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Energy Markets in Transformation

Geopolitical Implications of the Unfolding North American Energy Revolution

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See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures

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North America (so far without Mexico):
leaders of global supply growth

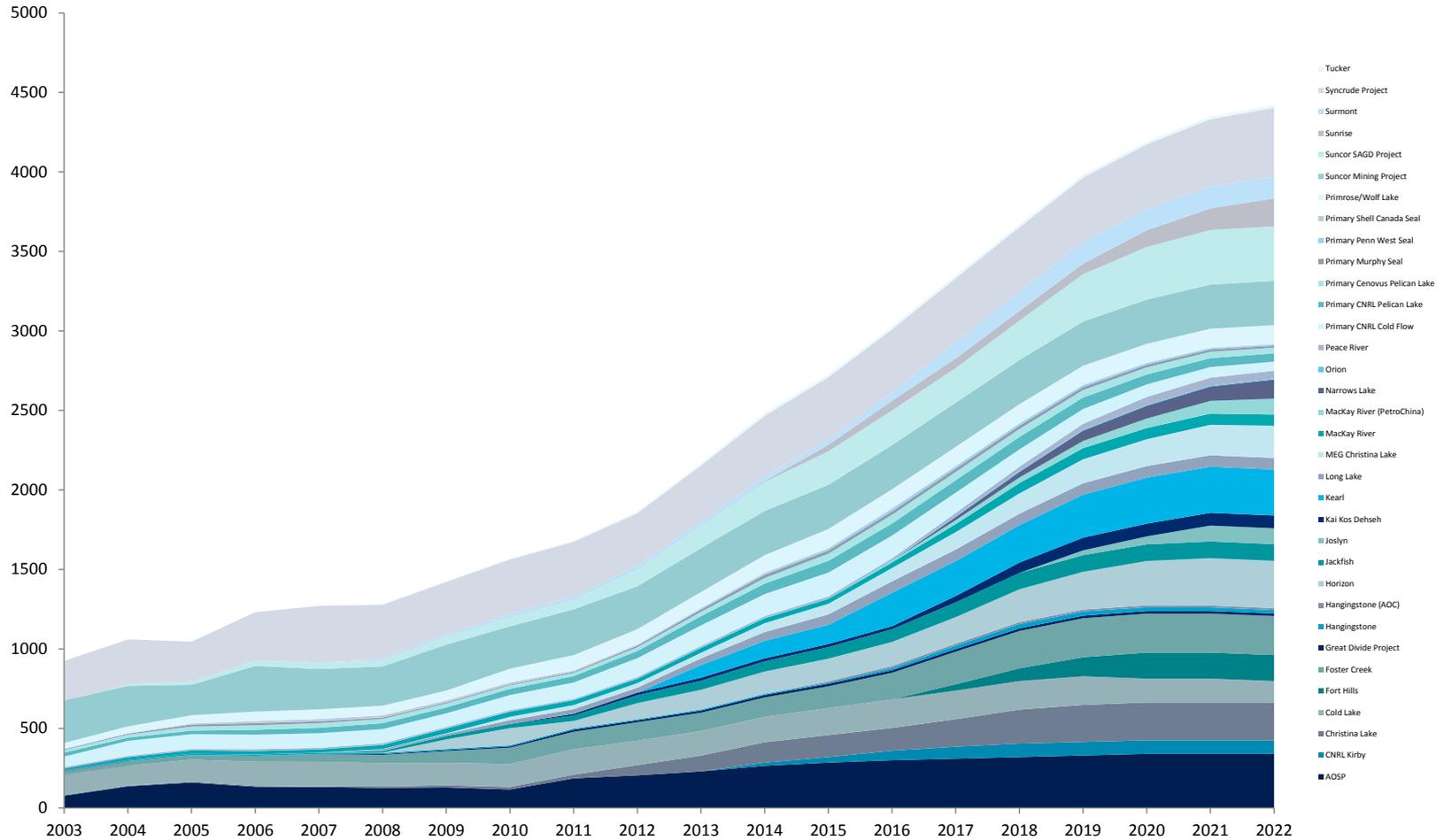
Setting the stage

Since first Libyan disruption, US and Canada have led global production growth, with no end in sight for at least a decade, so far keeping a lid on prices, potentially leading prices down

- Steady growth of **Canadian unconventional oil** (oil sands) soon to be buttressed by rebounding **deepwater** and onshore **natural gas** catapulting Canada from a lumpy supplier to the US to a global supplier of oil and gas by end of decade – perhaps **+ 1-m b/d of oil** and **+ 5 Bcf/d of natural gas by 2020**
- US petroleum from tight oil and deepwater should add **3.5- to 7-m b/d** by 2020
- Surging US product exports catapults US into largest supplier of petroleum products and NGLs to world, and largest trading hub, by 2015, with crude oil exports already growing to Canada
- US, already world's largest natural gas producer, should see demand/production rebound adding >20-Bcf/d of production, including >10-Bcf/d of pipeline and LNG exports by 2020, becoming a top-three LNG exporter
- Mexico could join the two northern neighbors, given rich shale, conventional and potential deepwater resources
- Two sets of questions – How do these three countries interact with one another? What is the potential impact of what's unfolding on the structure and politics of global markets?
- I'm focusing for now on the latter, with a particular emphasis on the US

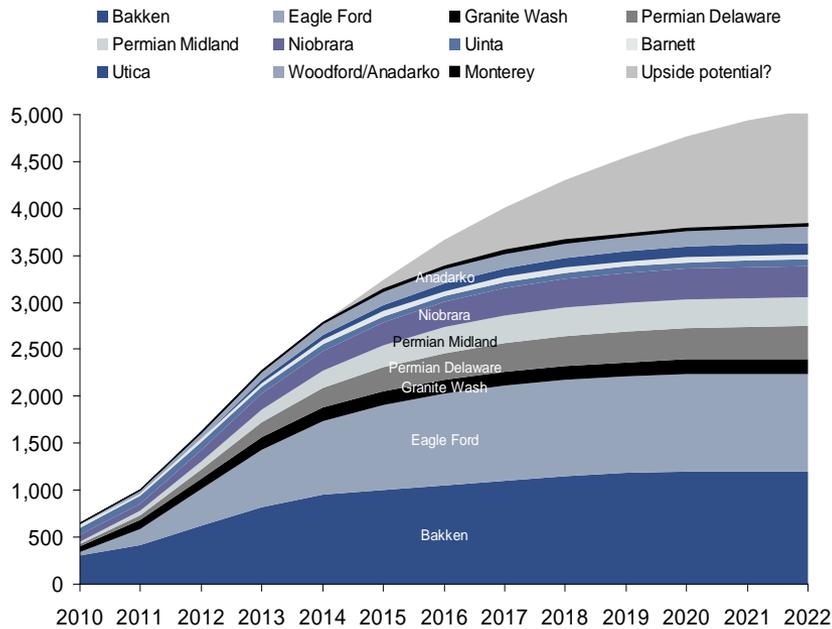
Canadian oil sands production can grow steadily and robustly...

Canadian oil sands outlook (k b/d)

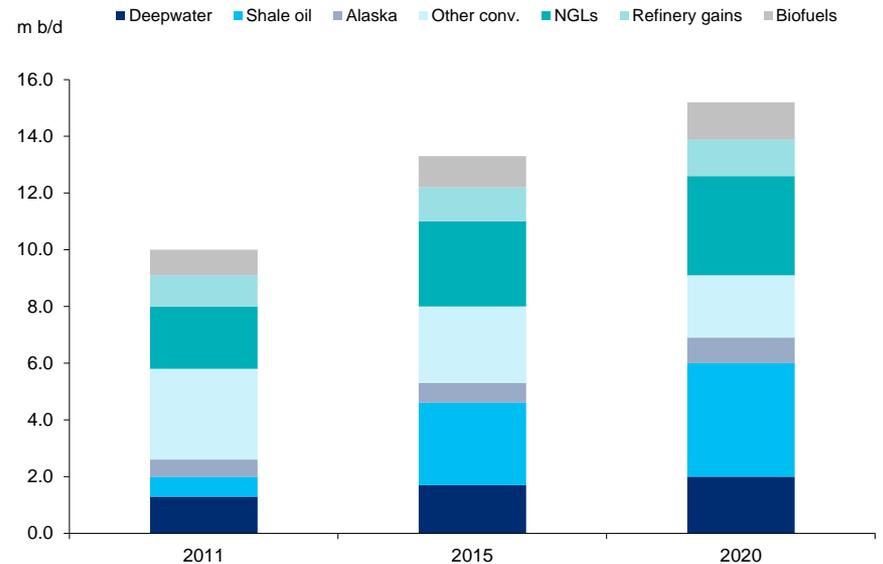


...along with shale oil and deep water in the US...

- US shale liquids could grow >3.5-m b/d to 2020 (k b/d)

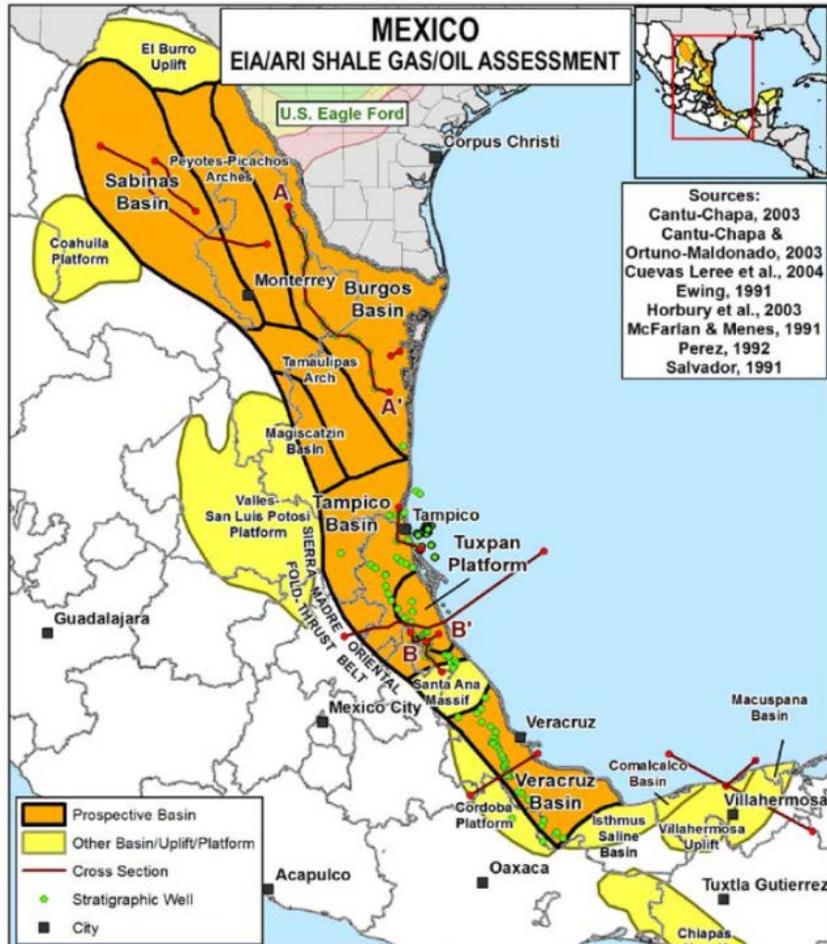


- ...and alongside deep water, US total liquids supply could surge by 2020, with plenty of upside potential

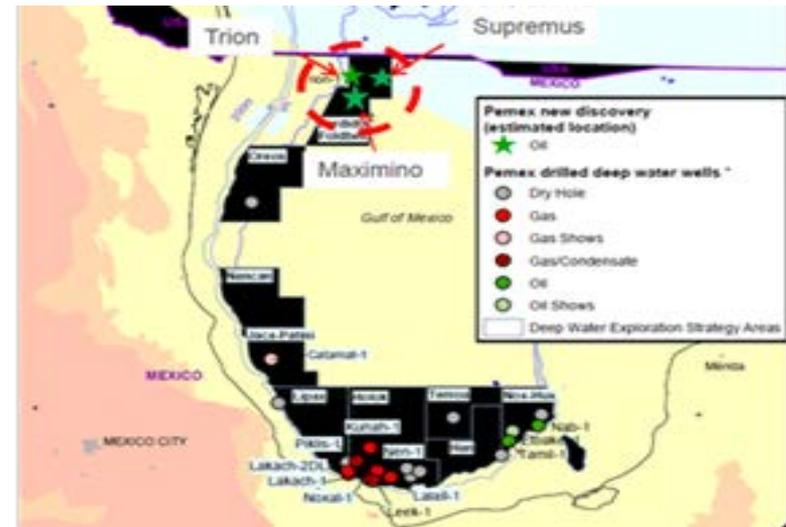


...and Mexico too, both from the onshore and offshore

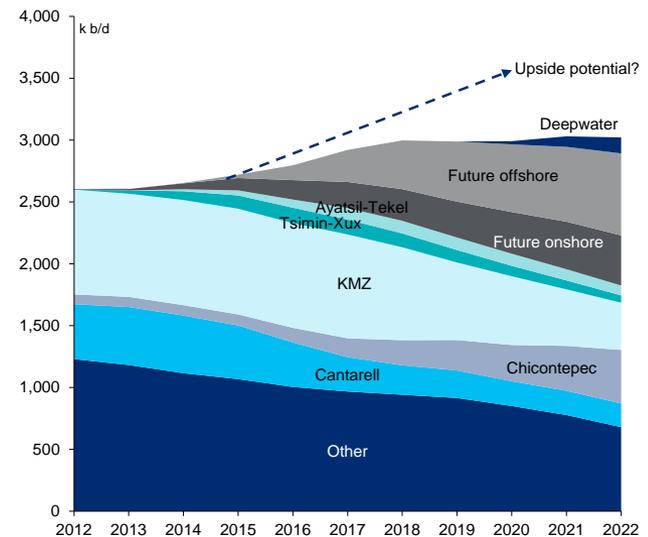
- Mexico's onshore shale potential



- Offshore Mexico oil and gas developments



- Mexico's oil output could grow +1-m b/d to 2020



Source: EIA, Wood Mackenzie, Pemex, Citi Research

The unconventional revolution: a generational disruptive change

Unconventional revolution: generational disruptive change

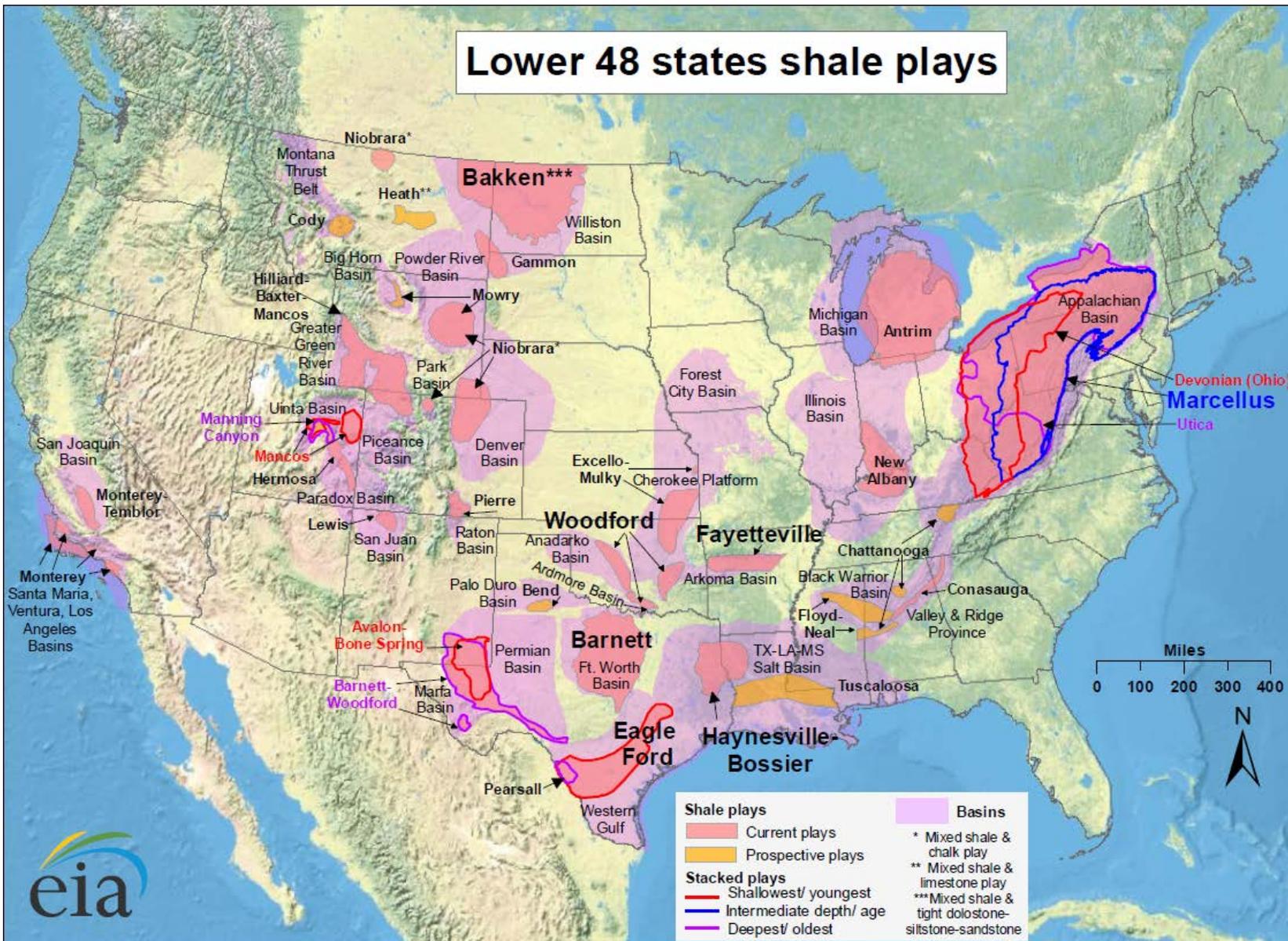
This is 40 years since the Yom Kippur war, which led to what we might call the OPEC half century; that's the sort of disruptive change we can expect from shale, combined with deep water, oil sands...

- Arab oil embargo decided October 16, 1973



- Three unconventional sources should propel non-OPEC supply growth for next decade or longer
- Investment concentrated in the US, now receiving record investment
- Trade, investment flows provide opportunities beyond just hydrocarbon
- US no longer imports meaningful quantities of light sweet crude
- US crude, product, NGL exports accelerating, will soon meet legal obstacles
- US LNG exports could approximate / exceed those of Australia and Qatar, potentially transforming global LNG pricing

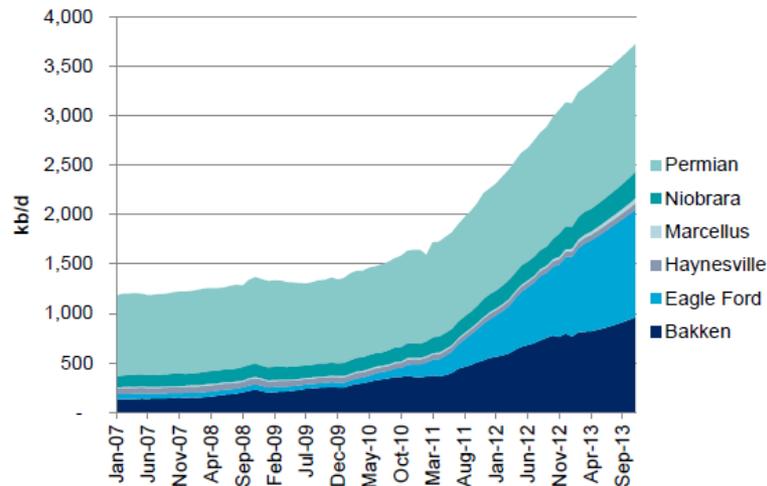
It starts with a geological base...and services, equipment, moxie, finance



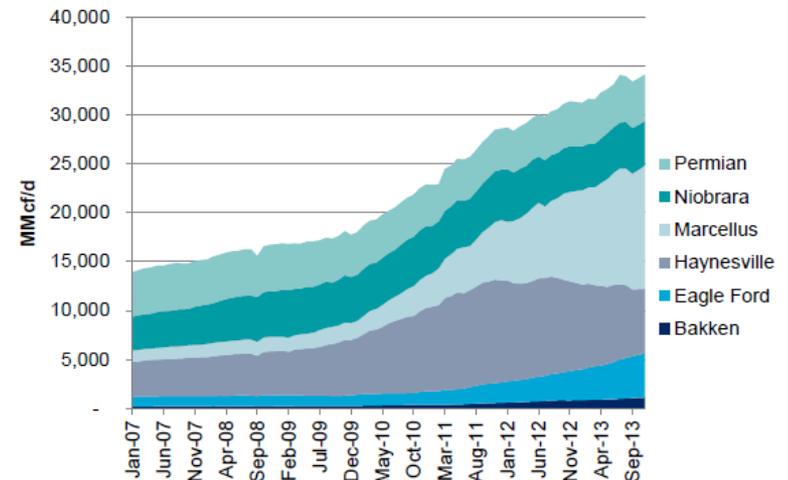
The evidence from the production side is now overwhelming

- US has been the world's fastest-growing hydrocarbon producer, with the pace accelerating
- Efficiency gains have been large and are accelerating
- The exploitable production base appears to be growing and is significant
- The technology is transferable
- Environmental risks are significant, but can be mitigated with best practices
- Even with a clear “made in America” twist, international growth is inevitable
 - The North American Advantage Remains:
 - Wildcatting mentality, capital markets providing risk finance, and private ownership of resources

Oil/liquids production began surging in late 2010...



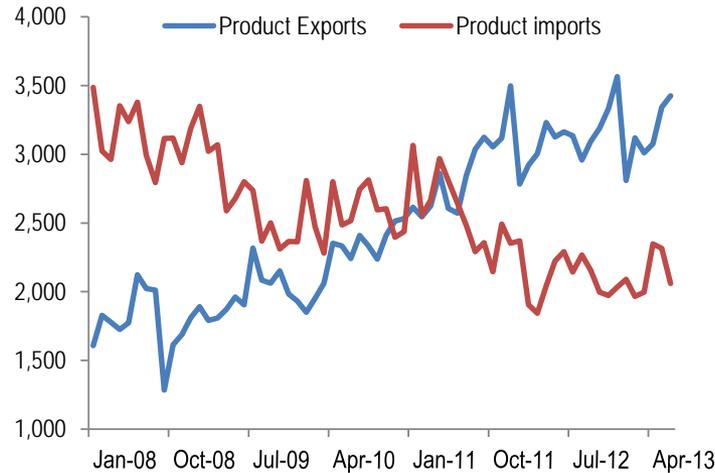
...Gas production started rising post-2008



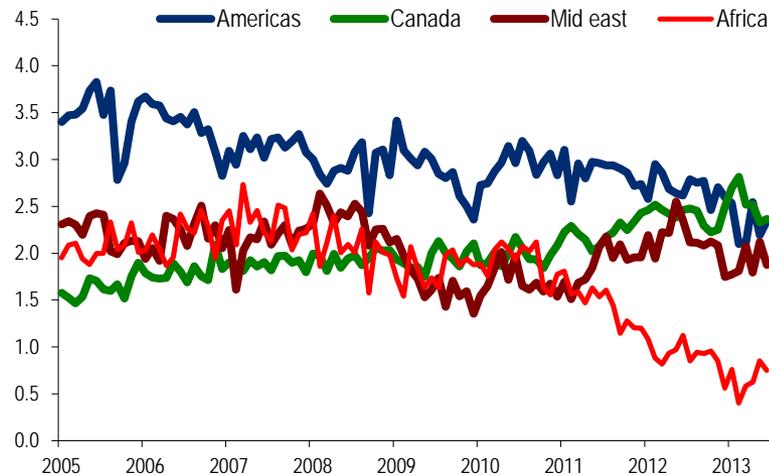
Consequences have already been disruptive

The US has become the world's largest gross petroleum product exporter, while crude price spreads (particularly between WTI and Brent) should continue to be volatile as legacy infrastructure adjusts to the shale revolution

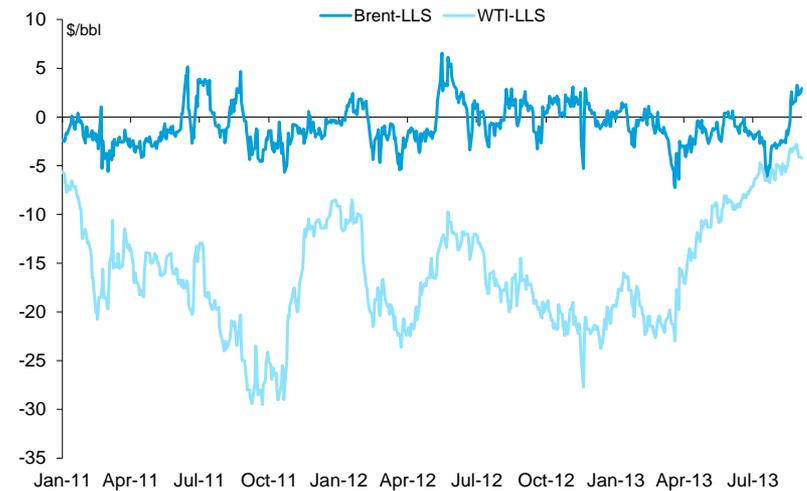
- The US as world's largest oil product exporter (k b/d)



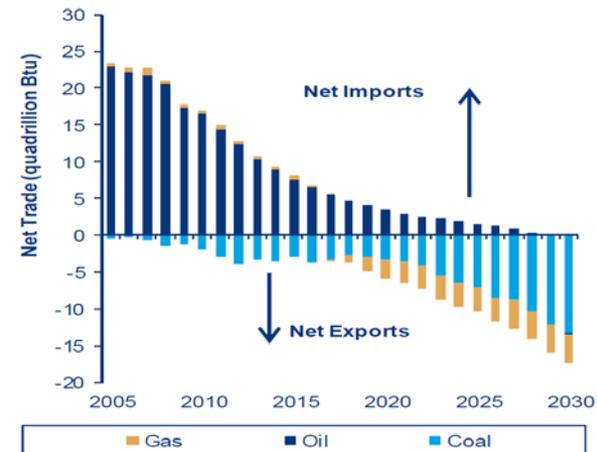
- The US pushes out light sweet crude imports (m b/d)



- Volatile crude spreads, as legacy infrastructure adjusts



- ...with much more to come – North America becomes a net exporter of oil, gas and coal

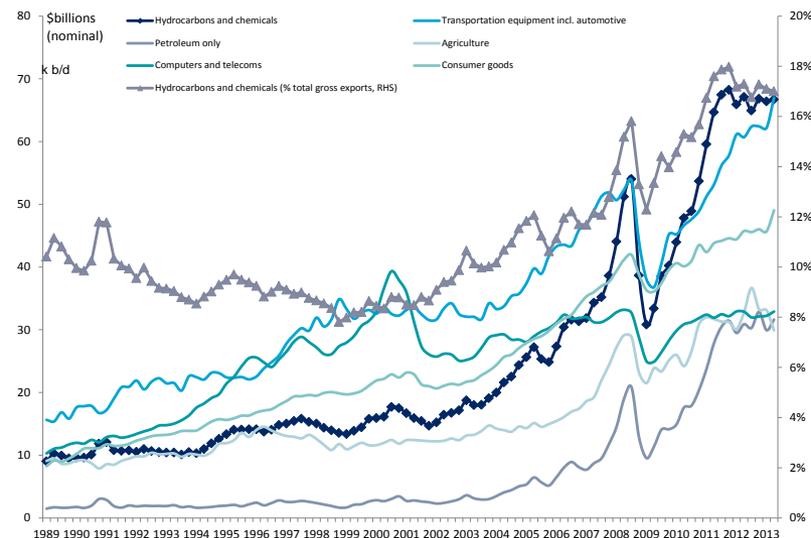


Source: EIA, Bloomberg, Citi Research, Wood Mackenzie

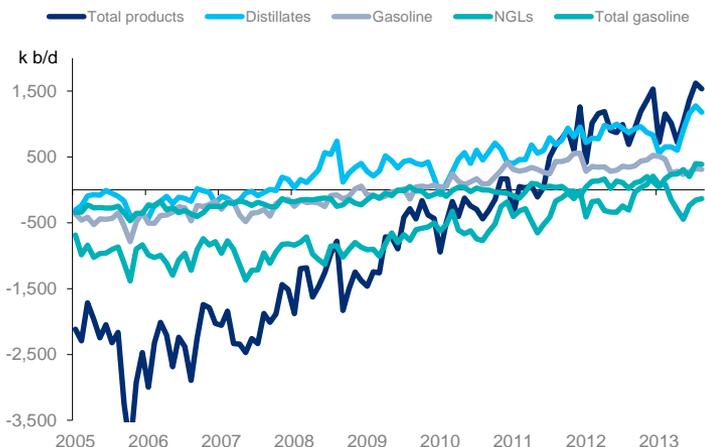
Hydrocarbons surge to top of the US export list – changing national interests

- 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 accounting for a sixth of total gross exports, after surging ahead of agricultural commodities. 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 energy powerhouse.
- 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.

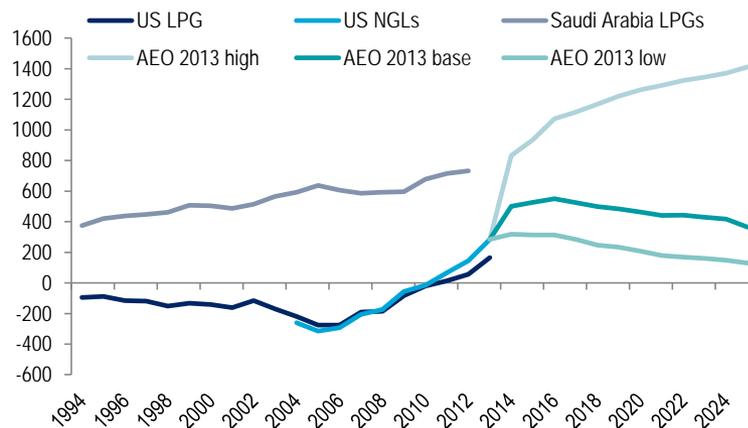
Major categories of US gross exports (1989-Present)



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

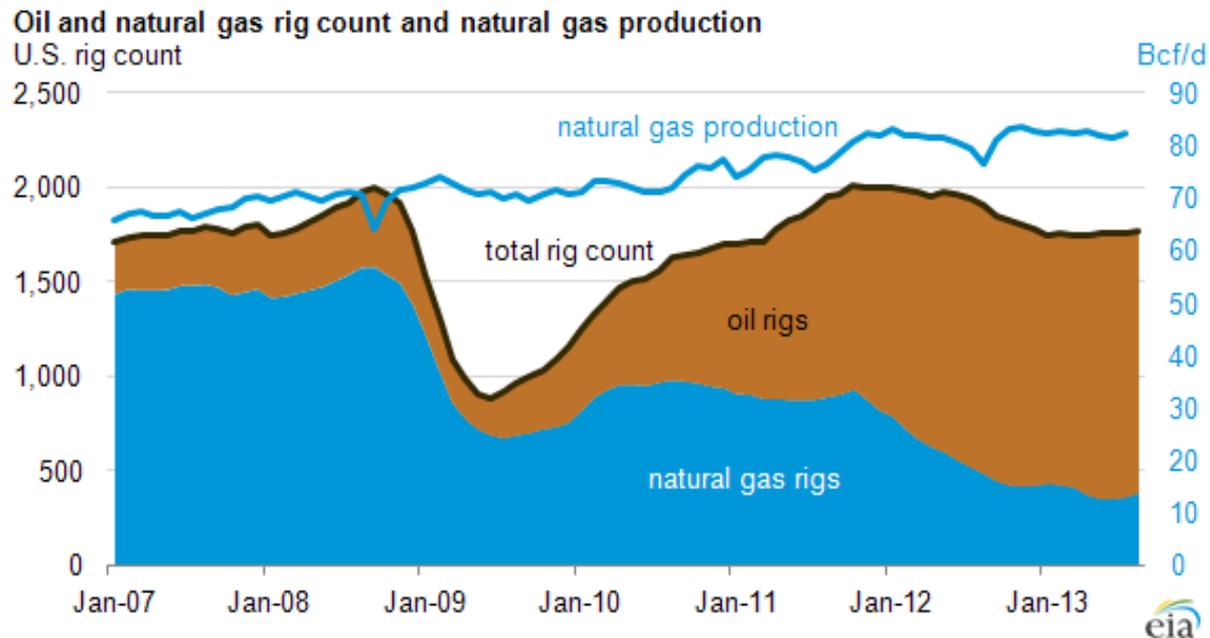


LPG/NGL net exports in the US versus Saudi Arabia LPG exports; US net export projections from EIA's AEO 2013



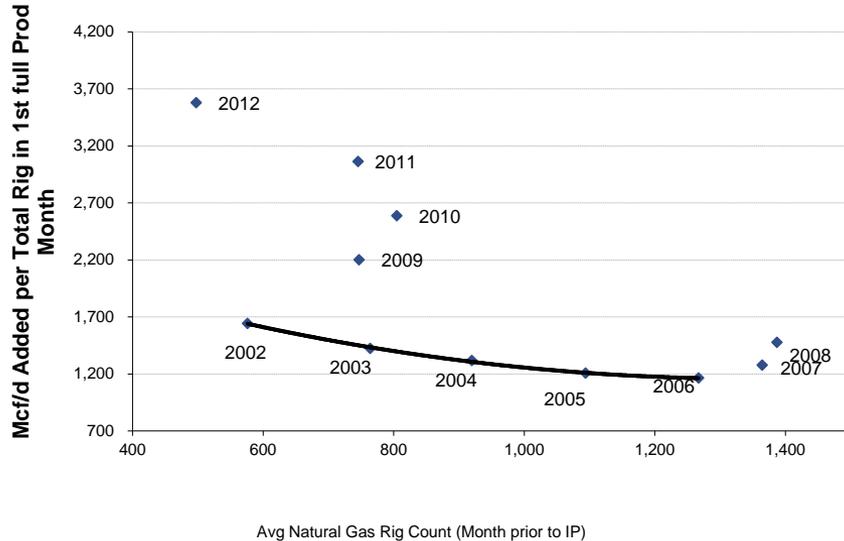
Efficiency gains are overwhelming: more output from fewer rigs

- EIA's new "Drilling Productivity Report" reinforces the need to rethink the relationship between rig count of oil/natural gas production
- The shale/tight oil/gas revolution is driven by technological innovation
- Technology is both expanding the recoverable resource base and driving down cost curves
- There are no signs that the technological revolution is losing steam or reaching the top of an "S" curve of progress



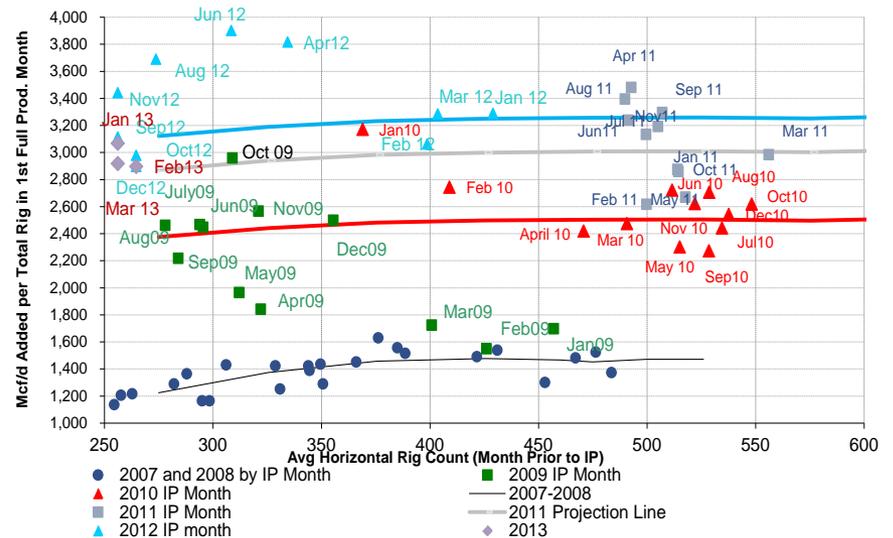
North America shale drilling costs can continue to fall

2002-2012 US onshore rig efficiency



Sources: HPDI, Baker Hughes, Citi Research estimates

US onshore rig efficiency

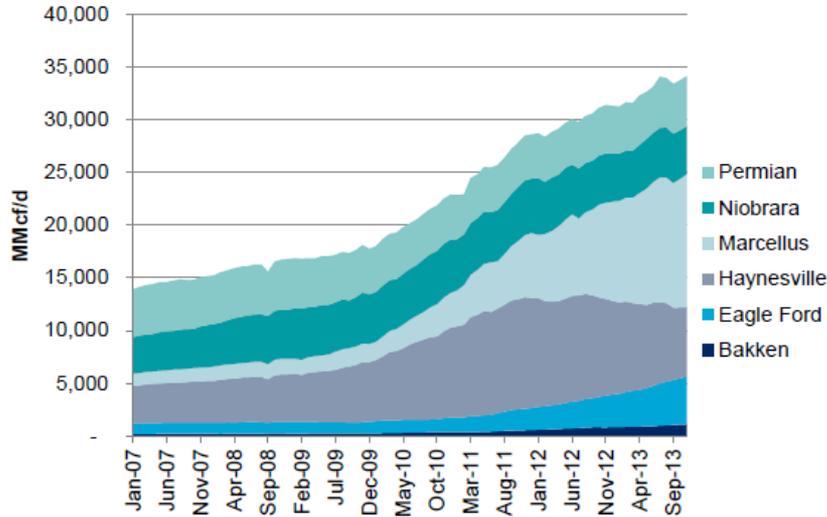


Sources: HPDI, Baker Hughes, Citi Research estimates

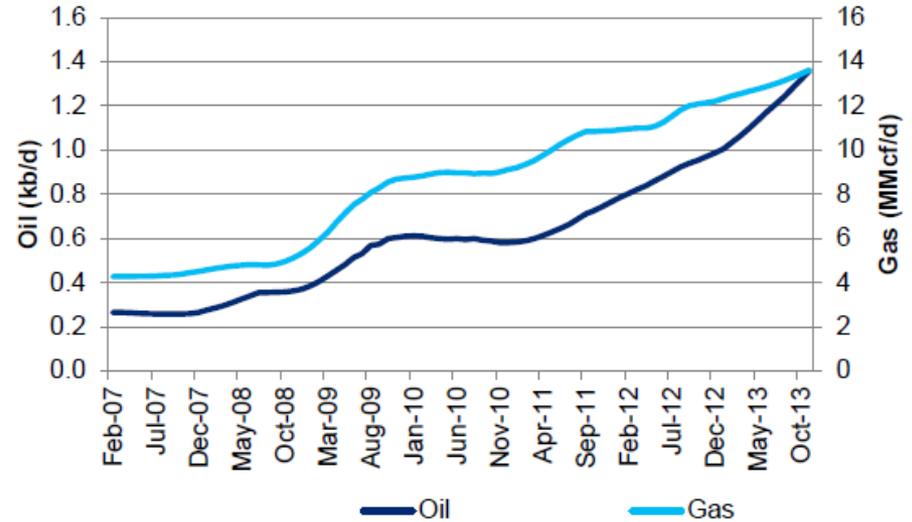
- Sharp improvement in rig efficiency over the past 5 years accompanied major shale plays
- Producers continue to reduce spud-to-spud times, drill longer laterals with more frac stages and optimize completion techniques, so production added per rig (rig efficiency) improves
- Total nat gas rig efficiency, augmented with associated production in oil and liquids-rich plays, has **more than doubled over the past four years**
- Efficiency gains should emerge in tight oil plays; and services sector should become increasingly competitive, reducing costs further

EIA's drilling productivity data support continued production growth for now

Gas production now dominated by shale plays...

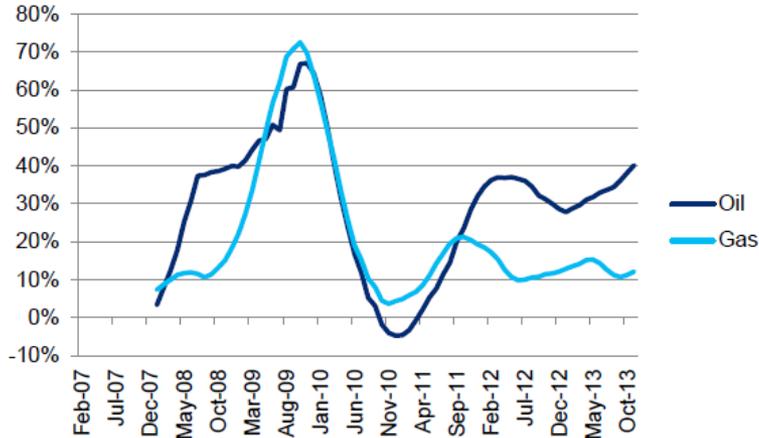


...First month production per rig also rising (2007-2013)

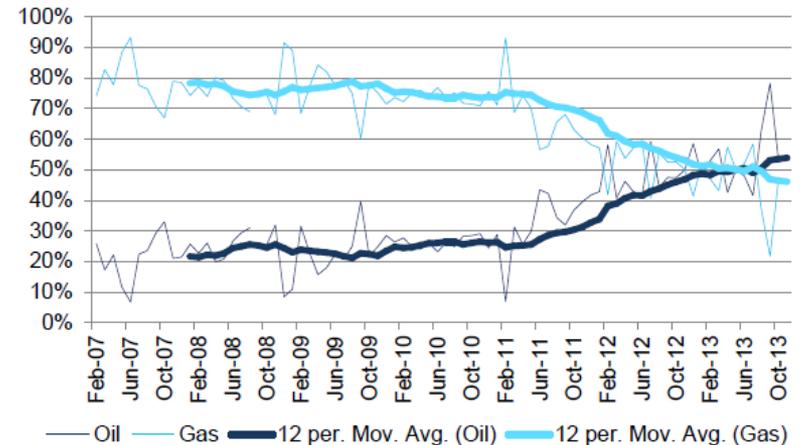


...Leading to continued productivity gains...

y/y change in production per rig

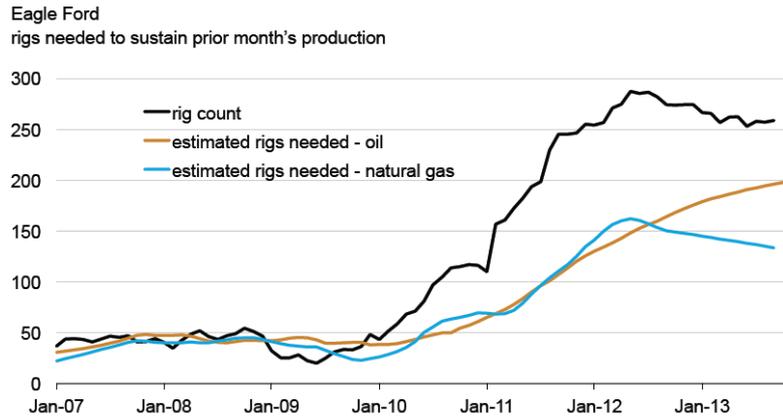


.... And the wide price differences between oil/liquids and gas have finally boosted liquids output above gas



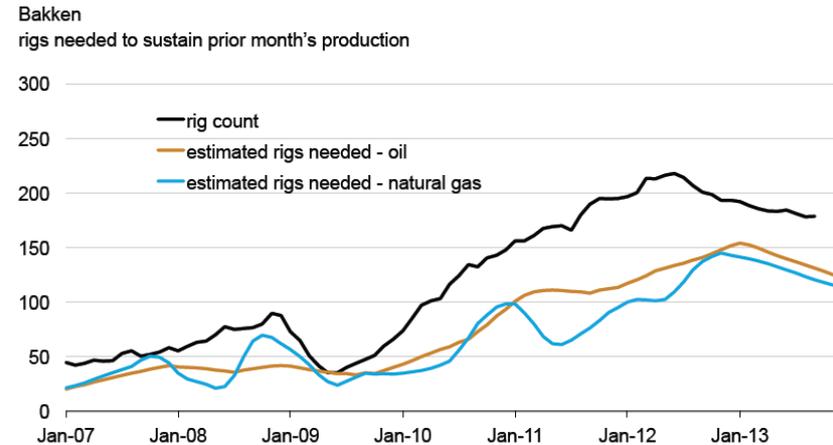
Rigs needed to sustain output is lower than current deployment in key plays

Rigs needed to sustain production in the Eagle Ford play



Source: EIA Drilling Productivity Report

Rigs needed to sustain production in the Bakken play



Source: EIA Drilling Productivity Report

- Another significant conclusion from the new EIA reports is that at some point production should be sustainable at a significantly higher level than current output for a long period of time
- Meanwhile, current rig utilization is significantly growing the reserve base
- It is here that all of the debates begin

Recapping: what needs to be in place to get it going?

The US and to some degree Canada are uniquely positioned for a take-off in shale gas and tight oil production

- A rich resource base that is fairly well understood
- A large, efficient services sector, with ample drilling capacity
- A benign if not facilitative regulatory environment, dominated by state rather than federal oversight
- A benign fiscal environment
- Private ownership of mineral resources, with private sector negotiating of share of exploitation via acreage leasing and royalty arrangements
- An efficient and large capital market, with an appetite for providing capital in risky E&P and sharing in the rewards
- A large number of small independent companies, with cost of entry very low given the capital markets, with a dominating swashbuckling wildcatting mentality
- But it really wasn't so easy to get it started: Meet the Frackers

It wasn't so easy to get it started; meet the frackers

Everything was tried, since 1973...

- Multiple nuclear detonations didn't do the job – three 30-kiloton detonations in Colorado, even more and bigger in the Soviet Union
- High prices in the last decade stimulated innovation, driving experimenting with the water mix with sands, horizontal drilling, 3-D seismic with entrepreneurship sparked by high >\$10/mmbtu natural gas
- The shale revolution is an old-fashioned made-in-America story of a bunch of wildcatters wanting to strike it rich... It's not easily replicable...

George Mitchell



Harold Hamm



Aubrey McClendon



Tom Ward



What's required for sustainability and profitability?

What are the doubts on sustainability/profitability

Despite the progress of the past half decade, there remains a persistent “Doubting Thomas” mentality

Six big issues beyond efficiency gains continue to raise doubts:

- Is the shale revolution replicable elsewhere
- Capex continues to exceed cash flow – will this ever end?
- Asset writedowns have been exorbitant – some large companies are getting out
- Decline rates remain high – are plateau production levels sustainable?
- Environmental issues remain open – is there a disaster on the horizon?
- Price levels could be problematic – will natural gas prices support more expansion of production ? Will future oil prices undermine project economics?

Replicating the unconventional revolution may be easier than conventionally thought

Spreading of unconventional would be geopolitically profound

Shale revolution's spread could have unexpected geopolitical impacts – a turn away from resource nationalism?

- Availability of shale could lead countries to rush to develop – this may be happening
- The shale revolution should be sustainable. US shale resources are only ~15% of TRC reserves globally. N. Africa, Ukraine, Saudi Arabia are taking steps. Other major shale resource holders include Mexico, Argentina, Russia, China
- More widespread development could cause a widespread fall in reliance on foreign sources supplies, changing global crude trade flows and the geopolitics of oil.
- Shale production could make net oil importers more self-sufficient. Structurally this means more stable global oil prices with downward pressure.
- US, Canadian supply surge already offset a massive rise in global supply disruptions in the world since Feb. 2011, keeping Brent prices range-bound at the \$110 level.

Global map of shale resources



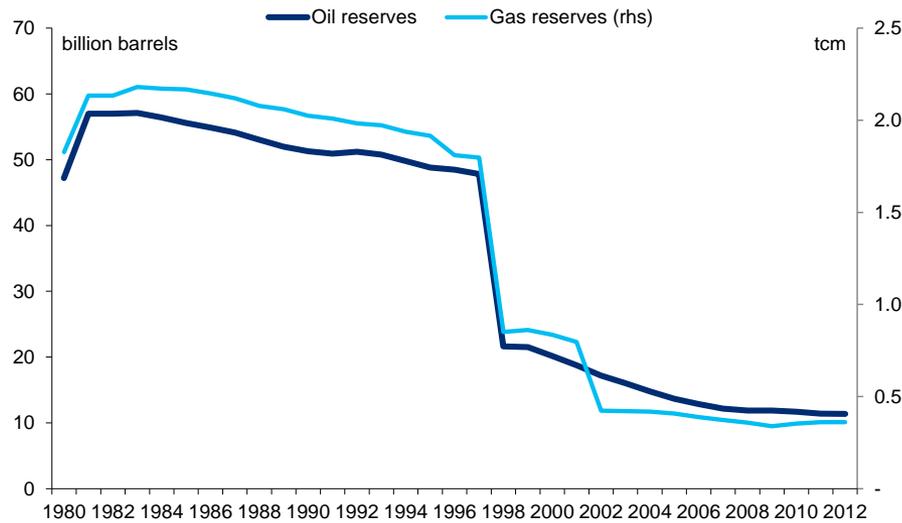
Major global oil transit chokepoints, with some 17-m b/d through Hormuz, 15-m b/d through Malacca, and 3.8-m b/d of crude and products through Suez and SUMED in 2011



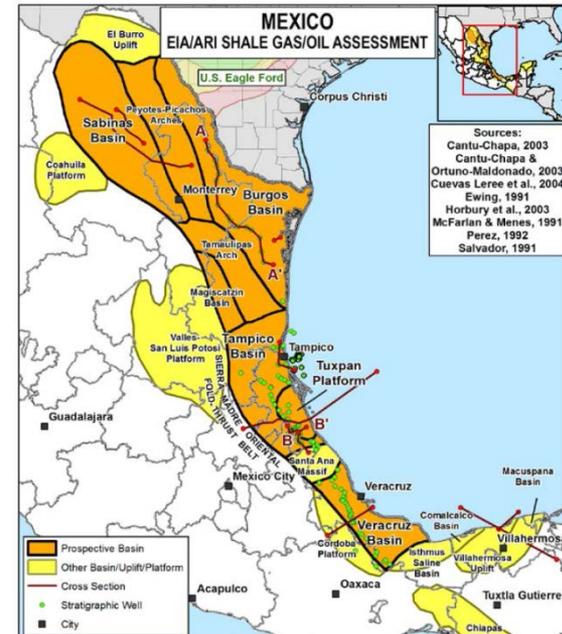
And Mexican resources aren't shabby

Tapping into them depends on constitutional, fiscal and regulatory/legal reform

Mexican oil and gas reserves



Map of shale resources



Is the US shale oil surge setting the stage for a 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.
- **Idea that the shale 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. As EIA's well productivity reports show, there is as yet no sign of production rolling over.
- **Three key variables 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. Companies continue to improve shale reservoir management to reduce decline rates, or have production plateau sooner and at higher levels. Recovery appears about to change dramatically, with EIA now estimating recovery rates in 28 significant shale plays at an average of 3.2% (range of 1% - 9%). With conventional fields seeing recovery at ~60% range, there is clearly scope for improvement via optimal well spacing; longer laterals and more frac stages, and by concentrating on the 80-20 rule, focusing on optimal 20% of wells drilled.
- **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. There has been an acceleration of efforts to tap into shale globally with the progressive removal of obstacles in many countries. Incentives to chase shale are more than just economic, with "energy security" weighing in. This is driving countries to adjust their tax systems to attract companies and capital.
- **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.** 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.

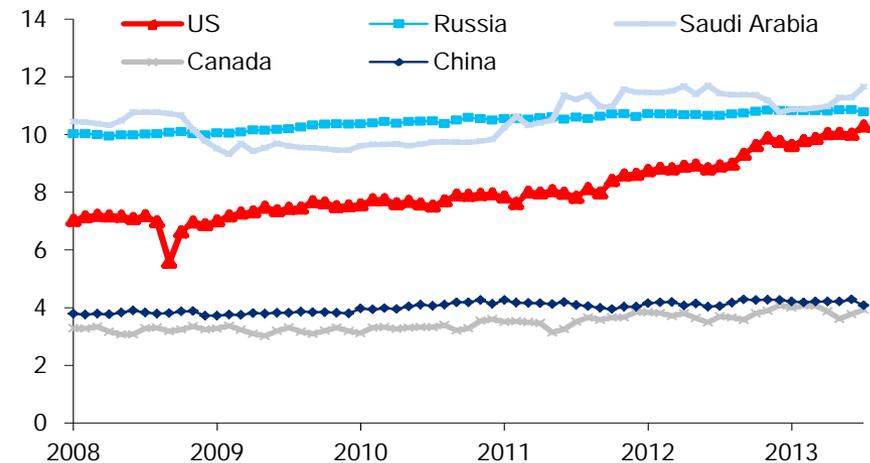
Shale developments beginning outside the US, though very slowly for now...

- 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 have 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.

Top 10 Technically Recoverable Shale Oil & Gas Reserves

Technically Recoverable 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

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



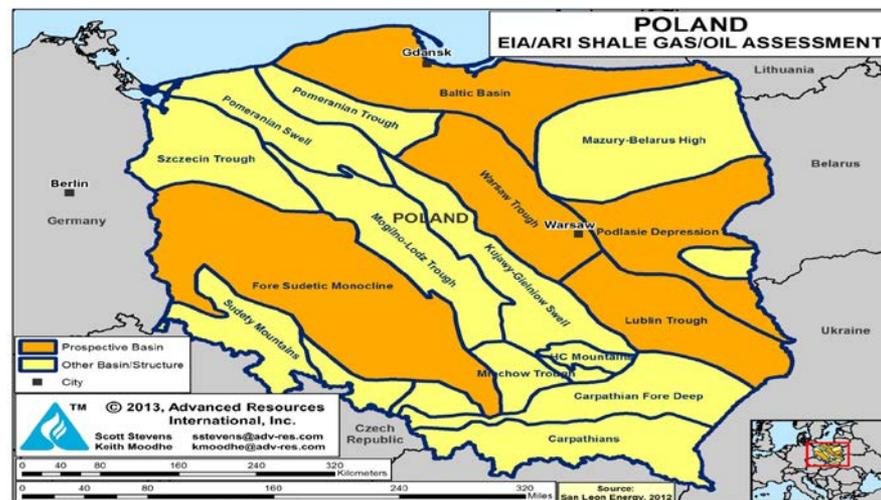
Shale activity rising to avoid production declines, protect energy security

- 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.

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



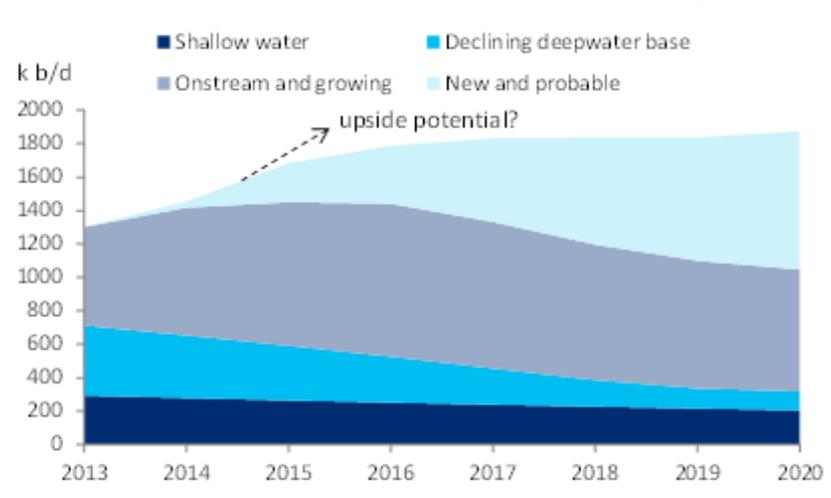
Favorable European policy is needed to help unlock Poland's shale potential



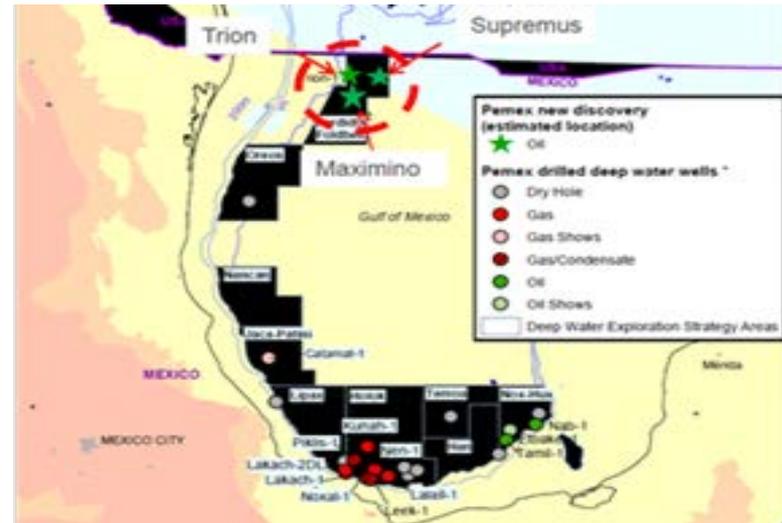
Deep water: US Gulf adding meaningful volumes; could Mexico be next?

- 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.

The US Gulf of Mexico can begin to boost output significantly in 2014



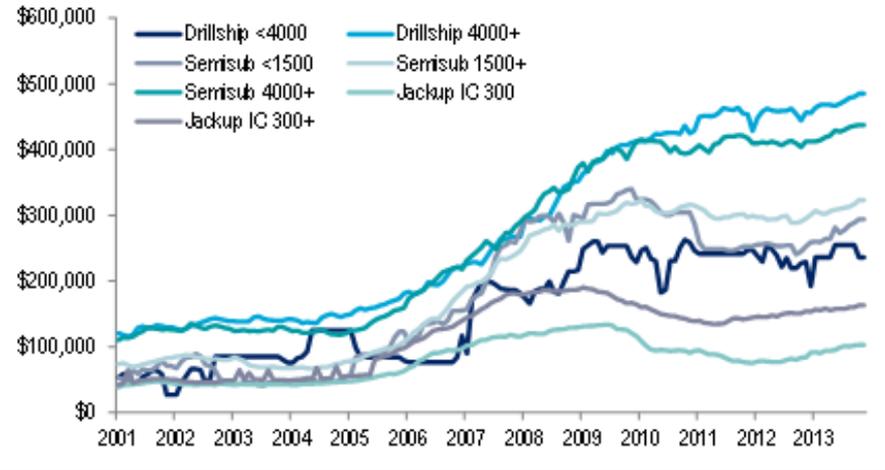
Mexico has seen significant discoveries in the Perdido Basin, close to viable production in the US Gulf of Mexico, which could be economic with cooperation with IOCs



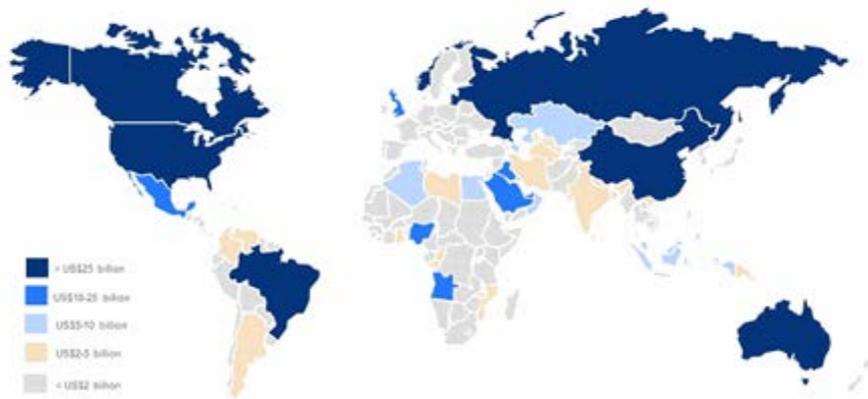
Deep water oil exploitation on the upside post Macondo

- Deep water supplies also represent significant 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. 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.
- Meanwhile, 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.

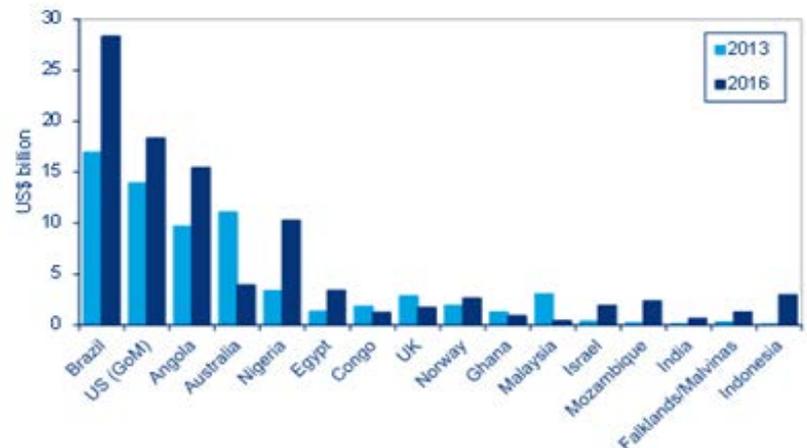
Deep water rig day rates on the rise, with high utilization even with new builds



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



Development spending in deep water plays, 2013 and 2016E



Deep water activity expanded substantially; should continue

Deep water drilling activity outlook in 2008...



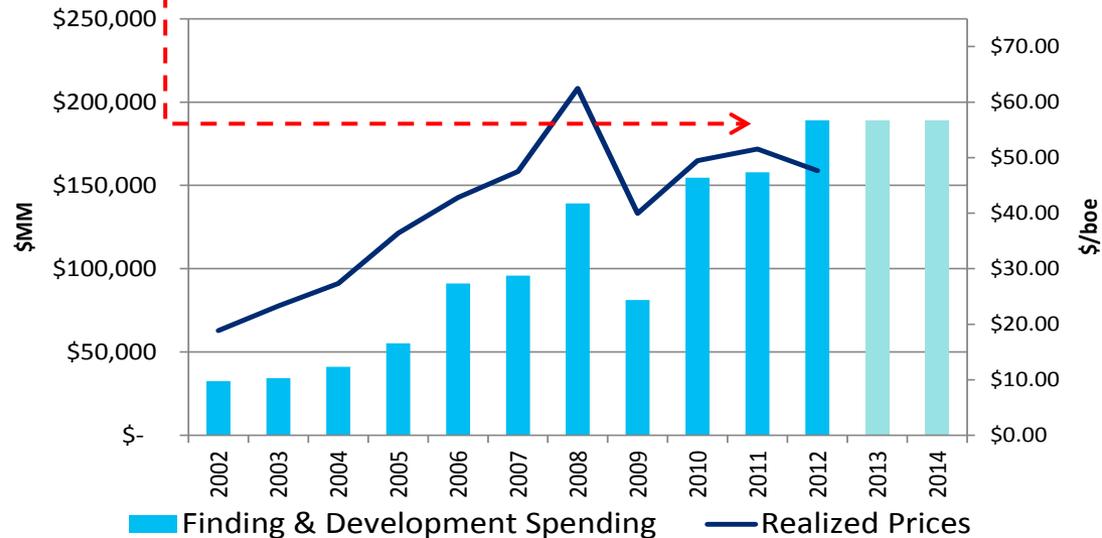
- ...expanded substantially to wide spread areas by 2012



What about the other doubts about shale?

US capex still robust, efficiency is rising, but cash flow negative

Capital spending surged in 2012, looks soft in 2013-2014



Results of oil & gas operations, \$MM

	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%

But there is another side to the story

The land grab significantly skewed results on two levels; the land grab phase is in many cases being replaced by more efficient operations

- 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 needed 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

(See Robert Morris, “Chesapeake Energy Corp (CHK)” Citi Equities Research, 24 October 2013, for a solid case study of this process)

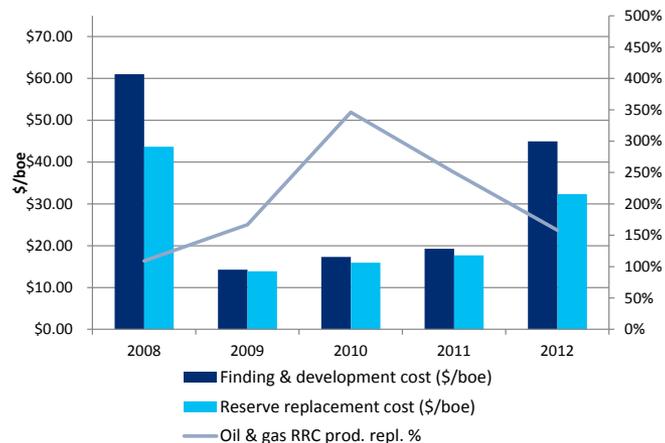
Reserves surged, while writedowns have become problematic

The land grab took place in a high natural gas price environment, the booking of reserves on an overly optimistic basis, and eventually writedowns and exiting from various plays

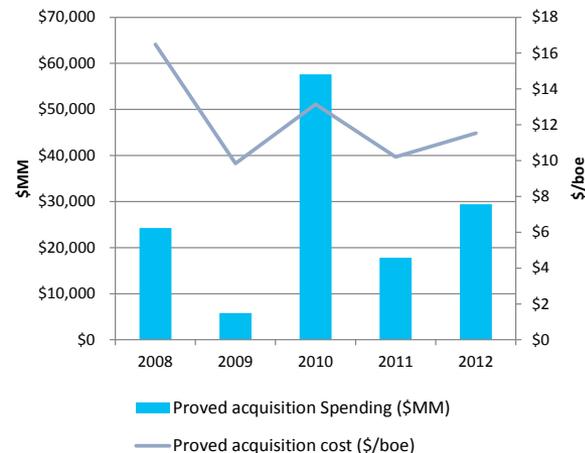
Reserve changes - oil/liquids (MMbbl) and gas (Bcf) reserve changes

	2008		2009		2010		2011		2012	
	Oil	Gas								
Beginning reserves	19,106	157,960	17,485	168,929	18,464	172,760	20,490	192,878	23,076	203,808
Revisions	(1,602)	(7,926)	1,214	(12,471)	974	319	769	(5,188)	(63)	(31,662)
Extensions & discoveries	892	21,668	1,073	31,077	1,909	32,242	2,862	29,770	4,442	26,097
Improved recovery	403	1,726	175	725	402	1,339	328	846	522	1,382
Purchases	376	6,582	295	1,756	1,272	18,668	491	7,513	1,215	8,033
(Sales of reserves)	(268)	(3,416)	(220)	(3,730)	(1,060)	(19,034)	(309)	(8,372)	(943)	(10,203)
Transfer/reclassify/other	(37)	4,727	(38)	(127)	86	366	64	492	(35)	(902)
(Production)	(1,385)	(12,391)	(1,519)	(13,400)	(1,558)	(13,781)	(1,619)	(14,129)	(1,835)	(14,598)
Year-end reserves	17,485	168,929	18,464	172,760	20,490	192,878	23,076	203,808	26,377	181,955
Developed reserves	12,192	109,686	12,873	109,307	13,529	117,401	14,503	120,511	15,821	113,474

Natural gas writedowns crush reserve replacement metrics



Rising proved acquisition spending pushes prices higher



Recapping: Growing evidence of profitability, sustainability

Multiple matrices are pointing to future profitability, sustainable at significantly higher production levels than today's

- 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-well 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

To what extent is demand driving supply?

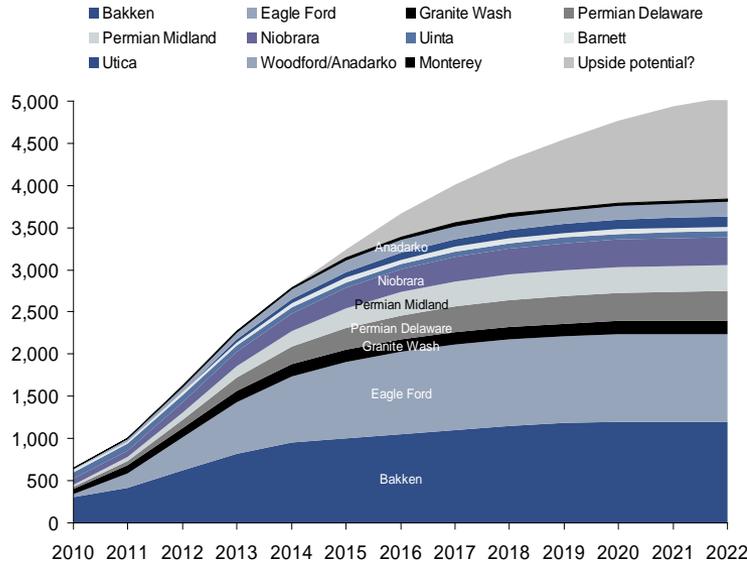
US shale gas revolution drives paradigmatic shifts across sectors

Natural gas production was the starting point of the game-changing shale revolution, and is beginning to transform multiple industries and sectors

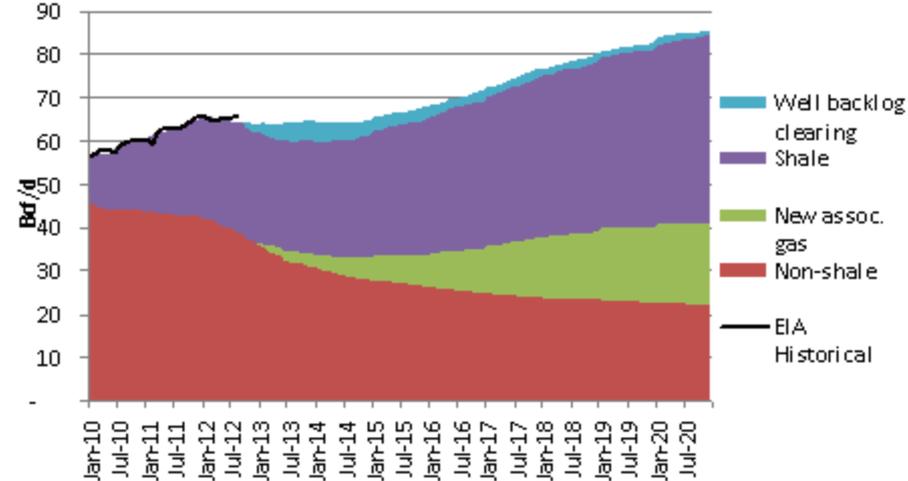
- While the supply and inventory overhang has capped gas prices and therefore production growth in the short term, *demand growth is accelerating* on the prospect of relatively low gas prices for years to come...
- **There are six areas of mushrooming, transformative demand growth**
 1. Pipeline exports to Mexico and Eastern Canada
 2. Resumption of solid growth in residential/commercial requirements due to switching of heating oil to gas, and falling vacancy rates
 3. A shift in global trade flows in gas, with growing North American LNG exports
 4. The re-industrialization of America based on dramatically lower-cost feedstock than is available almost anywhere else in the world, with the possible exception of Qatar, benefiting sectors ranging from petrochemicals to steel
 5. Higher gas-fired power generation as it captures power demand growth and the void left by retirement of coal-fired power plants
 6. A dramatic rise in natural gas use in land- and marine-based transportation, including natural gas vehicles (NGVs)

The resource base will not be the constraint: oil: +3.5m b/d; gas: +25 bcf/d

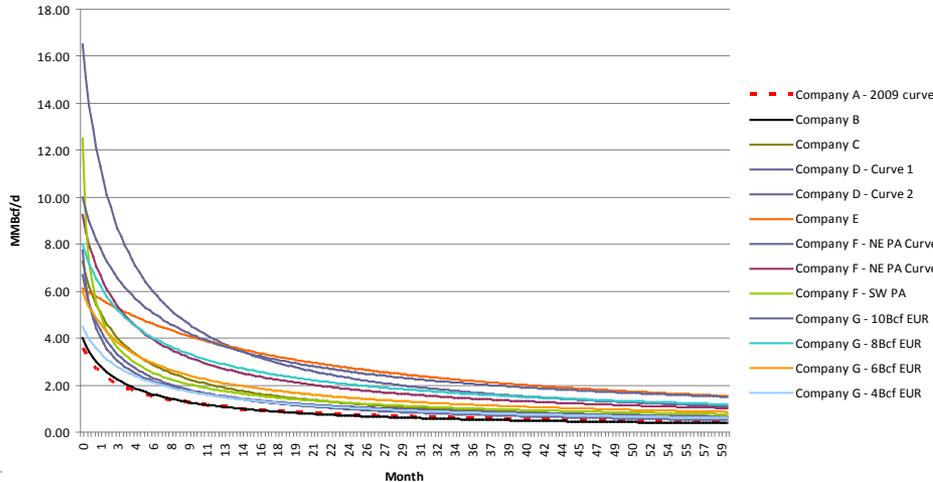
US shale liquids could grow by +3.5-m b/d by 2020



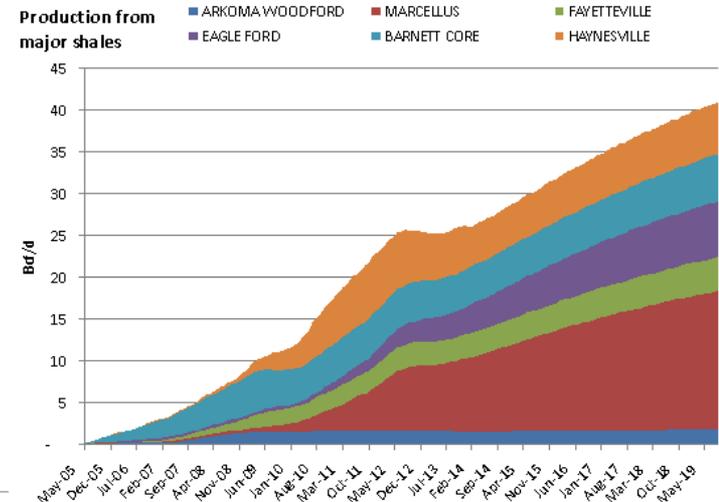
Higher projected US gas production on both shale gas and liquids drilling



Improvements in productivity and efficiency are key drivers of continued production growth



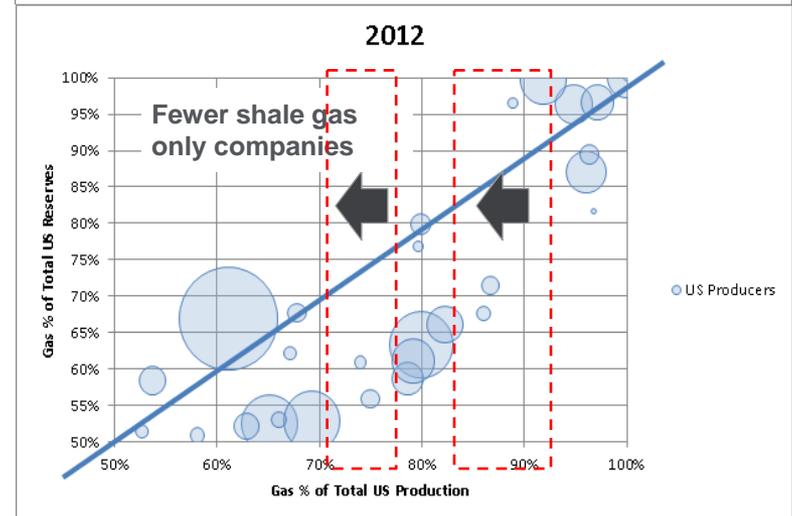
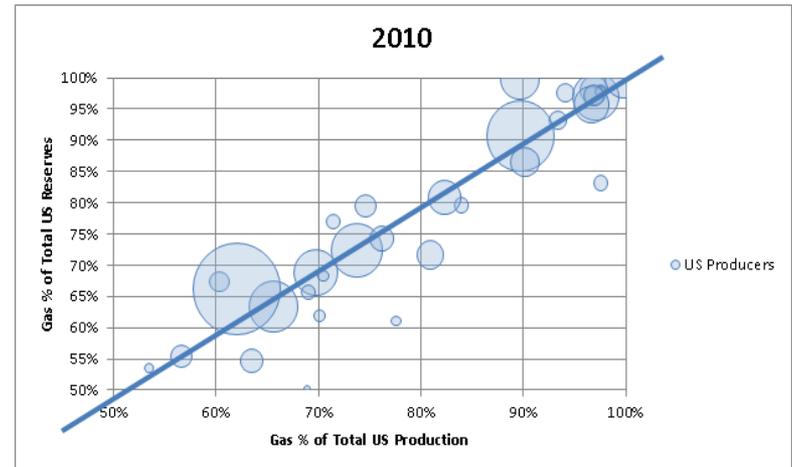
Shale gas could make up half of US gas production



Demand growth to drive partial price rise; but significant net benefit to economy

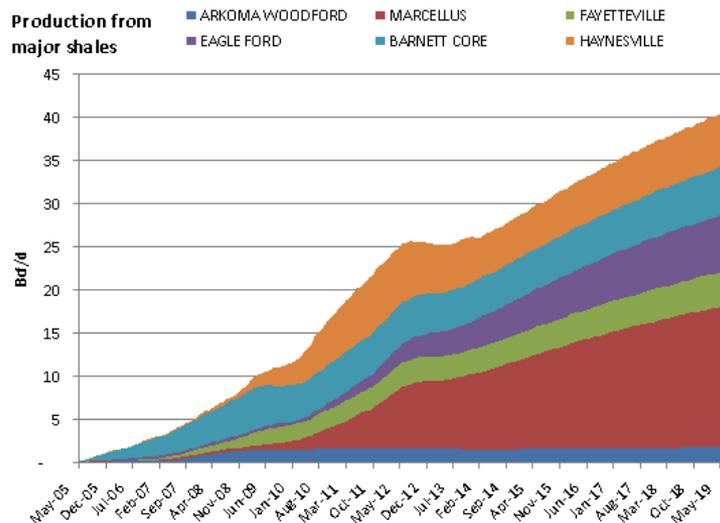
- Long-term price range: a soft floor at ~\$4 and a soft ceiling between ~\$6-\$7
 - Higher prices triggered by higher demand
 - In turn, higher prices will trigger more gas drilling, probably at prices ~5- to \$5.50/MMBtu
 - Soft floor set by marginal production costs
 - Soft ceiling to be set by fuel competition, gas imports from Canada and global LNG prices
- Prices too elevated would eliminate advantage of gas over coal in power generation
- Export arbitrage would limit export volumes: With long-term European gas prices ~\$9 netting back “transport” cost of ~\$2 (excluding capacity charge) to put US prices at ~\$7

There has been a migration of producers from gas production-focused to great mixes of oil/liquids
Gas reserves as % of total company-level oil-gas reserves vs. Gas production as % of total company-level oil-gas production

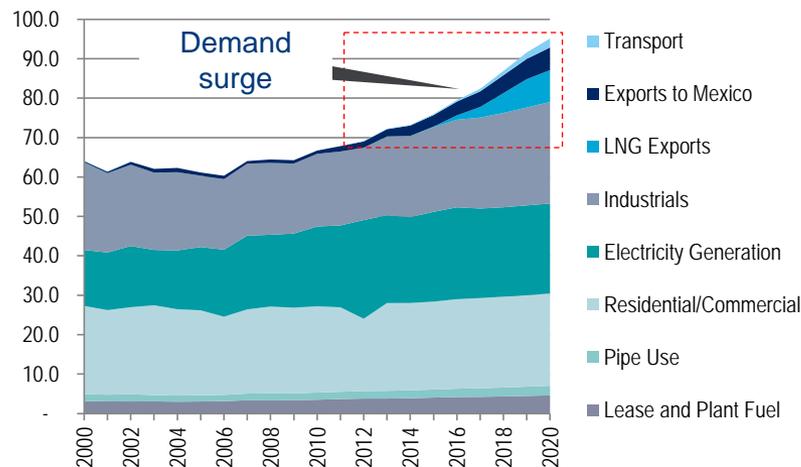


Gas production growth to transform industrial, transport and export demand

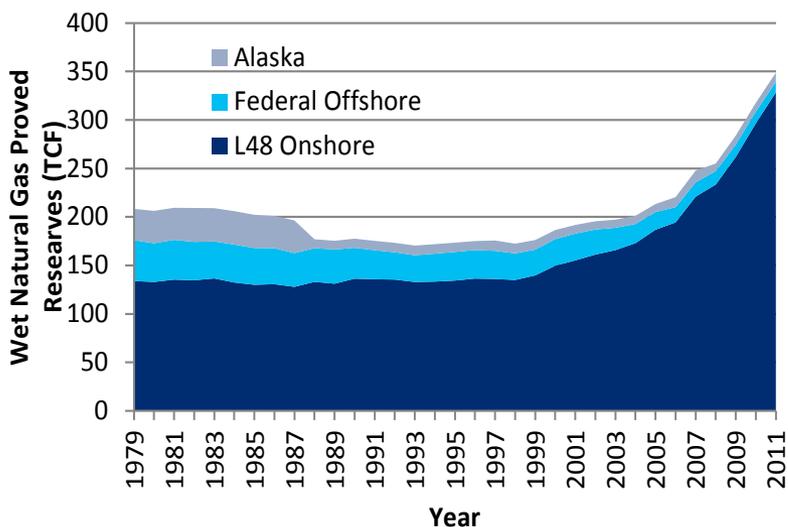
...Shale gas to make up ~50% of total gas production from near 0% (2005-2020)...



...Besides pipelines expansion, existing and new industries to benefit and drive gas demand growth



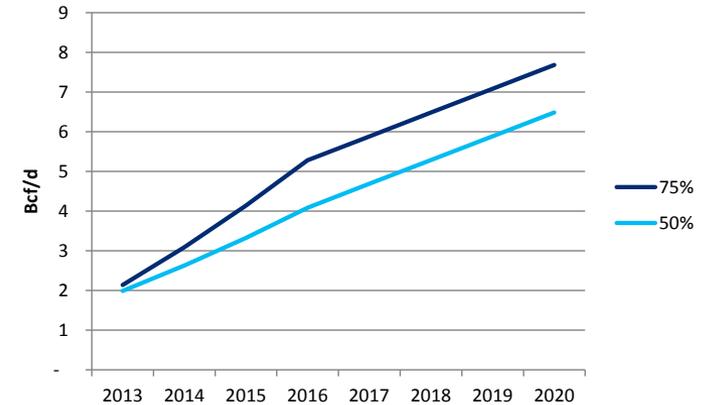
Rise of proved reserved driven by unconventional gas discoveries...



N. Am. poised to become one of the largest global gas suppliers

Exports to Mexico could surge as pipelines are constructed

Pipeline Name	Expected Start Service Date	Capacity (MMcfd)	Pro rated Year
Willcox Kinder Morgan Expansion	4/1/2013	185	139
Chihuahua-Topolobampo Pipeline	8/1/2013	1087	453
Mier Monterrey	4/1/2014	215	161
Reynosa Border Crossing	6/1/2014	300	175
Sasabe-Guaymas Pipeline	9/1/2014	770	257
Los Ramones pipeline	2015	2100	
Ramones Fase I	6/1/2015	1000	583
Ramones Fase II	12/1/2015	2100	175
Sasabe Pipeline	10/1/2016	510	128



US LNG exports could surpass Qatar and Australia by 2020

Terminal	Company	Location	mtpa	Bcf/d
US				
Sabine Pass	Cheniere	Cameron	16.9	2.2
Freeport	Freeport/Macquarie	Freeport/Macquarie	10.5	1.4
Lake Charles	Energy Transfer Partners	Lake Charles, LA	15.0	2.0
Cove Point	Dominion	Lusby, MD	7.3	0.8
Group 1				
Freeport expansion	Freeport/Macquarie	Freeport/Macquarie	10.5	1.4
Cameron	Sempra	Hackberry, LA	12.8	1.7
Jordan Cove	Jordan Cove	Coos Bay, OR	6.0	0.8
Oregon	LNG Dev Co.		9.4	1.3
Corpus Christi	Cheniere	Corpus Christi, TX	15.8	2.1
Lavaca Bay	Exelerate	Port Lavaca, TX	10.4	1.4
Group 2				
Gulf Coast	Gulf Coast LNG	Brownsville, TX	21.1	2.8
Southern LNG	Southern LNG	Savannah, GA	3.8	0.5
Gulf LNG	Gulf Coast LNG Export	Pascagoula, MS	11.3	1.5
CE FLNG	CE FLNG	Plaquemine, LA	8.0	1.1
Golden Pass	Golden Pass Products	Port Arthur, TX	19.5	2.6
Sabine Pass Train #5			3.9	0.5

Industrial demand growth driven by petrochemicals, fertilizers, others

Greenfield and brownfield development of ethylene cracking facilities

Ethylene Capacity (mm lbs)	Location	2011	2012	2013	2014	2015	2016	2017	2018
Announced New Crackers									
CP Chem	Cedar Bayou, TX							3,300	
Dow	Freeport, TX							3,300	
Shell	Monaca, PA								2,500*
Exxon	Baytown, TX								
Formosa	Point Comfort, TX						3,300		
Sasol	Lake Charles, LA						1,760		2,750*
Oxy / Mexichem	Ingleside, TX								
Indorama	Not disclosed						1,197		2,860
Restarts									
Dow	Taft, LA			850					
Debottlenecks / Feedstock Conversions									
Westlake - de-bottleneck & feedstock flexibility	Lake Charles, LA			235					
Westlake - de-bottleneck	Lake Charles, LA					235			
Westlake - de-bottleneck & feedstock flexibility	Calvert City, KY				180				
Williams - expansion	Geismar, LA				600				
LyondellBasell - expansion	La Porte, TX				850				
LyondellBasell - de-bottleneck	Morris, IL and Clinton, IA			100					
LyondellBasell - de-bottleneck	Channelview, TX		500						
Ineos - de-bottleneck	Chocolate Bayou, TX		465						
Nova - increase utilization by 10%	Joffre, Alberta					620			
Other de-bottlenecks				200	200	200	200	200	200
Incremental Ethylene Capacity (mm lbs)			965	1,385	1,830	1,055	6,457	6,800	8,310
US Nameplate Ethylene Capacity (mm lbs)		59,470	60,435	61,820	63,650	64,705	71,162	77,962	86,272
% of US Capacity		16%	16%	2.3%	3.0%	1.7%	10.0%	9.6%	10.7%
Global Nameplate Ethylene Capacity (mm lbs)		325,005	329,005	338,878	356,567	364,927	383,818	400,806	420,980
% of Global Capacity		0.3%	0.3%	0.4%	0.5%	0.3%	18%	18%	2.1%

- The ~147 million ton global ethylene market is growing at ~3%, meaning that 4 new 1mmt crackers per year are needed to keep pace with demand growth.
- 7-8 new ethylene crackers have been proposed in North America, but we think up to 5-6 will come to fruition. This amounts to only 1-2 years of demand growth.

Greenfield development of Ammonia facilities ('000mt)

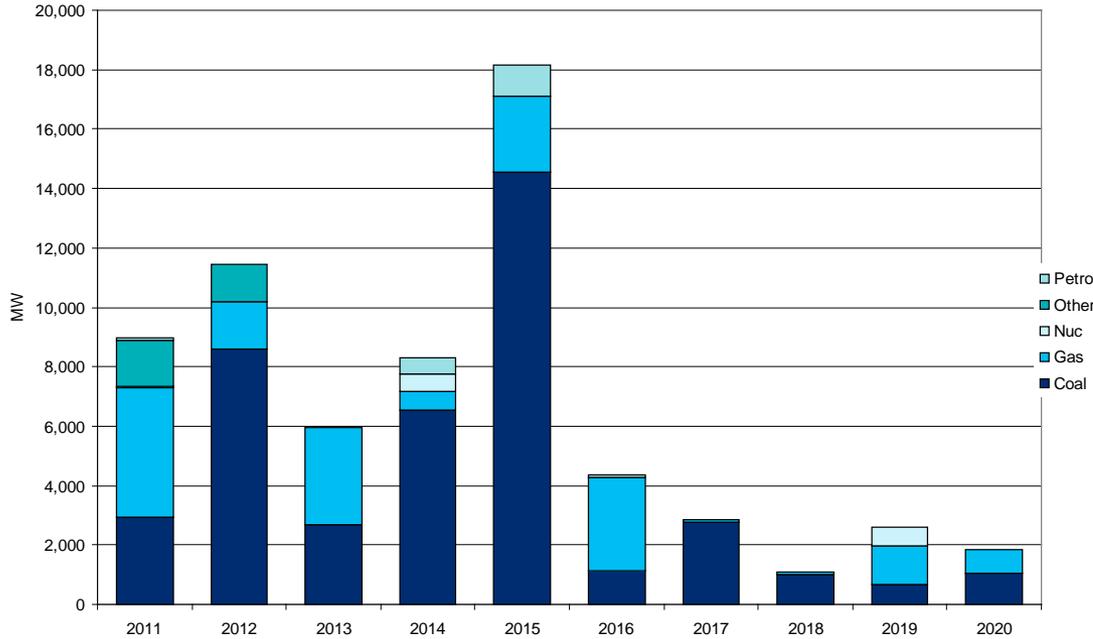
North American Ammonia Capacity ('000 tonnes of ammonia)										
Company	Location	2012	2013	2014	2015	2016	2017	2018	2019	2020
Projects - New Sites										
Agrium	US Cornbelt						750			
CHS	Jamestown, ND					750				
<i>Farmers of N. America</i>										
IFFCO	Quebec, Canada						750			
<i>ND Corn Growers Assoc</i>										
Ohio Valley Resources	Spencer County, IN					800				
Orascom Construction	Lee County, IA				450					
Summit Power Group	Odessa, TX					370				
US Nitrogen	Greenville, TN			60						

Source: Company reports, Citi Research

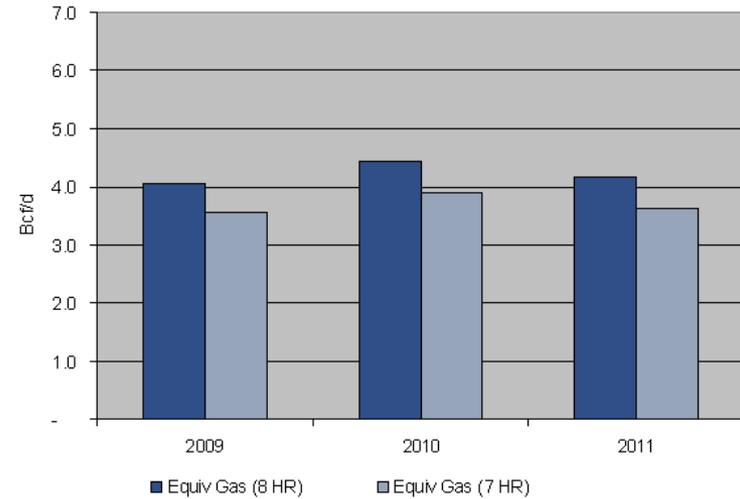
- Other sectors within industrials are also making new investments in the US
- Investments are motivated by lower fuel and feedstock costs, besides being closer to market

Power plant retirements tighten reserve margins, with gas the beneficiary

Plant retirements driven by both EPA emission rules and low gas prices, peaking in 2015...

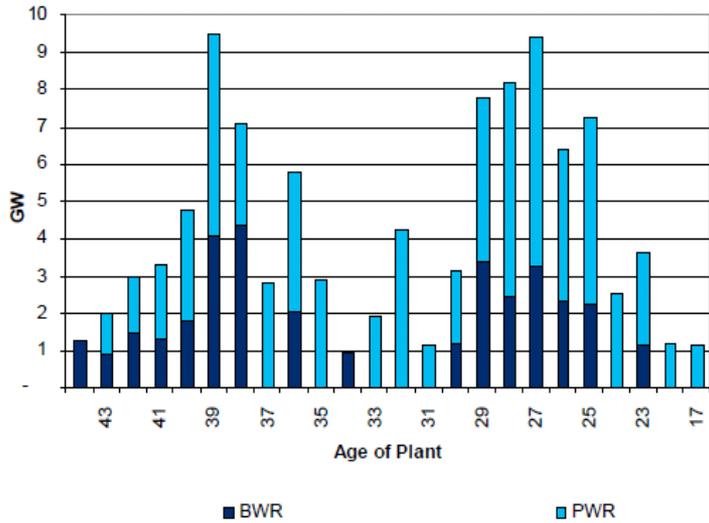


...Potentially bringing about 4-Bcf/d of gas demand increase, though this increase partially offset the amount of coal-gas switching

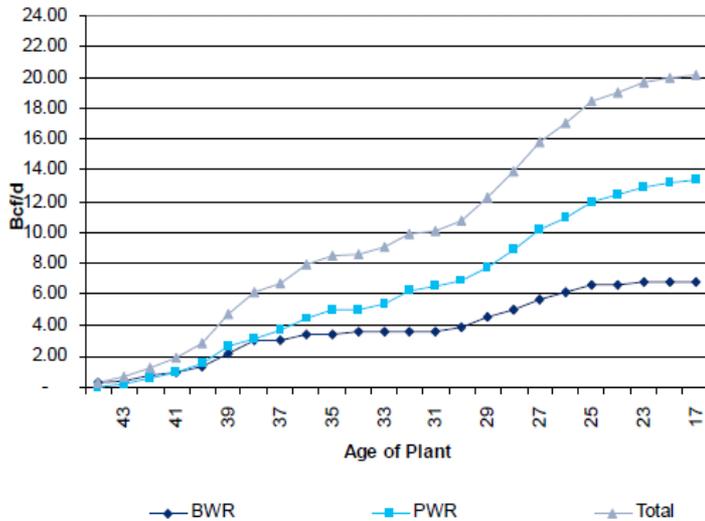


Potential retirement of nuclear units could further increase gas demand

Size and age of nuclear plants

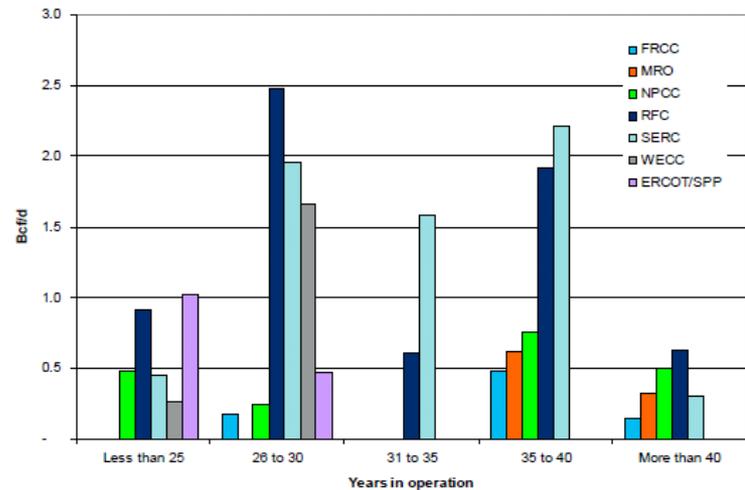


Cumulative gas demand impact based on the age of nuclear plants



- Longer term, the age of a nuclear unit, lackluster power demand growth and low power prices amid lower gas prices could pose challenges to nuclear operation
- The current nuclear capacity is equivalent to 20.2-Bcf/d of gas demand (8 heat rate combined cycle gas units)
 - Exelon, with the largest nuclear fleet in the US, canceled plans to spend \$2.3-billion on upgrades due to low power prices and demand.
 - More stringent post-Fukushima safety measures also raised capital and operating costs.
 - Nearly 14% of nuclear units are over 40 years old, representing 2.8-Bcf/d of gas demand.

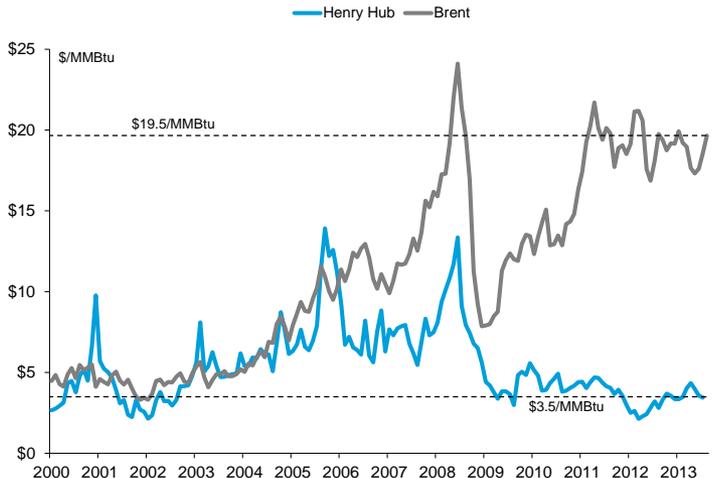
Plants by years in operation and by region



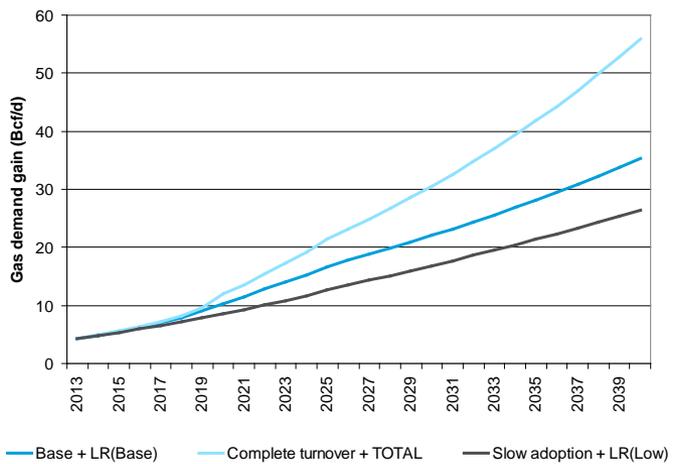
Gas could finally break oil's hold in transportation

Eroding the 40-m b/d global motor fuel market – natural gas can substitute for oil in transportation, particularly road vehicles, as shown below, but also for rail and marine transport too

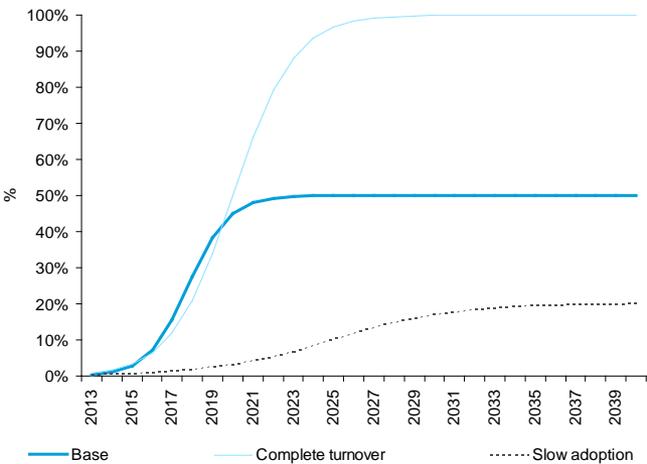
Crude and US natural gas prices have diverged



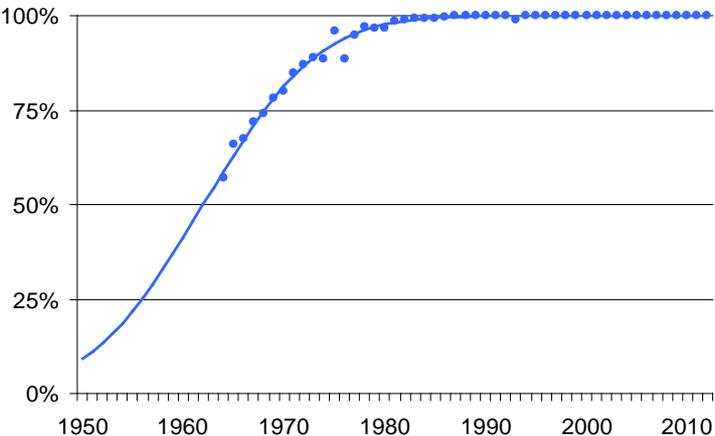
Projected gas demand in transportation



Estimated NGVs as % new HDV sales in the US



Diesel's share of new Class 8 trucks sales in US, 1950-2010

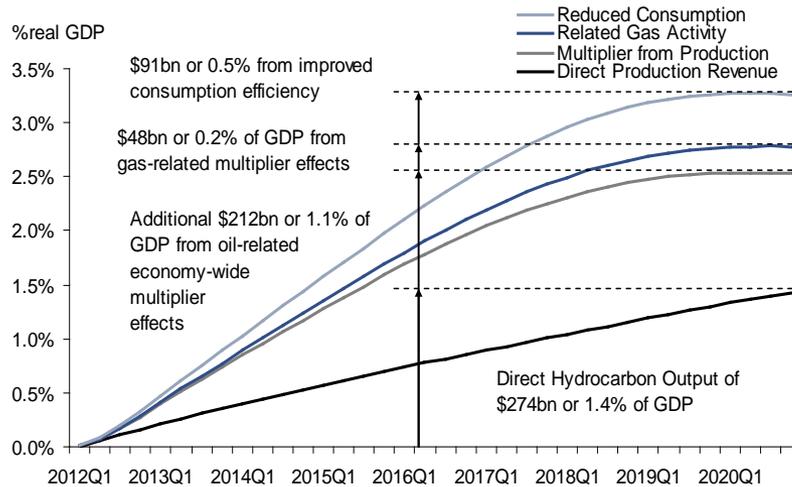


Source: MacKay, Wards Auto, Westport, Ayres-Ayres-Warr, Citi Research

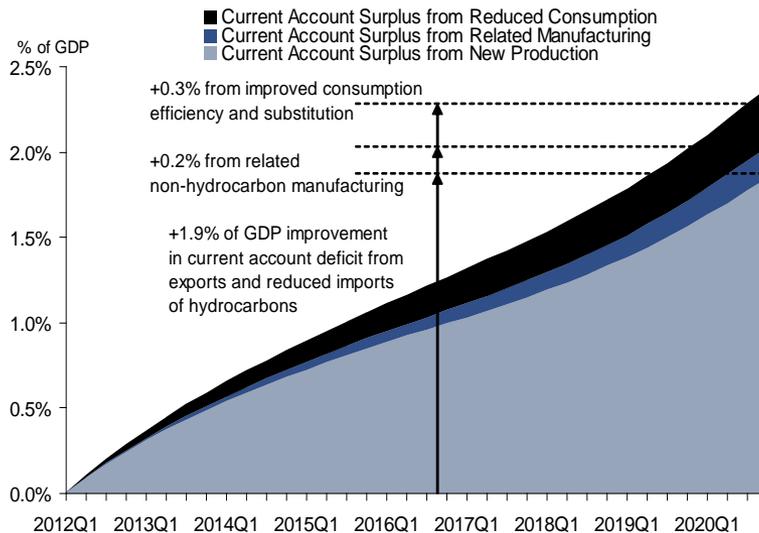
Other implications of shale/deepwater developments

Economic consequences for the US

Cumulative impact on US real GDP, 2012-2020



Impact on US current account, 2011-2020



- The cumulative impact of new production, reduced consumption, and associated activity could increase real GDP by 2.0 to 3.5%, or \$370-\$624 billion (in 2005\$), respectively
 - \$274 billion of this comes directly from the output of new hydrocarbon production alone
 - The rest is generated by multiplier effects as the surge in economic activity drives higher wealth, spending, consumption, and investment effects that ripple through the economy
- As many as 3.6 million new jobs may be created on net by 2020
 - 600,000 jobs could be in the oil and gas extraction sector
 - 1.1 million jobs in related industrial and manufacturing activity
 - ...and the remainder in ancillary job sectors
 - National unemployment could fall by as much as 1.1%
- The current account deficit, currently 3% of GDP, could be reduced by 1.2% to 2.4% of GDP
 - This would also have implications on the US dollar, potentially helping it appreciate by 2% to 5% in real exchange rate terms

Consequences for the global market

North America is strategically placed as the hub of global hydrocarbon growth, potentially transforming markets

- LNG exports from USGC, Alaska and Canadian Pacific could transform global markets, supporting a spot market because of limited destination restrictions, and along with Australian LNG providing more secure sources of supply
- Demonstration impact of shale revolution should accelerate its spread in Latin America and globally, especially as MENA supplies look increasingly risky, but also for domestic political and economic reasons
- Oil and natural gas prices should trend lower and with more ample supply should be less volatile than last decade
- Given energy intensity of other commodities, lower and less volatile hydrocarbon prices should tame a resurgence in other commodity prices over the next decade or longer and decrease their price volatility as well
- If and as Canadian supplies reach the Pacific Basin, Canada could provide a new benchmark for the Pacific Basin, challenging Middle East-based benchmarks (along with new ones potentially to be developed in China or at the ESPO hub)
- Mexico could see even more profound domestic implications than the US or Canada from energy development
- Global pricing could continue the move toward market transparency, depriving petro-states of maintaining a steep wedge between operating costs and realized prices

Higher volatility requires demand pushing toward newly elevated supply limits

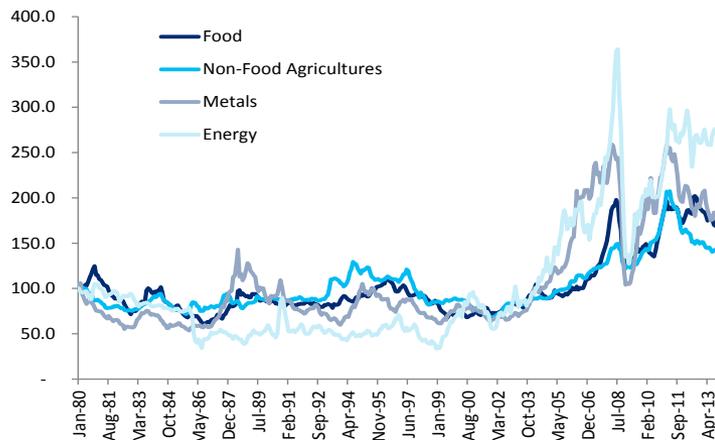
During the super cycle, energy prices boosted volatility as demand reached supply constraints. With high energy intensity of virtually all commodities, volatility in energy prices was transmitted to other commodities, raising their prices and volatility

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, reflecting several decades of under-investment in investing in new production capacity.

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.

The most important of the surprising supply constraints in the 2000s was oil, and the constraints were almost entirely within OPEC. Investments in new production capacity outside of OPEC lagged with low prices. By 2003, it became apparent that their capacities were collectively stagnating or falling and both deferred and prompt prices started to rise after 20 years of range-bound trading, persistently lower prices.

Commodity prices indexed to 1980



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: Bloomberg, Citi Research

Higher volatility requires demand pushing toward newly elevated supply limits

During the super cycle, energy prices boosted volatility as demand reached supply constraints. With high energy intensity of virtually all commodities, volatility in energy prices was transmitted to other commodities, raising their prices and volatility

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.

Oil volatility should decline with higher supply, demand slowdown

Volatility as a result of tightness in the supply-demand balance, transit bottlenecks or the availability of specific products could be mitigated going forward – eliminating the scarcity pricing that drives price spikes

Supply

- **More supply coming from geopolitically stable areas reducing price risk premium** (e.g. North America), eventually more than offsetting production from politically unstable areas
- **Offshore deepwater production** possibly subject to lower conflict-induced disruption risks
- **The power of swing players to fade:** The pricing power of cartels/oligopolies works well in a tight market, but additional supply should lengthen the supply curve. As many producers need to maximize revenue in a falling price environment, higher production could result, lowering prices further

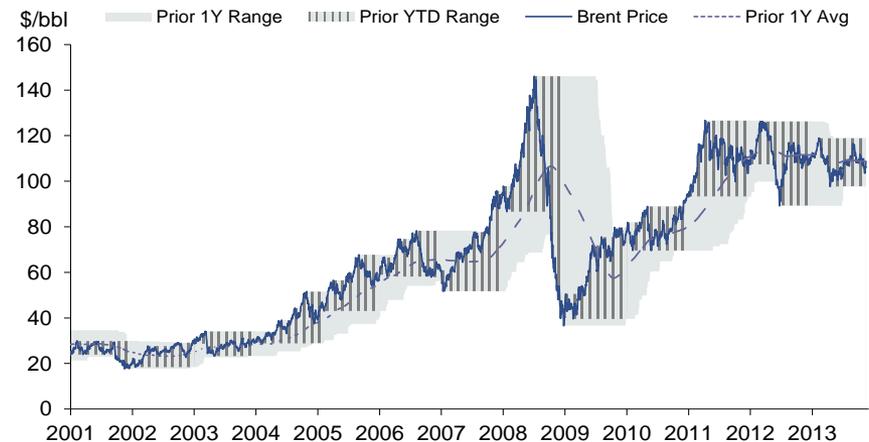
Demand

- **General slowdown in demand growth**, particularly the economic transition in China
- **Efficiency gains worldwide**
- **Fuel substitutions** (NGLs, NG etc) – (1) power gen in Middle East; (2) transportation's use of gas and/or electricity; (3) feedstock/energy substitution in petchem and other industrials

Refining

- **More capacity in areas with the most demand growth** (i.e., Asia), improving supply availability
- Rising refinery capacity and other upgrades, to raise the system's capability to take a variety of crude grades, **reducing the market's reliance on specific supply sources**

Brent price spikes more muted since 2011 despite production disruptions and escalated tension for a time



Appendix A-1

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