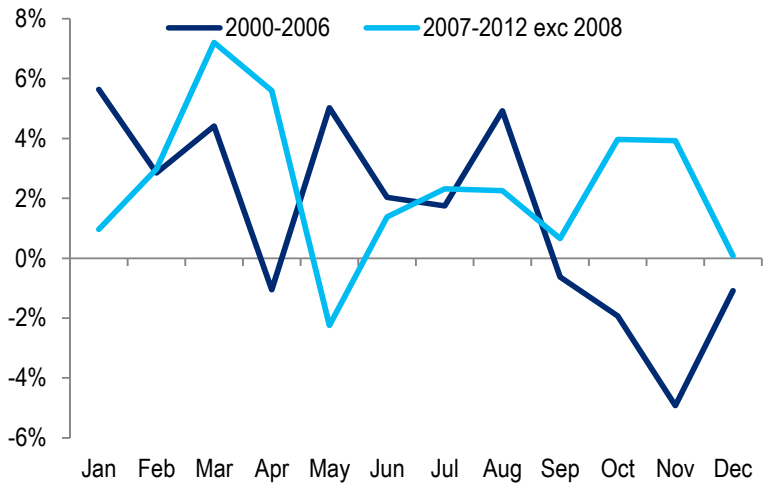
Source: EIG, Citi Research

Figure 70. Global Oil Stocks Average Q/Q Stock Change (m b/d) (2008-2012)



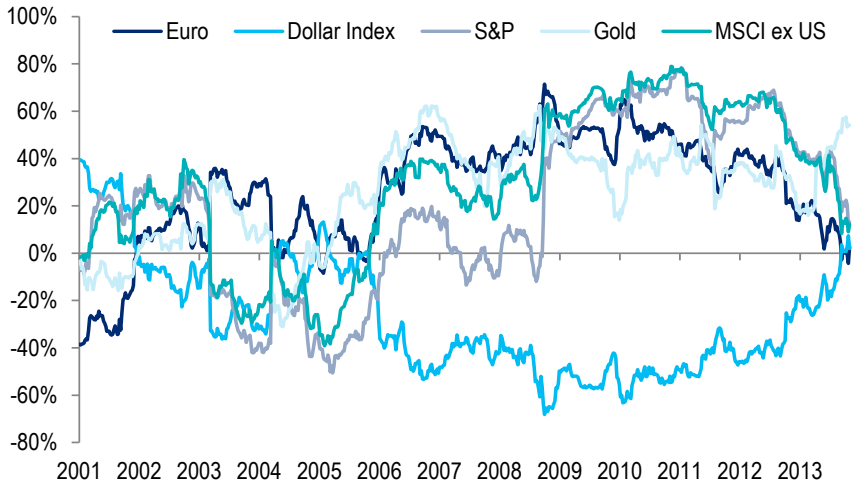
Source: EIG, Citi Research

Figure 71. Brent Seasonal Average Price Change (%) (2000-2012 exc. 2008)



Source: Bloomberg, Citi Research

Figure 72. Rolling 1-Year Correlations with Brent (%) (2001-2013)

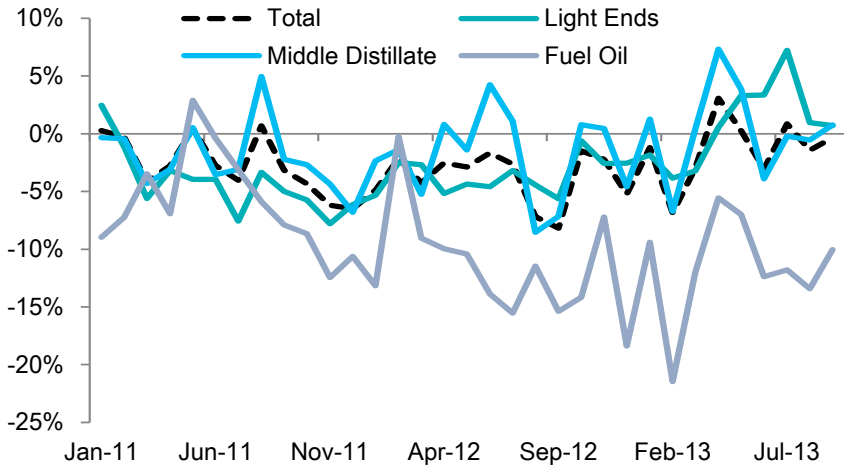


Source: Bloomberg, Citi Research

The global refining sector is facing overcapacity too, and European refiners are getting squeezed on all sides

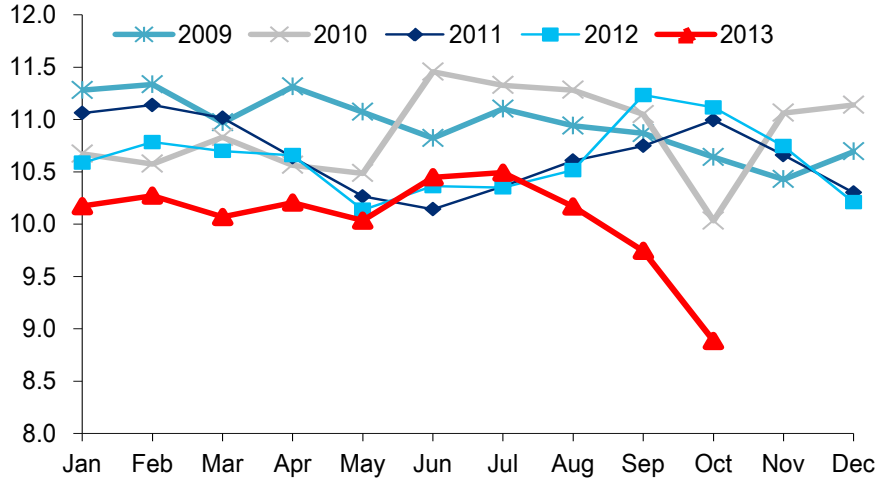
- **European runs hit their lowest point in over 20 years in October, yet despite this restraint, margins stayed resolutely weak throughout the month**. Dismal margins through refinery maintenance season speak to the problematic position for European refiners.
- **The European domestic market continues to sputter, and they are losing ground in their export markets too** as they are increasingly priced out of competition by their US rivals. Citi estimates that ~15% of European refining capacity faces closures this decade due to its unfavorable positioning on the global refining cost curve (see below right).

Figure 73. European Demand by Product Y/Y Growth (%) (2011-2013)



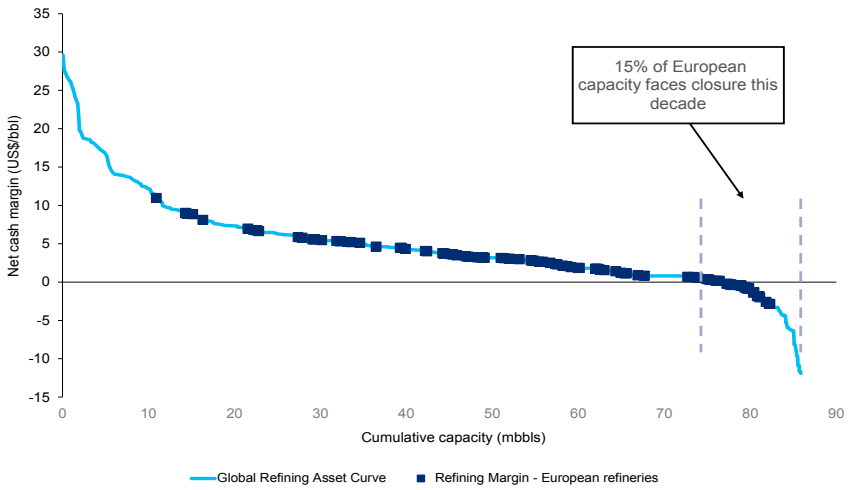
Source: IEA, Citi Research

Figure 74. EU-16 Refinery Crude Runs (m b/d) (2009-2013)



Source: Euroil, Citi Research

Figure 75. Global Refining Cost curve

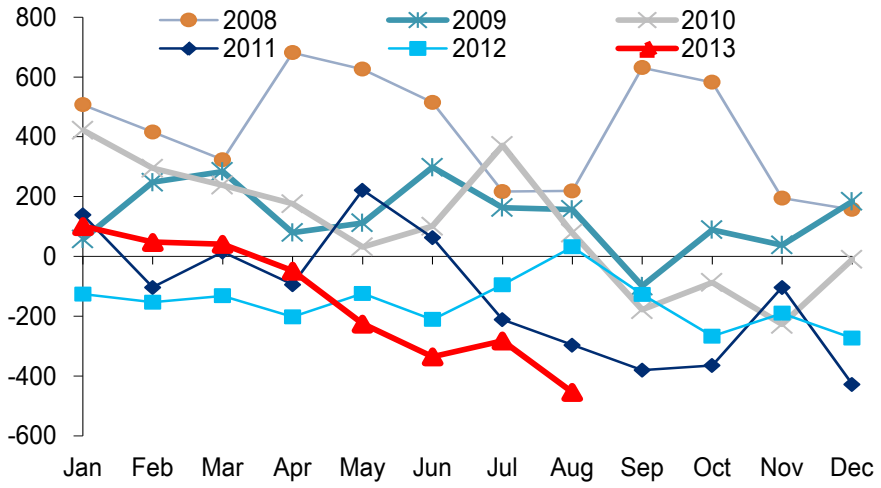


Source: Company Reports, OGJ, Woodmac, Citi Research

European refiners are getting squeezed on all sides

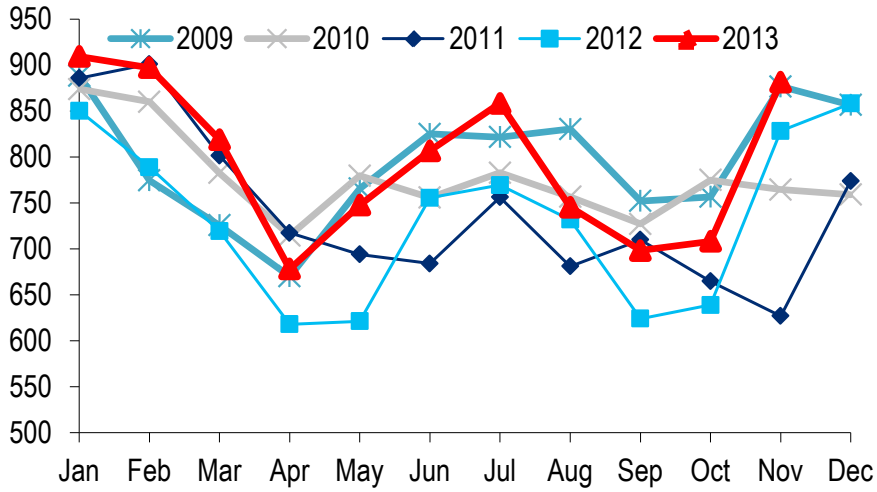
- **Almost 2-m b/d of European refining capacity has been shut over the last five years, but an overhang still remains.** Domestic demand remains in the doldrums, the US's exportable surplus continues to grow and encroach on what used to be European refiner's export turf. Net product flows between the US and Europe fell from 510-k b/d of net exports from Europe to the US in 1H 2008, to 70 k-b/d of net imports to Europe in 1H 2013.
- **European product demand remains in structural decline**, and increasing flows from Russia are pressuring cracks for Europe's prized ULSD market. The Mediterranean is increasingly long distillates. Asian export-oriented refiners are increasingly joined by China. And now the Middle East expansion is underway, with Jubail and Yanbu both looking to come online in 2014.

Figure 76. US Net Product Imports to Europe (k b/d)



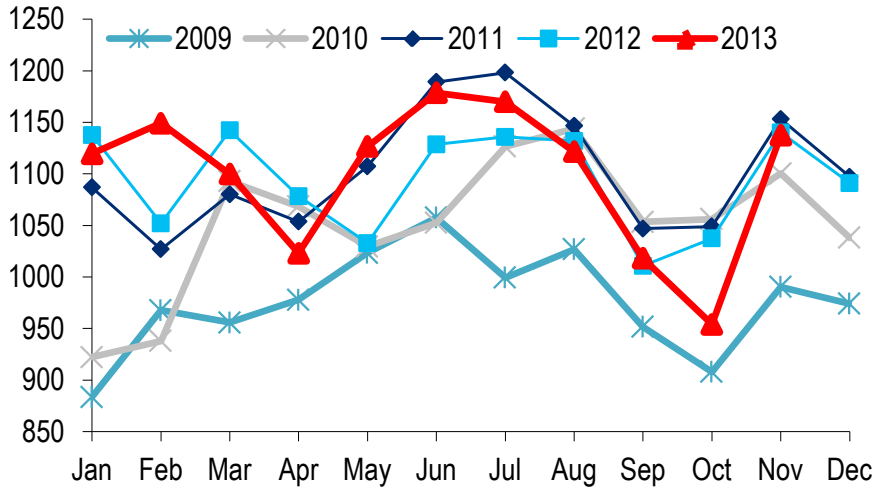
Source: EIA, Citi Research

Figure 77. Russian Gasoil Exports (k b/d)



Source: Citi Research

Figure 78. Russian Residual Fuel Exports (k b/d)

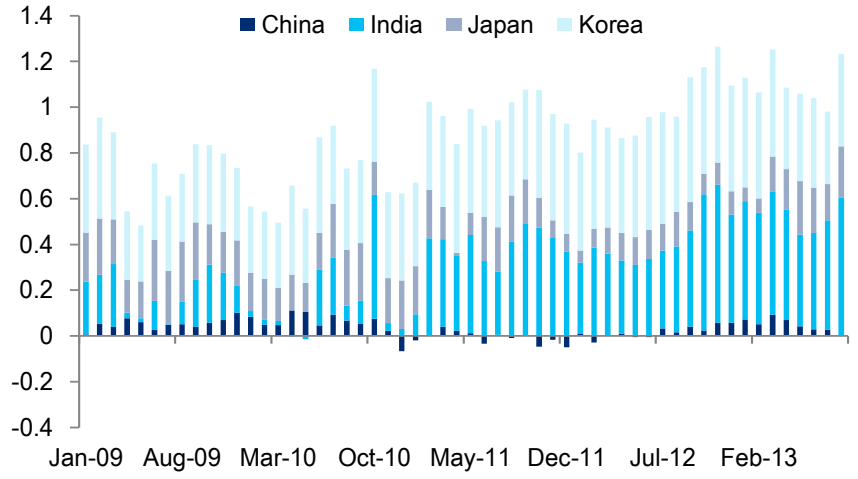


Source: Citi Research

Asian refining: Reluctance to shutter more European capacity is spreading the pain to Asia

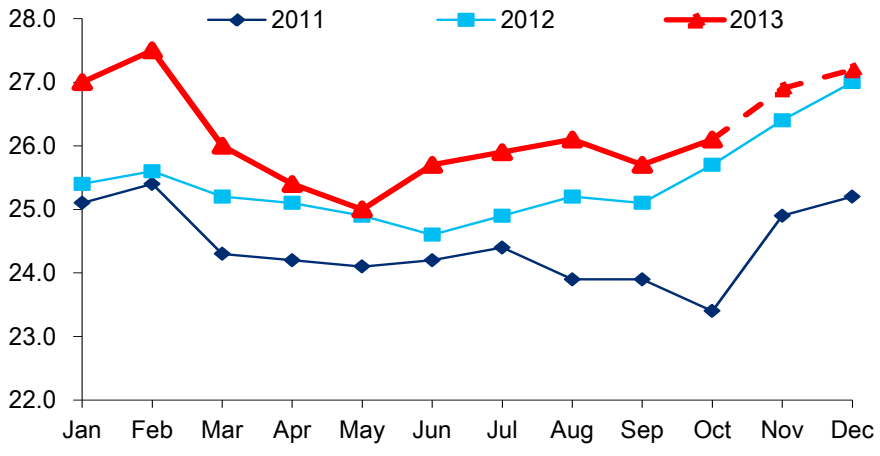
- **Asian refining margins will likely come under further pressure** as weakness spreads from European markets and the aggressive build-out in Middle East and Asian refining capacity continues to back-out product exports.
- **Chinese refinery additions have outpaced domestic demand growth leading to increased net exports of diesel** (see chart below). As Jubail ramps up Saudi imports of 200-300-k b/d of diesel and 100-200-k b/d of gasoline will get backed out leaving further supplies in the region.
- **Increased crude import licenses to Chinese teapot refiners has seen a switch of the feedstock slate away from fuel oil** which will continue to weaken demand for the bottom of the barrel.
- **Asian cracks will continue to benefit from non-OECD Asian demand growth,** expected at ~0.7-m b/d in 2014, but globally refining overcapacity ensures that this need should be easily met.

Figure 79. Japan, Korea, India and China Gas/Diesel Oil Net Exports (m b/d) (2009-2013)



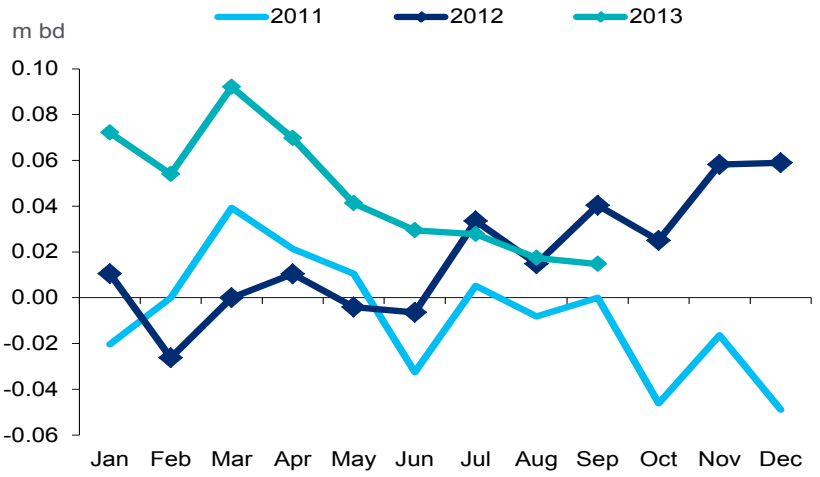
Source: JODI, Citi Research

Figure 80. Asian Refinery Runs (m b/d) (2011-2013)



Source: IEA, Citi Research

Figure 81. Chinese Diesel Net Exports (m b/d) (2011-2013)



Source: Chines Customs, Citi Research

Geopolitics remain hot in the "New Abnormal", but emerging US-Iran deal is lowering the risk temperature

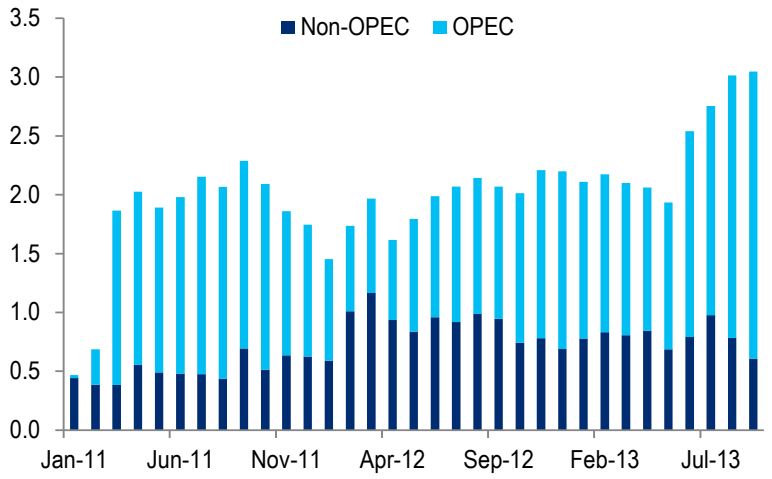
- Geopolitics came to the fore of oil markets in 3Q'13 and despite the geopolitical risk temperature having lowered, geopolitical risk remains elevated going into 2014, most notably in OPEC producers Iran, Libya and Venezuela. Given heavy curtailments already in Libya and Iran, Venezuela could provide the highest downside risk.

- **Talks with Iran over its nuclear program failed to come up with a grand bargain, but progress is significant with monitoring accords now in place for the first time in six years.** Iranian supply for 2014 remains a guessing game with a wide range of outcomes still possible. In the bear-case, Iran would comply with P5+1 demands of halting nuclear activity in return for an easing of oil export sanctions brining back 600-800-k b/d to market and ultimately over 1.5-m b/d of shut-in Iranian capacity could return; dropping oil prices $10 lower. Sanction relief will likely be reversible and modest in the near-term and another possible outcome is if Iran complies in part and Iranian assets abroad are unfrozen. The bull-case would be if talks continued to breakdown and congress further tightens sanctions. Further continuation of nuclear activity will further anger the P5+1, Israel and Saudi Arabia and military force is still a possibility.

- **Libyan output is expected to remain heavily disrupted in 2014** as government authority continues to diminish in Eastern Libya. Libyan militia groups recently announced the creation of regional oil company for the East which will handle the sale of crude and gas, further undermining government control. Production is currently around 250-k b/d and whilst there is more upside risk of returning barrels given the low level of output, troubles look set to remain and keep output heavily depressed.

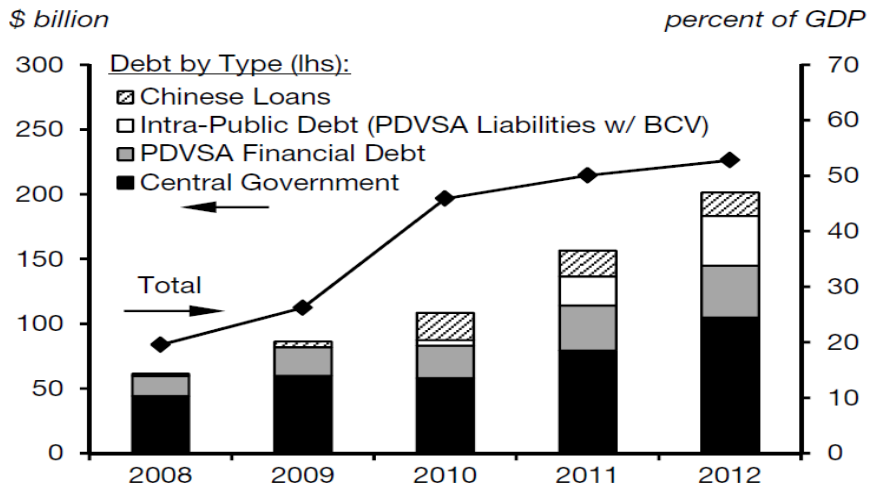
- **Venezuela is currently struggling to service its debt and currently requires an oil price of >$160/bbl to balance its budget.** The highest probability change is a military coup led by Cabello (>50%), leading to "get out of jail free" cards and a new beginning. The lowest probability would be new elections and a win by Capriles, despite his close-call loss in Presidential elections. The current status quo is unsustainable and any solution should require a big role for foreign investors.

Figure 82. Global Oil Supply Disruptions (m b/d) (2011-Present)



Source: EIA, Citi Research

Figure 83. Venezuelan Public Debt Obligations

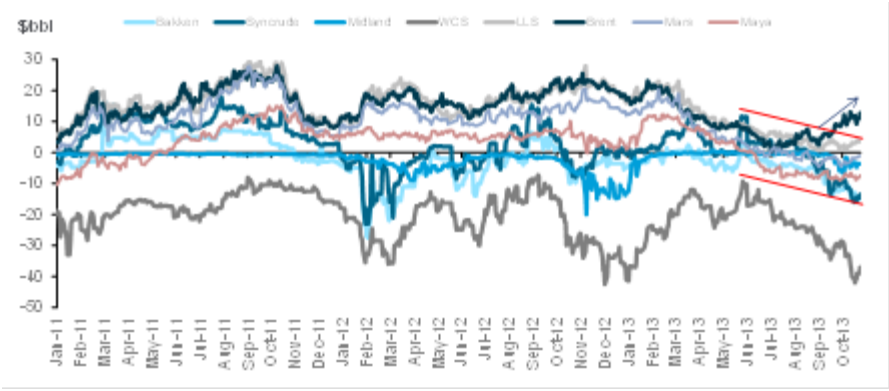


Source: BP, IIF, Citi Research

US and Canadian Crudes – painful adjustments without a free export regime

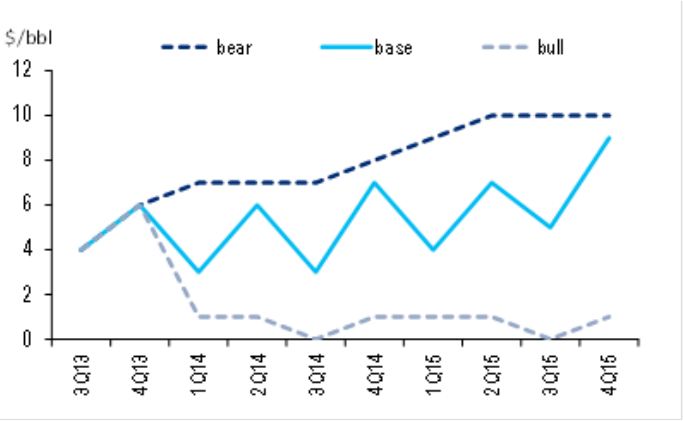
- **As pipeline connectivity continues to connect Cushing firmly to the US Gulf Coast (USGC), the question remains as to how the USGC can deal with rising arrivals of light and heavy crudes, without a free export regime.** With US production growth showing no signs of slowing, can more imports be pushed out, and movements to/between the coasts be rationalized? Inland crudes are reconnecting to the USGC, but USGC values are looking increasingly bruised and battered.
- **The current blowout in Brent-LLS should remind us that while there remain ways to "absorb" the crude glut that don't require large USGC discounts in theory, frictions and time lags can mean growth in absorption can fall behind growth in crude availability.** And even these ways of absorption could be exhausted in the next few years. The mechanisms for absorption have been discussed in recent reports ("Exit Strategies"), but these are not materializing quickly. These include (1) movements of crude (by water/rail to E. Canada, US East Coast, etc.), (2) USGC import substitution (pushing out light sweet, blending to replace mediums and light sours, heavy-to-light switching to push out heavy), (3) USGC greater refinery use (higher runs, new capacity), (4) loosening export regulations (potential for reclassifying condensates, crude swaps with Mexico, exports to other countries). "Movements of crude" may take time to ramp-up, but when they do, in step-wise additions. "Import substitution" could be surprisingly sticky, given term contracts and exporter countries' marketing strategies. New refinery capacity in the form of condensate splitters and pre-flash towers helps, but takes time. Loosening export regs may come sooner than thought ("Hydrocarbons Surge to Top of US Export List"), but would provide case-by-case increments that may lag. Seasonal refinery maintenance and weak refinery margins can exacerbate this.
- **But when each chunk of the glut is cleared, this can cause bullish pops in Brent-WTI, especially if combined with times of high refinery runs and, say, syncrude outages.** The USGC swing in refinery runs has been a 1-m b/d swing from peak to trough since this summer. Thus, Citi's updated WTI prices reflect an attempt to take an average of the narrowest and widest points, which are becoming increasingly wide/volatile with stronger seasonality, in our view.

Figure 84. Selected North American and Brent crude price differentials to WTI – North American crudes disconnected from Brent in 4Q'13 on supply and USGC refinery maintenance



Source: Bloomberg, Citi Research

Figure 85. Citi's updated price outlook for Brent-WTI



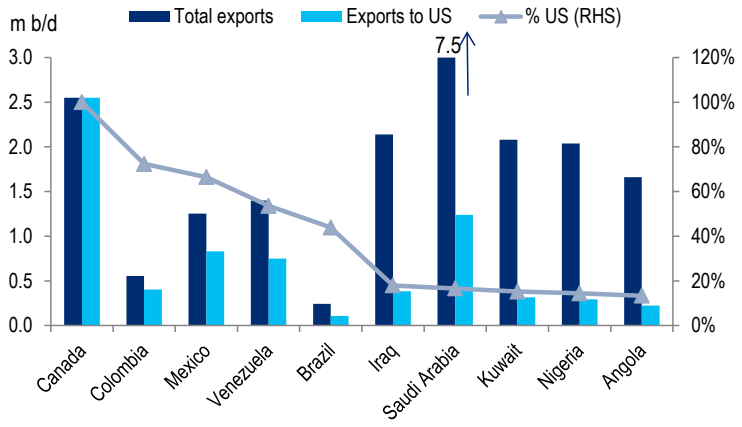
Source: Citi Research

- **Crude exporters may be willing to supply crude to the US at a discount to global prices, if it supports the rest of their portfolio (see below), which could keep a larger wedge between Brent and WTI. Every time each exporter diverts a chunk of their supplies elsewhere, Brent-WTI could narrow. But it could be more a case of Brent coming down to WTI, than WTI rising.** Sharp discounts of USGC crudes have not yet resulted in a significant drop in crude imports. Blending and heavy-to-light switching both require pushing out existing imports. But imports could stay firmer for longer, due to term contracts, and oil exporters' global portfolios. Which of the oil exporters to the US blink first if US crude prices fall? **Saudi Arabia has a number of term contracts, and may care more about supporting global prices within their portfolio, as seen in raising Asian OSPs but cutting USGC OSPs, while dumping into the USGC could also slow shale oil production growth.** West African producers Nigeria and Angola (together 500-k b/d into the US) have already taken the hit and could fall to zero, and could see further diversions to Asia. Venezuela, Mexico and Colombia may be the earlier ones to blink, as they clean up their "backyard" (US GoM), not unlike Norway needing to get its supplies out of the North Sea.

- **4Q'13 should still see a tightening of LLS-WTI as the Keystone XL south comes online in earnest, while the return of USGC refineries from maintenance should be supportive for USGC crude prices relative to Brent, narrowing Brent-WTI.** But PADD III inventory drawdowns to year-end for tax reasons and weak refinery margins could be bearish risks. 1Q'14 could be stronger ahead of 2Q'14 refinery maintenance, but there may be a step-up in the means to clear the USGC crude glut by sending crude to eastern Canada and the US East Coast, even if imports remain sticky. A repeat of significant syncrude disruptions could be bullish.

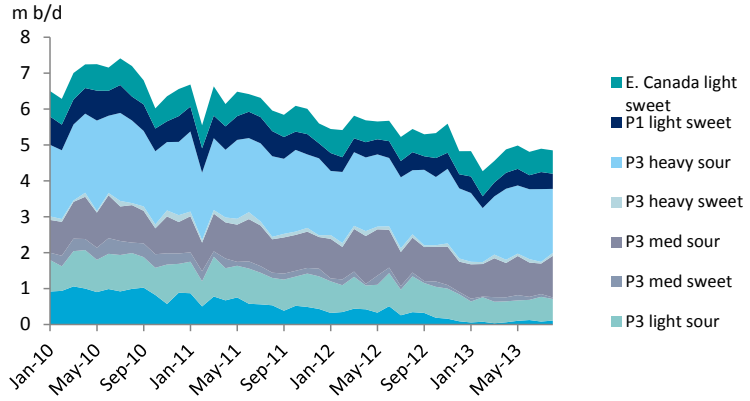
- **2014 should see continued infrastructure build-out help connect Cushing, then western Canada, to the USGC. While this helps WCS reconnect with USGC heavy crude prices like Maya (see "Exit Strategies"), all USGC crudes could face further downward pressure.** And as discussed earlier, the US Gulf of Mexico is also starting to see major deep water production growth add to the availability there too. Citi's base case – without an overhaul of export regs – sees 2014 Brent-WTI at ~$5, 2015 average at ~$6, 2016-17 at $7. 2018 could begin to see a lower spread with Energy East allowing an export outlet from eastern Canada.

Figure 86. US crude imports: top ten countries of origin, their total crude exports versus their crude exports to the US (January to August 2013*)



Source: EIA, JODI, Citi Research

Figure 87. Selected N. American crude imports that could be pushed out, with ~100-k b/d light sweet, ~600-k b/d light sour, ~1.2-m b/d medium, 1.8-m b/d heavy on USGC; 500-k b/d on US East Coast; 600-700-k b/d in eastern Canada, of which ~150-k b/d may already be from the US



Source: EIA, NEB, Citi Research

US Natural Gas was the first to peel away from the super cycle…

- **US natural gas could be the example of how the supply and capex cycles evolve, from scarcity to abundance and its impact beyond**. The effect of the shale gas production surge ripples across gas-consuming sectors and the rest of the economy.
- **Short term gas prices illustrate the power of supply growth while demand takes time to catch up. Citi expects US Henry Hub natural gas to average $3.70/MMBtu in 2014 and $4.50 in 2015**, unchanged from our last quarterly forecast from September. Low prices should continue into 2014 due to strong production growth amid very modest demand gains y/y. Production growth from the Marcellus should remain robust as new pipes come online, well backlogs are cleared and efficiency/productivity continues to improve. Production growth from associated gas production should stay strong as superior returns on oil/liquids drilling boost production. The improvement in productivity and efficiency of shale gas and oil production should continue due to the increased application of multi-well pad drilling, technological improvements and learning-by-doing. Meanwhile, "demand" growth in a normal weather scenario should be led by the industrial sector and exports to Mexico, as new cross-border pipes come online. Gas demand for power generation may turn out to be more modest, as lackluster electricity demand growth amid strong growth in renewables. Demand growth could not outpace production growth in 2014 yet.
- **The long term transformation in gas demand goes beyond the traditional gas-consuming sectors. With stronger demand, Citi expects prices in 2016 and 2017 to rise to $4.90, reaching $5.50 in 2018.** Years of low prices and resilient production growth demonstrate the abundance of gas resource. This motivates the kind of large-scale demand growth in the industrial and export sectors that add to total consumption. Coal retirements in 2015/16, the start of LNG exports in late 2015, the rise of industrial demand as large-scale facilities come online, should finally lift baseload gas demand. The pace of demand growth should accelerate as the consumption increase becomes structural.
- **The growth in demand and exports is powerful. Citi expects total domestic demand and net gas exports to rise from 72.5-Bcf/d in 2013 to 87-Bcf/d in 2018.** While production cost may be low for some shale gas plays, not all producers would dive headlong into shale gas production as soon as prices rise above marginal production costs. To entice more producers to drill for gas to meet this strong demand growth, the returns on oil/liquids drilling and shale gas drilling would have to be similar enough.
- Although this demand growth story is increasingly common, the near term forward curve would likely not reflect the reality at that time. As long as producers continue to hedge in the out years, believing that prices could stay low, this kind of selling pressure could depress the curve. Consumers typically do not hedge their gas purchases many years ahead and investors with long investing horizon collectively do not have enough "buying" power to take on all of the hedges from producers.

Figure 88. US Natural Gas Supply Demand Balance

Quarter	Jan-13	Apr-13	Jul-13	Oct-13	Jan-14	Apr-14	Jul-14	Oct-14	Jan-15	Apr-15	Jul-15	Oct-15	2013	2014	2015	2016	2017	2018	'14v'13	15v'14	'16v'15
Total Supply	**69.0**	**69.5**	**70.6**	**70.2**	**71.3**	**71.7**	**72.3**	**71.0**	**72.6**	**73.1**	**73.8**	**72.1**	69.9	71.6	72.9	74.8	75.8	77.4	1.7	1.3	1.9
Prod	64.9	66.0	66.9	67.0	67.6	68.5	68.8	68.8	68.8	70.0	70.5	70.6	66.2	68.4	70.0	73.2	76.0	80.2	2.2	1.6	3.2
LNG	0.3	0.1	0.1	0.2	0.3	0.2	0.3	0.4	0.2	0.1	0.2	0.3	0.2	0.3	0.2	0.1	0.1	0.1	0.1	(0.1)	(0.1)
Exports to Mexico	(1.8)	(1.8)	(1.9)	(1.9)	(2.2)	(2.3)	(2.5)	(2.7)	(2.7)	(2.8)	(3.0)	(3.2)	(1.8)	(2.4)	(2.9)	(3.5)	(4.0)	(4.6)	(0.5)	(0.5)	(0.6)
Imports from Canada	5.6	5.2	5.6	4.9	5.6	5.2	5.6	4.5	6.2	5.8	6.2	5.0	5.3	5.2	5.8	6.1	6.4	6.7	(0.1)	0.5	0.3
LNG Exports	-	-	-	-	-	-	-	-	-	-	-	(0.6)	-	-	(0.1)	(1.1)	(2.7)	(5.0)	-	(0.1)	(1.0)
Total Demand	**87.4**	**58.3**	**60.0**	**74.5**	**87.3**	**60.7**	**62.3**	**76.2**	**88.5**	**62.9**	**61.9**	**77.1**	70.6	70.7	73.1	74.9	75.8	77.4	0.1	2.4	1.9
IND	21.5	19.0	18.6	20.7	21.9	19.5	19.3	21.5	22.7	20.3	20.1	22.3	19.9	20.5	21.4	22.2	23.1	23.9	0.6	0.8	0.9
ResComm	40.5	14.1	8.5	27.1	39.4	13.5	8.9	27.7	39.8	13.6	9.1	28.0	22.5	22.4	22.6	22.8	22.9	23.1	(0.2)	0.3	0.1
EG	20.0	21.5	27.8	19.8	19.0	22.7	27.4	20.2	19.7	23.6	28.3	20.9	22.3	21.7	22.7	23.3	22.7	22.7	(0.5)	1.0	0.5
Pipe Use	2.5	1.6	1.7	2.1	2.5	1.7	1.8	2.1	2.5	1.7	1.8	2.2	2.0	2.0	2.0	2.1	2.2	2.3	0.0	0.0	0.1
Lease and Plant Fuel	3.8	3.8	3.8	3.8	3.9	3.9	3.9	3.9	4.0	4.1	4.1	4.0	3.8	3.9	4.0	4.2	4.2	4.3	0.1	0.2	0.1
Transport	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.1	0.2	0.3	0.4	0.7	1.1	0.0	0.1	0.1
Price Forecast	3.48	4.01	3.55	3.60	3.70	3.60	3.70	3.90	4.20	4.50	4.50	4.80	3.70	3.70	4.50	4.90	4.90	5.50	0.05	0.80	0.40

Source: EIA, Citi Research

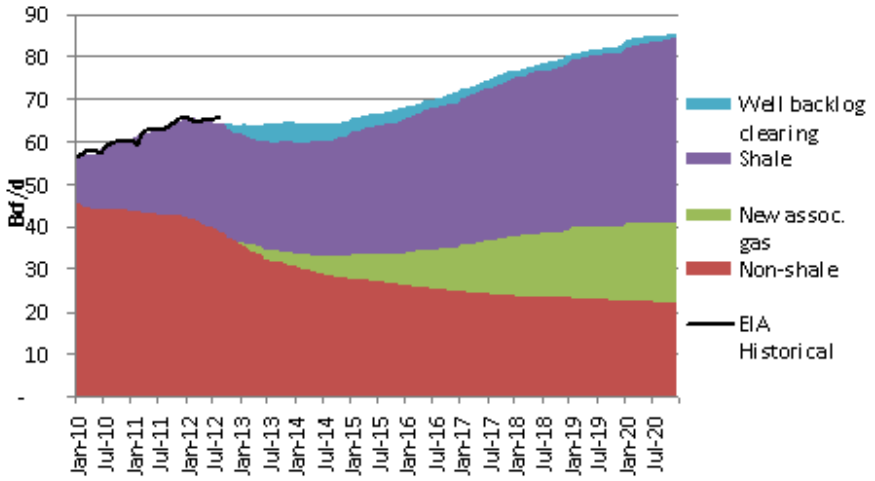
The stalled out production growth is about to surge again, supported by shale gas and associated gas production

- **Shale gas drilling should remain robust with the increased application of advanced drilling and completion methods**. Multi-well pad drilling, where wells are drilled at very close proximity to each other on the surface before branching out to different directions underground, reduces the time and cost of rig deployment. Technological improvements, better understanding of various plays and greater experience in drilling, completion and production engineering also contribute to the increase.

- **These advances are similarly applied to oil/liquids drilling, whose prolific production is also boosting the amount of associated gas produced**. As long as returns remain superior, oil and liquids production growth should stay strong, as discussed in the oil section

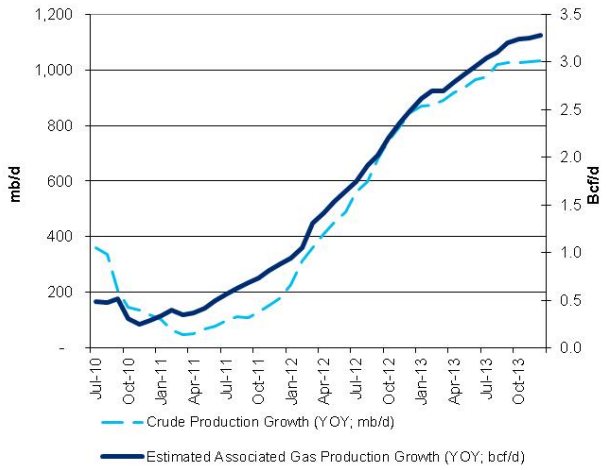
- **However, low gas prices should spur the kind of baseload demand growth that finally catches up to production growth**, just as some pure-play gas producers relent and move toward liquids drilling. Demand growth is demonstrated by commitments from the industrial and export sectors in their construction of new physical plants, pipes or liquefaction facilities.

Figure 89. Higher projected US gas production on both shale gas and liquids drilling



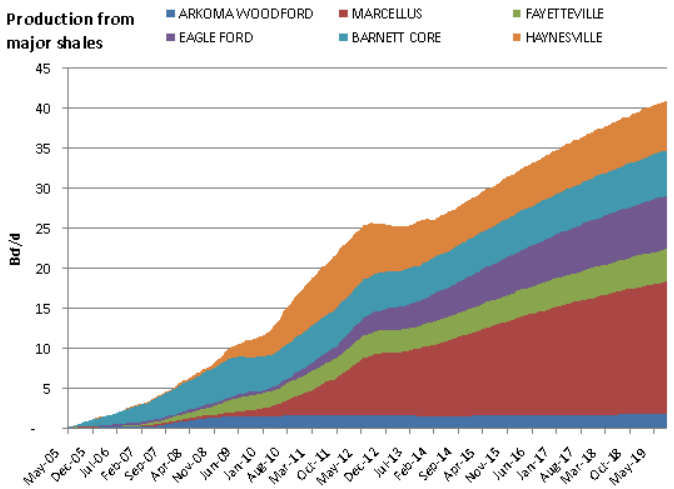
Source: EIA, Citi Research

Figure 90. Estimated y/y associated gas production growth



Source: EIA, Citi Research

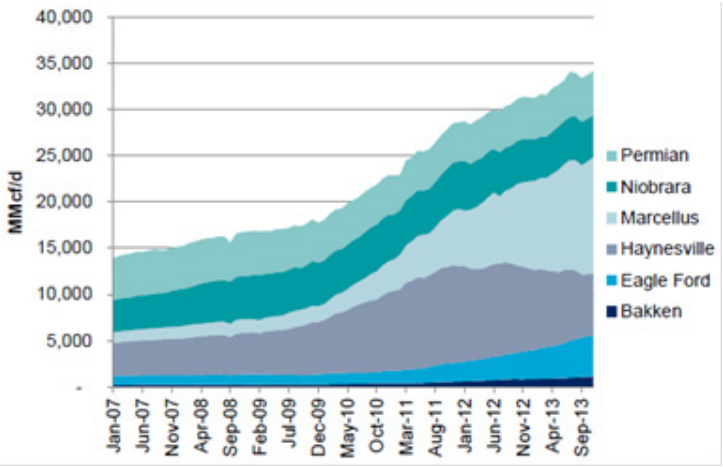
Figure 91. Shale gas could make up half of US gas production



Source: Citi Research

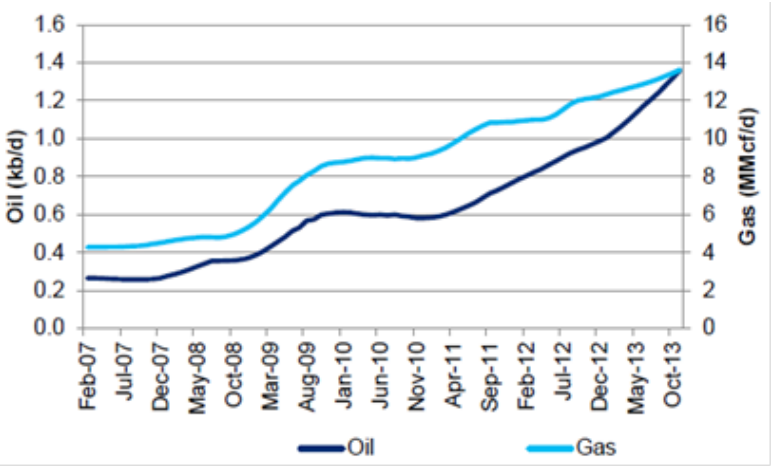
The increased drilling productivity that triggered the production increase should continue for years to come

Figure 92. Gas production now dominated by shale plays…



Source: EIA, Citi Research

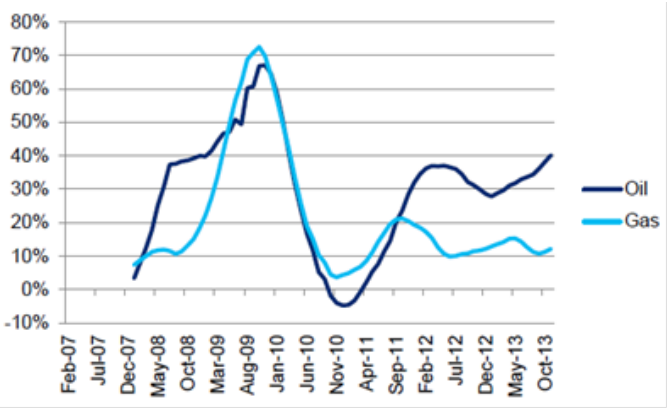
Figure 93. . ….First month production per rig also rising (2007-2013)



Source: EIA, Citi Research

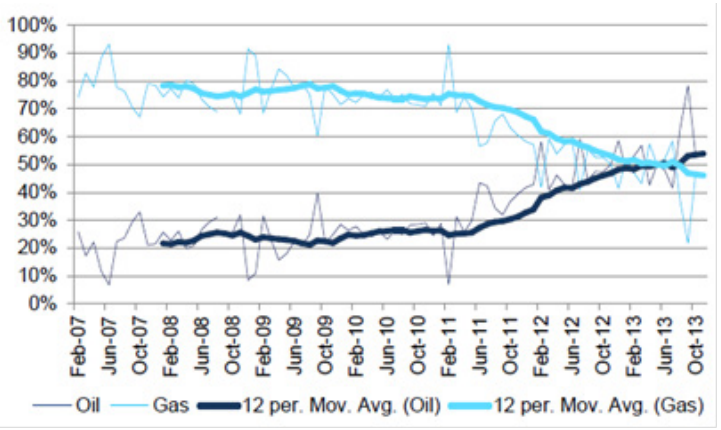
Figure 94. …Leading to continued productivity gains…

y/y change in production per rig



Source: EIA, Citi Research

Figure 95. …. But the wide price differences between oil/liquids and gas have finally boosted liquids output above gas

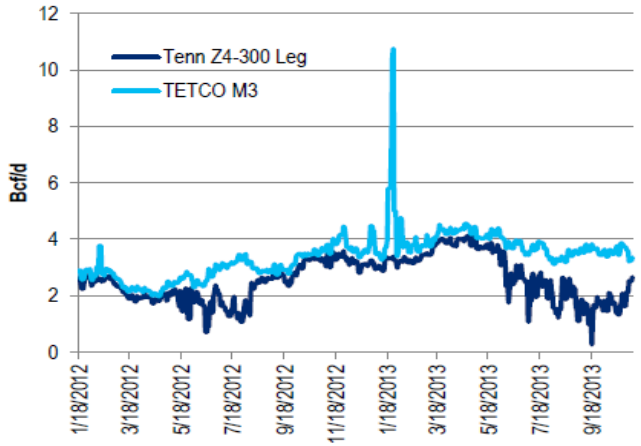


Source: EIA, Citi Research

Case Study: Despite low rig counts, strong Marcellus production growth resumed with new pipeline takeaway capacity

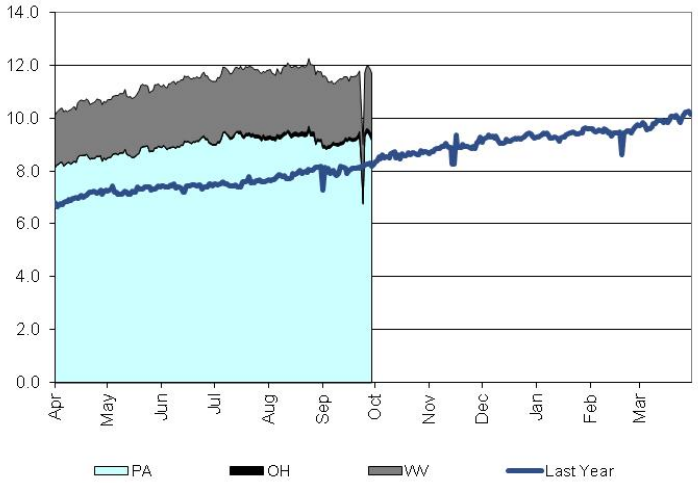
- **With new infrastructure, Marcellus production should continue to grow and a seasonal price pattern could be emerging** – rising just before winter and falling steeply in summer/early fall. Marcellus output could rise by an additional 2-Bcf/d from now to 3Q'14 as the backlog of production is cleared.
- **At one-fifth of US production, Marcellus production has already surpassed Norway and China and is approaching Qatar's and Iran's levels of ~15-Bcf/d**.
- **Local gas prices in the Northeast could exhibit seasonal patterns**. First, prices in the production area (e.g. Tenn Z4-300 leg) rise as new pipes debottleneck the region at the start of winter, then post-winter prices gradually weaken as production continues to grow but new pipes won't come online until the following winter. Second, gas prices near market centers in the Northeast (e.g. TETCO M3) could fall when new pipes enter into service as more Marcellus gas enters the market.

Figure 96. Marcellus area prices (e.g. Tenn Z4-300 leg) fell as output rises until new pipes enter service in Nov; market area prices (e.g. TETCO M3) fall when new pipes come online



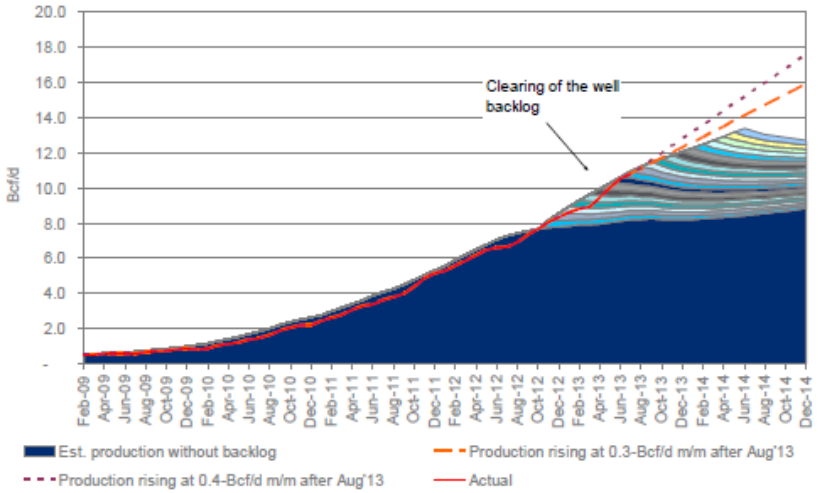
Source: Platts, Citi Research

Figure 97. Marcellus production has hit a plateau for now



Source: EIA, Bentek, Citi Research

Figure 98. Projected growth of Marcellus based on well-backlog and drilling activities



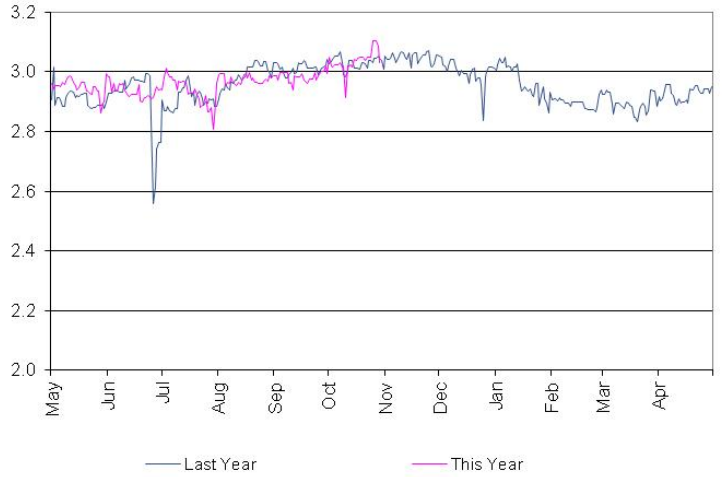
Source: EIA, Company Reports, Citi Research

Supply growth does not rely just on the latest plays: Building on top of legacy production - output from mature plays to remain robust

- **Unconventional gas production elsewhere has also stayed robust** despite a sharp decline in gas rig counts outside of the most prolific shale gas plays and higher return oil/liquids play.

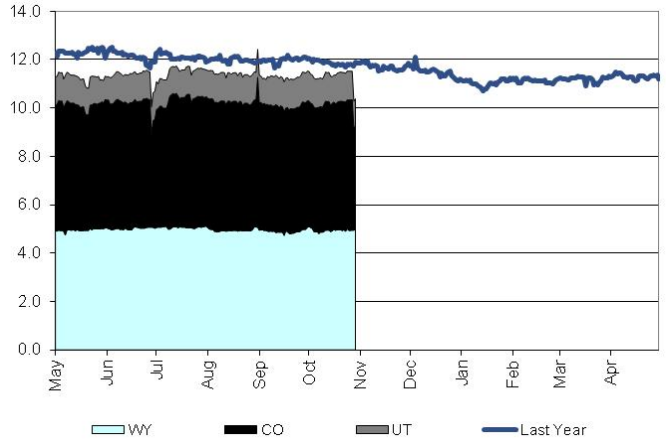
- **Steady or even flat productivity gains y/y have been providing enough improvement in production to keep output in these areas steady**. In the Rockies, coal-bed methane has a much flatter decline profile, unlike shale. Increased activities in the Niobrara have helped support production growth in recent periods. Fayetteville is a more mature shale play and production has been very consistent, with an increase since mid-year. Oklahoma has a mix of conventional, unconventional and associated gas production. Typically the worry is whether very cold weather, similar to the one nearly three years ago, could cause well freeze-offs that cut down production temporarily. But the odds of a severe production drop may be less likely, since the production loss back then was partly caused by a lack of electricity to pipelines, which should be rectified to some extent in the years since.

Figure 99. Fayetteville production has been flat but rising throughout 2013



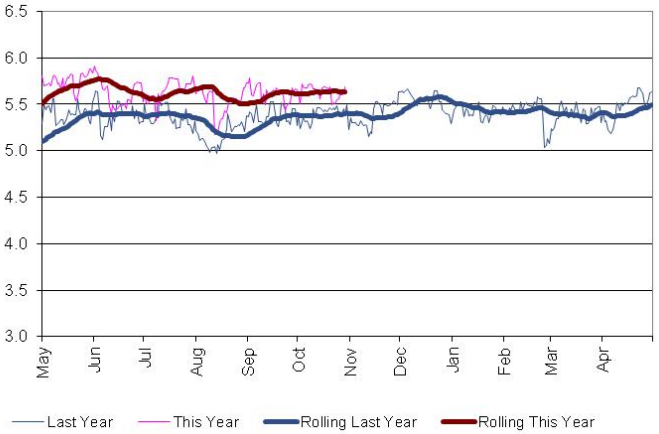
Source: EIA, Bentek, Citi Research

Figure 100. Rockies production has stabilized: Coal-bed methane typically has relatively flat decline profiles, while activities in Niobrara has been supporting growth



Source: EIA, Bentek, Citi Research

Figure 101. Production in Oklahoma includes both mature and new plays and has remained higher than year-ago levels

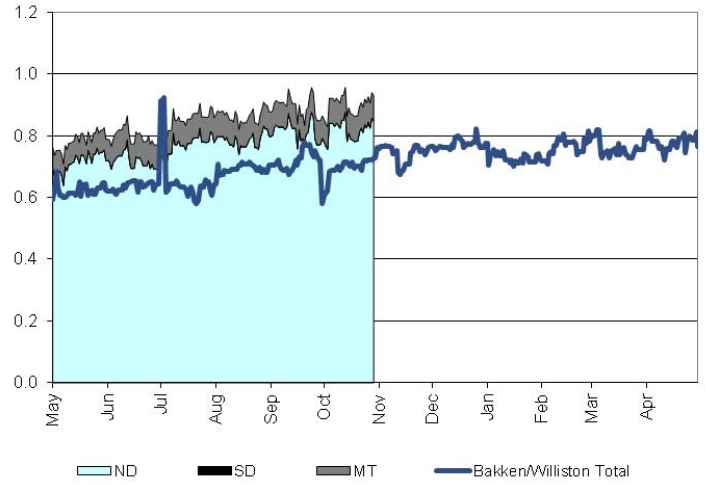


Source: EIA, Bentek, Citi Research

Production growth not restricted to gas shales: Technology diffusion across sectors - rise of oil production leads to higher gas production

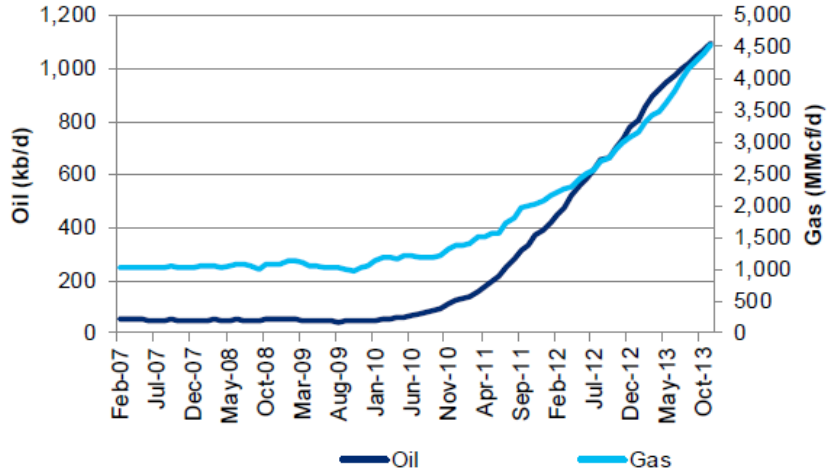
- An oft-overlooked aspect of gas production is associated gas production from oil/liquids plays. Bakken gas production is approaching 1-Bcf/d, with over 20% of y/y growth, even though Bakken is known much more as an oil play
- Of note is how gas production has risen together with oil/liquids production growth, as illustrated in hydrocarbon production in the Eagle Ford and Bakken. From shares of gas and oil output in these plays, wells in Eagle Ford tend to produce more gas because of higher number of gas wells and high gas content in liquids wells. Significant gas production has also come from the Bakken at a near 1-mb/d to 1-Bcf/d ratio of production.
- More-than-expected oil/liquids production growth (and therefore associated gas output) in 2013 might have contributed to the difference between a $4.25+ gas market vs. a ~$3.7 market for 2013. The oil/liquids and gas markets are increasingly tied together in both production and demand substitution

Figure 102. Bakken gas production continues to rise



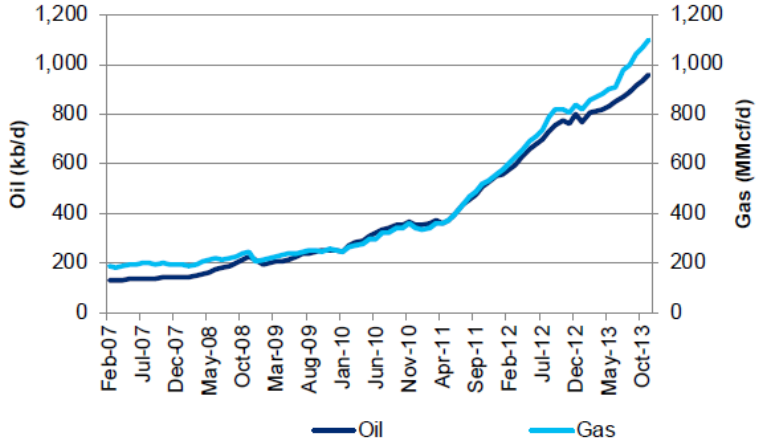
Source: EIA, Bentek, Citi Research

Figure 103. Eagle Ford gas production also rising with oil output growth



Source: EIA, Citi Research

Figure 104. Bakken gas output rising with oil production, with more could coming online as gas flaring were to be reduced

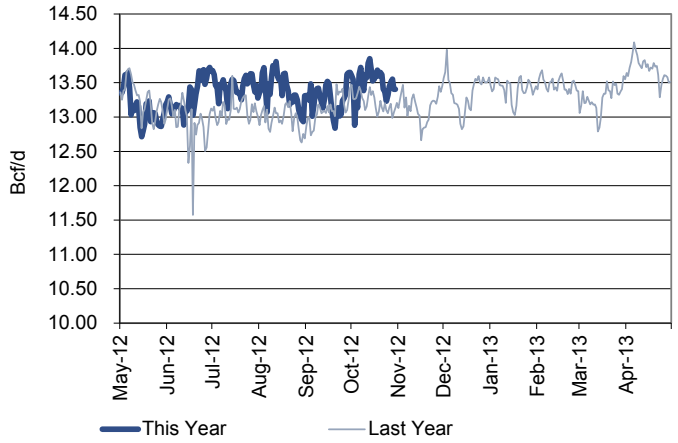


Source: EIA, Citi Research

Technology diffusion across borders: The power of interconnectedness - strong Canadian supply to serve the US market

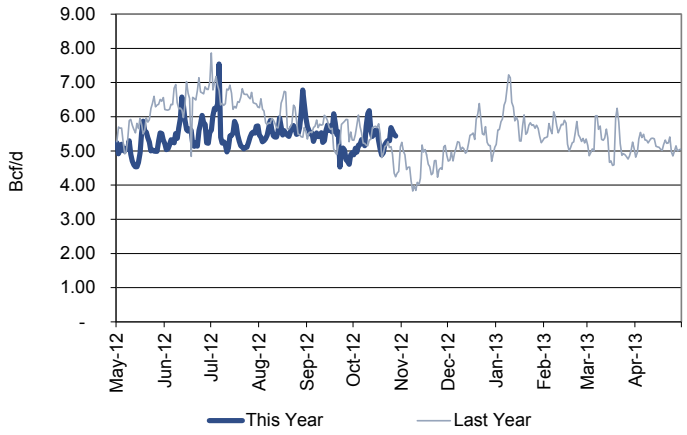
- Net gas exports from Canada to the US should remain about the same in 2014 at 5.2-Bcf/d, as pipeline gas flows across different import points are expected to stay similar y/y. Seasonal demand is generally the most important driver, given stronger demand needs in winter and parts of summer in the Lower 48.
- However, gas prices could occasionally diverge significantly from US prices due to an expected or actual gas glut in Canada. In 2012, a mild winter left substantial gas inventory in the ground, pushing down regional prices. With much reduced US demand for Canadian gas just as Canadian production stayed robust in early 1H'13, AECO prices at the low-$2 persisted through summer until it became clear that gas inventory levels at the beginning of winter would not breach the maximum-allowed levels. Similarly, 2013 AECO gas prices also fell to below $2 before rebounding, as the market became more assured that gas inventory in Western Canada would not surge beyond storage capacity.
- Going forward, with the increase in demand and exports in the US, Canadian gas could act as an additional source of supply using existing infrastructure. Citi expects Canadian gas exports to the US could rise back to the 6 to 7-Bcf/d level in between 2016 and 2018.

Figure 105. Canadian gas production remains elevated despite a sharp drop in gas rig counts



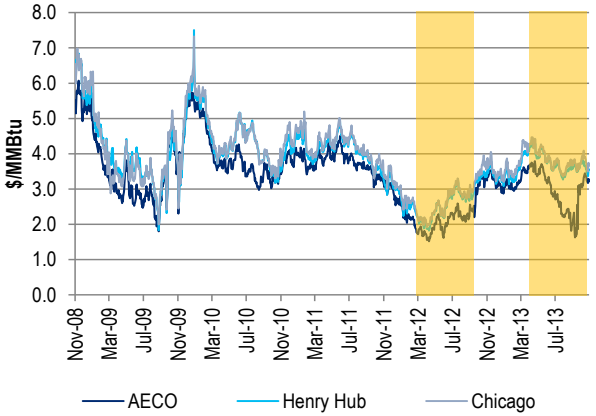
Source: EIA, Bentek, Citi Research

Figure 106. Robust Canadian gas exports to the US



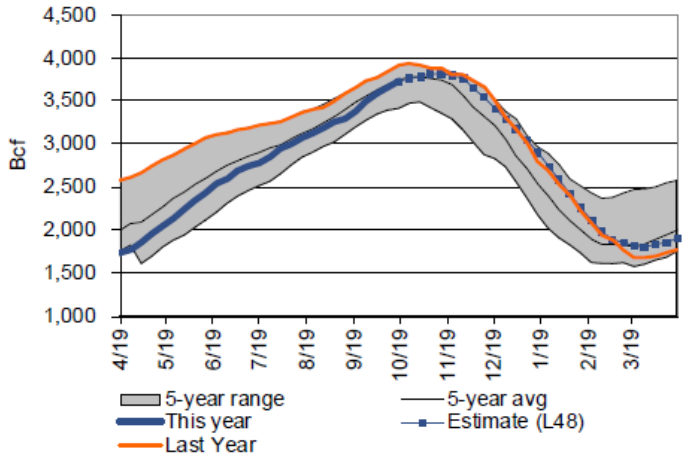
Source: EIA, Bentek,Citi Research

Figure 107. Canadian benchmark price (AECO) could diverge significantly from US prices due to an expected or actual gas glut in Canada on strong production



Source: Platts, Citi Research

Figure 108. Relatively low end-season gas storage partially supported prices, but weather and production paths key to outlook

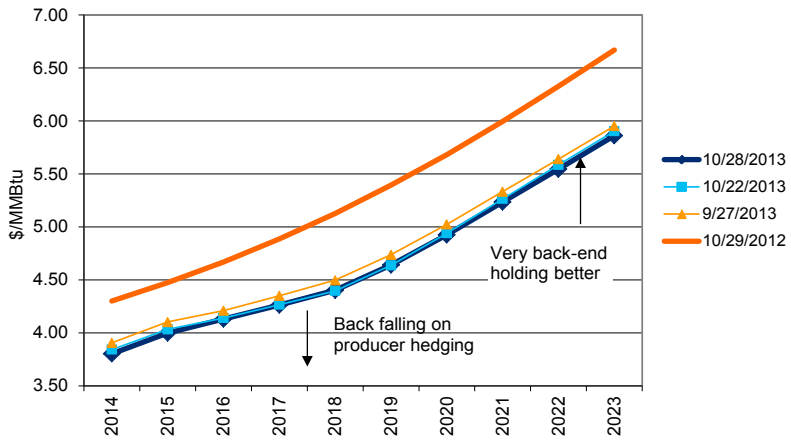


Source: EIA, Citi Research

Amid this broader supply/production cycle, the weather-driven nature of short-term NG market evokes mini-cycles (seasonality)

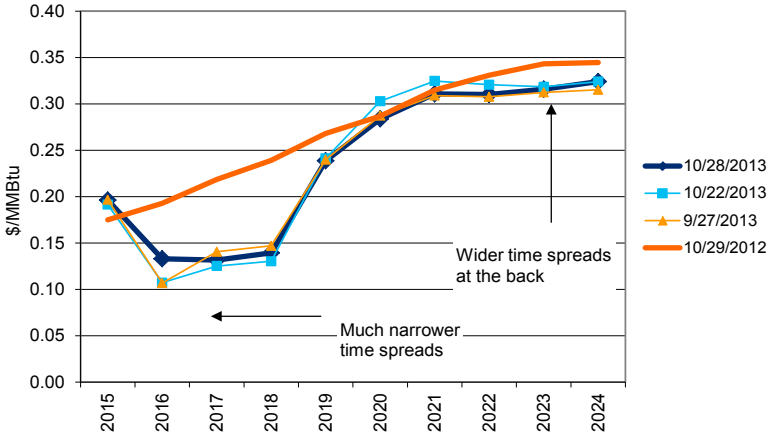
- **Winter weather and production paths critical to outlook.** Based on current gas inventory, a normal winter path could lead to both a bearish and bullish looking end-Mar'13 gas inventory scenario.
  - With lower production in Aug/Sep, the end-Mar'13 gas storage could be a relatively bullish 1.69-Tcf level
  - But if the lower production is only a temporary decline due to low Marcellus prices, the end-Mar'13 gas storage could reach a relatively bearish 1.80-Tcf level
- **But demand could finally catch up to and potentially exceed supply growth starting in 2015, but more so in 2017 and beyond**

Figure 109. While 2014 prices could have more room to fall, longer term prices could have more room to rise…



Source: Bloomberg, Citi Research

Figure 110. ….Especially after substantial producer hedging from 2014 onward depressed the forwards through 2018

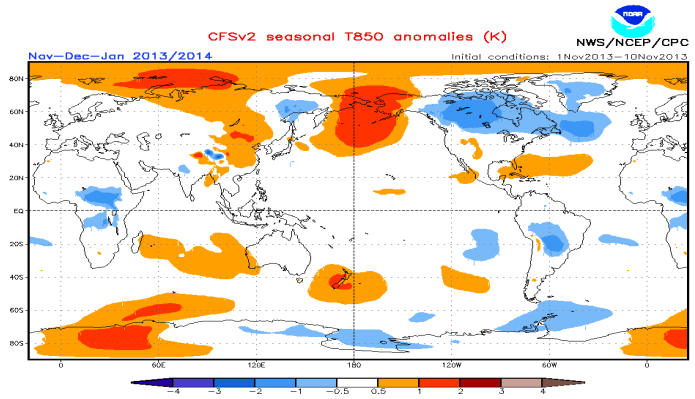


Source: Bloomberg, Citi Research

Winter weather to set the tone for 2014 gas market

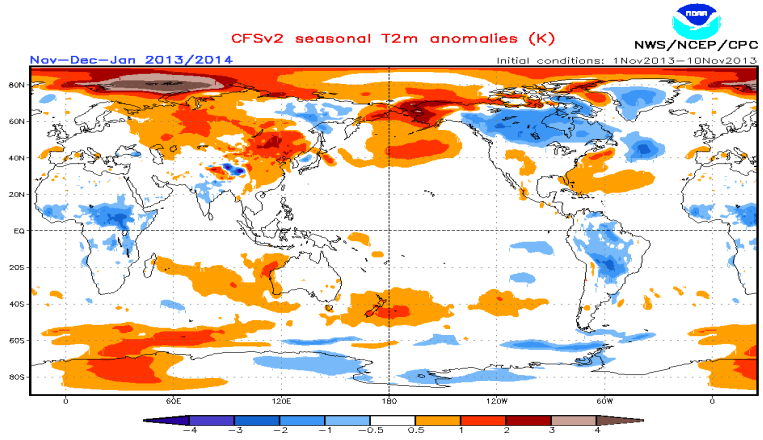
- **Weather in winter 2013-14 would set tone for 2014 prices with ripple effects to the rest of forward curve, but actual realized prices in the future could be very different from indications from forward curves months in advance**.
  - On the one hand, the 2011-12 winter was among the mildest in a century. Light winter gas demand resulted in a record-setting gas storage level post-winter, so that the amount of gas needed to be injected into storage ahead of the following winter fell sharply. The need to work off this excess gas supply partly pushed prices down to below $2/MMBtu.
  - On the other hand, a cold winter could quickly draw down gas inventories. A cold end to the 2012-13 winter propel prices from a low of $3.2 in mid-Feb'13 to a high of $4.4 in mid-Apr'13 amid fears of gas shortage ahead of the 2013-14 winter. At the time, the market was also expecting a production decline due to low rig counts in 2012. Instead, strong contribution from associated gas production via oil/liquids production helped to sustain production growth.
- **Assuming normal weather, the supply-demand balance should continue to loosen at the margin**, since gas production should continue to grow after gas pipelines came online in the beginning of November.

Figure 111. Dec-Jan-Feb forecast at the 850m level pointing to cold in Canada but normal to warm in the continental US



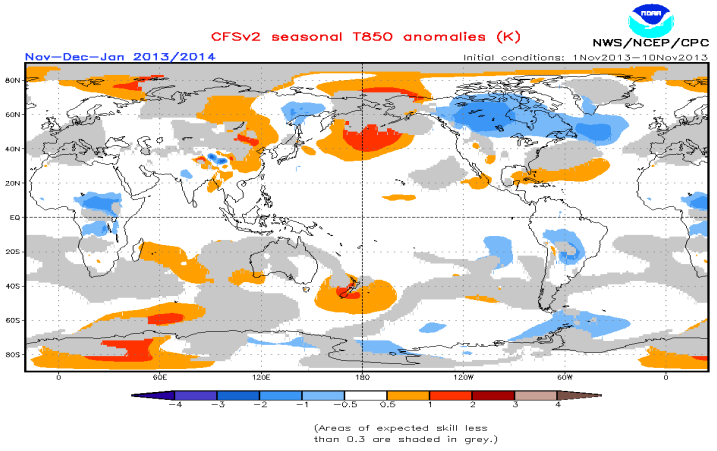
Source: NOAA

Figure 112. Dec-Jan-Feb forecast at the 2m level, similar to forecasts at the 850m level



Source: NOAA

Figure 113. Dec-Jan-Feb forecast at the 850m level, with unshaded area points to higher confidence level

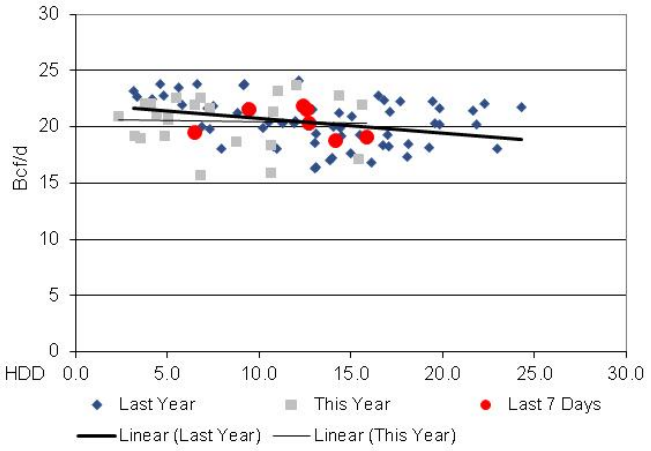


Source: NOAA

Structurally, coal power plant retirements should boost gas demand, but only temporarily, due to structural change in the power sector

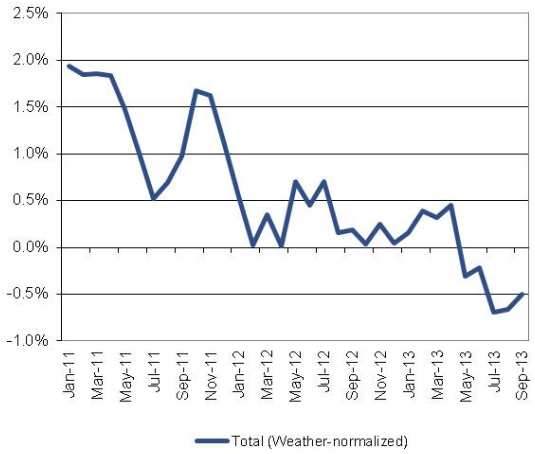
- **As 2014 prices are expected to be similar to 2013, assuming normal weather, gains from coal-to-gas switching may not be repeated**. Gas demand intensity graphs illustrate how there is no growth in consumption. Part of the reason is stagnant electricity demand growth.
- **Recent observations in power markets show that only Texas, and perhaps California, has positive weather-norm power load growth**, while other regions are experiencing year-on-year declines:
  - If gas-fired generation makes up about one-third of all generation, then the negative impact on gas burn could be ~1-Bcf/d (at 30-Bcf/d of gas burn) if a 1% decline in electricity demand were all absorbed by gas-fired generation, where gas is the marginal fuel.
  - Lower coal prices have made coal units more competitive in the power stack, while renewables have always been at the bottom of the stack.
- **By 2015/16, coal plant retirements should give gas demand a lift, but the continued rise of renewable generation amid lackluster electricity demand growth could reduce the need for gas-fired generation**.

Figure 114.Weather-normalized gas demand for power generation similar y/y at the national level



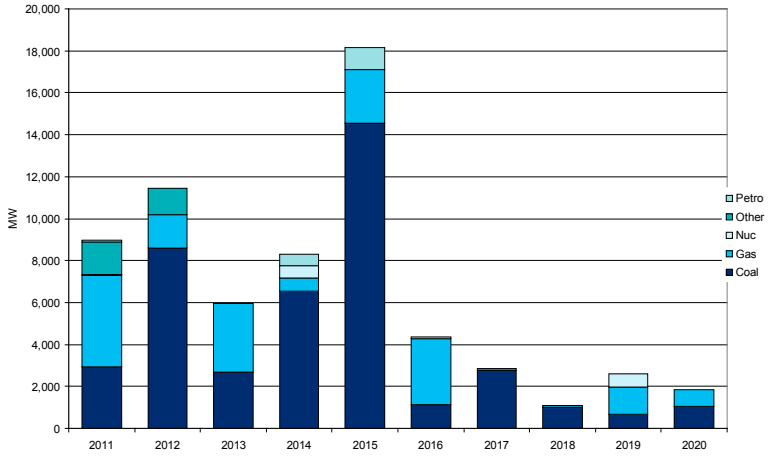
Source: EIA, Bentek, Citi Research

Figure 115.Weather-normalized electricity demand has been flat to negative, possibly limiting gas burn for power generation



Source: ISOs, Citi Research

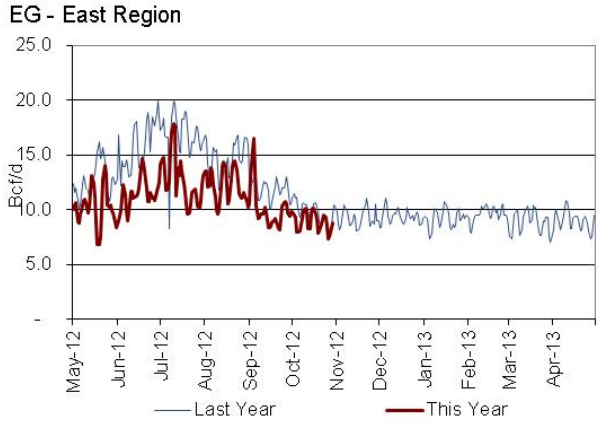
Figure 116.Power plant retirements to give a short term boost to gas demand as gas plants substitute retiring ones



Source: Ventyx, Citi Research

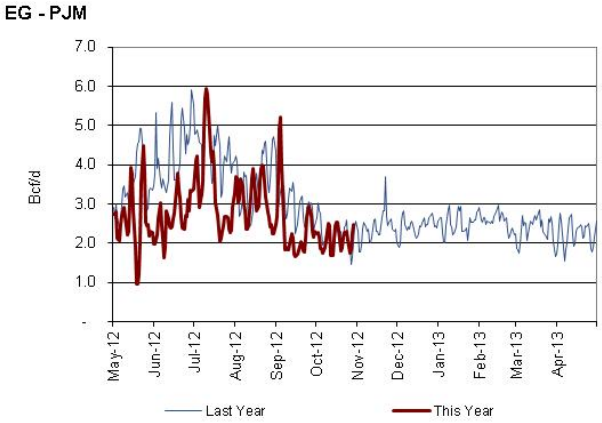
Forward gas demand in major switching regions looks weaker due to a lack of electricity demand growth

Figure 117.Power burn in the East region now slightly below last year's level despite similar prices y/y



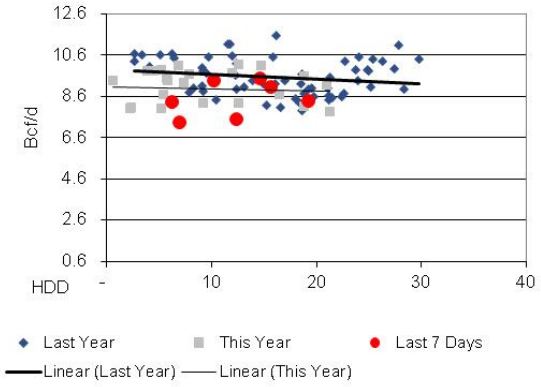
Source: EIA, Bentek, Citi Research

Figure 118.PJM in the Mid-Atlantic may be the only region with generally similar demand to last year



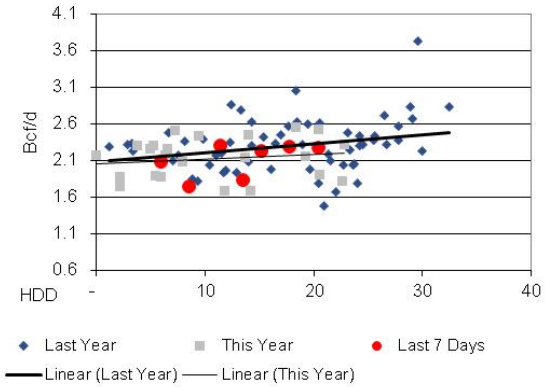
Source: EIA, Bentek, Citi Research

Figure 119.Weather normalized power burn has trended weaker currently amid weak power demand



Source: EIA, Bentek, Citi Research

Figure 120.Only PJM's weather-normalized power burn has been somewhat near last year's level



Source: EIA, Bentek, Citi Research

But this commodity cycle takes off again when long-awaited industrials expansion takes advantage of low-cost energy/feedstock

- **With lower gas prices, the increased use of gas as a feedstock and energy source in the industrial sector, partly through fuel substitutions from both oil and coal to gas, could add 0.6-Bcf/d of demand in 2014 over 2013**. (2013's actual demand is expected to be greater than its weather-normalized demand because of the cold and extended into the 2012-13 winter. Weather-normalized demand growth y/y should be 0.8-Bcf/d).

- **While fuel-switching is one part of the story, the migration of industries to the US from overseas with high energy/feedstock prices**. Petrochemicals, fertilizers, primary metals/steel-making, refineries and other energy-intensive industries should benefit.

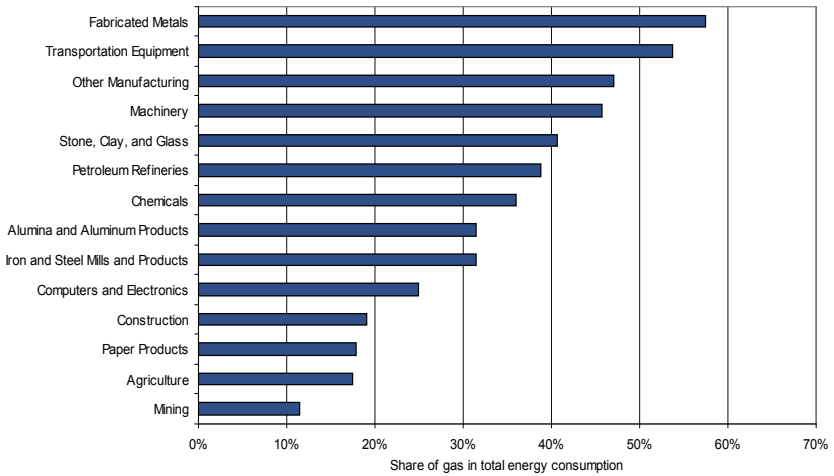
  – **Although the petrochemical sector mainly uses natural gas liquids as a feedstock, natural gas is also used for co-generation and as a heat source for making steam**. Hence, the expansion of this sector should raise gas demand as well. Ethylene cracking capacity is expected to expand by 20 to 40% from now to 2020

  – **Steel and other primary metals manufacturing also benefit from the natural gas boom**. In addition to using natural gas as an energy source, gas can be used in electric arc furnace in steel-making. The midstream development and realignment have a substantial requirement for steel piping

  – **Factors that similarly support the petrochemical expansion in the US, especially the low cost of feedstock, are also driving a resurgence in the manufacturing of nitrogen fertilizer**. Natural gas makes up a substantial amount (~60-80%) of the cash cost of ammonia production, where ammonia is a key ingredient of fertilizer for direct application and the feedstock for other products, such as urea.

  – **Refineries are major users of natural gas, nearly 4-Bcf/d, or a fifth of total industrial gas demand**, according to the EIA. Using low cost natural gas as a fuel for energy can translate into substantial savings. East Coast refineries, which previously had been running at a loss, were recently bought by new owners, who touted the use of low cost Marcellus gas as a way to reduce cost.

Figure 121.Natural gas as a share of total energy consumption within each sector

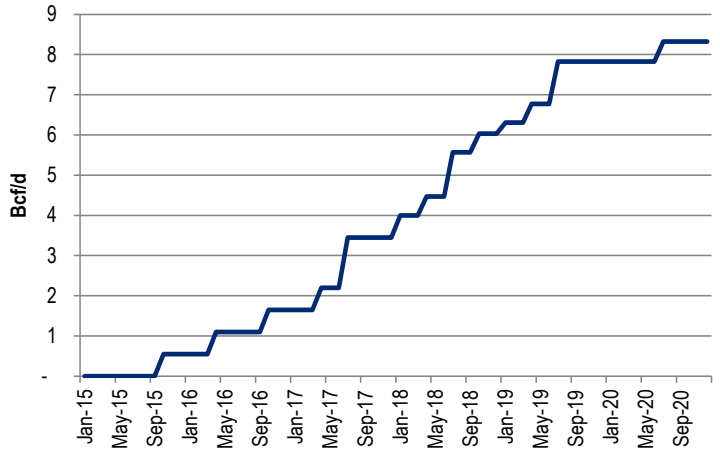


Source: EIA, Citi Research

Gas exports are expected to drive the next phase of the gas "demand" cycle: first piped gas to Mexico, then LNG to the world

- **Collectively, US gas exports could rise by 7.8-Bcf/d between 2013 and 2018, driven first by pipeline gas exports to Mexico but subsequently via LNG to the rest of the world**.
  - Pipeline exports to Mexico should in the medium term overshadow LNG exports and these exports don't require significant policy review.
- **The DOE has already approved 6.4-Bcf/d (~50-mtpa) of onshore LNG export capacity** (Sabine Pass, Freeport, Lake Charles and Cove Point).
  - With two other facilities, Cameron and Freeport expansion, widely-expected to receive similar export authorizations, total approved export capacity could soon exceed 8-Bcf/d.
  - Other terminals could receive the go-ahead, possibly pushing the total amount of exports to 10-Bcf/d.
- **US LNG exports and the introduction of Henry Hub pricing, whose presence is already being felt globally through US coal exports, could have far-reaching impact**, from
  - (1) bringing gas-indexed pricing to the global market (instead of the current oil-indexed pricing, as if oranges should be priced using apple prices), to
  - (2) redrawing global geopolitics. Low political risk and gas-indexation of prices appeal to importing countries looking for alternatives to oil-indexed gas and leverage for negotiation with current and future LNG suppliers.
- **Almost all U.S. LNG export projects are brownfield developments, with lower costs and shorter construction time, significantly reducing the probability of delays or cost overruns that plagued other projects globally**.

Figure 122.LNG exports are expected to rise gradually starting in 2015



Source: EIA, Citi Research

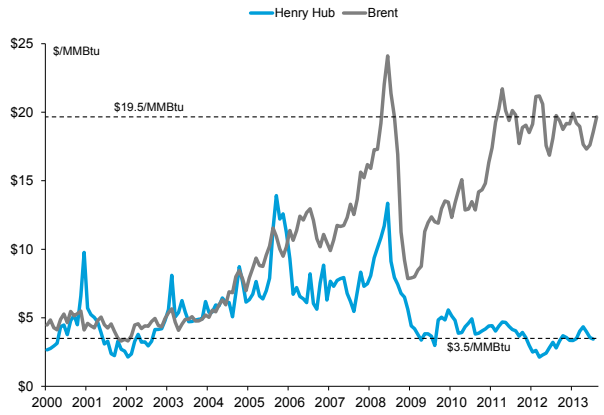
Figure 123. List of LNG liquefaction projects

Terminal	Location	mtpa	Bcf/d
Approved (non-FTA)			
Sabine Pass	Cameron, LA	16.5	2.2
Freeport	Freeport, TX	10.5	1.4
Lake Charles	Lake Charles, LA	15	2
Cove Point	Lusby, MD	5.8	0.8
Pending			
Freeport expansion	Freeport, TX	10.5	1.4
Cameron	Hackberry, LA	12.8	1.7
Jordan Cove	Coos Bay, OR	6	0.8
Oregon		9.4	1.3
Corpus Christi	Corpus Christi, TX	15.8	2.1
Lavaca Bay	Port Lavaca, TX	10.4	1.4
Gulf Coast	Brownsville, TX	21.1	2.8
Southern LNG	Savannah, GA	3.8	0.5
Gulf LNG	Pascagoula, MS	11.3	1.5
CE FLNG	Plaquemine, LA	8	1.1
Golden Pass	Port Arthur, TX	19.5	2.6
South Texas LNG	Offshore, TX	8.2	1.1
Main Pass	Offshore, LA	24.2	3.2
Sabine Pass	Cameron, LA	2.1	0.3
Sabine Pass	Cameron, LA	1.8	0.2

Source: DOE, Citi Research

This next phase also goes across sector: gas-for-oil substitution in transportation to boost gas demand

Figure 124. The divergence in crude oil and US natural gas prices encourages fuel-substitution, especially in gas-for-oil substitution



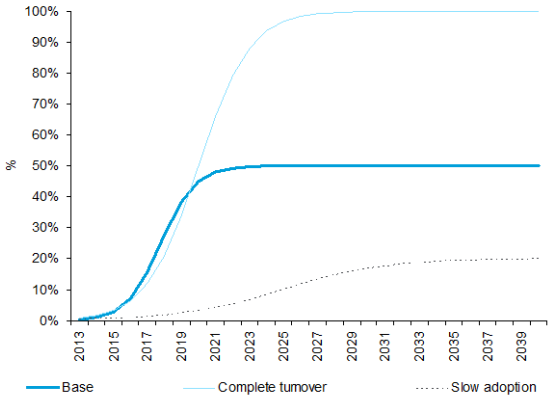
Source: Bloomberg, Citi Research

Figure 125.Projected gas demand in US transportation could reach nearly 2-bcf/d in 2020 (over 1-Bcf/d in 2018)

	2013	2015	2020	2025	2030
On-road vehicles					
U.S.					
Base	0.1	0.2	1.8	4.5	6.7
Complete turnover	0.1	0.3	2.2	5.9	9.8
Slow adoption	0.1	0.1	0.3	1.1	2.5
EU	**0.2**	**0.3**	**0.5**	**0.7**	**0.8**
Asia	**2.9**	**3.8**	**6**	**8.1**	**10.1**
South America	**1.1**	**1.2**	**1.4**	**1.6**	**1.8**
International Marine					
Lloyds Register (High)	0	0.1	0.3	3.2	5.1
Lloyds Register (Base)	0	0	0.1	1.1	1.7
Lloyds Register (Low)	0	0	0	0.4	0.6
TOTAL*	0	0	1.5	4.4	7.1
Other U.S. (rail + marine)	**0**	**0.1**	**0.4**	**0.9**	**0.9**
Total Demand					
Base + Lloyds Register (Base)	4.3	5.5	10.2	16.7	22.1
Complete turnover + TOTAL*	4.4	5.6	11.9	21.4	30.6
Slow adoption + Lloyds Register (Low)	4.3	5.4	8.6	12.7	16.9

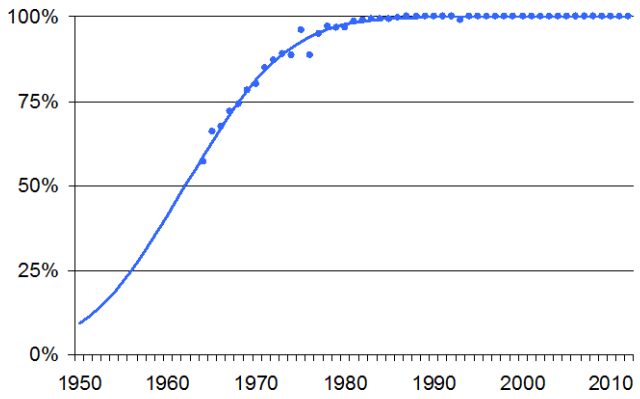
Source: IEA, Citi Research

Figure 126.The adoption of natural gas in heavy-duty trucking could follow the classic S-curve
Estimated NGVs as % new Heavy Duty Vehicle sales in the US



Source: Citi Research

Figure 127. Large-scale fuel substitution happened in the past: Diesel's share of new Class 8 trucks sales in US (1950-2010) rose from less than 10% to nearly 100% in ~20 years



Source: MacKay, Wards Auto, Westport, Citi Research

As the cycle turns, from scarcity to abundance and a new equilibrium: Long term gas prices to average ~$5.5/MMBtu…

- Long term price range: a soft floor at ~$4 and a soft ceiling between ~$6-$7
- Soft floor would be set by the production cost of marginal gas plays, e.g. Haynesville.
- Soft ceiling would be set by global LNG prices. US gas exports should slow when delivered US gas prices overseas are above regional prices. With long term European gas prices in the ~$9 range, then a "transport" cost of ~$2 (excluding the ~$3 liquefaction capacity charge) would put US prices at ~$7.
- This price clears many investment hurdles for shale gas investment, creating a strong supply response. Hence it is more likely the ceiling price would be closer to $6 than $7.

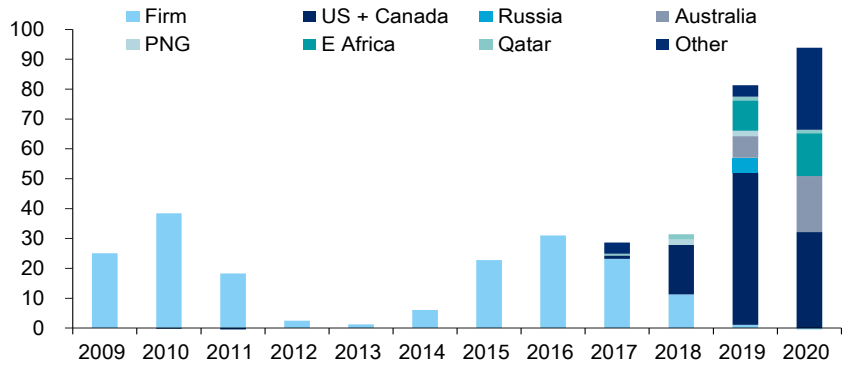
… As the long term price equilibrium depends not just on gas but oil, too

- Although some in the industry have suggested that the long term gas price should fall to the marginal cost of production, market structure and calculations on returns on investments will likely push this long term gas price higher.
- Producers that largely only have shale gas properties will likely not have enough production capacity to both fill the natural decline of existing production and meet rising demand from higher domestic consumption and gas exports.
- Although higher oil and liquids production does produce associated gas, the growth of ~3-Bcf/d per year, if liquids production were to rise at a rate of ~1-mb/d in the years to come, would also not be enough to meet demand growth
- Therefore, producers that have both shale oil/liquids and shale gas properties would have to be enticed back to gas drilling to boost total gas production with equivalent to higher returns on gas drilling.
- Based on analysis on play-level economics, the "indifference" gas price between drilling for gas and liquids would be in the mid-$5/MMBtu at ~$90/bbl oil.

Global Natural Gas – price cycle about to crest amid a coming wave of supply

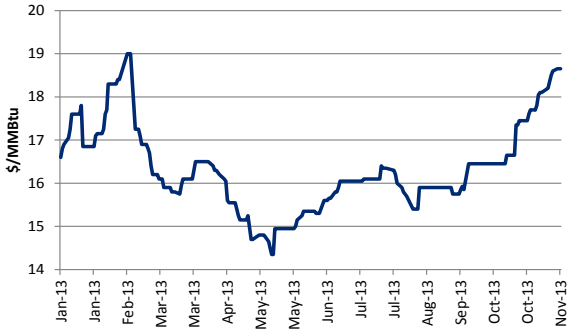
- **While US natural gas was the first to peel away from the super cycle, global natural gas could be one of the last. The global liquefied natural gas (LNG) market continues to see prices edging higher, as the supply-demand balance looks tight on the surface. A lack of LNG to Europe is also boosting gas imports from Russia and prices**. These developments create the perception that prices could rise further. But high oil/gas prices have led to three developments:
  - Promoted further exploration and production that many new discoveries are made (e.g., US shale, offshore East Africa, Mediterranean etc) and new liquefaction facilities are being planned or built globally. The surge in US LNG exports, supported by lower-cost shale gas, could reach 8 to 10-Bcf/d (~78-mtpa) by 2020, accounting for ~20% of the global LNG supply by then. Many importing countries have come to the US to lobby for more LNG exports;
  - Partly contributed to falling European gas demand and possibly slowed demand growth elsewhere, if not for the Fukushima accident grounding Japan's nuclear;
  - With high prices but an expected supply surge coming, long term LNG contracts are not being signed, with exporters insisting on higher prices but importers holding out hope for a lower price era.
- **In the short term, prices could remain robust as importers await a wave of LNG liquefaction terminals to come online, but longer term fundamentals look weak**. For NBP, Citi is marking to market 2013 price to $10.4/MMBtu (67-p/th) but maintains 2014 at $9.7/MMBtu (65-p/th) and 2015 at $9.4/MMBtu (63-p/th). For Global LNG using the Japan-Korea Marker (JKM) as a benchmark, Citi is marking to market 2013 price to $16.3, unchanged from our earlier forecast. 2014 could rise to $16.5 on continued global demand growth, while Japanese nuclear restarts would initially reduce oil demand, but fall in Cal '15 to $15.5.

Figure 128. North American LNG exports could make up the bulk of the new supply



Source: Woodmac, Citi Research

Figure 129. Asian LNG prices fell sharply in mid-year but edged higher as supply-demand tightened toward winter

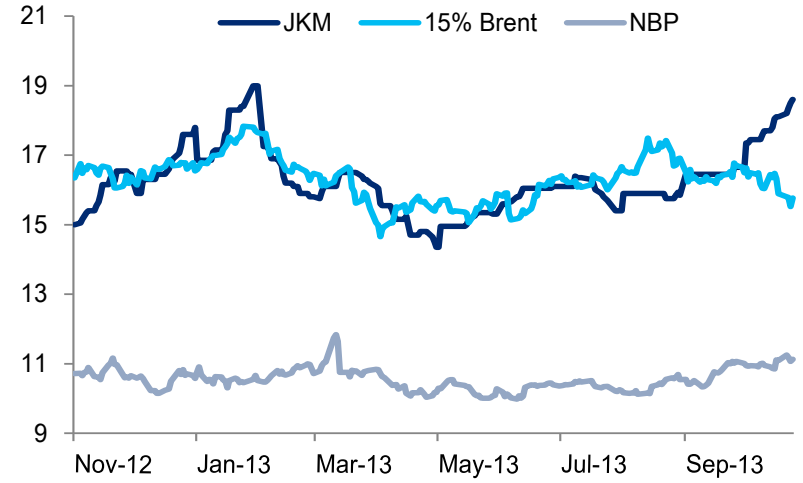


Source: Bloomberg, Citi Research

Asian LNG: 'tis the season to rally…but is the market as deep as last year?

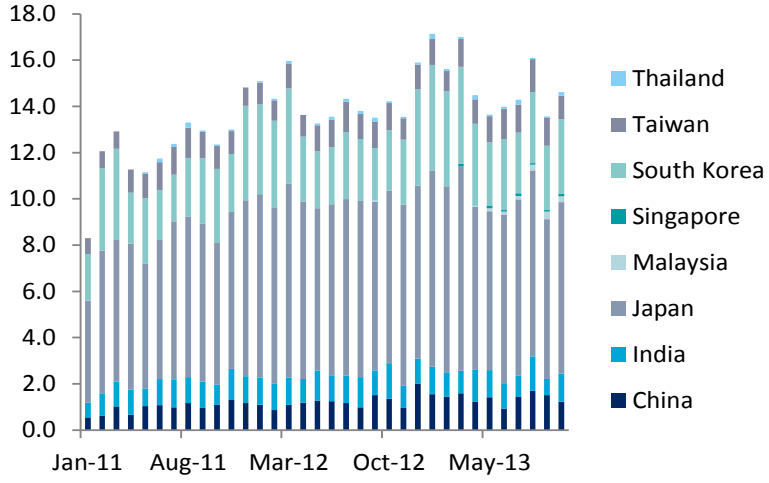
- **Citi has long argued that global LNG markets look a lot like global oil markets in the middle of the last decade**, with robust EM-led demand growth, disappointing supply growth and regular supply disruptions compounding the bullishness. These are exactly the dynamics driving the NE Asian spot LNG markets up to its current level of over $18/mmbtu for deliveries in January 2014. This is already at or over oil parity, and the rally shows no sign of reversing any time soon with looming gas shortages remaining a concern in China for this winter. The startup of 2 new regas terminals in China (Tangshan 3.5 mmtpa and Tianjin, a 2.2 mmtpa FSRU unit) takes China's import capacity from 33 mmtpa to 38.7.
- **Buyers are trying to source term supplies with delivery starting in early 2014**, but with colder than average weather now expected in Japan and the possibility that Latin America - which has been surprisingly quiet in recent months - could come in to buy, it remains a sellers' market.
- **There is little incremental LNG supply coming on line in 2013 and 2014**. Angola LNG (ALNG), the world's newest liquefaction plant remains problematic and is now shut for one month's maintenance. The key bearish risk for Asian LNG markets in 2014 is the potential restart of Japanese nuclear reactors, though there is no sign of progress on this as yet.
- **High spot prices may signal a tight market, but the underlying cause is the reduced availability of cargoes along with a fall in the demand for spot LNG**. Many importers have altered their procurement strategy this year, after seeing price spikes last year. Importers have maximized their upward quantity tolerance (UQT) from their long term suppliers. Hence, the number of spot cargoes from these long term suppliers fall. But as more importers also have short term contract or strip deals for LNG, they also do not need to go to the spot market. Therefore, those importers that are short LNG and have no contractual agreement would likely be caught chasing for very few available cargoes. Rising prices should also boost re-exports of cargoes from Europe to Asia.

Figure 130. Gas Prices ($/MMBtu) (2012-2013)



Source :Bloomberg, Citi Research

Figure 131. LNG Deliveries to Asia (Mln tonnes) (2011-2013)

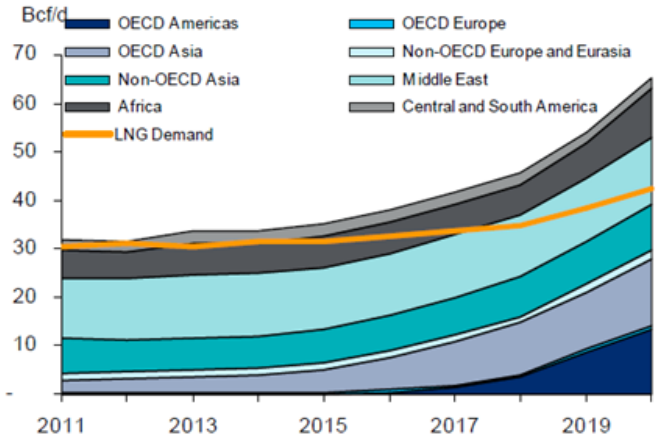


Source: Citi Research

Longer term fundamentals point to a reversal of the advancing price cycle…

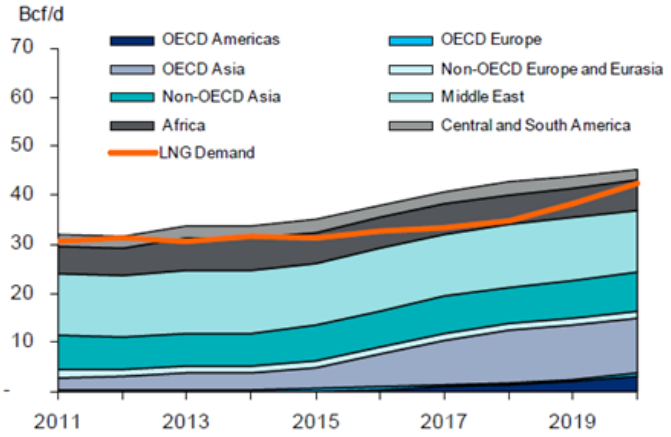
- **Four key factors starting in the middle of the decade should drive supply higher but prices lower**:
  - **Supply fundamentals**: although the wave of new LNG liquefaction facilities coming online may be delayed, North American LNG, backed by still surging production, could more than fill the gap, with 8 to 10-Bcf/d of LNG exports highly possibly by 2020, representing ~20% or more of global LNG supply
  - **Oil pricing**: Prices biased toward the downside on high supply and modest demand growth, consistent with Citi's call for lower crude prices due to strong North American oil/liquids production, in addition to supply additions elsewhere globally
  - **Coal demand**: If China were to transition and coal demand were to slow, then global coal prices could fall by such an extent that makes coal very competitive vs. gas, despite gas' other desirable attributes. A slowdown in fuel-substitution from coal to gas in the developing world could slow gas demand growth
  - **LNG demand**: Consumption may not be as strong as expected, even if nuclear restarts were to be modest in Japan. Demand could not grow without supply and importers are reluctant to sign expensive long term contracts. China has insatiable demand, but supply is not being made available. Rather than a demand driven price increase, demand may rise because of a price decline.
- **In this environment, oil-indexation could be broken, but low oil prices should still bring down gas prices**. More hybrid deals are being signed. Long term contracts with a high slope (0.145 or more vs. oil prices) have largely been absent from the market, although recent contracts with lower slope do come with sizeable equity investments by the same importer in upstream and liquefaction facilities.

Figure 132. World LNG demand and supply (if all projects go ahead)



Source: BP, EIA, Exxon, IEA, Woodmac, Citi Research

Figure 133. World LNG demand and supply (if only existing facilities and projects currently under construction go ahead)



Source: BP, EIA, Exxon, IEA, Woodmac, Citi Research

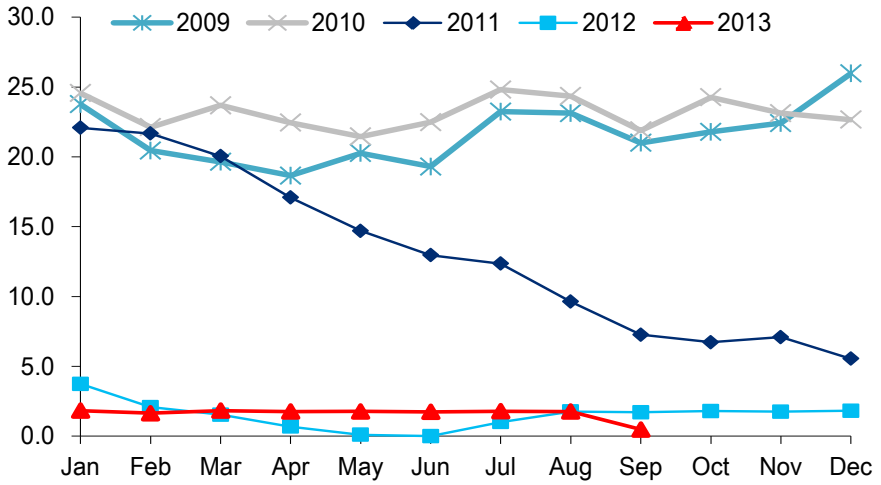
…Meanwhile, both suppliers and buyers are in semi-holding pattern

- **Bridge deals are being made for supply needs before the pricing cycle goes from crest to a possible trough.** An example of a long term bridge agreement is UK Centrica's 4.5-year deal to buy LNG from Qatargas. The deal will run till Dec'18, at the same time as the start of Centrica's 20-year deal with US's Sabine Pass. Centrica is the largest gas suppliers to homes in the UK.
  - **Long term LNG buyers have been more interested in signing these medium term deals**, with even short term deals covering their demand needs without going into the spot market. While LNG contracts do have "price re-openers" for periodic negotiations on price terms, newer LNG contracts may have very restrictive terms where prices could only move ±5%. This relative rigidity possibly presents another headwind to more contracts being signed. Chinese buyers are also unlikely to sign any deals with a slope greater than 0.14.
- **Gradual steps are in the works to bring on another wave of supply projects**. Cyprus signed a memorandum of understanding with France's Total on the French company's future partnership in Cyprus' liquefaction facilities. Despite the slow progress in the development of Canadian LNG exports, more services companies are entering the upstream area, including the Montney shale, in preparation for a ramp-up in production.
- **However, obstacles remain in the development of Eastern Mediterranean gas but should be solved over time as the gas resource remains sizeable**. Initial well results from an appraisal well at Aphrodite in Cyprus were disappointing; Israel continues to weigh the amount for domestic use vs. exports; Lebanon's politics remain in phases of turmoil.
  - Negotiation is ongoing between Noble Energy, the operator that drilled the first offshore well, and the Cypriot government. Although an agreement is supposed to be reached late this year, it might prove elusive due partly to the downward revision to the mean gas resource estimate from 5 to 8-Tcf to 3.6 to 6-Tcf. Noble is not expected to drill offshore again until late 2014, with Total or Eni much later. Final Investment Decision on a new liquefaction project may not come about until 2017.
  - Israel's consideration involves not just domestic vs. export options, but within the export option what are the competing alternatives: LNG (onshore liquefaction may not be easy), pipeline to Palestine or Jordan, or pipeline to the gas-hungry Turkey. But political factors weigh on economic considerations. In addition, discussions between Cyprus and Israel on energy cooperation would need to move further ahead.
- **But how major liquefaction terminals arrange their offtake agreements could pave the way for more spot LNG trading in the years to come.**
  - **Since some major liquefaction projects leave a small part, perhaps ~25%, of its capacity open for spot rather than under long term contract, the move could go for or against a project operator**. (Gorgon is 65% committed and Wheatstone is 85% committed.)
  - **As US gas exports have no destination clause, the gas could theoretically be shipped anywhere**, effectively becoming spot cargoes if the original intended destinations of these cargoes do have sufficient gas supply already to meet demand.
  - **In a loose market where supply is greater than demand, prices should fall but also vice versa.** Calculations may be considering that, even with equal probability of having a tight or loose market, prices could skew to the upside in periods of tightness due to scarcity pricing and the absolute need for some buyers to purchase gas. The upside skew in price could much more so than the downside in price, when many buyers would be willing to purchase cargoes once prices fall below a certain point.

Critically, Japanese LNG demand should fall from current levels as nuclear returns

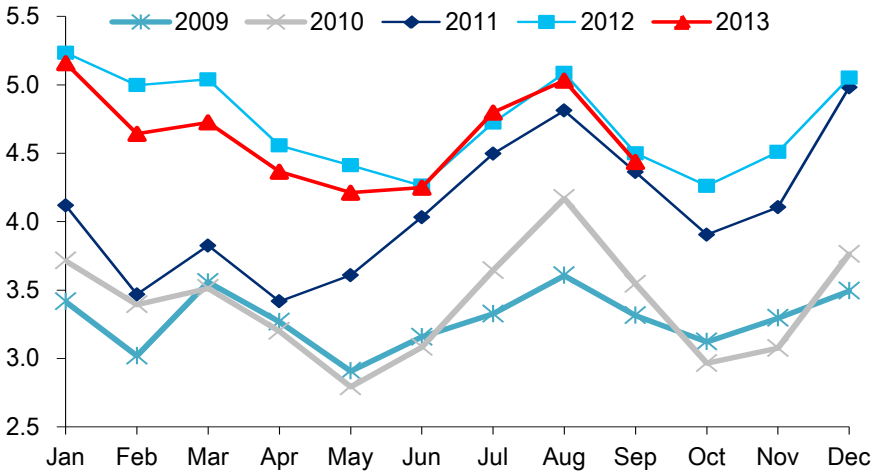
- **The return of Japanese nuclear reactors remains highly uncertain,** however, given that scheduled maintenance in September brought power generated by nuclear to zero, we see risks now are only to the upside.
- **The shutdown of nuclear that spurred the surge in LNG imports should gradually fade,** as some nuclear units will likely restart in the longer term.
- **Longer term, gas demand is expected to stay flat, with lower power demand and some nuclear restarts reducing gas demand for power generation**, offset by higher gas demand outside of the power sector.

Figure 134. Japanese Power Generated by Nuclear (GWh) (2009-Present)



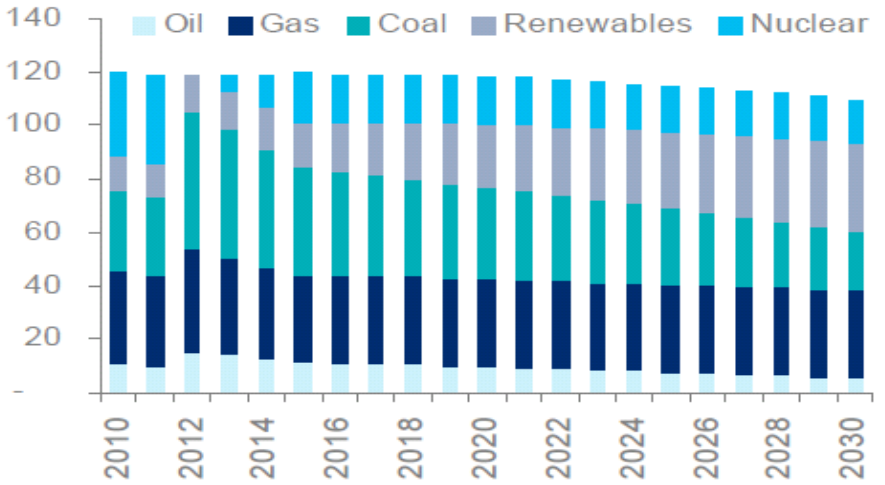
Source: FEPC, Citi Research

Figure 135. Japanese Power Generated by LNG (Mln Tonnes) (2009-Present)



Source FEPC, Citi Research

Figure 136. Generation by Fuel in Japan (GW) (2010-2030)

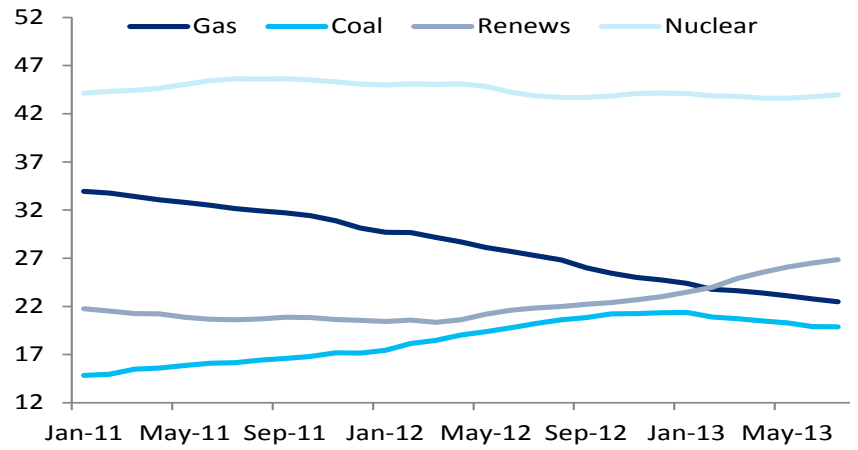


Source IEEJ, Citi Research

European Gas: Everything Looks Bearish, Except Prices

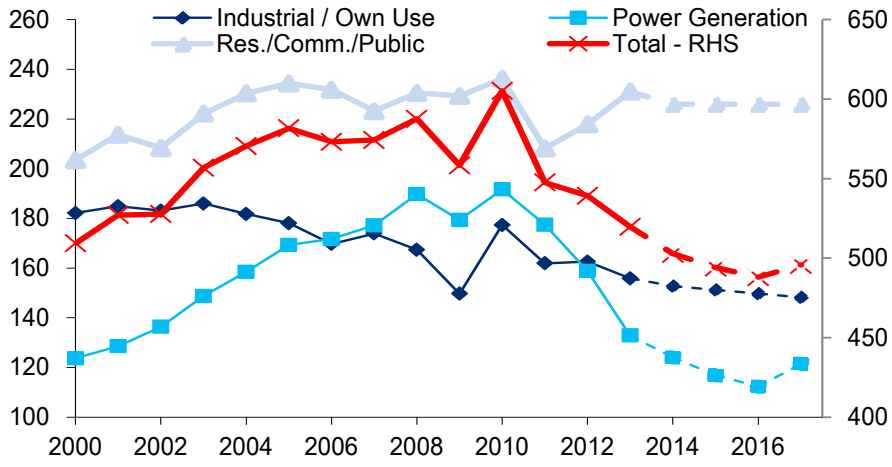
- **Although demand fundamentals look weak, the lack of LNG cargoes and the supply decline from elsewhere have tightened the market, boosting imports of Russian gas**.
- **European gas prices have been exceptionally stable in 2013 except for 2 spikes,** one up in March during a pan-continent cold snap, the other down during an interconnector shut down. Citi expects this price stability to continue, despite numerous bearish indicators.
- **Demand has been assailed on all sides**; total power generation was down 1.6% y/y in 1H13, while strong hydro coupled with another record year for non-hydro renewables left total fossil fuel power gen down 11%. Within fossil fuel, cheap coal continues to crowd gas out of the power stack; the 4 countries that provide data on their fossil fuel break out show the clear trend of gas losing out to renewables and coal combined.

Figure 137. Combined France, Italy, Spain & UK Power Generation by Source (TWh) (2011-2013)



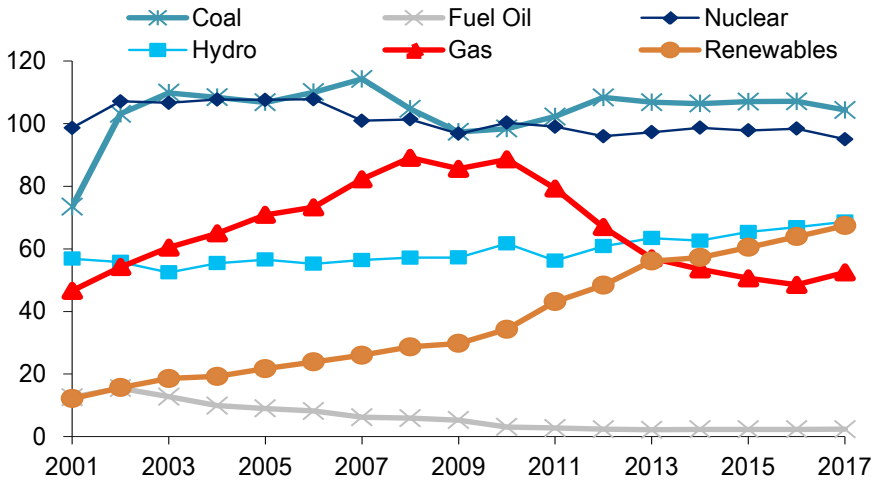
Source: ENTSOE, Citi Research

Figure 138. European Gas Demand by Sector (bcm) (2000-2012+ Forecast)



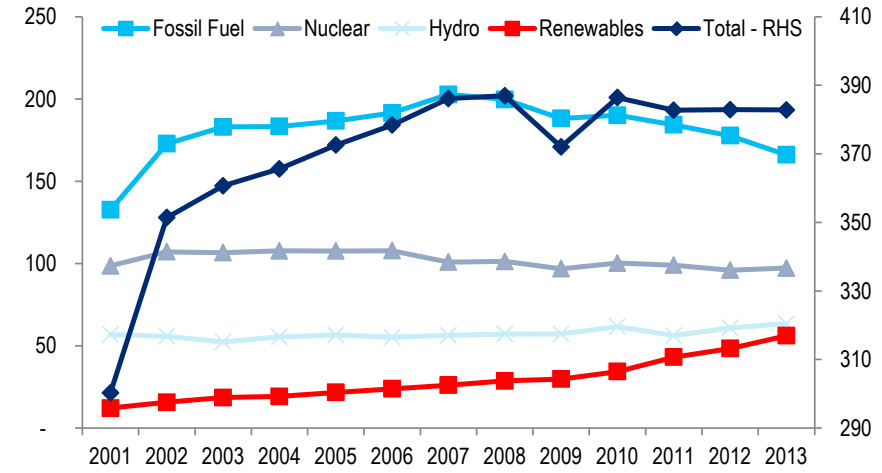
Source: PIRA, Citi Research

Figure 139. European Utilized Capacity by Fuel (GW) (2001-12 & Forecast)



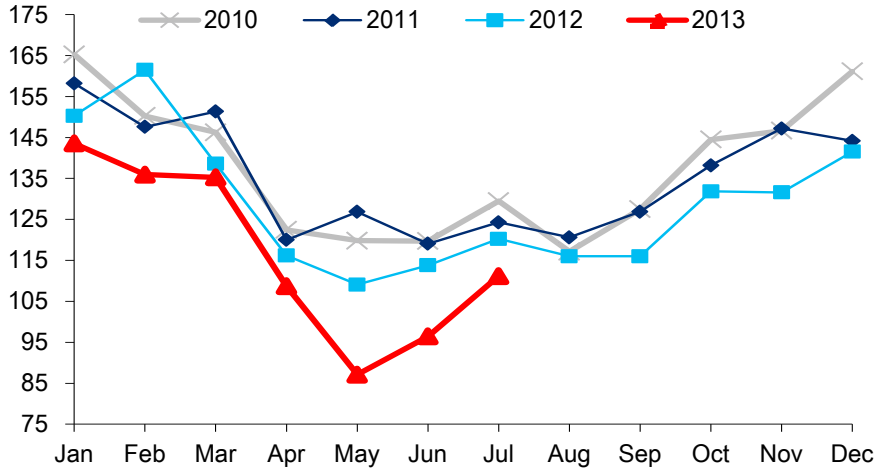
Source PIRA, :Citi Research

Figure 140. European Utilized Capacity by Fuel (GW) (2001-2012)



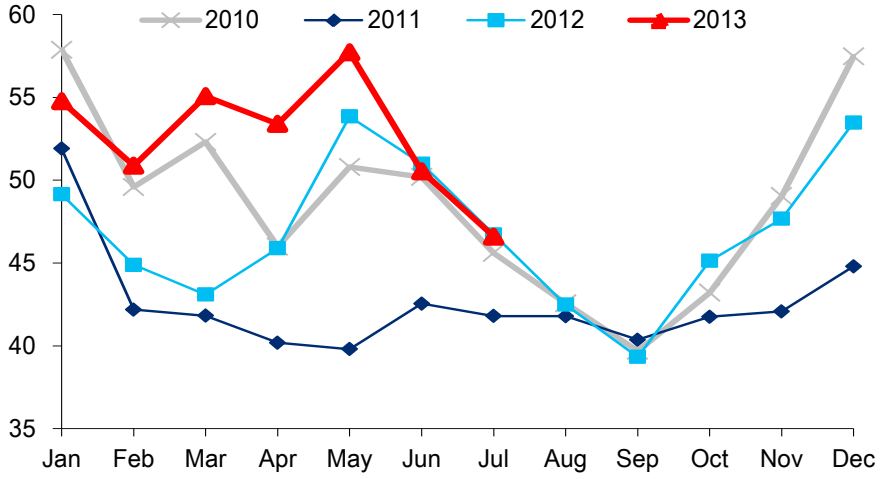
Source: PIRA, Citi Research

Figure 141. European Power Generation from Fossil Fuels (TWh) (2010-Present)



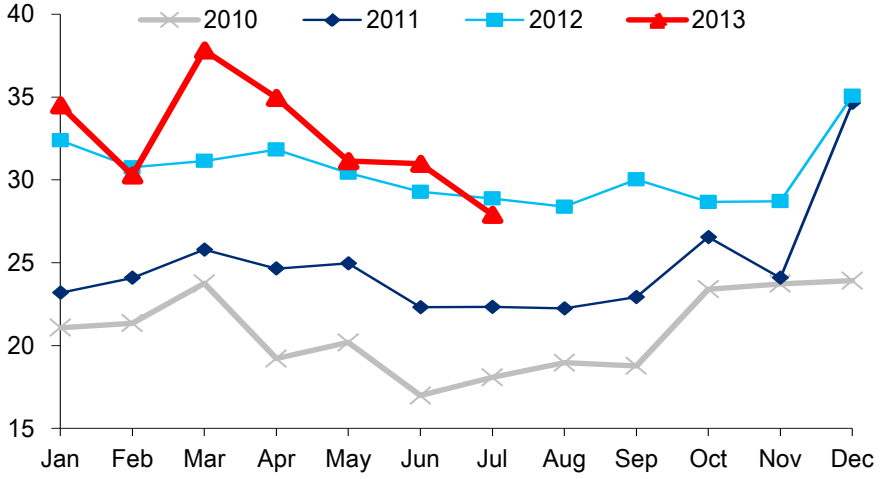
Source: ENTSOE, Citi Research

Figure 142. European Power Generation from Hydro (TWh) (2010-Present)



Source: ENTSOE, Citi Research

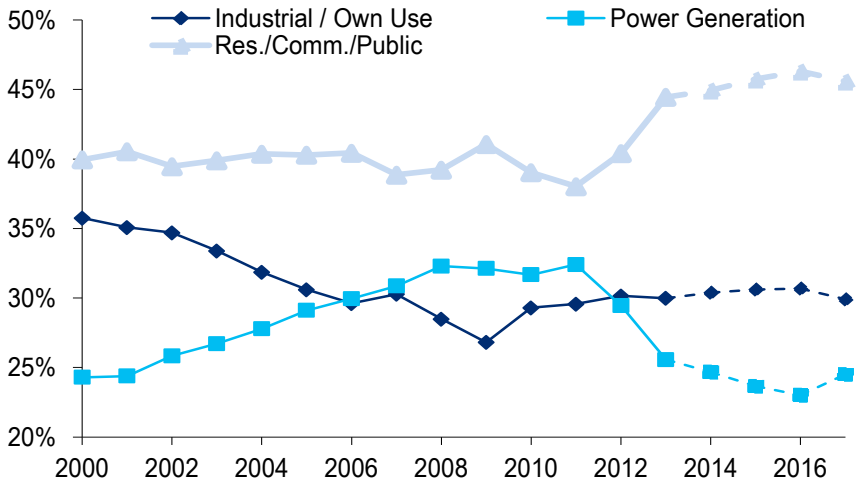
Figure 143. European Power Generation from Other Renewables (TWh) (2010-Present)



Source: ENTSOE, Citi Research

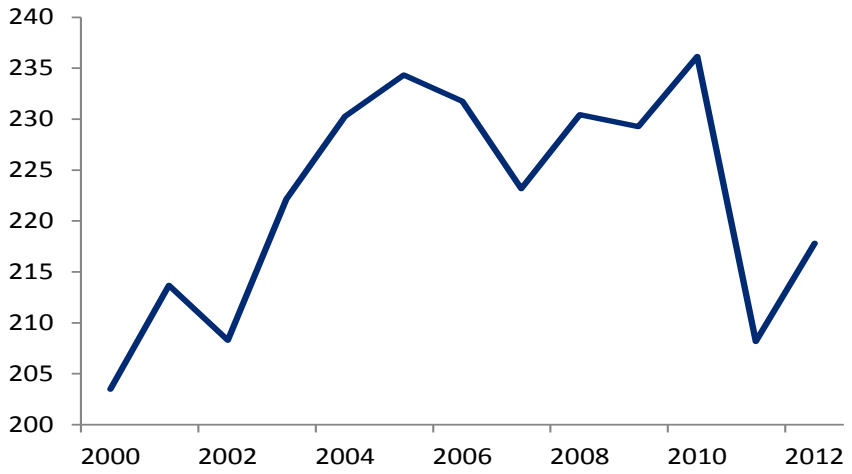
- **Industrial gas demand in Europe is in structural decline as cheap US shale gas makes European industrials far less competitive than their US counterparts**.
  - Futures curves for US and UK gas show little sign of converging; the differential is still over $5/MMBtu in 2017.
  - We expect industrial gas demand to continue to decline as gas intensive industries continue to move to the US.
  - Given Citi's estimate of declining power and industrial demand this increases weather dependent res/com's share of total gas demand.
- **This heightened sensitivity to weather in winter is exacerbated by the increasing reliance on Russian flows**, which in 2013 look set to account for over 30% of total European supply.

Figure 144. European Gas Demand by Sector (% of total gas demand) (2000-2012 + Forecast)



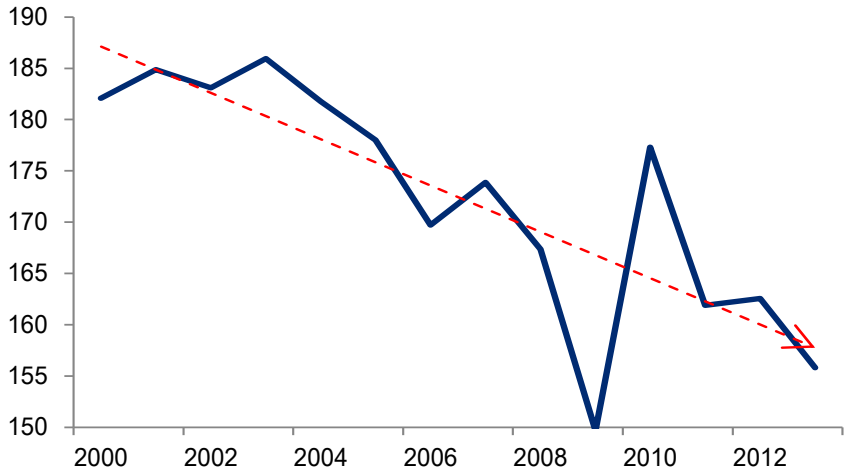
Source: PIRA, Citi Research

Figure 145. European Residential/Commercial Gas Demand (bcm) (2000-2012)



Source: PIRA, Citi Research

Figure 146. European Industrial Gas Demand (bcm) (2000-2012)

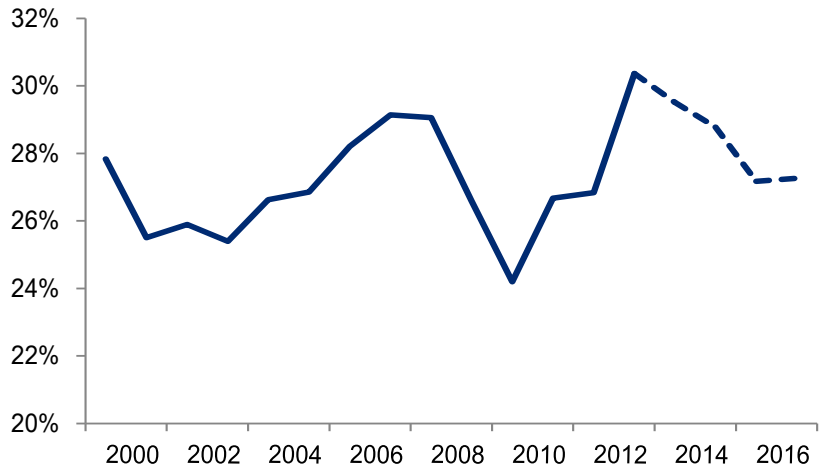


Source: PRIA, Citi Research

The price outlook is slightly bearish, but due to oil not gas

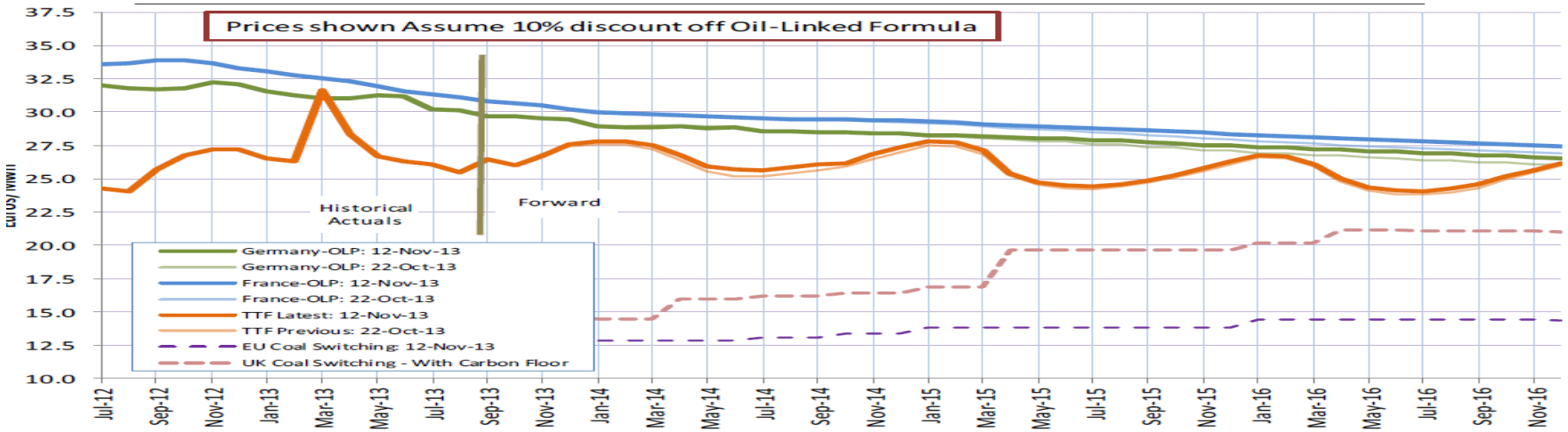
- **Reliance on Russian gas flows as gas demand has become increasingly weather dependent in Europe** has kept European spot prices supported despite the bearishness emanating from the demand-side. This reliance on Russian gas is expected to remain high, over 25% out to 2017 which should continue to negate the bearishness that is expected from further falls in European gas demand.
- **Russian gas to Europe is priced off oil and current formula prices (OLPs) are currently close to European spot prices.** These OLPs will fall in 2014 if oil markets conform to Citi's bearish view. This should therefore bring down spot prices given the current proximity to OLPs and cap upside moves in spot prices.
- **Downside moves should be capped however** as the market dynamics that have drifted prices higher over the past 2 years remain in place.

Figure 147. The call on Russian gas to Europe is expected to remain over 25%



Source: Citi Research

Figure 148. European Spot and Oil Linked Prices and Forward Curves (€/MWh) (2012-2016)



Source: Citi Research

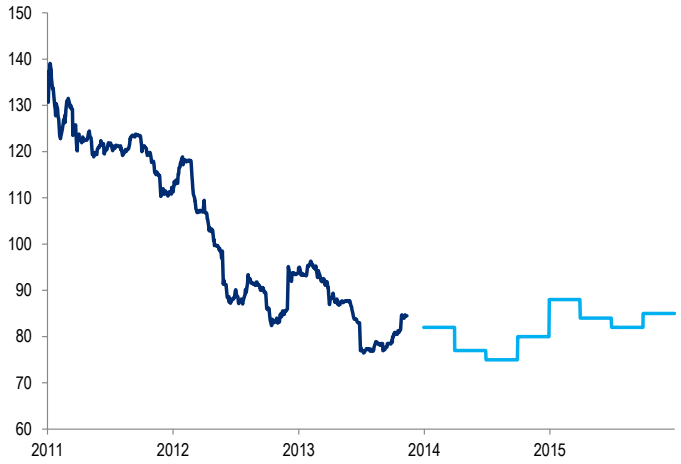
Thermal Coal – structural decline in demand

- **The thermal coal market remains in surplus and we do not expect this to change in 2014 as we continue to see insufficient supply response, partly due to take or pay rail contracts in Australia.** We have slightly increased our Q1 2014 thermal coal (Newcastle) price forecast to $82 from $80 and left our 2015 forecast unchanged at $85.

- Global benchmark thermal coal prices have been quite volatile of late, however, particularly for Richards Bay and ARA. We think most of these influences are temporary and should soon pass, but we do worry that the **shrinking share of production that meets 6,000 kcal benchmark standards may make these benchmarks less representative of the coal market as a whole**.

- **We have downgraded our long-run forecast to $90 from $105. We believe that thermal coal demand is in structural decline as a result of both increasing environmental pressure and declining cost competitiveness compared to alternatives for power generation.** In China, we forecast much slower growth in coming years as a result of slower GDP growth, a transition to the service sector, growing alternative power sources, and improving thermal plant efficiency. In the US, environmental requirements effectively prevent the construction of new coal fired power plants. And on a global basis, lower costs for gas, wind, and solar power are significantly decreasing coal's cost competitiveness for power generation.

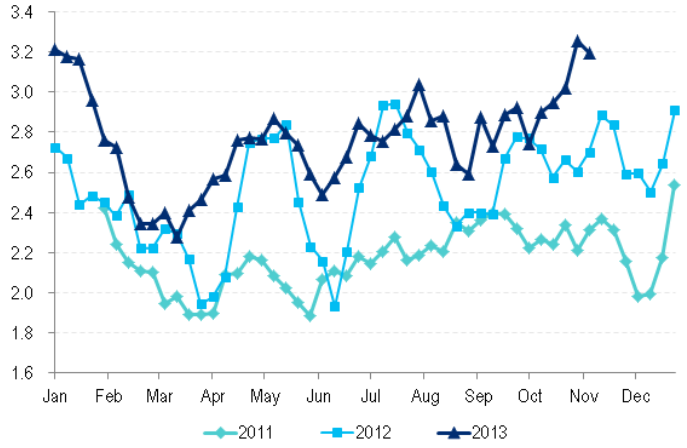
Figure 149.Thermal coal prices are expected to move broadly sideways over 2014 and 2015



Source: Bloomberg, Citi Research

Figure 150.With the market remaining amply supplied

Exports from Newcastle, Australia



Source: Port of Newcastle, Citi Research

Trader activity and grade issues have distorted the market

- Global benchmark thermal coal prices have experienced an incredibly volatile autumn. Prices have risen considerably from summer lows, but more notable was a spike in API4 and API2 prices in October followed by a sharp reversal. As the locus of the move was Richards Bay in South Africa, the implied freight with ARA in Europe was pushed sharply negative. While Newcastle prices in Australia were also pulled higher, their more moderate increase resulted in a rare positive differential between API 4 and Newc.

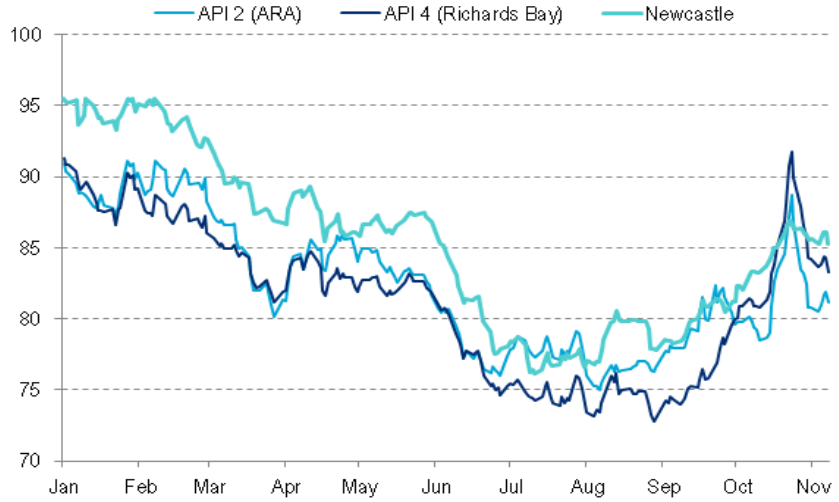
- **The primary driver of recent volatility is believed to be positioning by a large trading house, and the removal of their bids for API4 cargos is likely to see thermal coal prices correct back lower, in line with oversupplied fundamentals.** Similarly, we expect implied freight to return to normal positive levels (with the risk that the rebound will take it to higher than average levels on the other end – e.g. $4-5/t) and API 4 to decline significantly relative to Newc as well, particularly given the strong seasonality around Newc prices in December and January.

- However, the ability for a trader to execute such a large move highlights an important market trend. While Richards Bay inventories and rail deliveries are at record levels, a decreasing proportion of coal produced is of sufficient quality to meet the 6,000 kcal benchmark upon which futures are traded. Similar to iron ore, **this decreasing availability of index grade material is making these indices less representative of the market as a whole and more vulnerable to influence from factors specific to benchmark grade materia**l (e.g., a production disruption, hoarding of cargos, shifts in calorific content consumption of consumers, etc.).

- There have also been concerns in the market around exports from the Drummond mine in Columbia and bottlenecks in Russian export supply chain. However, we believe both issues are moderate and that the fundamental oversupply in the market will push prices back lower in 2014, particularly as we move beyond the beginning of the year.

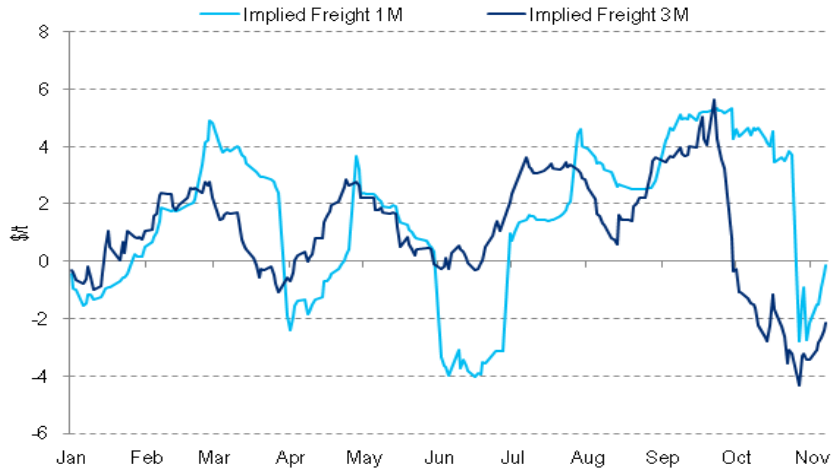
Figure 151. There have been huge swings in coal futures prices lately

Three month futures prices, $/t



Source: Bloomberg, Citi Research

Figure 152. Implied freight rates between Richards Bay and ARA were pushed sharply negative



Source: Bloomberg, Citi Research

China: amply supplied

- **The Chinese coal market remains amply supplied, with coal supply having increased notably in the second half.** The import arb is now negative as a result of the recent sharp increase in international prices, despite a modest uptick in domestic thermal coal prices and more significant rise in domestic freight rates.
- Moreover, the increase in domestic prices has not been driven by stronger demand from power plants as electricity generation has fallen and power plant purchasing prices have not joined in the price rally. In fact, **we expect weaker demand in the coming months as tighter credit conditions result in slower industrial sector growth.**
- **Inventories are also relatively high across the supply chain**, including at mines, ports, and power plants. Chinese buyers have also been willing to purchase cheaper lower calorific value coal – buying 5,000 kcal rather than higher quality material.

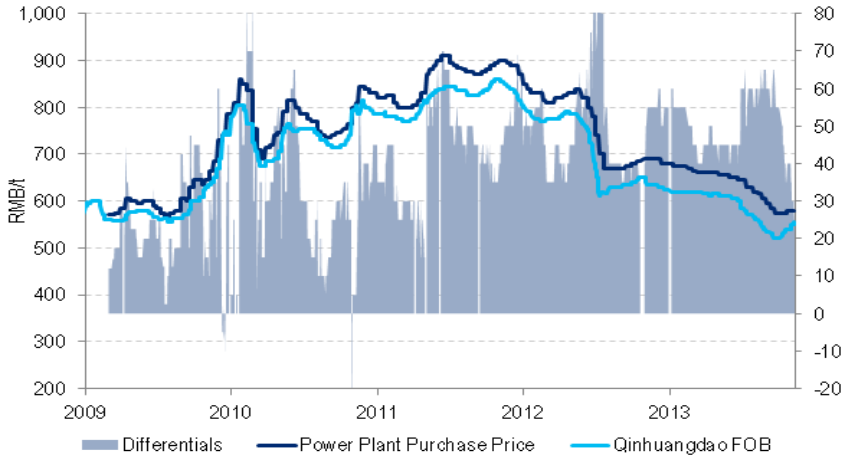
Figure 153.The import arb has turned negative, even in Guangzhou
6,000 kcal coal into Guangzhou

Source: Bloomberg, Citi Research

Figure 154.Inventories are relatively high at mines, ports, and power plants
Stocks of Key State-owned Coal Mines

Source: Bloomberg, Citi Research

Figure 155.The recent increase in domestic prices has not been driven by power plant purchases, with power plant purchase prices not participating in the uptick

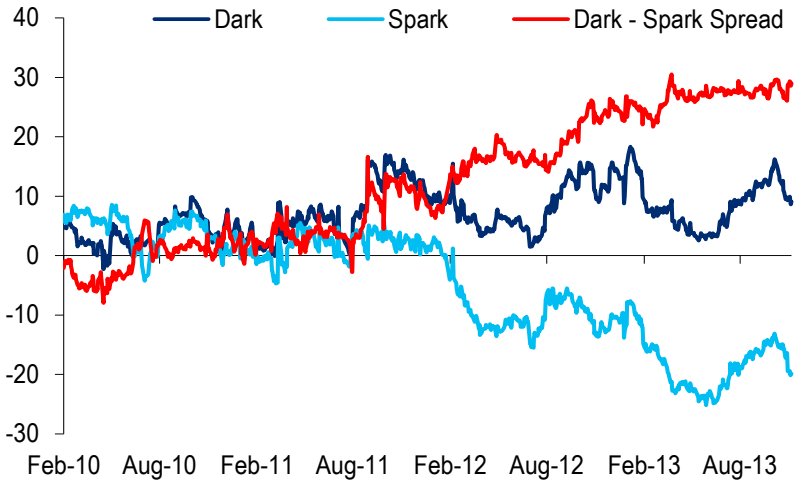


Source: Bloomberg, Citi Research

Demand varied by region

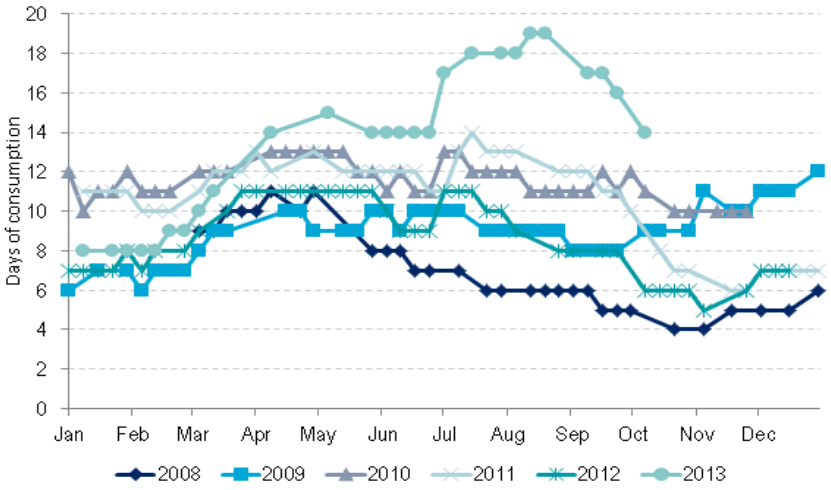
- Coal demand remains mixed by region. **In Europe, the wide differential between utility dark and spark spreads** (nearly 30 EUR/MWh in the Eurozone and over 20 GBP/MWh in the UK) **continues to incentive strong coal usage by utilities.**
- **In the United States**, coal consumption is up this year as a result of stronger electricity demand. Coal's share of generation has held relatively steady this year as a result of cheaper coal prices and higher natural gas prices. However, **we expect coal generation to resume its structural decline in 2014.**
- **In India**, after having imported large volumes earlier in the year and build up substantial inventories, purchases slowed as the rupee depreciated and freight rates rose. A strong monsoon further contributed a decline in coal demand. While Indian buyers may continue to limit purchases in the short term due to high prices, **we expect them to be forced to re-enter the market in size in 2014 given the gap between c10% demand growth and c4% domestic production growth.**

Figure 156. European utility margins continue to incentivize high coal utilization



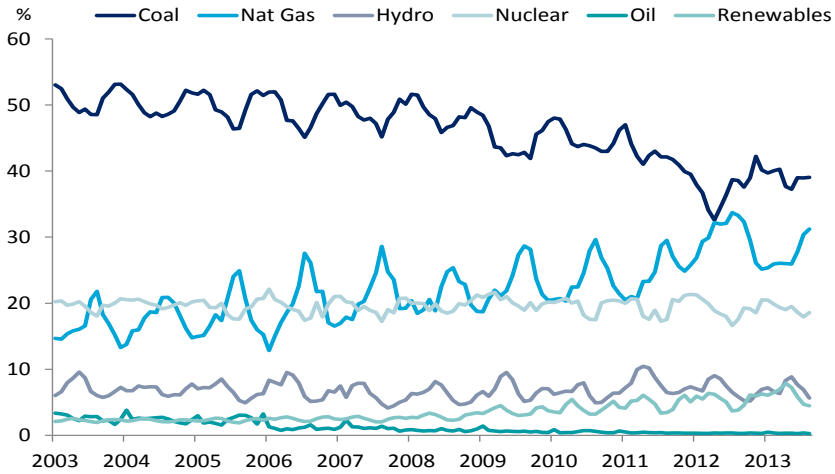
Source: Bloomberg, Citi Research

Figure 157. Indian inventories are declining, but remain at high levels



Source: Bloomberg, Citi Research

Figure 158. US coal electricity generation share held steady in 2013 thanks to lower coal and higher nat gas prices, but should resume its structural decline

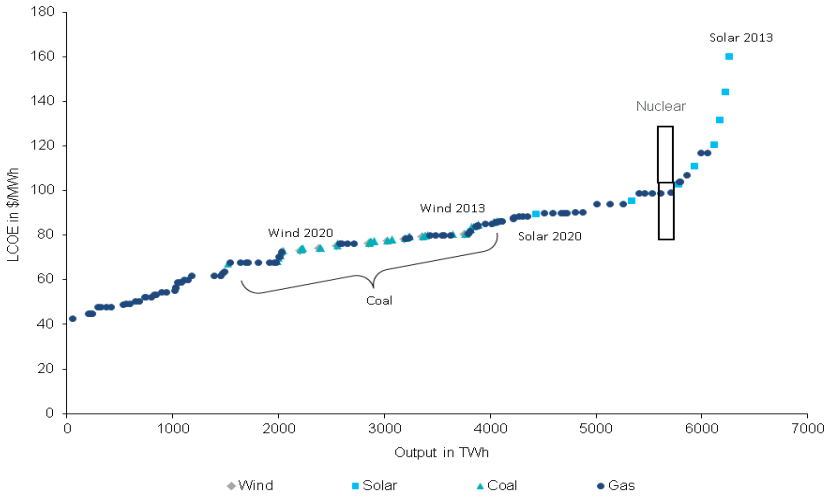


Source: Bloomberg, Citi Research

Structural decline in thermal coal demand

- Thermal coal demand globally is in structural decline, with declining growth rates expected in the coming years followed by an eventual peaking in absolute global consumption. The primarily drivers of this decline are increasing environmental pressure and decreasing cost competitiveness relative to alternative fuels.
- **Coal's cost competitiveness is declining as a result of both the shale gas revolution as well as improving economics of renewable energy.** Citi has compiled a global cost curve for power generation, finding that not only is gas generally a cheaper option for new generating capacity but also that wind power is rapidly achieving parity with coal generation and that solar has the potential to become competitive within the next decade.
- On the environmental front, **EPA regulations in the US already effectively prevent the construction of new coal power plants.** As a result, the US coal fleet is steadily aging and capacity will shrink as old plants are decommissioned. We estimate that US coal power generating capacity will shrink by 9% over the next 5 years, equivalent to 27.8 GW or 52.3 Mt/y of coal consumption.
- **In China, regulations issued in September limit new coal power plant construction in the country's three main economic regions**: Pearl River Delta, Yangtze River Delta, and Beijing/Tianjin/Hebei. The central government also continues to target a reduction in coal's share of total energy consumption and promote the growth of alternatives for electricity generation.
- **In fact, we believe that Chinese coal demand is likely slow significantly as a result of slower GDP growth, shift towards the services sector, increase in alternative generation capacity and improvements in power plant efficiency**. While Chinese coal demand grew at roughly 10% per annum over the past decade, we forecast demand from the power sector (which accounts for roughly 2/3 of Chinese thermal coal consumption) to slow to between +2.5% and -0.5% per annum over the next 5 years.

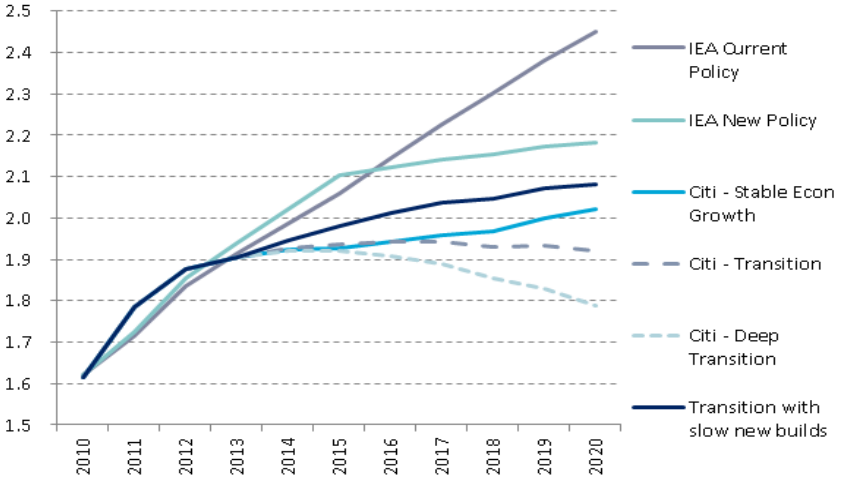
Figure 159: Coal is becoming less competitive compared to alternative power sources



Source: Citi Research

Figure 160: Chinese demand likely to slow considerably as generation mix shifts

Chinese power sector coal consumption, billion tonnes



Source: Citi Research

Notes

Appendix A-1

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