Deutsche Bank
Markets Research

Industry
Natural Gas

Date
27 May 2014

North America
United States

Industrials
Oil & Gas Exploration & Production

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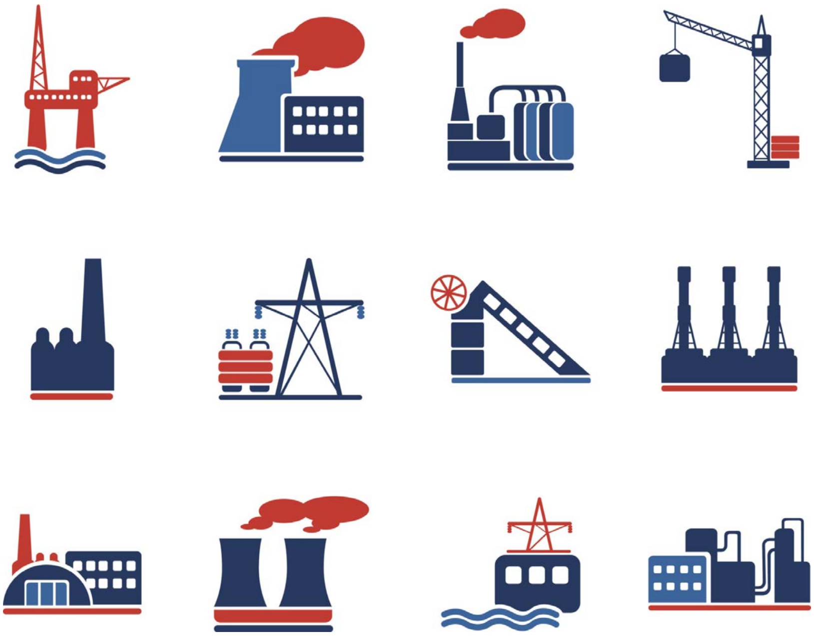

F.I.T.T. for investors

Fueling the Next Industrial Expansion

100 Projects that Change a Market

The cycle has turned for US natural gas. Oversupply was generated by resource expansion, as unconventional supply growth surpassed expectations. We are focused on long-cycle & stable demand growth from the industrial complex, which has likely been masked by shorter term seasonal factors. Expansion & Greenfield projects promise to alter the trajectory of demand growth with an inflection point by 2016. Our bottom up, project by project view of demand identifies 2.3 Bcf/d of incremental industrial demand through 2018, likely additive to our 2.7 Bcf/d baseline industrial demand forecast.

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Long Cycle Demand Finally Catching up to Short Cycle Supply

The supply side has dominated natural gas balances for 5+ years. Revisions to resource in the ground, efficiency gains in the field, and explosive growth from the Marcellus have all been drivers. Oversupply drove prices lower, and encouraged alternative fuel switching, primarily from power generation to balance the market (2012/13). A new baseload of natural gas demand on the industrial side is just emerging as a result of multi-year investments. This on-shoring of energy intensive industries is predicated on stable, available domestic energy sources.

Top Down & Bottom Up

Demand bottomed with the industrial economy in 2009 and has unsurprisingly recovered in-line with broader economic activity. Higher capacity utilization and Brownfield expansions have accounted for much of the 2009/13 growth (3.6 Bcf/d), while Greenfield demand is the result of longer-cycle investment decisions. Our project by project view suggests demand should inflect by 2016 as both expansions and Greenfield projects gain critical mass. While wary of double counting, we see 2.7 Bcf/d of industrial demand growth based on the trajectory of US IP through 2018 (22.5 Bcf/d total), likely additive to this level is an additional 2.3 Bcf/d of industrial demand growth through 2018 (risked) from a ~100 project backlog. For our analysis we have used a baseline of 2012 industrial demand of 19.7 Bcf/d.

The End of Supply Rationing

Other demand drivers for natural gas far exceed the industrial projects summarized within. The potential for LNG exports starting in 2016 (7.9 Bcf/d of LNG export capacity by 2022), rapid growth off a small base in the transportation sector, and fuel switching (coal to gas) in the utility sector all underpin the longer term demand outlook. While supply looks adequate to address demand growth, the implication is for an end to the supply rationing that has typified the US natural gas upstream. This dynamic should reduce a key downside risk for cash flows of the E&Ps, the winners will be those able to rapidly grow natural gas volumes and access demand centers on the Gulf Coast.

Permitting & Emissions the Key Risks

A decade + removed from the construction of world scale petrochemical facilities, permitting and emissions (carbon) remain the key risks to the outlook. We see $60Bn+ in capital required to deliver our base case forecast, and have risked yet to be sanctioned projects (particularly those utilizing unproven technologies) with startups in the 2018+ timeframe as a result.

Deutsche Bank Securities Inc.

Quantifying the Industrial Renaissance

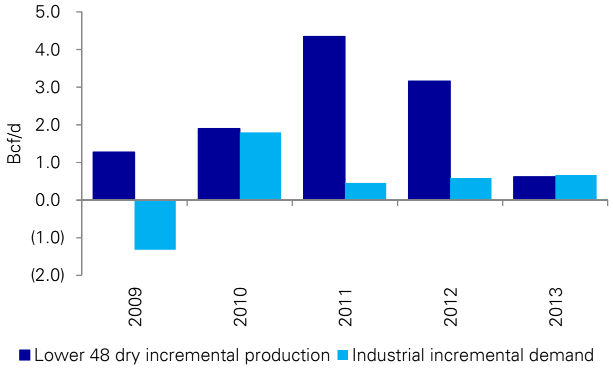
US Natural Gas & Industrial Demand Growth

The US natural gas market is in the midst of a multi-year shift. An industrial capital expenditure cycle is underway to address the opportunity generated by cheap, plentiful domestic sources of natural gas. Unconventional supply growth (and resource expansion) precipitated a fall in price, improving the competitiveness of energy intensive US industries within the global cost curve. The pace of supply growth (despite lower price) and confidence in the resource opportunity have stimulated the next industrial re-investment cycle, supportive of a multi-year view of demand growth.

Our focus on industrial demand growth is an explicit attempt to isolate natural gas demand elements from more cyclical & seasonal factors impacting US natural gas balances. Electric utility demand for natural gas should continue to show underlying share gains, but lackluster overall demand growth and the impact of alternative fuel pricing in the near-term limits the upside potential, in our view. Net exports (primarily LNG) are the other highly visible, structural demand driver for natural gas. While LNG exports are a key aspect of the bull case for US natural gas, here too total levels of demand will be driven in part by alternative fuel pricing and subject to regulatory (permitting) & administrative oversight which will remain a key risk.

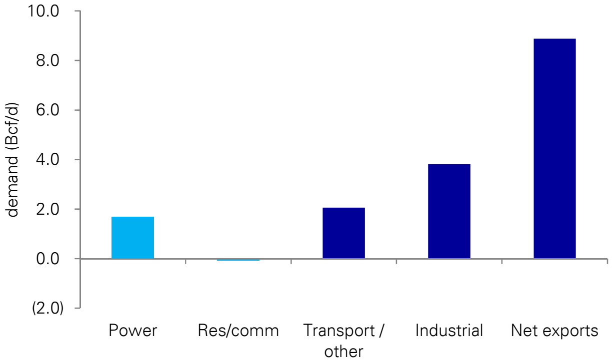
It is the industrial sector which is likely to absorb a significant proportion (41%) of total demand growth through 2022. While supply growth has been driven by short term capital allocation decisions (the most economic unconventional natural gas wells payout in ~12-18 months), industrial demand is slow moving and long cycle in nature. Higher capacity utilization rates, particularly for natural gas intensive industries, have been a key driver of demand growth in the 2009-2013 period, in our view. Our focus is the longer-cycle investment decisions driven by the attractiveness of re-domiciling energy intensive activities to the US and alternative fuel pricing. The capital expenditure cycle underway ($60Bn+) to capture the opportunity for energy intensive industries is very real demand growth. This spend will establish a new base load of domestic natural gas demand, and should exhibit limited sensitivity to a shift in longer-term commodity prices (+/- $1-2/mmbtu).

Figure 1: Production Growth Has Far Exceeded Industrial Demand Growth



Source: EIA, Deutsche Bank

Figure 2: Total US natural gas demand growth - 2013 to 2020



Source: Wood Mackenzie, Deutsche Bank
Note: Total natural gas demand is net Canada imports and LNG imports

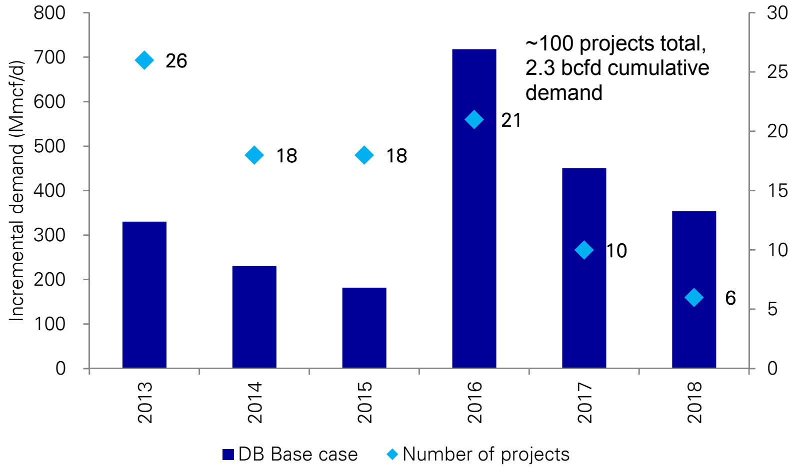
Quantifying the Industrial Renaissance

Bottom Up – Project by Project Review

Industrial gas growth is driven by both cyclical (recovery in the industrial economy since 2009) and secular (increased natural gas intensity) drivers. Our belief is that the industrial sector constitutes a true baseload of natural gas demand due to the large installed base, multi-year investment horizon, and implied capacity utilization of facilities. This report attempts to quantify both the magnitude and timing of capacity adds by energy intensive sub-sectors of the US industrial economy.

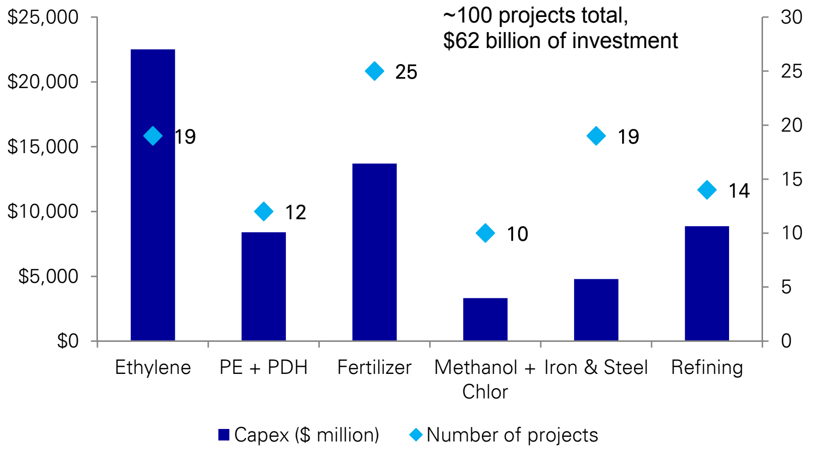
- Capacity additions in energy intensive sub-sectors encompass both Brownfield (incremental expansion projects) and Greenfield (new facilities) projects. Unsurprising to us, Brownfield expansions account for a high proportion of the project additions in the 2013-2015 timeframe (75%) while due to the longer lead nature of Greenfield expansions, these projects become a more significant factor in the 2016+ timeframe.
- Our approach focuses solely on dry natural gas use as a feedstock and fuel source for industrial processes. For example, we do not include the natural gas equivalent of ethane used to supply ethylene capacity additions in the petrochemical sector. We do however include methane used as a feedstock for natural gas derivate or alternative products such as methanol and ammonia. This approach may account for the lower energy intensity of our demand survey relative to what other industry sources may outline.
- Our survey encompasses 100 projects which are expected to add 2.3 Bcf/d of incremental natural gas demand from 2013-18. We see a significant inflection in incremental demand by 2016 due to the combination of expansions and Greenfield project startups.

Figure 3: Project level contribution to industrial natural gas demand



Source: Wood Mackenzie, EIA, IEA, industry sources, Deutsche Bank

Figure 4: Project capex by industrial sub-segment (2013-2018)



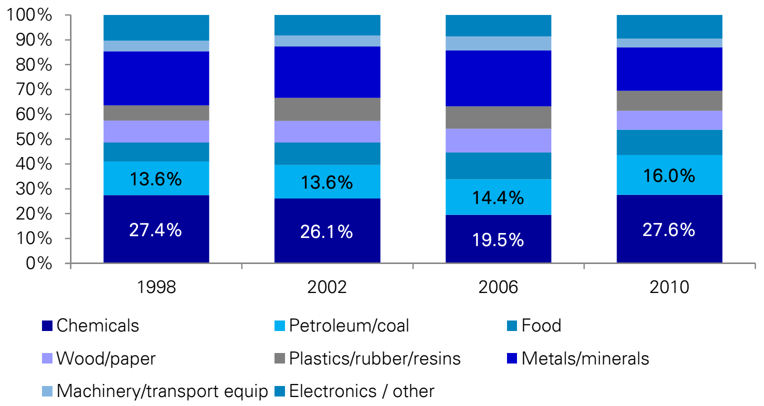
Source: Wood Mackenzie, EIA, industry sources, Deutsche Bank

Quantifying the Industrial Renaissance

Top Down – Macro Driven Demand Forecast Understates Impact

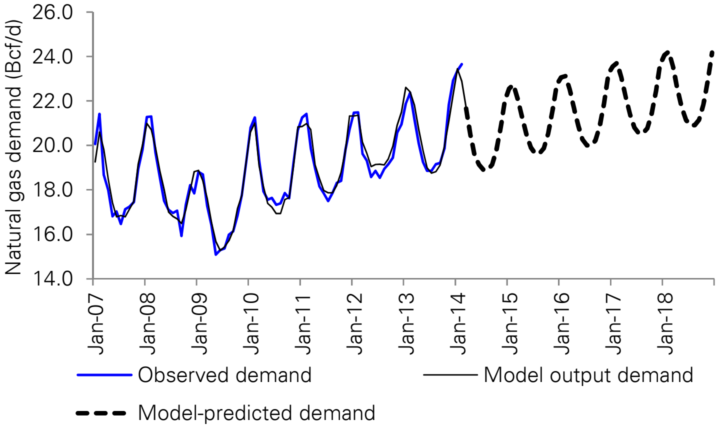
Our top down approach to modeling industrial natural gas demand aims to capture a number of key drivers including the US industrial production growth, the impact of alternative fuel pricing (gas/oil ratio) and normalization for the impact of weather (gas-weighted HDDs). This multi-variable approach provides a baseline for industrial supply growth over the 2013-2018 timeframe (22.5 Bcf/d by 2018, 0.5 Bcf/d avg. per annum growth) which assumes current levels of natural gas intensity (last survey dates to 2010) and based on forward expectations for US industrial production. Importantly, <u>we do not believe this forecast fully captures the pending increase in industrial production from facility expansions and new build facilities.</u> While this top down approach compares favorably to aggregate industrial demand forecasts outlined by others (EIA) we believe this approach understates the full potential of this trend, particularly in the 2016+ timeframe.

Figure 5: Natural gas energy consumption by industry weight



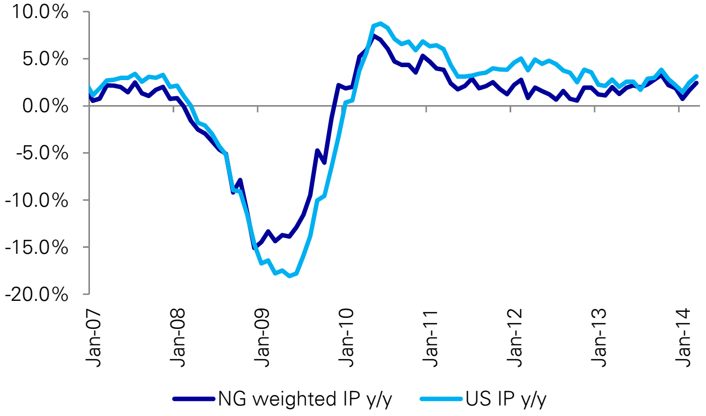
Source: EIA, US Manufacturing Energy Consumption Survey, Deutsche Bank

Figure 6: Top down industrial natural gas demand forecast



Source: EIA,NOAA, Bloomberg Finance LP, Wood Mackenzie, Deutsche Bank

Figure 7: Gas weighted IP lagging that of the broader economy



Source: Bloomberg Finance LP, EIA, Deutsche Bank

Quantifying the Industrial Renaissance

Putting the Pieces Together

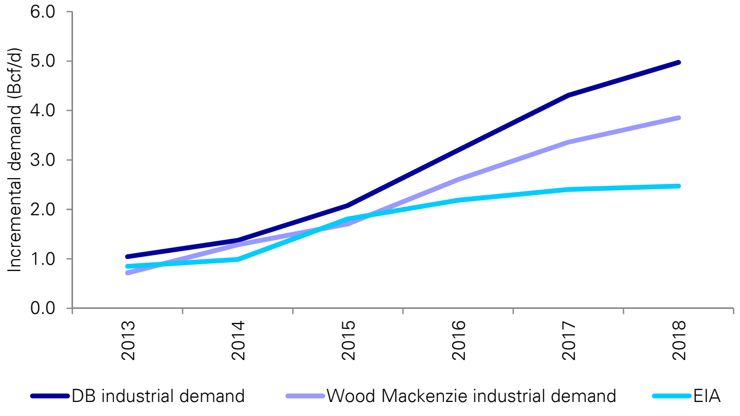
Our bottom up analysis suggests US industrial demand is likely to assume a higher growth trajectory as new projects take hold beyond 2015. While we are wary of simply adding both our top down and bottom up approach to forecasting, the announced project backlog and the implied intensity of incremental natural gas demand is significantly ahead of consensus expectations. Our view is that some portion of the industrial projects is additive – not a substitute - to the baseload of US industrial natural gas use implied by a top down survey.

The EIA and Wood Mackenzie forecast US industrial demand growth for natural gas based on trend. The EIA annual energy outlook assumes 22.2 Bcf/d of 2018 demand (up 2.5 Bcf/d from 2012). Wood Mackenzie looks to add both a baseline of GDP driven growth (1.9 Bcf/d) and a similar project build-up adding 2.0 Bcf/d. We would also note Wood Mackenzie recently revised its total industrial demand estimates, with total 2018 industrial demand increasing from 22.7 Bcf/d (Fall 2013) to 23.6 Bcf/d, directionally in line with our work.

Our utilities equity research colleagues highlight the potential impact from the pending EPA ruling on carbon regulations for existing coal plants. Aggressive carbon reduction targets are expected, but mandating specific levels may prove difficult in light of the Clean Air Act limitations. We expect the result will be more demand side reductions and more natural gas burn in the power stack. While a potential positive for deferred natural gas, compliance is likely in the 2019-2030 timeframe.

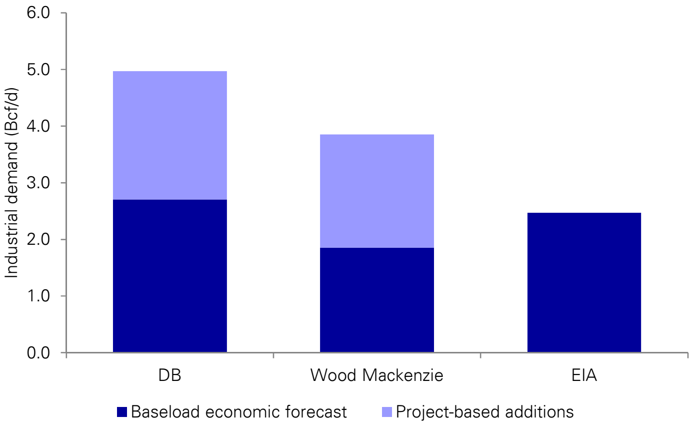
Our top down macro approach forecast based on a multi-variable regression model compares favorably with a 22.5 Bcf/d implied forecast by 2018, implying ~0.5 Bcf/d annual growth. At risk of double counting, we remain confident that little of the project based inflection in demand is included in the EIA estimates. We see the potential for 2.3 Bcf/d of incremental natural gas demand through 2018 based on our bottom up forecast. This demand is identifiable, risked, and promises to reach an inflection point by 2016. We believe that industrial demand is likely to find a balancing point between these our top down and bottom up approach, but above levels implied by major forecasting agencies such as the EIA.

Figure 8: Industrial natural gas demand forecast



Source: EIA, Wood Mackenzie, Deutsche Bank, Deutsche Bank

Figure 9: Comparative Industrial Demand Growth Outlooks (2013/18)



Source: EIA, Wood Mackenzie, Deutsche Bank, Deutsche Bank

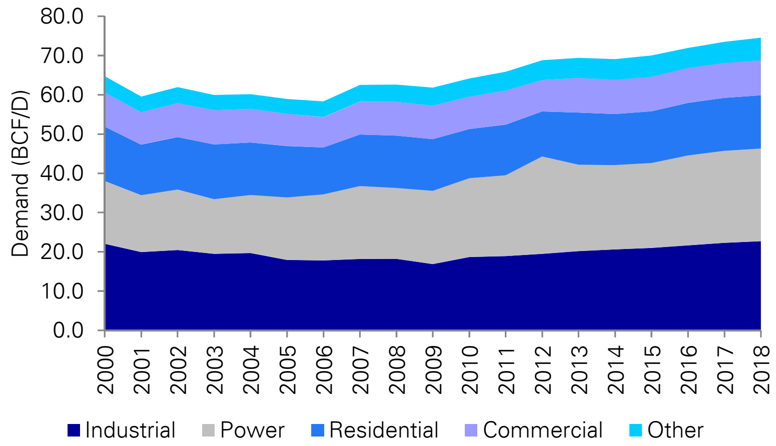
Quantifying the Industrial Renaissance

Industrial Demand is Key

The slow moving and more deliberate demand side of the natural gas market has struggled to keep pace with the explosive growth of the supply side of domestic natural gas. Due to the importance of weather and the ~40% swing in demand due to seasonality, identifying the true underlying change in demand for natural gas can prove opaque. Further, as the market has moved from resource scarcity (early 2000s) to a period of oversupply, there has been little question that any move higher in price stimulated by demand (seasonal or otherwise) would be addressed by supply growth. Multi-year forecasting in natural gas has proven a challenge and multi-year forecasts used by industry are often mean reverting by nature as price will act as the arbiter of either supply or demand imbalance. A number of basic facts surrounding natural gas demand growth and trends are outlined below, as context for a broader discussion in regards to industrial demand

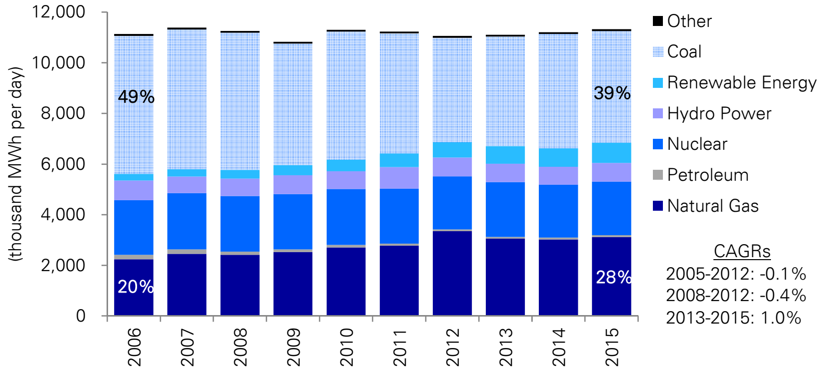
- Total US domestic demand has grown from 63.0 to 70.5 Bcf/d (for context, US supply grew 56.6 to 66.5 Bcf/d during the 2009-2013 period)
- Growth has been focused on the industrial and power sectors; industrial demand has grown 3.6 Bcf/d since the market lows in 2009, a non-weather adjusted consideration of demand on the power side has seen a move from 18.8 to 22.3 Bcf/d.
- Broader market use of natural gas is clearly witnessing a change. The fuel mix has shifted for total US generation needs in favor of natural gas (peaking at the low of commodity prices in 2012 at 30%), US electric power demand peaked at 24.9 Bcf/d in 2012. Of significance is the share of natural gas in the total generation pool is growing at the expense of coal generation, offset by growth in the share of renewable.

Figure 10: US demand growth by sector



Source: Wood Mackenzie, Deutsche Bank

Figure 11: US power generation by fuel type



Source: EIA, Deutsche Bank

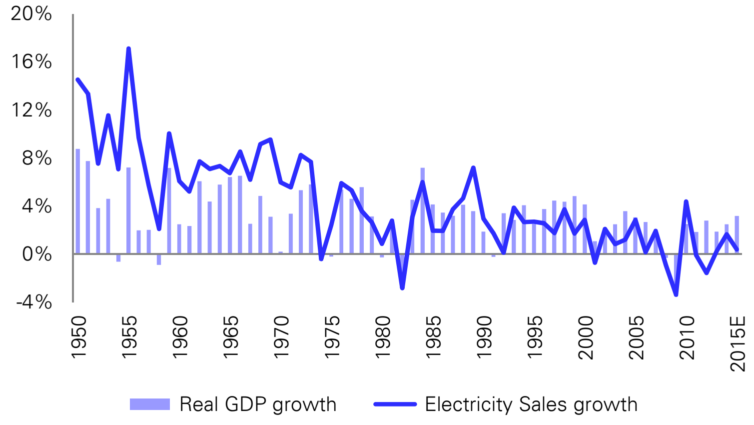
Quantifying the Industrial Renaissance

Important Demand Drivers – Electric Generation Sector

While natural gas is enjoying demand growth from a number of sectors and initiatives, our focus is on the industrial segment. It is our view that the long dated nature and high fixed cost nature of industrial investments will contribute to a new baseload of demand for US natural gas. We would be remiss not to mention the significant secular drivers of natural gas demand likely to impact markets over the coming cycle; power demand from the utility sector and the increasing visibility of LNG exports.

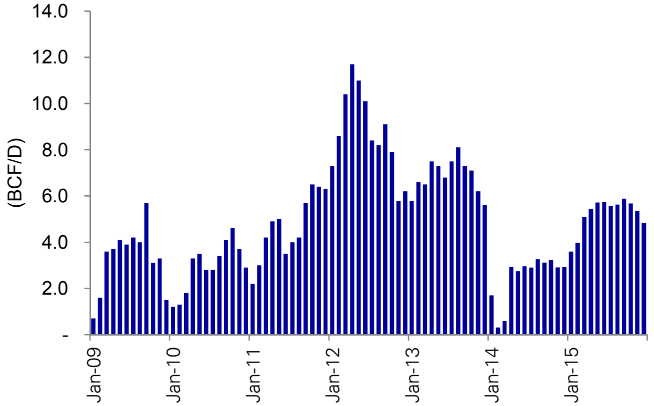
- Overall electricity generation growth has migrated to below GDP levels in the US due to efficiency and conservation factors. This secular trend means natural gas is competing for share, but in the context of a flat total generation market (on a weather adjusted basis).
- Fuel switching has been the lever to allow the natural gas market to find balance over the past ~5 years of oversupply. While an important demand driver, this displacement (of coal by gas) is an economic decision driven by price. While the strengthening of prices more recently has seen a decline in the need (or incentive) to switch from coal, this dynamic will likely persist moving forward. While the movement away from coal for generation (due to regulatory and emissions regulations) is a tangible demand driver for natural gas; the offset will be renewable sources of electricity generation which will keep natural gas generation on the margin in some instances.

Figure 12: US Electricity Demand Growth in Secular Decline



Source: EIA, Deutsche Bank

Figure 13: Coal to Gas displacement (cumulative)



Source: Wood Mackenzie, Deutsche Bank

Quantifying the Industrial Renaissance

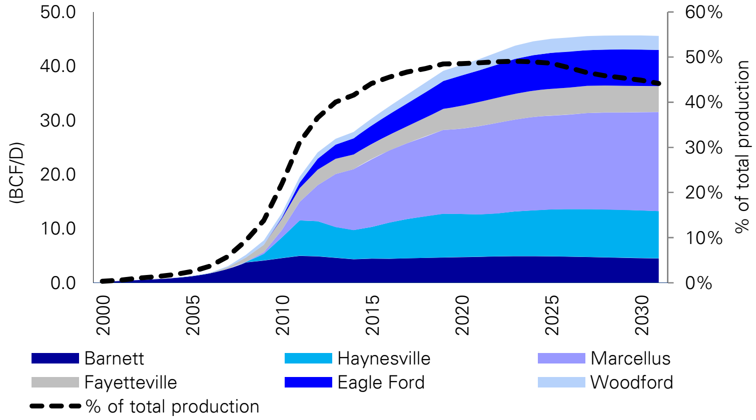
Certainty in the Resource – The First Step

North America enjoys a fully integrated oil & gas upstream with decades of experience and clear separation of surface and mineral estates in most jurisdictions. Domestic supply growth over the past half decade has been supported by resource in the ground and the technical capabilities and capital formation required for extraction. At the right price, the domestic upstream is prepared to rapidly grow supply, a unique attribute relative to other geographies.

While supply growth has clearly surpassed expectations, the scope of the unconventional resource (hence the duration of supply) will remain a key question. Our view has been that consumers (and regulators) will need to see a persistence of deliverability and lower than trend prices in order to make longer-term investment decisions. Proved reserves (90% certainty of recovery) is one metric to consider, and clearly the US has shown an expansion in the proved reserve base of natural gas. Looking more broadly, a number of third parties have assessed the resource potential for unconventional gas alone.

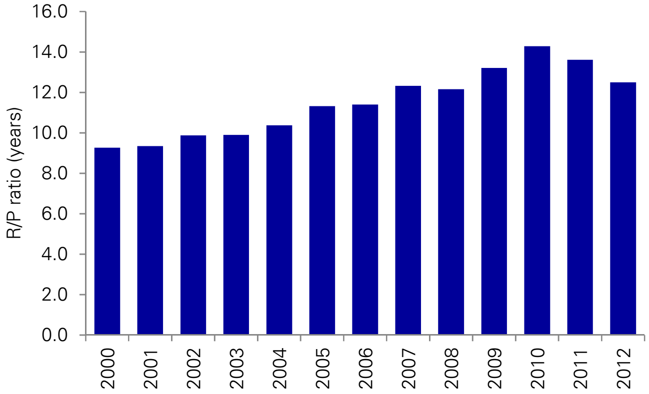
- The Potential Gas Committee (PGC) 2013 biennial resource assessment outlined an expansion in shale gas (excludes other unconventional sources such as CBM) to 1,073 Tcf in 2012 up from 615.9 Tcf in 2008. This growth is underpinned by the Marcellus (Northeast), which accounts for 33.4% of the total US resource assessment.

Figure 14: US Unconventional Supply Growth by Basin



Source: Wood Mackenzie, Deutsche Bank

Figure15: Expanding Resource



Source: 2013 BP Statistical Review, Deutsche Bank
Note: R/P = Proved resources / current year production

Quantifying the industrial renaissance

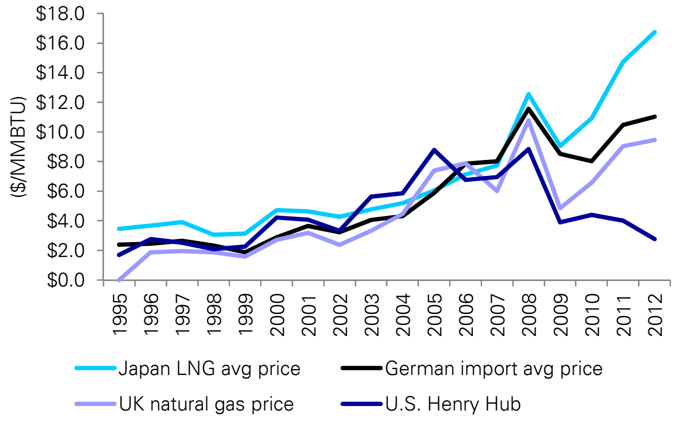
The Global Gas Opportunity

The opportunity posed by the unconventional natural gas revolution is centered upon the delta between domestic and international natural gas prices. This location differential is driven primarily by indigenous supply availability and the development of demand centers. While the US and particularly the Gulf Coast have enjoyed a price advantage vs. other geographies, this advantage has widened with the supply growth from unconventional sources.

The arbitrage between domestic and international price can be addressed in a number of methods via raw, intermediate and finished goods.

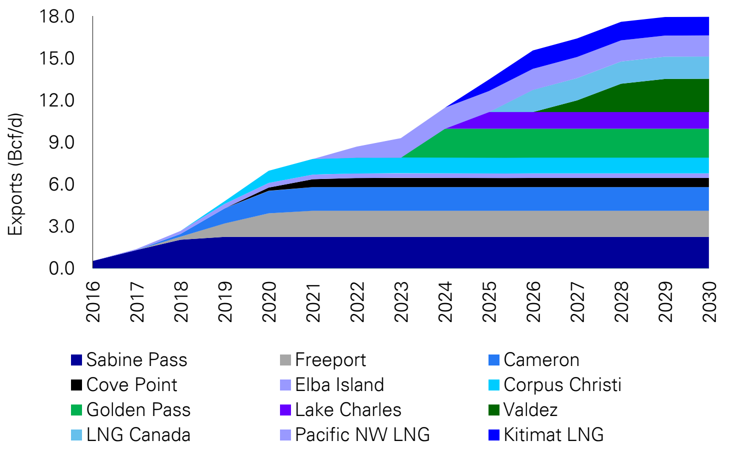
- LNG has been the technology of choice to link disparate and stranded natural gas sources (Middle East, Australia, West Africa, Caribbean) to global natural gas consumers. Asia and Europe have been the destinations for these flows. US LNG exports are a very real and tangible bull case for natural gas. We expect ~7.9 Bcf/d of export capacity online by 2022, which should provide an important linkage to global prices.
- The industrial processes outlined later in this report include alternative opportunities to arbitrage local to global natural gas differentials. Particularly for energy intensive industries (petrochemicals) where energy forms an important portion of the cost of goods sold let alone an important input as a feedstock.
- The tertiary and more difficult to quantify arbitrage opportunity comes from finished industrial or consumer goods that benefit from lower energy prices domestically. Clearly, the knock on effect of available energy (and power) sources is the expansion of basic manufacturing (heavy industry, autos, technology).

Figure 16: Global gas prices



Source: BP Statistical, Deutsche Bank

Figure 17: North American LNG exports



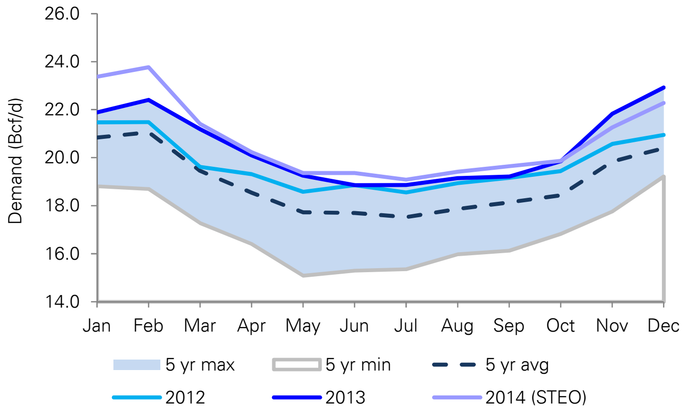
Source: Wood Mackenzie, EIA, Company Reports, Deutsche Bank

Quantifying the industrial renaissance

Shift Already Underway

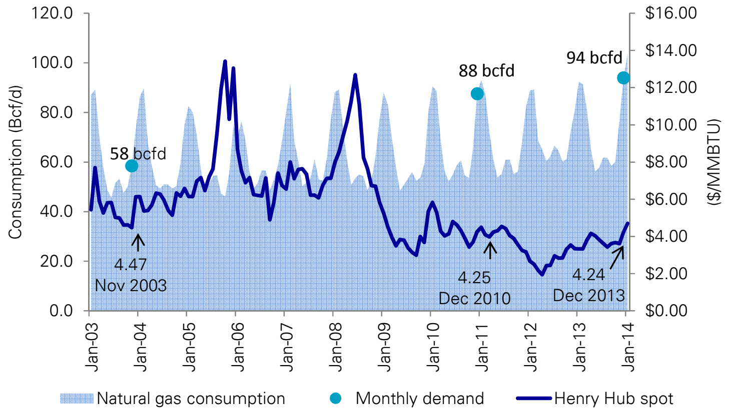
The move towards more usage of natural gas (even on a seasonally or weather adjusted basis) is already underway. While the growth of US industrial demand is indicative, we note the lag in the industrial production index weighted by energy intensive industries. An instructive exercise is to consider total US natural gas demand at similar price points in order to adjust for the impact of alternative fuel and more price sensitive demand drivers. We would note based on ~$4.30/mmbtu prices in December of 2013, total demand registered levels ~6 Bcf/d higher than 3 years previously. Further adjustment of demand level for seasonality (based on HDDs) shows that demand was still materially higher (~20%) on a 3 year basis. The US natural gas market is exhibiting signs of secular demand growth.

Figure 18: Industrial gas demand trend



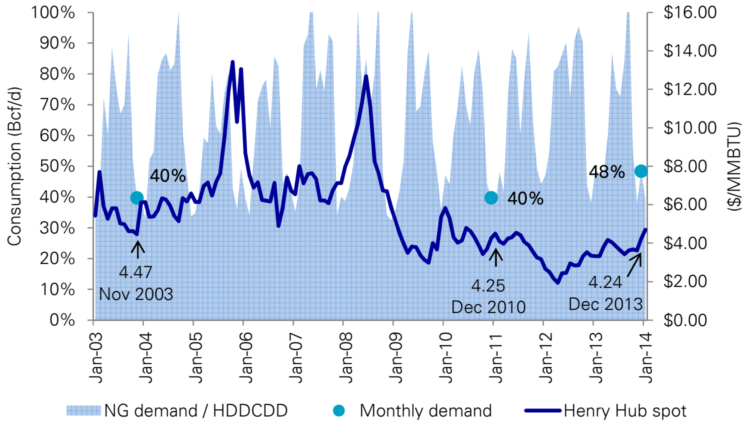
Source: EIA, Deutsche Bank

Figure 19: Incremental gas demand at winter prices



Source: Bloomberg Finance LP, EIA, Deutsche Bank

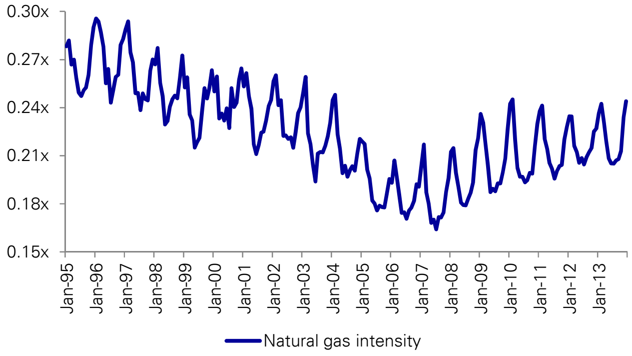
Figure 20: Incremental gas demand at winter prices (seasonally adjusted)



Source: Bloomberg Finance LP, EIA, Deutsche Bank

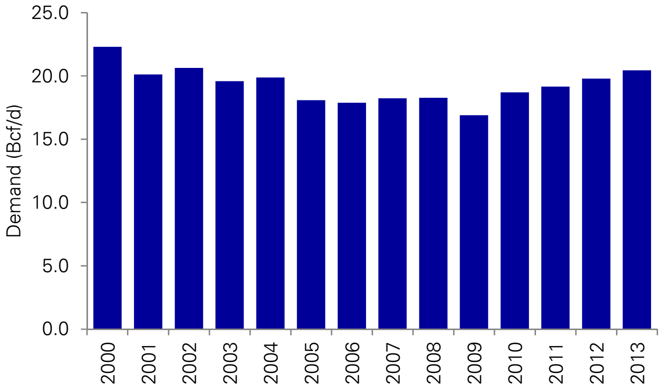
Drivers of Industrial Demand Growth

Figure 21: Natural gas intensity of US industrial production rising



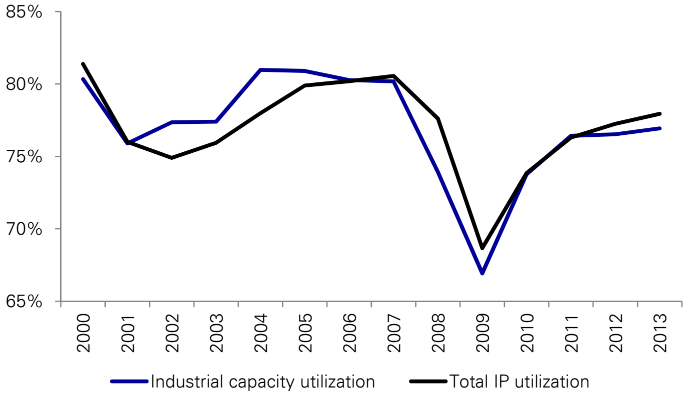
Note: Natural gas intensity defined as stated industrial NG demand per unit if US industrial production (monthly).
Source: EIA, Deutsche Bank

Figure 23: Industrial Demand (up 3.6 Bcf/d 2009-2013).



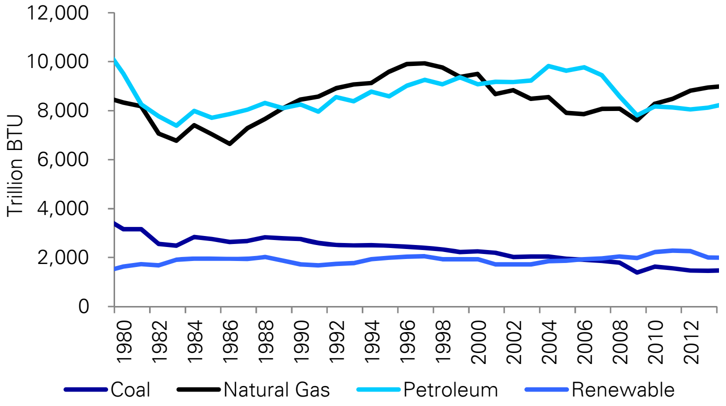
Source: EIA, Deutsche Bank

Figure 22: US IP & Capacity Utilization



Source: EIA, Deutsche Bank
**Industrial capacity includes Petroleum & coal, Chemicals, Plastics & rubber and Primary metals*

Figure 24: Industrial sector energy demand

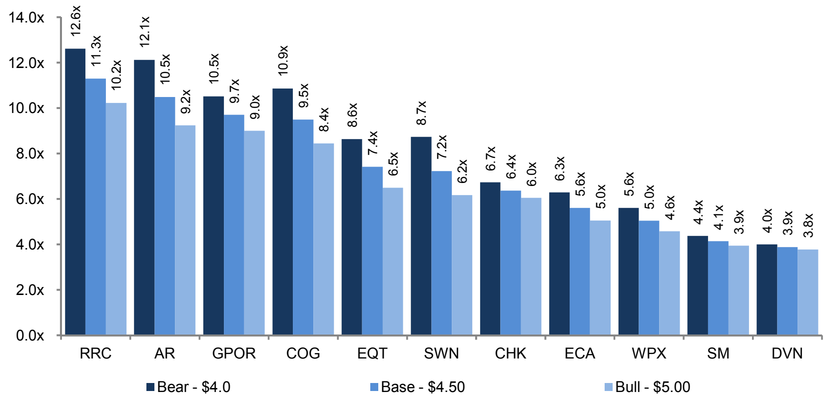


Source: EIA, Deutsche Bank

End of Oversupply a key positive for producers

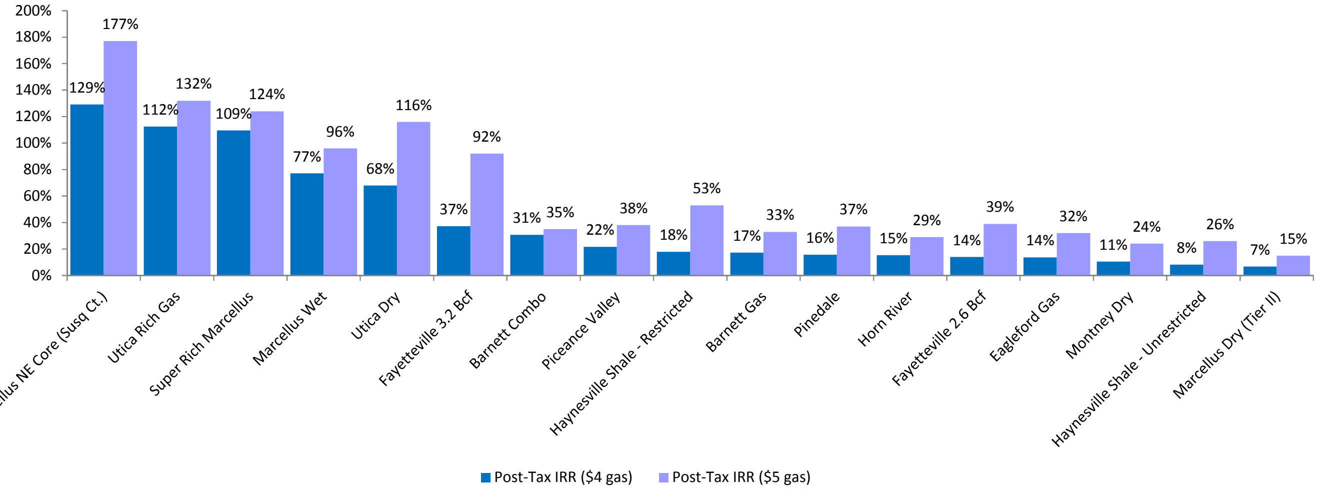
To be clear, we expect the North American upstream (enjoying a significantly expanded resource base and increased productivity) will grow supply to address the demand growth we envision. However, the first indications of secular demand growth should serve to stabilize the commodity at a more sustainable price. The key positive for producers (particularly gas-focused E&Ps) is an elimination of the precarious downside risk to commodity faced by industry over the past 4-5 years. While the option value of outlier demand events (primarily weather driven) will persist, demand growth should continue to expand the addressable market for US producers and lead to more sustainable prices (likely in a narrower band). We would note the wellhead (half cycle) returns of the major lower cost unconventional plays pivots significantly (1.5-2.0x) as longer-term natural gas price expectations move from $4/mmbtu to $5/mmbtu.

Figure 25: Commodity price sensitivity of E&P Valuations (2015e EV/DACF)



Source: Deutsche Bank

Figure 26: Post-tax well head IRRs of major US unconventional supply basins

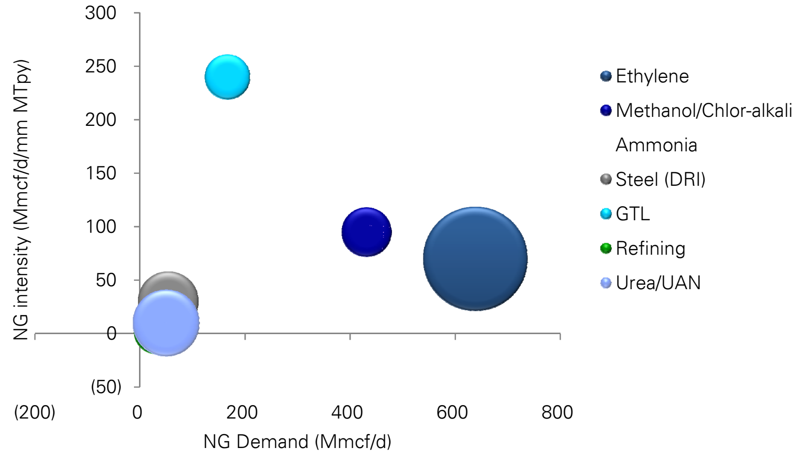


Note: wellhead returns = half cycle IRRs. Excludes acreage acquisition and other corporate overhead costs.
Source: Company data, Deutsche Bank

Outlining industrial natural gas demand

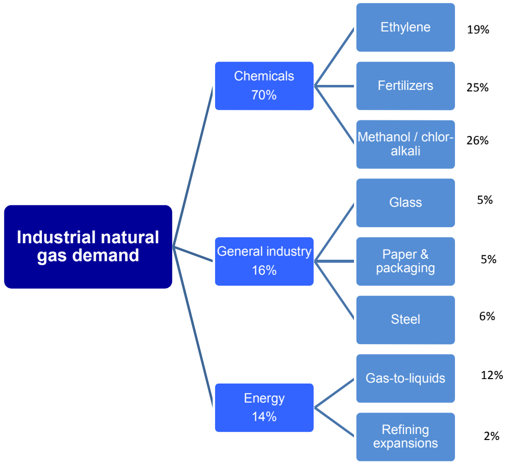
Our primary research was to survey and consolidate announced capacity expansions by industry sub-group. The predominance of announced projects are in natural gas intensive sub-sectors. Where possible, we classified projects as announced vs. under construction and collected further granularity of where in the permitting, FEED process the projects stand. We then assumed natural gas intensity per project (mmcf/d per annual metric ton of output) at an assumed 90% utilization factor. This approach explicitly risks yet to commence projects (primarily post 2018), and our focus is primarily the sanctioned / progressing projects that start up in 2015-2017 as a result.

Figure 27: Incremental demand and NG intensity by sub-segment



Source: Deutsche Bank

Figure 28: Sub-sector Breakdown and Weights



Source: Company data, Deutsche Bank

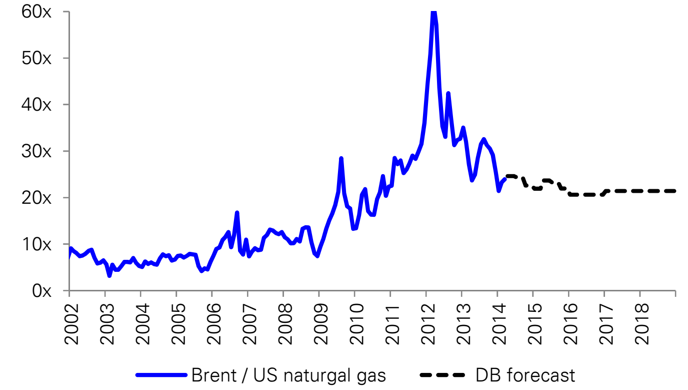
Chemicals

The Ethylene Super-Cycle

Domestic natural gas supply has changed the game for US ethylene producers. The single largest 'building block' chemical, ethylene feeds key petrochemical processes. The domestic supply of natural gas and more importantly ethane (the predominant natural gas liquid) has advantaged domestic ethylene producers. The implications for natural gas demand is two-fold: the extraction of ethane (fractionation) to feed ethylene crackers as a feedstock, and the use of natural gas as a fuel for steam crackers. We focus primarily on the dry gas demand from ethylene project expansions and new project startups.

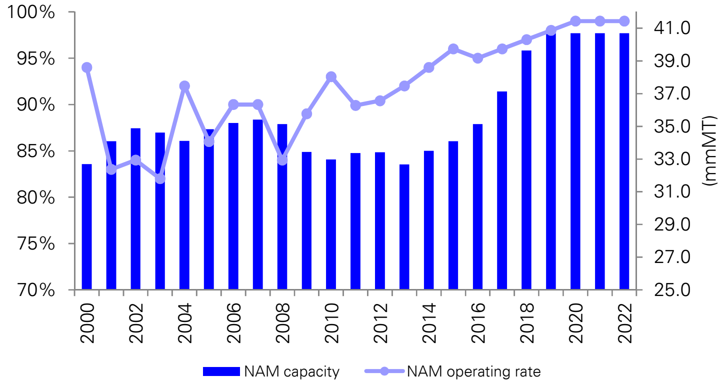
- The North American ethylene industry is expected to expand capacity (Brownfield + Greenfield) by 13.4 mm MT through 2020 (a ~40% expansion relative to 2012 levels.

Figure 30: US Gas Attractive Relative to Alternative Sources



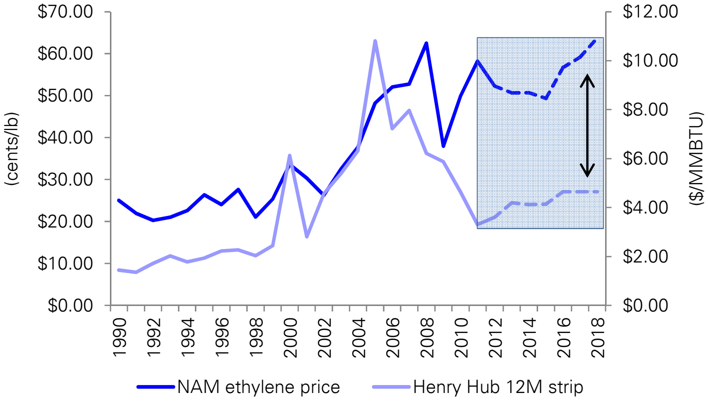
Source: Bloomberg Finance LP, Deutsche Bank (DB forecast based on Henry Hub NYMEX 12M strip

Figure 29: NAM ethylene capacity and capacity utilization



Source: IHS Chemical, DB Chemicals team, Deutsche Bank

Figure 31: Wider for Longer Margin Opportunity for US Producers



Source: Bloomberg Finance LP, IHS Chemical, Deutsche Bank

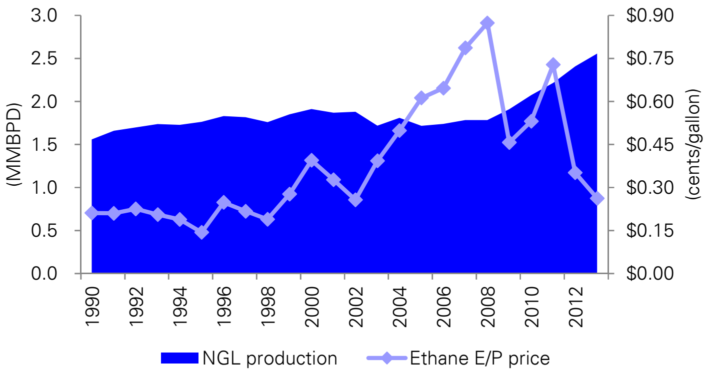
Chemicals

What the Ethylene Chain Means for Natural Gas?

Growing supply of domestic NGLs find a home, with an industrial natural gas demand kicker. The US petrochemical complex historically benefited from a cost-advantage associated with domestic supply (primarily from the Gulf of Mexico) The rise in gas prices in the 2000s reduced the competitiveness of the US industry and capacity was shuttered or off-shored. The growth of domestic natural gas in the 2008/09 timeframe brought with it a wet gas stream (NGLs) as upstream producers pursued higher margin liquids plays (Marcellus, Anadarko Basin, Eagle Ford).

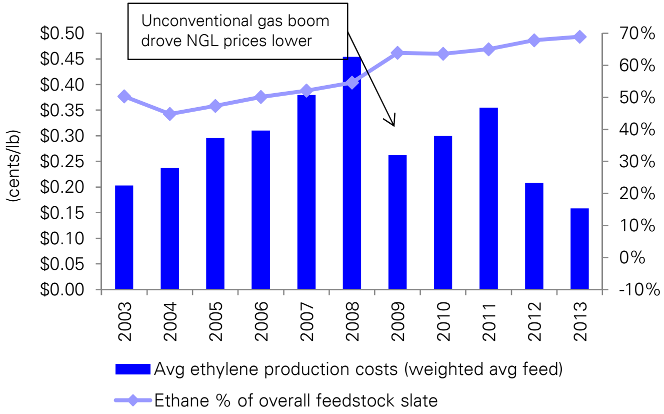
- Unconventional gas production growth (4.5 Bcf/d to 27 Bcf/d from 2008 to 2013) was accompanied by a comparable growth in NGLs (1,780 mbpd to 2,560 mbpd) over the same timeframe. 1 mm MT of ethylene capacity requires ~100 kbpd of ethane feedstock, while we assume a purity ethane facility will consume ~70 mmcf/d of methane (NG) – assuming no use of ethane as a process fuel.

Figure 32: US NGL production



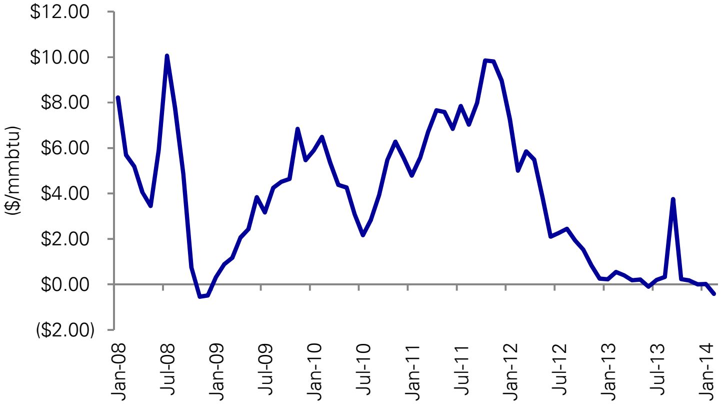
Source : EIA, IHS Chemical, DB Chemicals team, Deutsche Bank
**Ethane E/P price assumes 80% ethane, 20% propane*

Figure 33: US ethylene production cost



Source: IHS Chemical, DB Chemicals team, Deutsche Bank

Figure 34: Ethane Fractionation Spread



Note: Based on USGC (Mt. Belvieu) prices
Source: EIA, Bloomberg Finance LP, Deutsche Bank

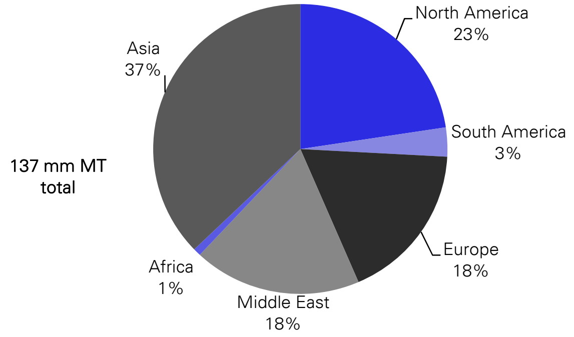
Chemicals

Ethylene Demand Growth & the Global Cost Curve

The low end of the cost curve should benefit from ethylene demand driven capacity expansions. Global ethylene demand is expected to increase by ~42 mm MT over 2013 levels to 180 mm MT by 2020 (3.5% CAGR). Asia is the primary driver where China accounts for 12% of the global market today (45% of demand growth), and added ~9.2 mm MT of capacity over the 2005-13 period. The US should capture a growing share of capacity additions (13.5 mm MT implies ~30%) due to its cost advantaged position.

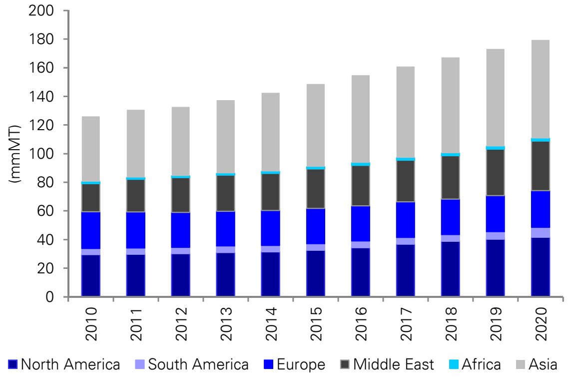
- The impact of ethane fractionation has likely contributed to NG demand growth of 1.1 Bcf/d between 2009 & 2013.
- We see incremental US ethylene projects adding an additional 0.7 Bcf/d of demand by 2020 on a gas equivalent basis.

Figure 36: Global ethylene demand by region (2013)



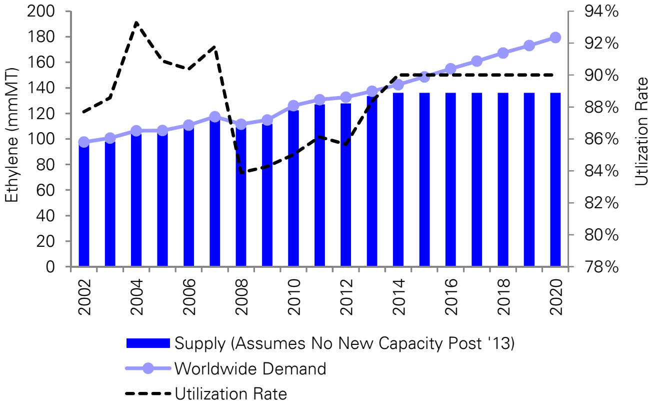
Source: IHS Chemical, DB Chemicals team, Deutsche Bank

Figure 35: Global ethylene demand growth by region



Source :EIA, IHS Chemical, DB Chemicals team, Deutsche Bank

Figure 37: Global ethylene supply demand



Source: IHS Chemical, DB Chemicals team, Deutsche Bank

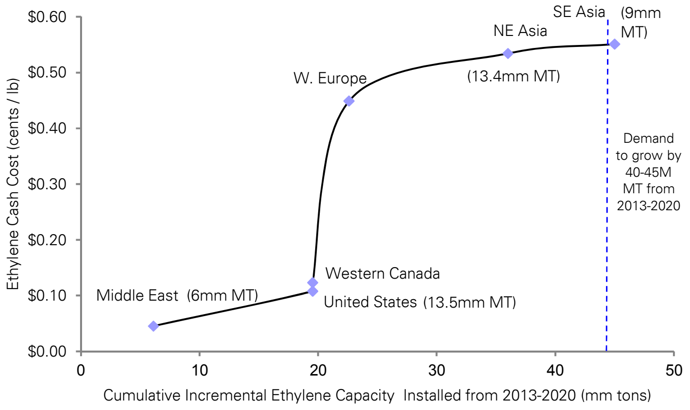
Chemicals

Feedstock Advantage Fuels Capacity Expansion

The build in capacity we (and industry experts) forecast is not without risks. 2013/14 will see the first expansion projects, while true Greenfield ethylene capacity startups are in the 2016 timeframe. We see 2,842 mm MT of expansion (Brownfield) projects, and 10,600 mm MT of new facilities by 2022. We see 1.4 Bcf/d from expansions and 0.5 Bcf/d of demand from new starts respectively.

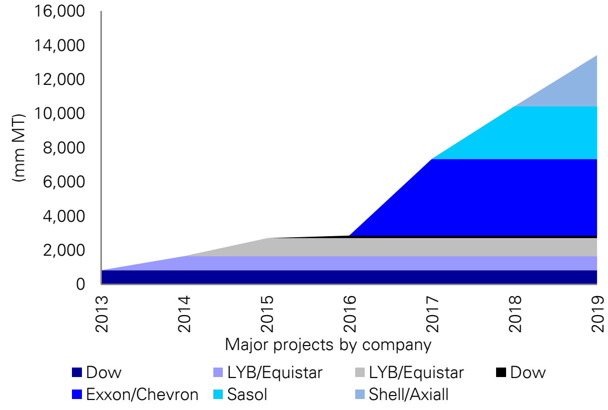
- The key risk to capacity expansions will be project delays related to federal and state permitting approvals. Projects require a greenhouse gas permit from the EPA as well as air permits at the state level (mainly Texas Commission on Environmental Quality and Louisiana Department of Environmental Quality). Considering the last domestic ethylene facility was constructed in 2001, uncertainty in permitting and emissions certainly bear watching.

Figure 38: US producers advantaged on the global cost curve



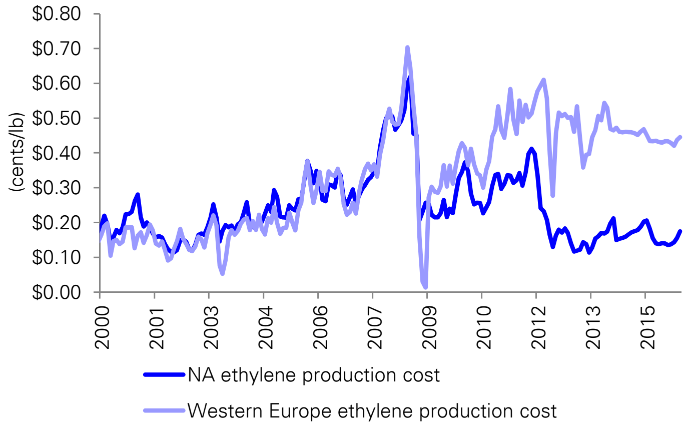
Source : IHS Chemical, DB Chemicals team, Deutsche Bank

Figure 39: US ethylene capacity expansions



Source: Wood Mackenzie, DB Chemicals team, Deutsche Bank

Figure 40: Ethylene production cost – US vs. Western Europe



Source: IHS Chemical, , Deutsche Bank

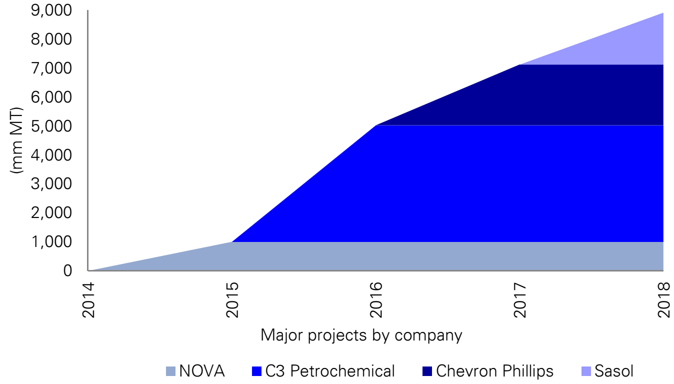
Chemicals

Major Contributors from Polyethylene and Propane Dehydrogenation (PDH)

We see additional 14.7 mm MT of annual capacity from "other" petrochemicals through 2022. Polyethylene is the most widely used plastic in the world and is a derivative of ethylene. We tally approximately 6.5 mm MT of capacity from projects through 2018. Focusing on ethane as the feedstock, and benefitting from the same dynamics as ethylene, producers such as Dow, Enterprise, and ExxonMobil are all proceeding with projects.

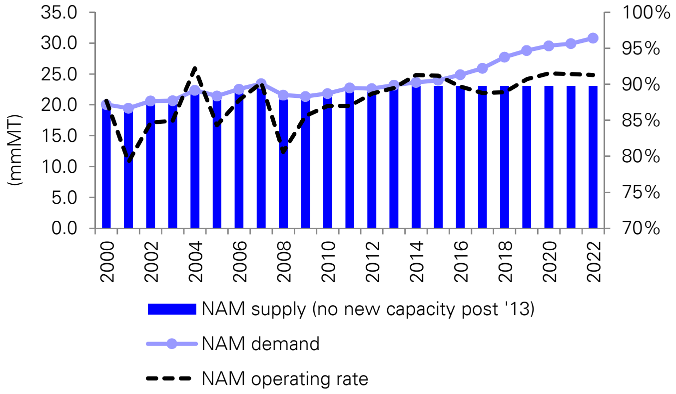
An additional beneficiary of plentiful NGLs is propane (C3). PDH plants use propane to produce propylene, a pervasive intermediate product of the chemical chain. While dehydrogenation of propane gas accounts for a small fraction of current propylene production, our research suggests 1.2 mm MT of capacity build out through 2018 due to the increased supply of propane and the opportunity this affords domestic petrochemical producers.

Figure 42: US PDH and polyethylene capacity



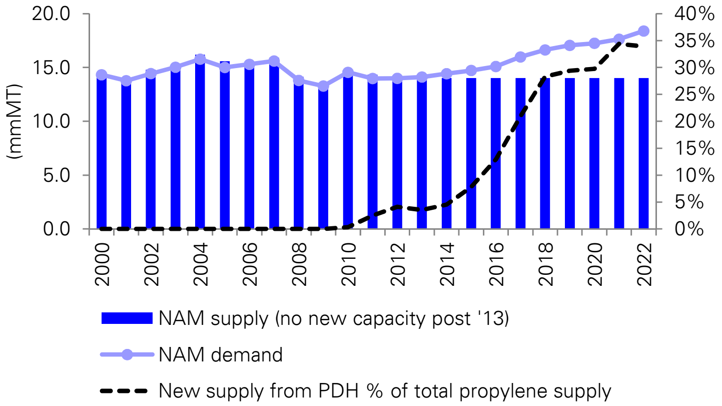
Source: Wood Mackenzie, DB Chemicals team, Deutsche Bank

Figure 41: NAM polyethylene supply demand



Source : IHS Chemical, Deutsche Bank

Figure 43: NAM propylene supply demand



Source: IHS Chemical, , Deutsche Bank

Chemicals

Figure 44: Petrochemical project queue – purity ethane

Company	Location	Online	Petchem	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
Dow	St. Charles, LA	2013	ethylene	Restart	410,000	Operational	25.8
Westlake	Lake Charles, LA	2013	ethylene	Expansion	100,000	Operational	6.4
BASF Total Petrochemicals	Port Arthur, TX	2013	ethylene	Feedstock flex	300,000	Under construction	4.8
Ineos Olefins	Chocolate Bayou, TX	2014	ethylene	Expansion	115,000	Under construction	7.2
Williams	Geismar, LA	2014	ethylene	Expansion	275,000	Announced	17.4
LyondellBasell / Equistar Chemicals	Laporte, TX	2014	ethylene	Expansion	360,000	Under construction	22.6
Westlake	Calvert City, KY	2014	ethylene	Feedstock Flex	82,000	Under construction	1.2
Dow	Plaquemine, LA	2015	ethylene	Feedstock flex	300,000	Announced	4.8
Westlake	Lake Charles, LA	2015	ethylene	Expansion	90,000	Announced	5.6
Ineos	Alvin, TX	2015	ethylene	Expansion	200,000	Announced	12.6
LyondellBasell / Equistar Chemicals	Channelview, TX	2015	ethylene	Expansion	50,000	Announced	3.2
LyondellBasell / Equistar Chemicals	Channelview, TX	2015	ethylene	Expansion	50,000	Announced	3.2
LyondellBasell / Equistar Chemicals	Corpus Christi, TX	2015	ethylene	Expansion	360,000	Announced	22.6
NOVA Chemicals	Joffre, AB	2015	polyethylene	Expansion	1,000,000	Under construction	9
Williams	Redwater, AB	2016	PDH	New	500,000	Announced	6.8
Dow	Freeport, TX	2016	ethylene	Feedstock flex	150,000	Announced	2.4
Dow	Freeport, TX	2016	polyethylene	New	750,000	Announced	10.1
Enterprise Products	Mont Belvieu, TX	2016	polyethylene	New	750,000	Announced	10.1
C3 Petrochemical	Alvin, TX	2016	PDH	New	725,000	Announced	9.8
ExxonMobil	Mont Belvieu, TX	2016	polyethylene	New	1,300,000	Considered	11.7
Formosa	Point Comfort, TX	2017	polyethylene	New	300,000	Announced	2.7
ExxonMobil	Baytown, TX	2017	ethylene	New	1,500,000	Planning	94.6
Chevron Phillips	Baytown, TX	2017	ethylene	New	1,500,000	Permitted	94.6
Chevron Phillips	Old Ocean, TX	2017	polyethylene	New	1,000,000	Permitted	9
Dow	Freeport, TX	2017	ethylene	New	1,500,000	Engineering	94.6
Formosa	Point Comfort, TX	2017	polyethylene	New	800,000	Announced	10.8
Sasol	Lake Charles, LA	2018	polyethylene	New	870,000	Engineering	7.8
Sasol / Ineos JV	Lake Charles, LA	2018	polyethylene	New	426,000	Engineering	3.8
Formosa	Point Comfort, TX	2018	ethylene	New	1,040,000	Planning	65.6
Sasol	Lake Charles, LA	2018	ethylene	New	1,500,000	Engineering	94.6
Dow*	Freeport, TX	2018	PDH	New	500,000	Considered	6.8
Occidental*	Ingleside, TX	2018	ethylene	New	544,000	Planning	34.2
Shell Chemicals*	Monaca, PA	2019	ethylene	New	1,000,000	Announced	63
Axiall Corporation*	LA	2019	ethylene	New	1,000,000	Announced	63
Odebrecht*	Parkersburg, WV	2019	ethylene	New	1,000,000	Announced	63
Total ethylene					13,426,000		807.0
Total polyethylene and PDH					8,921,000		98.4
Total					22,347,000		**905.4**

Source: Deutsche Bank

*Note: Natural gas demand assumes utilization rate of 90%, ethylene gas intensity of 70 mmcfd/mmtpy, PDH gas intensity of 15 mmcfd/mmtpy, polyethylene gas intensity of 10 mmcfd/mmtpy; *Projects with risked capacity and natural gas demand in DB forecast*

Figure 45: Petrochemical project queue – lower intensity ethylene

Company	Location	Online	Petchem	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
Dow	St. Charles, LA	2013	ethylene	Restart	410,000	Operational	12.9
Westlake	Lake Charles, LA	2013	ethylene	Expansion	100,000	Operational	3.2
BASF Total Petrochemicals	Port Arthur, TX	2013	ethylene	Feedstock flex	300,000	Under construction	2.4
Ineos Olefins	Chocolate Bayou, TX	2014	ethylene	Expansion	115,000	Under construction	3.6
Williams	Geismar, LA	2014	ethylene	Expansion	275,000	Announced	8.7
LyondellBasell / Equistar Chemicals	Laporte, TX	2014	ethylene	Expansion	360,000	Under construction	11.3
Westlake	Calvert City, KY	2014	ethylene	Feedstock Flex	82,000	Under construction	0.6
Dow	Plaquemine, LA	2015	ethylene	Feedstock flex	300,000	Announced	2.4
Westlake	Lake Charles, LA	2015	ethylene	Expansion	90,000	Announced	2.8
Ineos	Alvin, TX	2015	ethylene	Expansion	200,000	Announced	6.3
LyondellBasell / Equistar Chemicals	Channelview, TX	2015	ethylene	Expansion	50,000	Announced	1.6
LyondellBasell / Equistar Chemicals	Channelview, TX	2015	ethylene	Expansion	50,000	Announced	1.6
LyondellBasell / Equistar Chemicals	Corpus Christi, TX	2015	ethylene	Expansion	360,000	Announced	11.3
NOVA Chemicals	Joffre, AB	2015	polyethylene	Expansion	1,000,000	Under construction	9
Williams	Redwater, AB	2016	PDH	New	500,000	Announced	6.8
Dow	Freeport, TX	2016	ethylene	Feedstock flex	150,000	Announced	1.2
Dow	Freeport, TX	2016	polyethylene	New	750,000	Announced	10.1
Enterprise Products	Mont Belvieu, TX	2016	polyethylene	New	750,000	Announced	10.1
C3 Petrochemical	Alvin, TX	2016	PDH	New	725,000	Announced	9.8
ExxonMobil	Mont Belvieu, TX	2016	polyethylene	New	1,300,000	Considered	11.7
Formosa	Point Comfort, TX	2017	polyethylene	New	300,000	Announced	2.7
ExxonMobil	Baytown, TX	2017	ethylene	New	1,500,000	Planning	47.3
Chevron Phillips	Baytown, TX	2017	ethylene	New	1,500,000	Permitted	47.3
Chevron Phillips	Old Ocean, TX	2017	polyethylene	New	1,000,000	Permitted	9
Dow	Freeport, TX	2017	ethylene	New	1,500,000	Engineering	47.3
Formosa	Point Comfort, TX	2017	polyethylene	New	800,000	Announced	10.8
Sasol	Lake Charles, LA	2018	polyethylene	New	870,000	Engineering	7.8
Sasol / Ineos JV	Lake Charles, LA	2018	polyethylene	New	426,000	Engineering	3.8
Formosa	Point Comfort, TX	2018	ethylene	New	1,040,000	Planning	32.8
Sasol	Lake Charles, LA	2018	ethylene	New	1,500,000	Engineering	47.3
Dow*	Freeport, TX	2018	PDH	New	500,000	Considered	6.8
Occidental*	Ingleside, TX	2018	ethylene	New	544,000	Planning	17.1
Shell Chemicals*	Monaca, PA	2019	ethylene	New	1,000,000	Announced	31.5
Axiall Corporation*	LA	2019	ethylene	New	1,000,000	Announced	31.5
Odebrecht*	Parkersburg, WV	2019	ethylene	New	1,000,000	Announced	31.5
Total ethylene					13,426,000		403.5
Total polyethylene and PDH					8,921,000		98.4
Total					22,347,000		**501.9**

Source: Deutsche Bank
*Note: Natural gas demand assumes utilization rate of 90%, ethylene gas intensity of 35 mmcfd/mmtpy, PDH gas intensity of 15 mmcfd/mmtpy, polyethylene gas intensity of 10 mmcfd/mmtpy; *Projects with risked capacity and natural gas demand in DB forecast*

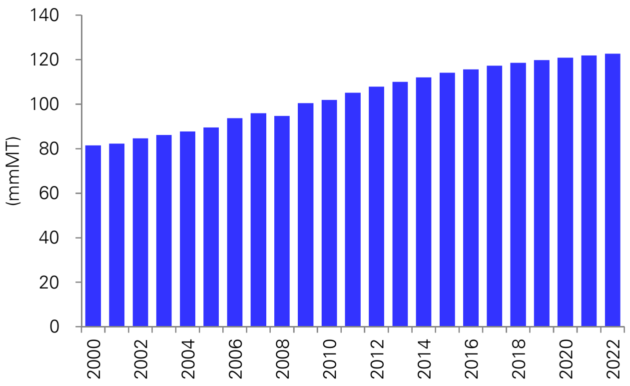
Chemicals

The Fertilizer Value Chain; Natural Gas Intensive

The US feedstock advantage again driving increased investment in nitrogen production capacity. Nitrogen, a key constituent of fertilizer and the main driver of crop yield, is produced using natural gas. A wave of construction of new nitrogen fertilizer plants is underway in the US, in addition to the restart of previously shuttered facilities. Again, the driver is discounted domestic natural gas and continued global crop demand growth. During periods of high gas prices (~2000-2007), domestic fertilizer production was pushed off the global cost curve, and the US nitrogen capacity was shuttered / mothballed. Sustained low natural gas prices have enabled improvement in nitrogen production margins, and a resurgence of US fertilizer production.

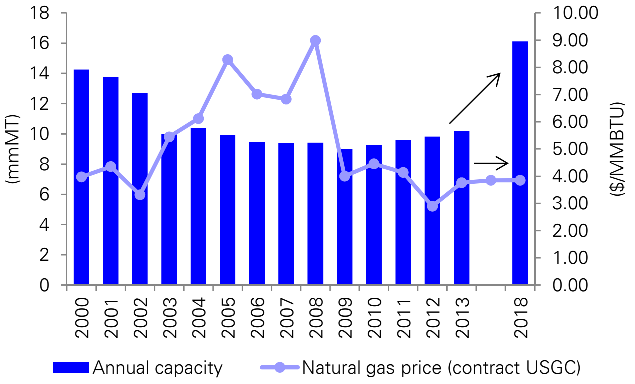
- We expect new projects and restarts to translate into 13.5 mm MT of capacity through 2018 driving an incremental demand for ~560 mmcf/d of natural gas per our base case estimates (upside to 720 mmcf/d).

Figure 46: Global nitrogen-based fertilizer consumption



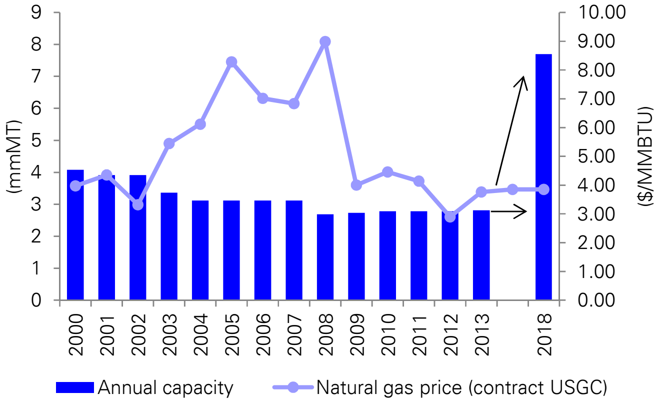
Source : DB Chemicals team, Deutsche Bank
**Consumption in metric tons of Nitrogen*

Figure 47: US ammonia capacity vs. natural gas price



Source: IHS Chemical, Deutsche Bank
**Consumption in metric tons of Nitrogen*

Figure 48: US urea capacity vs. natural gas price



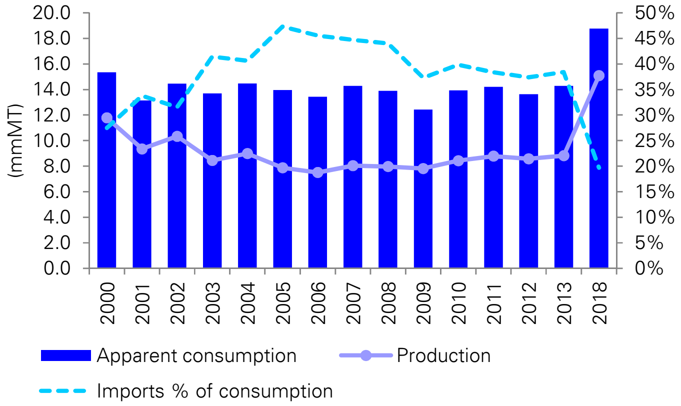
Source: IHS Chemical, Deutsche Bank
**Consumption in metric tons of Nitrogen*

Chemical Demand

The Fertilizer Value Chain. Natural Gas Intensive

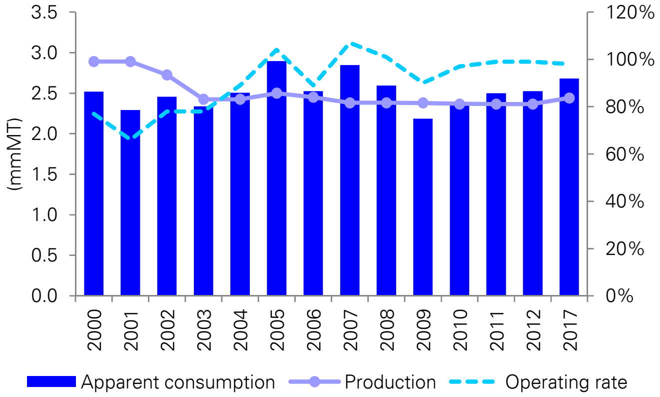
Similar to other energy intensive industries, the production of nitrogen based fertilizers in the US was shuttered and off-shored in the past cycle. This too reversed trend with the growth in global agriculture demand underpinning the opportunity to re-establish a competitive domestic nitrogen industry. Ammonia remains the basic building block for the sectors, and is most effectively produced almost exclusively from natural gas as both a feedstock (for hydrogen production) and a process fuel. Ammonia is the basic building block for urea and urea ammonium nitrate (UAN). Nitrogen fertilizer consumption represents over 80% of the world ammonia market. Given continued population growth and limited new development of arable land, expect renewed nitrogen fertilizer growth. Falling production costs and infrastructure investment positions the US well for incremental supply growth.

Figure 49: US ammonia supply demand



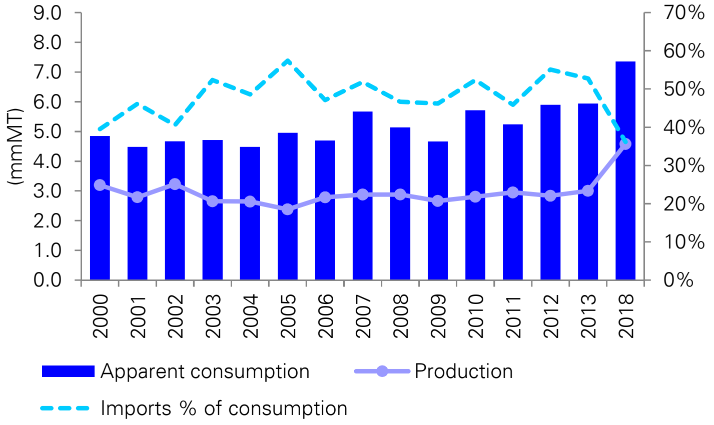
Source : IHS Chemical, Deutsche Bank
*Production / consumption in metric tons of Nitrogen

Figure 50: US UAN supply demand



Source: IHS Chemical, DB Chemicals team, Deutsche Bank
*Production / consumption in metric tons of urea

Figure 51: US urea supply demand



Source: IHS Chemical, Deutsche Bank
*Production / consumption in metric tons of Nitrogen

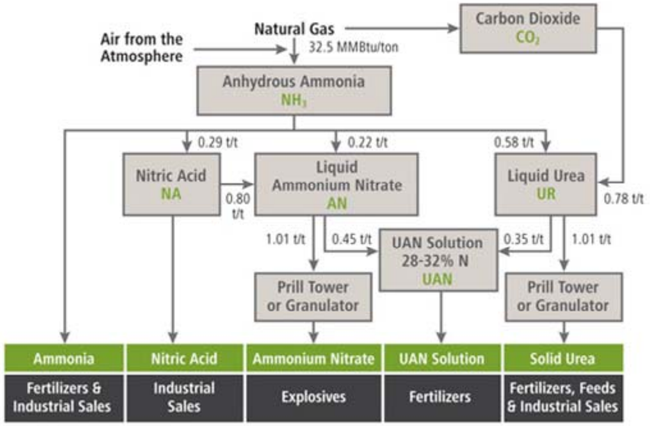
Chemical Demand

Agriculture a Key Contributor

Improving fundamentals for ammonia, urea and urea ammonium nitrate (UAN)

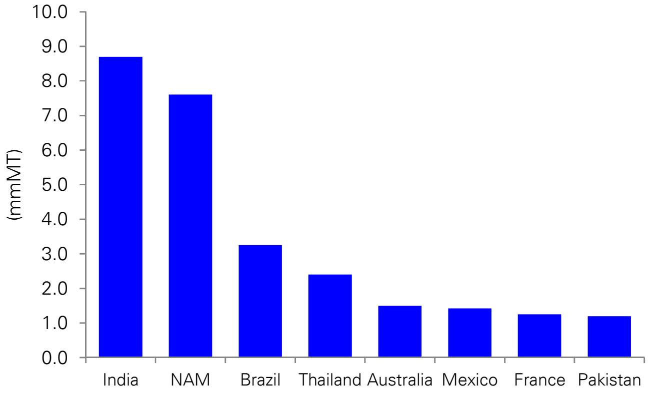
Production of nitrogen-based fertilizers is natural gas-intensive; 1 ton of ammonia requires 32.5 mmbtu natural gas, 1 ton of urea requires 24 mmbtu natural gas and UAN requires 13.7 mmbtu natural gas. The availability of natural gas and globally competitive price again positions the US market well to capture incremental share. Increased domestic production should lower dependence on fertilizer imports, (North America nitrogen fertilizer consumption totals approximately 20 mm metric tons, of which roughly one third is imported as ammonia, urea or UAN). Displacement of imports may translate into spare nitrogen tonnage being exported to higher production cost regions such as Europe.

Figure 52: Nitrogen value chain



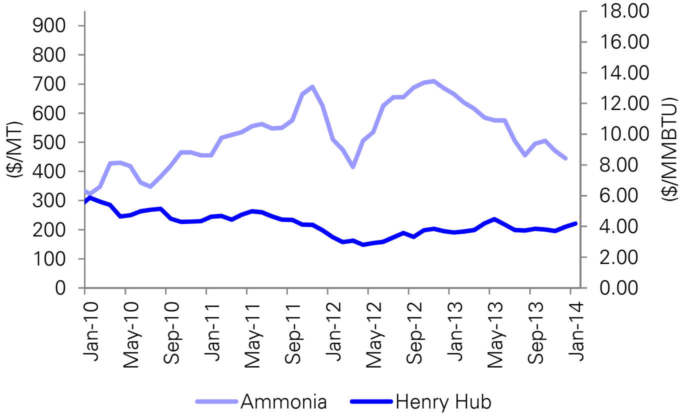
Source : Potash, Deutsche Bank

Figure 53: Major urea importers (2013)



Source: IHS Chemical, DB Chemicals team Deutsche Bank
**Metric tons of urea*

Figure 54: US natural gas price vs. ammonia price



Source Bloomberg Finance LP, DB Chemicals team, Deutsche Bank

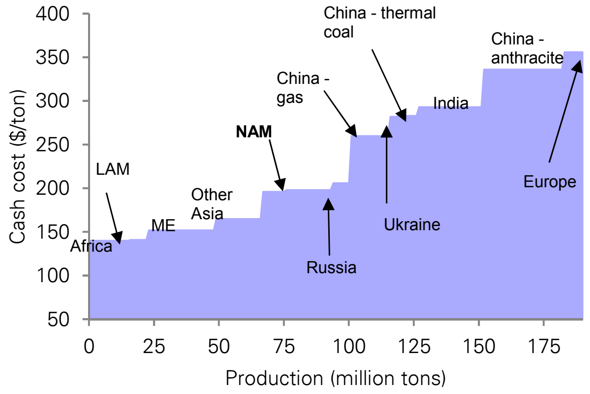
Chemicals

Nitrogen-based fertilizer: global cost curve

The US position towards the bottom of the global cost curve is a key driver for increased investment spend in nitrogen fertilizer capacity

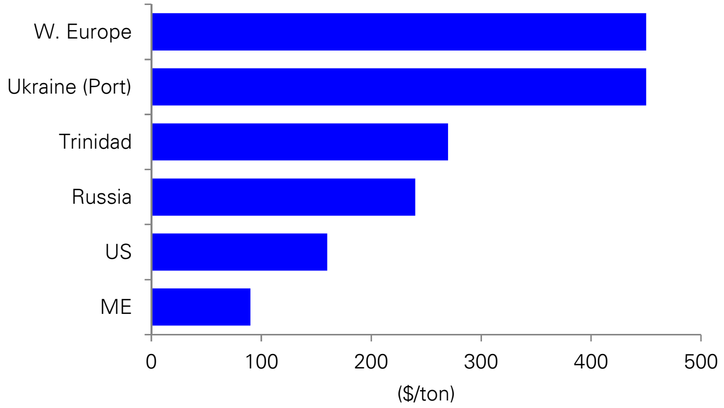
- US producers are benefiting from a large supply of cheap natural gas from unconventional resources
- Natural gas prices are expected to remain low, thereby insulating producers' cost advantage versus foreign alternatives.
- Given the attractive economics on a global scale, the US should be the key beneficiary of significant capacity expansion over the next several years (capacity 10.9 MTPY / nat gas demand 515 mmcf/d)

Figure 56: Urea cost curve (2020)



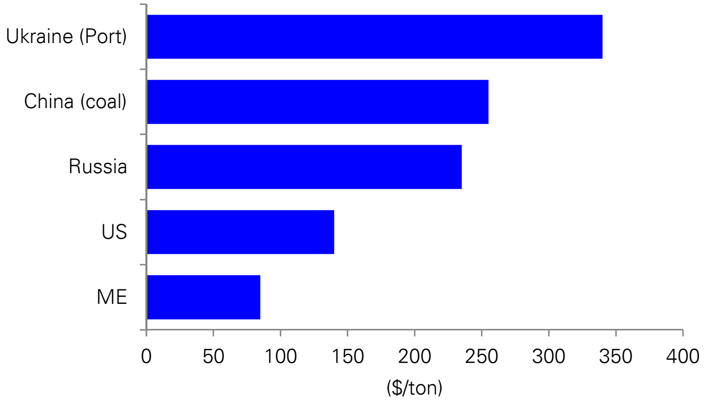
Source :Fertecon, DB Chemicals team, Deutsche Bank

Figure 55: 2013 ammonia cost curve



Source : Potash, Fertecon, Deutsche Bank

Figure 57: 2013 urea cost curve



Source: Potash, Fertecon, Deutsche Bank

Chemicals

Nitrogen-based fertilizer: the feedstock advantage

The US position towards the bottom of the global cost curve is a key driver for increased investment spend in nitrogen fertilizer capacity

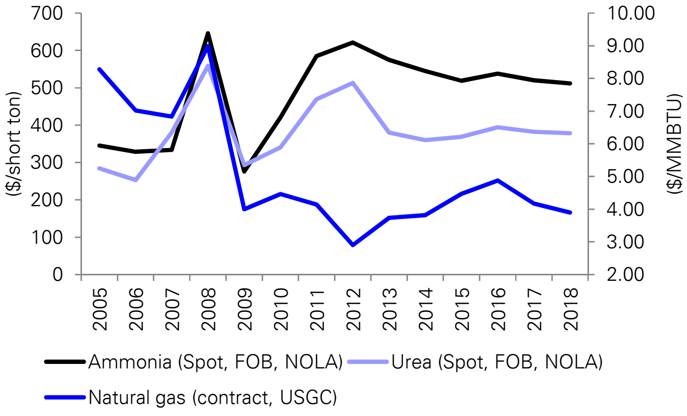
Feedstock cost advantage: Historically, the spread between ammonia values and natural gas has been narrow. In recent years nitrogen demand coupled with lower natural gas prices has widened the gap and improved production margins, providing US producers with a competitive advantage. Based on expectations for elevated ammonia and urea prices and sustained low natural gas prices through 2018, production margins for nitrogen should remain attractive in the US (Natural gas represents largest part of US production cost, 70-85% of total) Even accounting for an increase in natural gas prices to $6.00/mmbtu, cash production cost still remains well supported at current ammonia and urea prices.

Figure 59: US cash production costs ($/MT)

	Ammonia			
Gas price ($/MMBTU)	$4.00	$6.00	$8.00	$10.00
Gas use (MMBTU/MT)	35	35	35	35
Gas cost	140	210	280	350
Conversion cost	24	24	24	24
Total ($/MT)	**164**	**234**	**304**	**374**
	Urea			
Ammonia cost	94	135	175	215
Energy cost	20	30	40	50
Conversion cost	16	16	16	16
Total ($/MT)	**130**	**181**	**231**	**281**

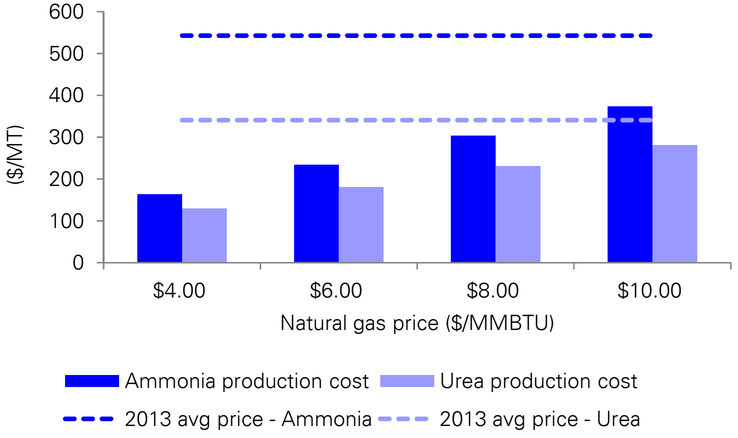
Source :IHS Chemical, Deutsche Bank

Figure 58: Ammonia and urea margins



Source : IHS Chemical, Deutsche Bank

Figure 60: 2013 urea cost curve



Source: IHS Chemical, Deutsche Bank

Chemicals

Figure 61: Nitrogen Fertilizer Project Queue

Company	Location	Online	Fertilizer	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
Rentech Nitrogen	East Dubuque, IL	2013	Urea	Expansion	20,000	Operational	0.2
LSB Industries	Pryor, OK	2013	Ammonia	Expansion	55,000	Operational	5.5
Potash Corp	Geismar, LA	2013	Ammonia	Restart	455,000	Operational	45.1
Austin Powder	Mosheim, TN	2014	Ammonia	New	61,000	Under construction	6.0
Austin Powder	Mosheim, TN	2014	UAN	New	139,000	Under construction	1.3
Rentech Nitrogen	East Dubuque, IL	2014	Ammonia	Expansion	64,000	Under construction	6.4
BioNitrogen	Hardee County, FL	2015	Urea	New	113,000	Under construction	0.1
CF Industries	Donaldsonville, LA	2015	Ammonia	Expansion	91,000	Under construction	9.0
Potash Corp	Lima, OH	2015	Ammonia	Debottleneck	73,000	Under construction	7.3
Potash Corp	Lima, OH	2015	Urea	Debottleneck	66,000	Under construction	0.6
Agrium	Borger, TX	2016	Ammonia	Debottleneck	120,000	Announced	11.9
Agrium	Borger, TX	2016	Urea	Debottleneck	640,000	Announced	5.8
BioNitrogen	Pointe Coupe Parish, LA	2016	Urea	New	113,000	FEED	0.1
CF Industries	Port Neal, IA	2016	Ammonia	New (Brownfield)	805,000	Permitted	79.7
CF Industries	Donaldsonville, LA	2016	Urea	New (Brownfield)	1,278,000	Permitted	11.5
CF Industries	Port Neal, IA	2016	Urea	New (Brownfield)	1,278,000	Permitted	11.5
Dyno Nobel	Waggaman, LA	2016	Ammonia	New (Brownfield)	800,000	Under Construction	79.2
LSB Industries	El Dorado, AR	2016	Ammonia	New (Brownfield)	340,000	Announced	33.7
Orascom Construction Industries	Wever, Lee County, IA	2016	Ammonia	New (Greenfield)	800,000	Under Construction	79.2
Orascom Construction Industries	Wever, Lee County, IA	2016	Urea	New (Greenfield)	1,000,000	Under Construction	9
CF Industries	Donaldsonville, LA	2016	Ammonia	New (Brownfield)	1,208,000	Permitted	119.6
BioNitrogen	Pointe Coupe Parish, LA	2017	Urea	New	113,000	FEED	0.1
Koch Fertilizer	Enid, OK	2017	Ammonia	Expansion	290,000	Approved	28.7
Koch Fertilizer	Enid, OK	2017	Urea	Expansion	1,000,000	Approved	9.0
Mosaic*	St. James Parish, LA	2018	Ammonia	Expansion	800,000	FEED	79.2
Northern Plains Nitrogen*	Grand Forks, ND	2018	Ammonia	New (Greenfield)	730,000	FEED	72.3
Northern Plains Nitrogen*	Grand Forks, ND	2018	Urea	New (Greenfield)	1,000,000	FEED	9
Total					**13,452,000**		**720.9**

Source: Deutsche Bank
*Note: Gas demand assumes facility utilization rate of 90%, ammonia gas intensity of 110 mmcfd/mmtpy, Urea gas intensity of 10 mmcfd/mmtpy, and UAN gas intensity of 10 mmcfd/mmtpy; *Projects with risked capacity and natural gas demand in DB forecast*

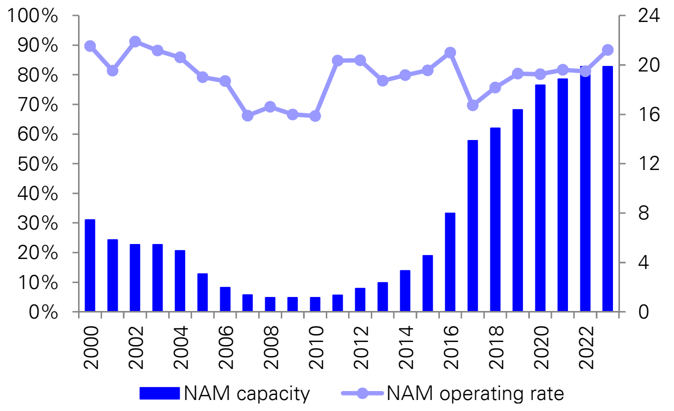
Chemicals

Methanol: market context

Global methanol demand is expected to rise over the next several years

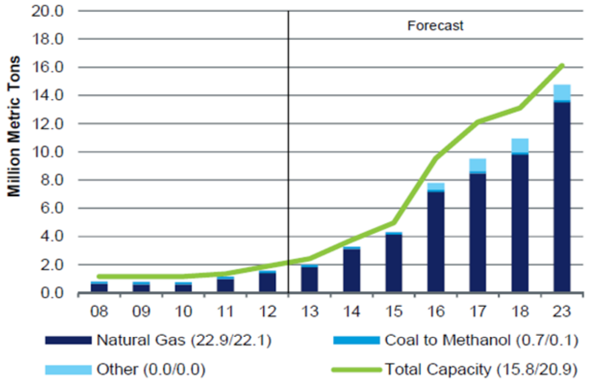
Methanol is an alcohol that serves as a raw material in several intermediate chemicals as well as end uses including MTBE (fuel additive), formaldehyde and acetic acid. It is primarily produced from steam reforming, which uses natural gas as its primary feedstock. Historically, methanol prices have been correlated with oil prices. Global methanol demand growth forecast of incremental 43 mm MT is largely driven by light olefin production and fuel applications, accounting for nearly half of demand over the next 10 years. NAM methanol capacity is expected to significantly increase over the next several years as producers open new facilities and relocate existing facilities, taking advantage of low cost natural gas feedstock in the US.

Figure 62: NAM methanol capacity and facility utilization



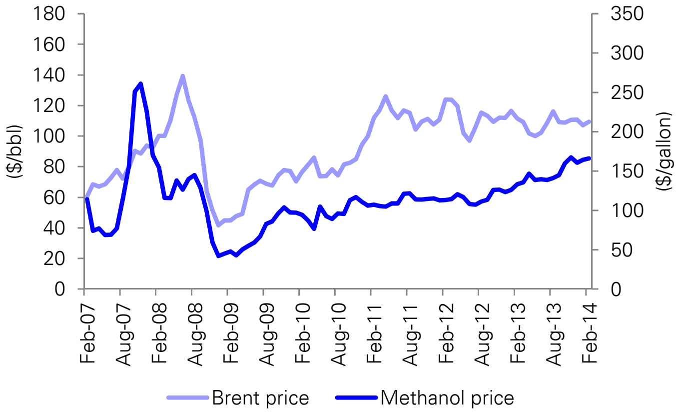
Source: IHS Chemical, Deutsche Bank

Figure 63: NAM production by feedstock



Source: IHS Chemical, Deutsche Bank

Figure 64: Brent crude oil price vs. methanol price



Source: IHS Chemical, Deutsche Bank

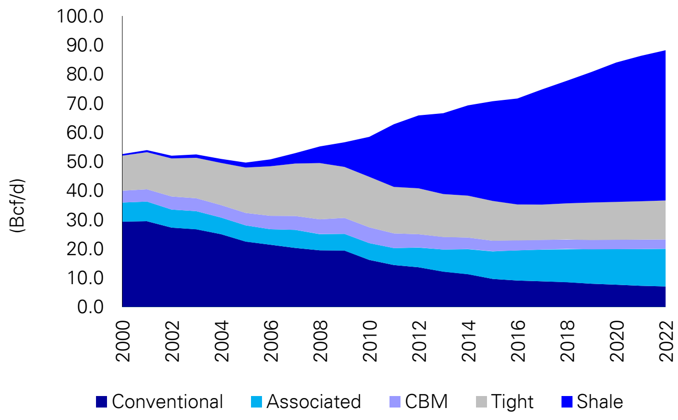
Chemicals

Methanol: what it means for natural gas

Methanol capacity returns to the US in light of feedstock supply from unconventional gas basins

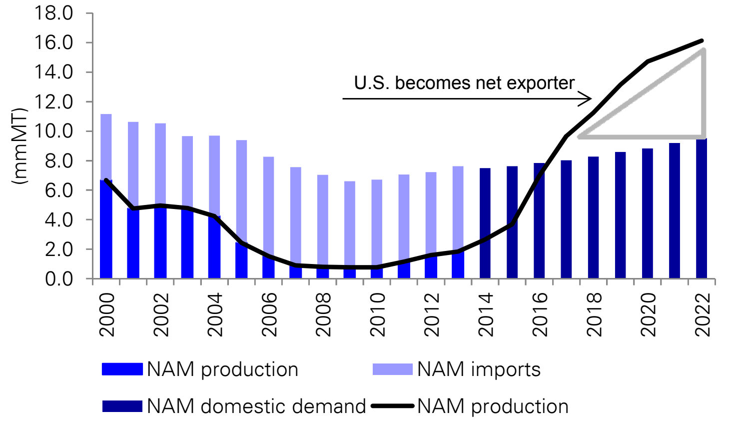
The advent of unconventional gas drilling has led to increasing supplies of methane, the primary feedstock for methanol. While natural gas prices rose in the early 2000s, US methanol production costs increased, and after a point became uneconomic. Capacity rationalization ensued for the next several years as facilities were either idled or relocated to more cost-effective regions. The US is now witnessing a resurgence of methanol production, driven by increasing natural gas supply, attractive production economics and increasing methanol demand. Methanex, a US-based methanol provider, has announced plans to relocate two methanol facilities from Chile to Louisiana, with potential for a third plant relocation.

Figure 65: US dry gas production



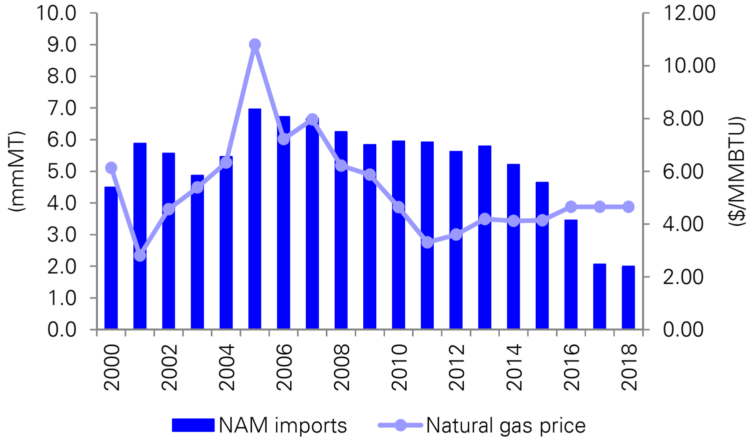
Source : Wood Mackenzie, Deutsche Bank

Figure 66: NAM methanol supply demand



Source :IHS Chemical, Deutsche Bank

Figure 67: NAM methanol imports



Source: IHS Chemical, Deutsche Bank

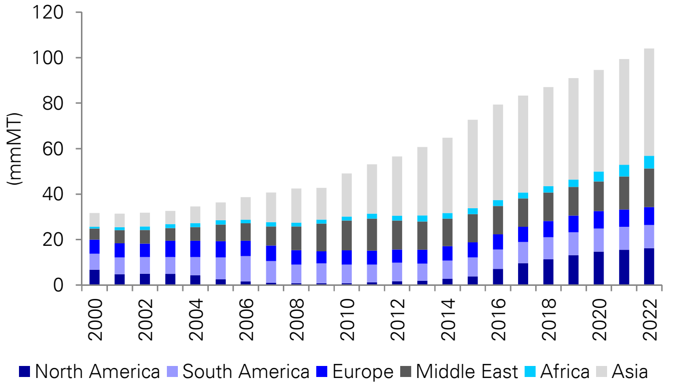
Chemicals

Methanol: the global cost curve

As methanol demand is poised to rise through 2022, the North America position at the bottom of the global cost curve justifies significant capacity addition and investment over the coming years.

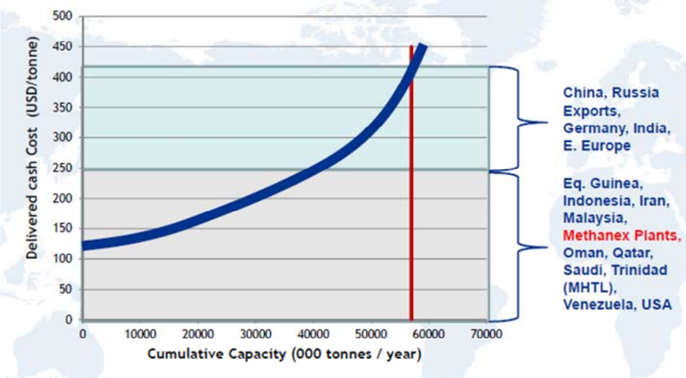
Global methanol demand is expected to increase by an incremental ~43 mm MT by 2022. Cheaper unconventional gas is attracting significant investment in methanol capacity in North America, evidenced by construction of new plants and both restart and relocation of existing plants. With lower cost natural gas, the largest component of production cost, North America methanol producers sit below foreign competitors on the global cost curve. Of the total 48 mm MT of global capacity, 17.5 mm MT (~36%) is slated to be built in North America.

Figure 68: Global methanol demand by region



Source : IHS Chemical, DB Chemicals team, Deutsche Bank

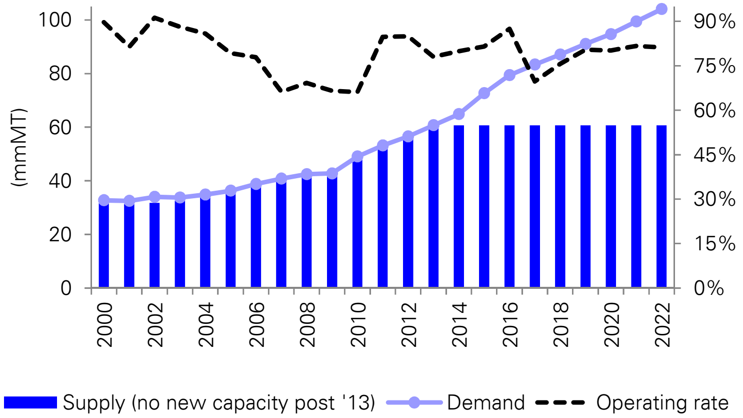
Figure 69: Global methanol cost curve



Source: Methanex
Assumes $105/bbl Brent oil; RMB 640/MT coal (approx. US$105/tonne)

Source: Methanex, Deutsche Bank

Figure 70: Global methanol supply demand



Source: IHS Chemical, Deutsche Bank

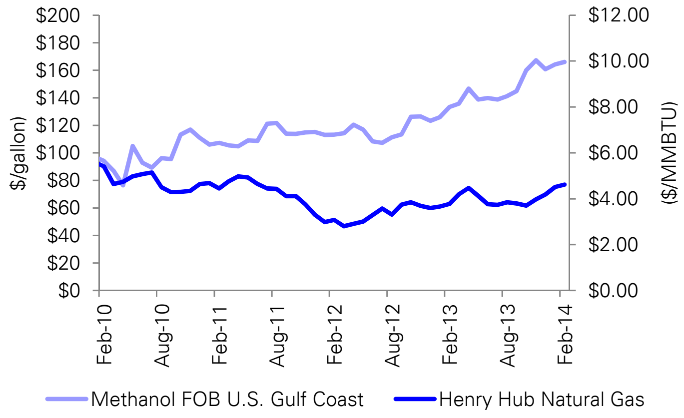
Chemicals

Methanol: the feedstock advantage

The US feedstock cost advantage should be a catalyst for considerable capacity ramp over the next several years barring project permitting and approval delays.

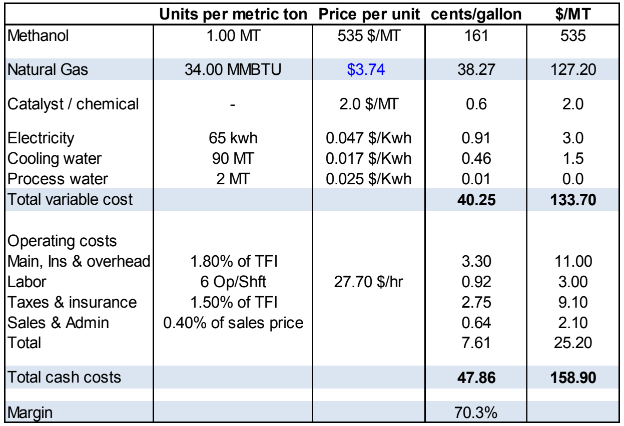
- Natural gas typically represents 80% of the total cost of North America methanol production.
- Accounting for low cost natural gas feedstock, coupled with increasing methanol prices (correlated with Brent crude oil), we expect the margin profile for US methanol production to remain attractive.

Figure 71: NAM methanol producers' cost advantage (margins)



Source : IHS Chemical, Deutsche Bank

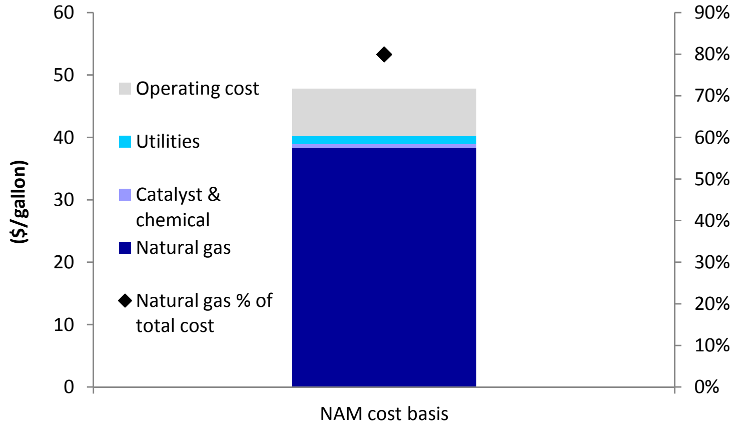
Figure 72: US methanol production economics



	Units per metric ton	Price per unit	cents/gallon	$/MT
Methanol	1.00 MT	535 $/MT	161	535
Natural Gas	34.00 MMBTU	$3.74	38.27	127.20
Catalyst / chemical	-	2.0 $/MT	0.6	2.0
Electricity	65 kwh	0.047 $/Kwh	0.91	3.0
Cooling water	90 MT	0.017 $/Kwh	0.46	1.5
Process water	2 MT	0.025 $/Kwh	0.01	0.0
Total variable cost			**40.25**	**133.70**
Operating costs				
Main, Ins & overhead	1.80% of TFI		3.30	11.00
Labor	6 Op/Shft	27.70 $/hr	0.92	3.00
Taxes & insurance	1.50% of TFI		2.75	9.10
Sales & Admin	0.40% of sales price		0.64	2.10
Total			7.61	25.20
Total cash costs			**47.86**	**158.90**
Margin			70.3%	

Source: IHS Chemical, Deutsche Bank

Figure 73: NAM methanol production cost



Source: IHS Chemical, Deutsche Bank

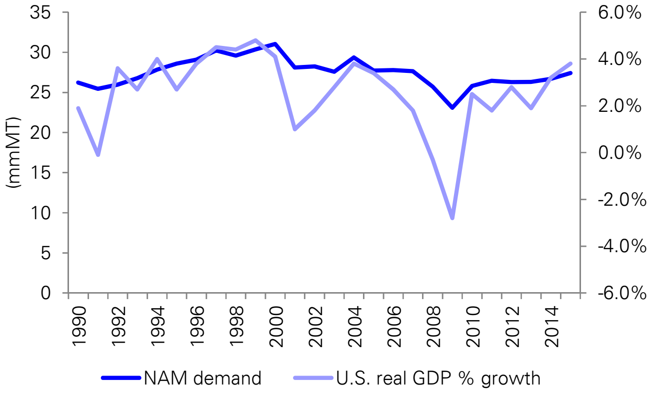
Chemicals

Chlor-alkali benefitting from the same positive underlying market dynamics.

Domestic chlor-alkali production benefitting from a renewed competitive advantage.

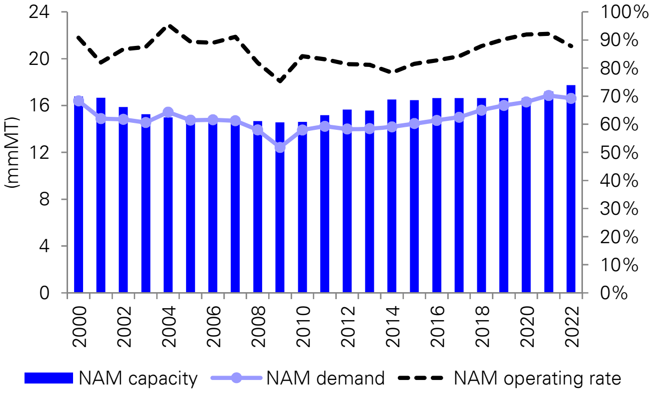
- Chlor-alkali demand growth globally has been closely tied to GDP growth. Chlorine, a key chlor-alkali input, is driven by construction sectors and is typically used to produce PVC (polyvinyl chloride) and organic chemicals.
- Also tied to the manufacturing sector, caustic soda is a key component in petroleum, alumina and pulp & paper.
- Expected North American GDP growth and the low cost feedstock advantage enjoyed by chlor-alkali producers are translating into renewed investment in capacity additions in North America.

Figure 74: NAM chlor-alkali demand growth vs. GDP



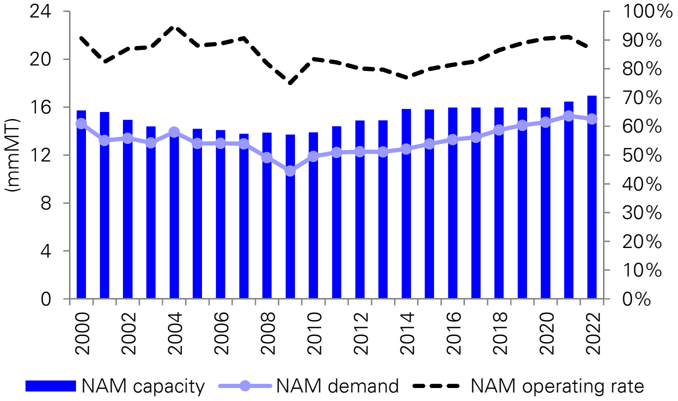
Source : IHS Chemical, Deutsche Bank

Figure 75: NAM caustic soda capacity



Source: IHS Chemical, Deutsche Bank

Figure 76: NAM chlorine capacity



Source: IHS Chemical, Deutsche Bank

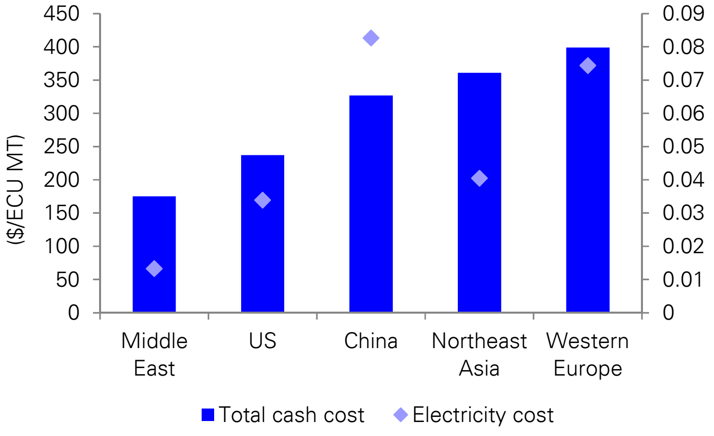
Chemicals

Chlor-alkali: feedstock advantage and the global cost curve

Unconventional gas development has also enhanced US competitiveness of chlor-alkali production

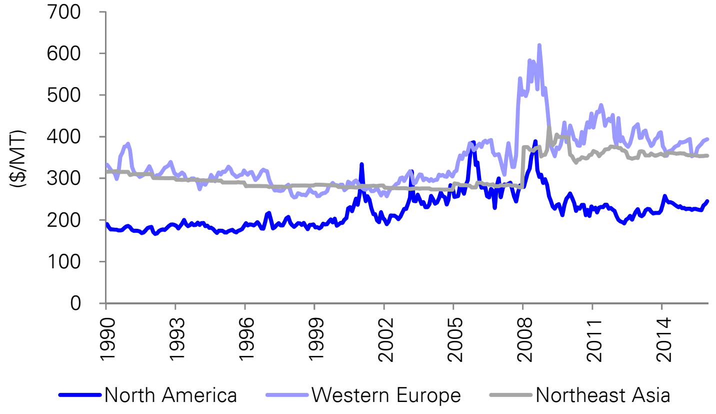
- Electrochemical unit (ECU) is the term designated for the collective unit of chlorine and caustic soda. Production and pricing for these co products are linked.
- Natural gas supply growth in the US has increased competitiveness of chlor-alkali producers in the US Gulf Coast region, as low cost feedstock has improved the ECU margin profile relative to other regions
- Announced new projects and expansion of existing facilities should result in incremental 1.3 mm MT of capacity (24 mmcf/d of NG demand) over the coming expansion cycle.

Figure 78: Global 2013 new chlor-alkali investment cost



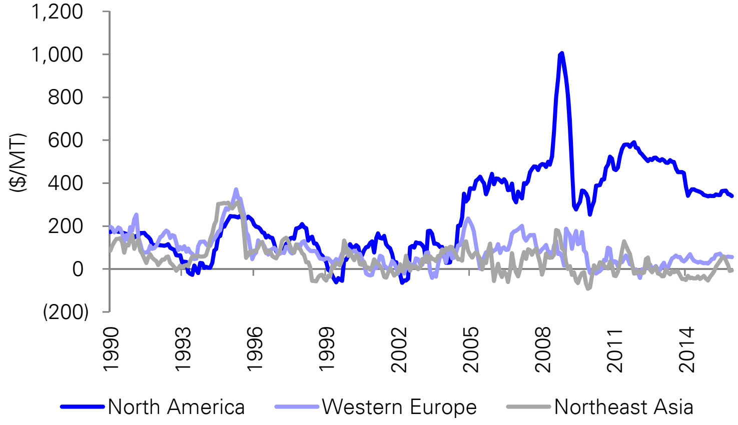
Source: IHS Chemical, Deutsche Bank

Figure 77: ECU total cash cost



Source : IHS Chemical, Deutsche Bank

Figure 79: ECU margins



Source: IHS Chemical, Deutsche Bank

Chemicals

Figure 80: Methanol & Chlor-alkali project queue

Company	Location	Online	Fertilizer	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
Methanex	Medicine Hat, AB	2013	Methanol	Expansion	100,000	Operational	8.6
Occidental	Humphrey's County, TN	2013	Chlor-alkali	New	166,000	Under construction	3.0
Dow/Mitsui	Freeport, TX	2013	Chlor-alkali	New	816,000	Under construction	14.7
LyondellBasell	Channelview, TX	2013	Methanol	Restart	710,000	Under construction	60.7
Westlake	Geismar, LA	2013	Chlor-alkali	Expansion	320,000	Under construction	5.8
G2X	Pampa, TX	2014	Methanol	New (Brownfield)	65,000	Under construction	5.6
Methanex	Geismar, LA	2014	Methanol	Migration	1,000,000	Under construction	85.5
Celanese / Mitsui	Clear Lake, TX	2016	Methanol	New	1,300,000	Announced	111.2
Methanex	Geismar, LA	2017	Methanol	Migration	882,000	Approved	75.4
South Louisiana Methanol	St. James Parish, LA	2018	Methanol	New	1,800,000	Permitted	153.9
Valero*	St. Charles, LA	2018	Methanol	New	1,650,000	Considered	35
Methanex*	Medicine Hat, AB	2018	Methanol	Expansion	1,000,000	Considered	85.5
Methanex*	Geismar, LA	2018	Methanol	Migration	1,000,000	Considered	85.5
Total					**12,015,971**		**730.4**

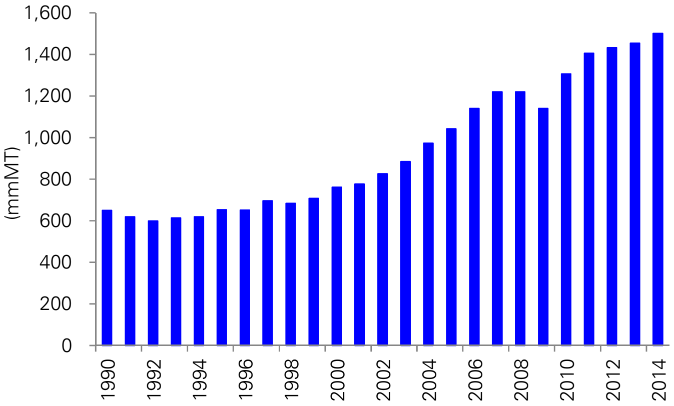
Source: IHS Chemicals, Wood Mackenzie, DB Chemicals team, Deutsche Bank
*Note: Natural gas demand assumes utilization rate of 90%, methanol gas intensity of 95 mmcfd/mmtpy chlor-alkali gas intensity of 20 mmcfd/mmtpy; *Projects with risked capacity and natural gas demand in DB forecast*

Industrial

Steel / metals; market context

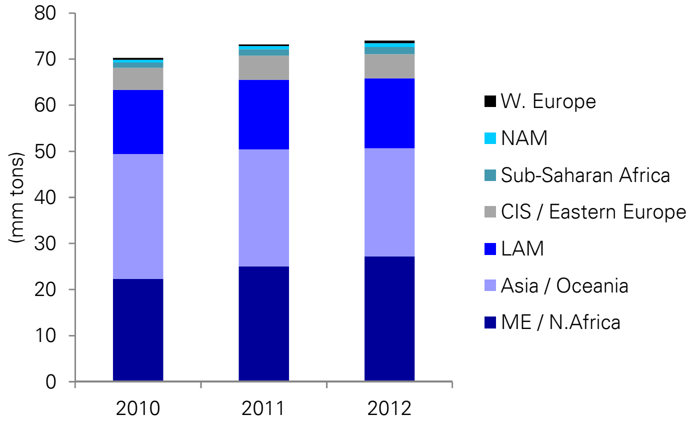
Steel remains a growing market globally. Steel consumption has continued to demonstrate growth, along with steel production. The two main routes of production are through a traditional basic oxygen furnace (BOF) or newer electric arc furnace (EAF, or mini mills). EAF uses scrap metal as an input, with options for substitutes including direct reduced iron, hot-briquetted iron or pig iron. Of the total ~74 mm tons produced using EAF mills in 2012, ~ 21 mm tons were produced from natural gas-based DRI (Indian plants use coal as main reductant fuel). While global steel production generally relies on BOF (~70%), steel production in the US through EAF represents more than half of total US production. Increasing EAF production in the US (vs. BOF) represents a greater opportunity for DRI production, as low cost natural gas has encouraged facility investment from companies including Nucor. While still a nascent industry in the US, DRI production is common in the Middle East, South America and Asia – disadvantaged feedstock regions.

Figure 81: World apparent steel use (finished steel)



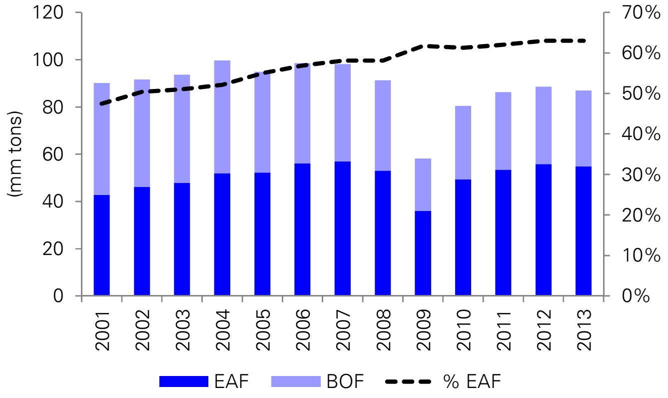
Source : Bloomberg Finance LP, worldsteel Association, Deutsche Bank

Figure 82: EAF (DRI) production by region



Source: Midrex, Deutsche Bank

Figure 83: US steel production by type



Source: Platts, Deutsche Bank
**Note: EAF production using DRI (direct reduced iron) accounts for a small portion of total production today*

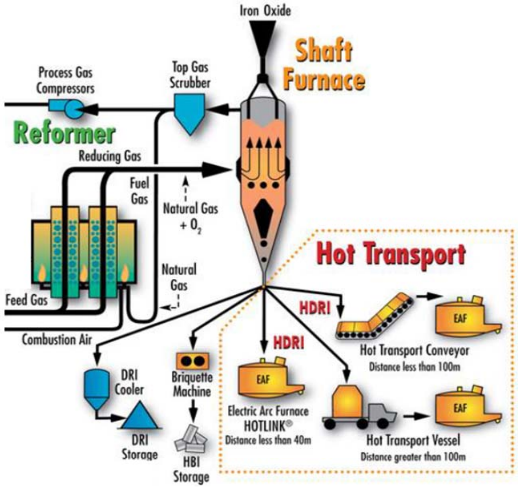
Industrial

Steel / metals: what it means for natural gas

The greatest demand for natural gas from the steel industry will come from direct reduced iron facilities

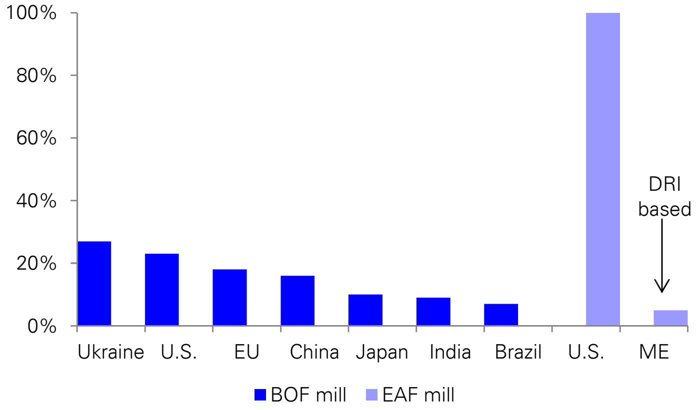
- Direct reduced iron (DRI) is a charge material that can be used for a type of steel production – scrap to electric arc furnace (EAF). DRI is produced by converting iron ore in solid form into purer, metallic iron using a reductant fuel, most commonly natural gas. While steel scrap is the most common material for electric arc furnace steel production, DRI poses several advantages. In general, EAF steel production is less capital intensive than steel production using a blast furnace. DRI pellets are made from ore fines, which eliminates the coke cooking process (requires extremely high temperatures). BHI, hot-briquetted iron, is DRI in compact form and enables easy transport and storage
- Scrap rates (% scrap used in steel production) vary depending upon production mill and region, with EAF mills typically using larger amounts.
- Particular to the US, low cost natural gas enhances the competitive advantage of DRI production, and increased availability could lead over time to scrap rates comparable to that of a Middle East EAF mill

Figure 84: DRI – electric arc furnace production



Source : Platts, Deutsche Bank

Figure 85: Scrap rates by mill and country



Source : Platts, Deutsche Bank

Industrial

Steel / metals: cost analysis

Current natural gas supply dynamics encourage DRI facility investment, evidenced by announced projects from major steel producers. Companies including Nucor and Midrex have announced plans for DRI facilities to take advantage of low cost natural gas. Nucor's $750mm Lousiana-based facility began DRI production in late 2013 and the company is permitted for another US facility. By combining DRI pellets with scrap steel, producers can make finished steel at lower costs than by using scrap steel alone. Increased availability of DRI should reduce US reliance on scrap steel and other scrap substitutes it currently imports, including Venezuelan BHI and Brazilian pig iron. While US Steel is considering a DRI JV with Republic Steel, the company has been using increased volumes of gas as a substitute for coal in its blast furnaces (BOF). This opportunity, however, is limited due to the nature of BOF production; we therefore expect modest incremental gas demand in this regard (approximately ~30mmcfd for total industry).

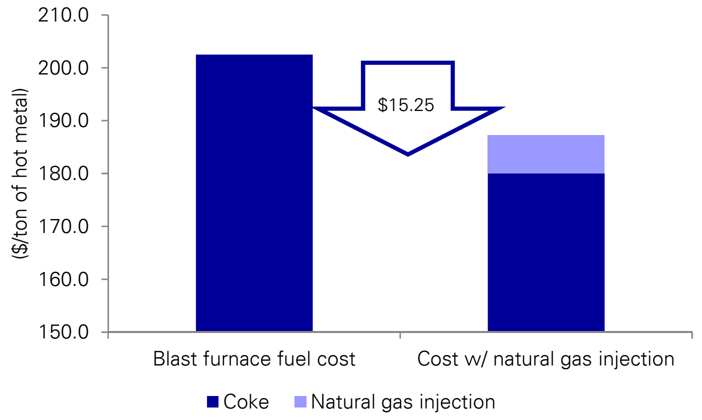
Figure 86: Nucor production cost

$ / ton	**Blast furnace**	**DRI**
Iron ore (62% FE, FOB Brazil)	125	125
Pellet premium	40	40
Iron premium (BF=65% Fe &DRI = 68% Fe) x $2.20	7	13
Freight	25	15
Iron ore consumption (BF=1.6 ton & DRI=1.5 ton)	315	290
Cash conversion costs	70	35
BF Reductant (100% coke)	107	
DRI reductant (11 mmbtus @ $4.00)		44
Iron unit cost	**492**	**369**
BF with sinter plant cost savings	30	
BF cost savings by substituting 40% of coke usage with PCI & natural gas	11	
BF higher "value-in-use" benefit	15	
"Adjusted" BF iron unit cost	**436**	**369**

*Coke cost assumes 0.5 ton of coke using 1.5 tons of metallurgical coal costing $125/ton

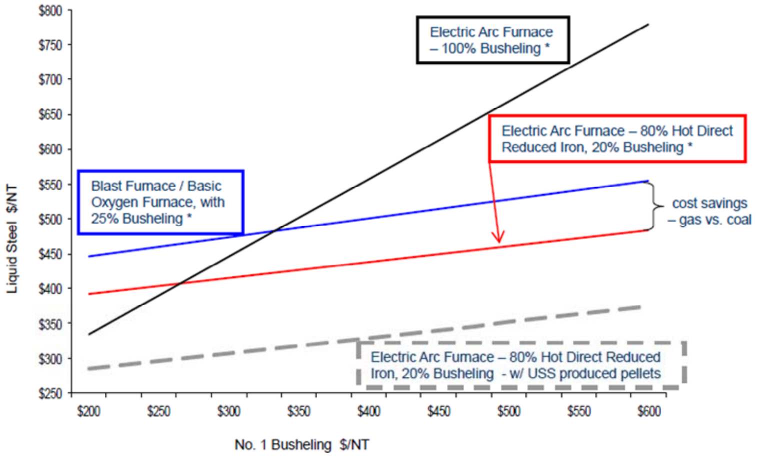
Source : Nucor, Deutsche Bank

Figure 87: Blast furnace fuel cost savings using natural gas



Source: US Steel Corp, Deutsche Bank
**Assumes coke at $450/ton, natural gas $4.00/mmbtu, 100 lb reduction in coke per ton of hot metal*

Figure 88: US steel cost curve



Source: US Steel, Deutsche Bank

Industrial

Figure 89: Steel and Metals Project Queue (Expansion & Greenfield)

Company	Location	Online	Metal type	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
ThyssenKrupp	Calvert, AL	2013	Steel Products	New	60,600	Under Construction	0.5
US Steel	Gary, IN	2013	Coke-Reduction	Fuel Flex	5,450,000	Announced	10.8
US Steel	Great Lakes, MI	2013	Coke-Reduction	Fuel Flex	2,550,000	Announced	5.0
Vallourec SA	Youngstown, OH	2013	Steel Products	New	500,000	Operational	4.5
Essar Steel Minnesota	Nashwauk, Minnesota	2013	Iron ore	New	3,700,000	Under Construction	3.3
Nucor	St James Parish, LA	2013	DRI	New	1,140,000	Under Construction	30.8
US Steel	Granite City, IL	2013	Coke-Reduction	Fuel Flex	2,270,000	Announced	4.5
US Steel	Mon Valley, PA	2013	Coke-Reduction	Fuel Flex	2,450,000	Announced	4.9
US Steel	Fairfield, AL	2013	Coke-Reduction	Fuel Flex	1,820,000	Announced	3.6
US Steel	Leipsic, OH	2013	Steel Products	Expansion	455,000	Under Construction	4.1
Rio Tinto	Labrador City, NL	2014	Iron ore	Expansion	1,300,000	Under Construction	1.2
Alcoa	Davenport, IA	2014	Aluminum Sec	Expansion	160,000	Under Construction	1.4
Borusan Mannesmann	Baytown, TX	2014	Steel Products	New	273,000	Announced	2.5
Nucor	St James Parish, LA	2014	DRI	New	1,140,000	Under Construction	30.8
Timken	Canton, OH	2014	Steel Products	Expansion	168,000	Announced	1.5
Alcoa	Lafayette, IN	2014	Aluminum Sec	New (Brownfield)	20,000	Under Construction	0.2
Alcoa	Alcoa, TN	2015	Aluminum Sec	Expansion	na	Announced	na
California Steel	Fontana, CA	2015	Steel Products	New	360,000	Under Construction	3.2
Essar Steel Minnesota	Nashwauk, Minnesota	2015	Steel Mill	New	1,500,000	Permitted	13.5
Accelerated Tanks*	Fort Wayne, IN	2016	Steel products	New	na	Announced	na
Tenaris*	Bay City, TX	2016	Steel products	New	545,000	Announced	4.9
Nucor*	St. James Parish, LA	2017	DRI	New	1,140,000	Permitted	30.8
Nucor*	St. James Parish, LA	2018	DRI	New	1,140,000	Permitted	30.8
US Steel / Republic Steel*	Lorain, OH	2022	DRI	New	1,000,000	Considered	27.0
Total					**29,145,600**		**219.8**

Source: Wood Mackenzie, Deutsche Bank
Note: Natural gas demand assumes utilization rate of 90%, DRI gas intensity of 30 mmcfd/mmtpy, steel products / mill gas intensity of 10 mmcfd/mmtpy, alumina gas intensity of 10 mmcfd/mmtpy, coke reduction gas intensity of 2 mmcfd/mmtpy and iron ore gas intensity of mmcfd/mmtpy;
**Projects with risked capacity and natural gas demand in DB forecast*

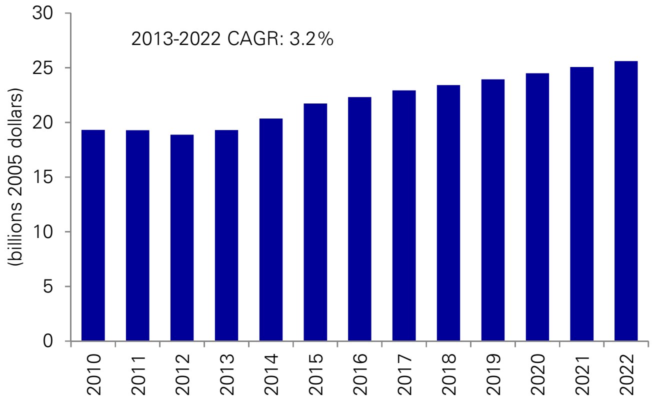
Industrial

Glass: market context and demand

Glass manufacturing is one of the most energy-intensive industries, with a dominant fuel source of natural gas.

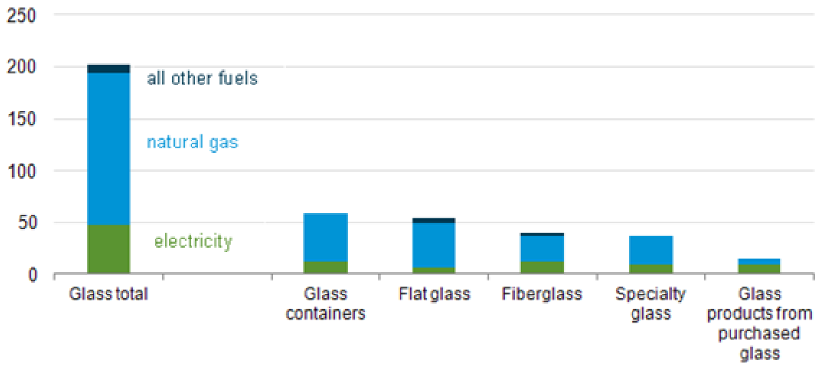
- The industrial sector represents a significant amount of US energy consumption, comprised of a number of energy-intensive sub segments.
- While electricity represents ~25% of the glass industry's energy use, the bulk of it (73%) stems from natural gas. Glass is produced using natural gas-fired furnaces that heat the raw material inputs in order to form the finished glass product.
- The glass industry today consumes nearly 150 billion cubic feet (Bcf) of natural gas (410 mmcf/d). Based on annual glass shipment growth of ~3% through 2022, we expect incremental 120 mmcf/d of natural gas demand.

Figure 90: US glass industry shipments



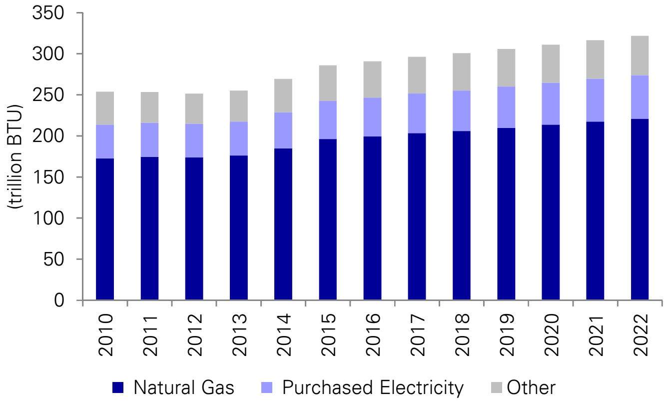
Source : EIA, Deutsche Bank

Figure 91: Energy mix by glass sub-segment



Source: EIA, Deutsche Bank

Figure 92: US Glass industry energy consumption by fuel source



Source: EIA, Deutsche Bank

Industrial

Paper: market context and demand

Over the next several years, US containerboard capacity is expected to rise, supported by a number of company announced expansions through 2015. Within containerboard, the majority of the capacity coming online is recycled linerboard (versus virgin linerboard), of which energy represents 20% of the total production cost versus 5% energy cost for virgin linerboard facilities. International Paper, the largest paper company in North America, plans to use ~65 Bcf of natural gas in 2014, 5-6x more than its other purchased fuel sources. As a whole, the paper industry consumes over 320 bcf of natural gas (875 mmcf/d) for fuel and power needs.

- Based on continued growth of the containerboard industry and 2.5% annual shipment growth for total through 2022, we expect incremental 105 mmcf/d of natural gas demand.

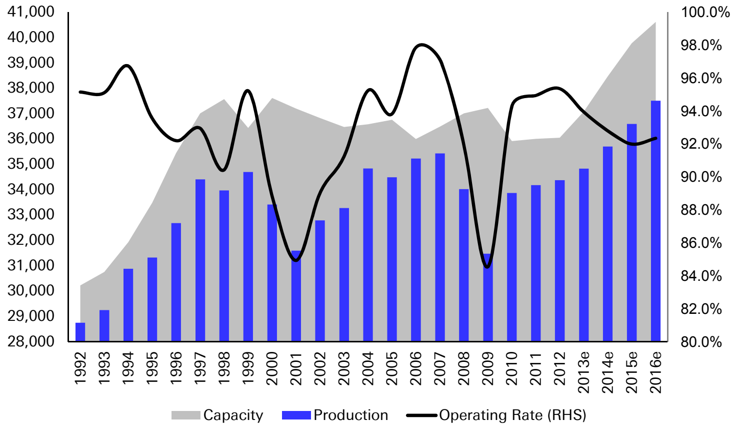
Figure 93: US paper industry natural gas consumption

Company	Mill	Capacity	Grade	Date
Newark	Fitchburg, MA	96,000	RL, RM, bag	1Q13
KapStone	Roanoke Rapids, NC	100,000	KL	2013
SP Fiber Technologies	Dublin, GA	396,000	RL, RM, bag	2Q13
Atlantic Packaging	Whitby, ON	300,000	RL, RM	2Q13
Norampac	Niagara Falls, NY	540,000	RL	3Q13
Kapstone	North Charleston, SC	30,000	-	1Q14
SP Fiber Technologies	Dublin, GA	125,000	bag, RM	1Q14
SP Fiber Technologies	Newberg, OR	200,000	RL, RM	2Q14
RockTenn	Hopewell, VA	126,000	KL	2Q14
PCA	DeRidder, LA	355,000	KL, RM	4Q14
Pratt Industries	Valparaiso, IN	360,000	RL, RM	3Q15
Greif	Riverville, VA	55,000	SC	4Q15

Note: KL=kraft linerboard; RL=recycled linerboard; SC=semichemical corrugating medium; RM=recycled medium

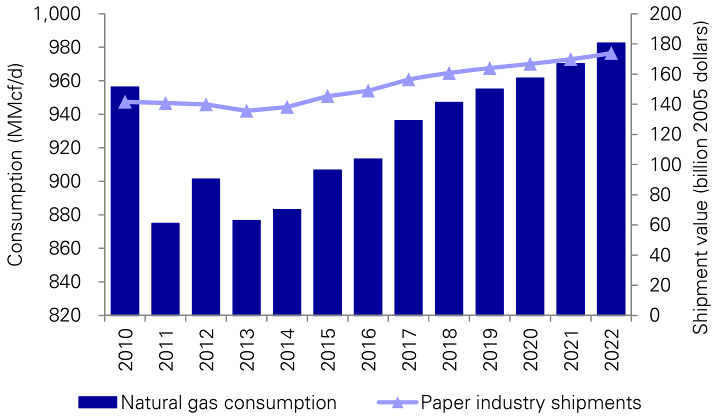
Source: Risi Paper Packaging Monitor, DB Paper & Packaging team , Deutsche Bank

Figure 94: US containerboard demand/supply & operating rates



Source: AF&PA, DB Paper & Packaging team, Deutsche Bank

Figure 95: US paper industry natural gas use and shipments



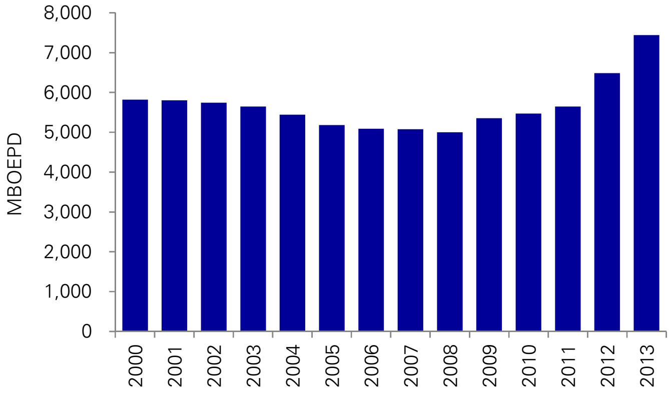
Source: EIA, Deutsche Bank

Energy & Refining

Growth in US oil supply is generating an advantaged position for US refining. The knock-on impact of the growth in US unconventional natural gas production and resource expansion has been the re-emergence of US oil production growth. Addressing a higher return opportunity and leveraging the lessons learned from gas development in tight reservoirs, upstream operators have shifted focus to oil and liquids plays in the lower-48.

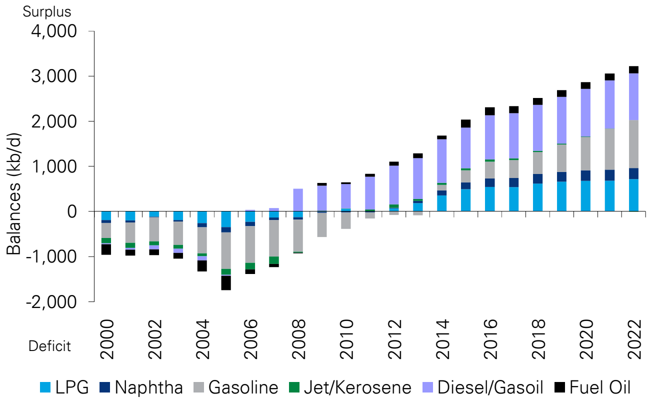
- Total US oil production has grown ~2.45 mmbpd to ~7.45 mmbpd in 2013 (stands at above 8.0 mmbpd today) from the low in 2008. The drivers of this growth have been unconventional oil plays in the Bakken (North Dakota), Eagle Ford (S. Texas) and the Permian (W. Texas). While market expectations are for continued growth in the ~1 mmbpd range for the coming 3-5 year period our expectations is for a moderation of this pace of growth. We forecast total US oil supply growth of ~770 mbpd in 2014 with an average of ~650 mbpd of annual growth during 2014-16.
- While the economic (balance of payments) and foreign exchange impact of this shift are having an impact, domestic oil growth has proven a boon for one of the most natural gas intensive of domestic energy industries, namely refining. The confluence of higher global product prices (and demand) in addition to growth in domestic light oil supply is providing a margin opportunity for domestic refiners; the US has seen a shift in the net product flow from net imports to net exports over the past 2-3 years.
- In regards to refining capacity, it is clear that domestically supplied light oil (particularly in land locked regions) and lower natural gas prices (lower operating costs) are providing a tailwind to profitability. The regulatory context, particularly the inability to export crude from the US is an important consideration in terms of the duration of this opportunity. Capacity expansions have been limited relative to previous cycles.

Figure 96: Domestic crude oil supply



Source: EIA, Deutsche Bank

Figure 97: North America products net trade



Source: WoodMac, Deutsche Bank

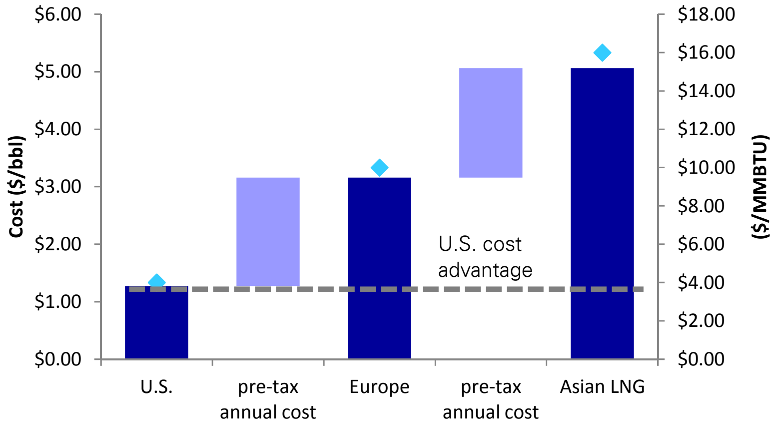
Energy & Refining

US operating cost advantages.

As we have highlighted with other industries, the benefits for US refiners (particularly those with access to domestic crudes without better waterborne or coastal pricing alternatives) are material on both the crude input and operating cost items.

- Refiners have outlined the magnitude of this opportunity and the impact on operating costs. Relative to global natural gas prices and regions where gas to oil parity is a reality the operating cost advantage is material. Valero's disclosure has outlined a $2-4/bbl cost advantage for US refiners with access to ~$4/mmbtu natural gas vs. global peers. This constitutes a straight margin uplift for US refiners in a highly competitive and commoditized industry where margins have been transitory.
- Despite the evident cost advantages, limited expansion of the US refining network has been announced to date. This capital discipline is likely indicative of the desire to maintain the current margin environment (supported by shareholders) but also due to permitting challenges (small projects have already been delayed), and the perceived sustainability of the current advantaged margin environment.

Figure 98: Illustrative US Refining Cost Advantage



Source: Valero, Deutsche Bank

Figure 99: Select US Refinery Expansion Projects

Operator	Refinery	Location	In-service date	Capacity addition (kbpd)
Tesoro	Salt Lake City	PADD 4	2Q13	17
Tesoro	Salt Lake City	PADD 4	4Q13	5
Kinder Morgan	Galena Park	PADD 3	1Q14	50
National Cooperative Refining Assoc.	McPherson	PADD 2	2Q14	15
Valero Energy Corp.	McKee	PADD 3	3Q14	25
Western Refining	El Paso	PADD 3	4Q14	25
HollyFrontier	Woods Cross	PADD 4	4Q15	14

Source: IEA, Deutsche Bank

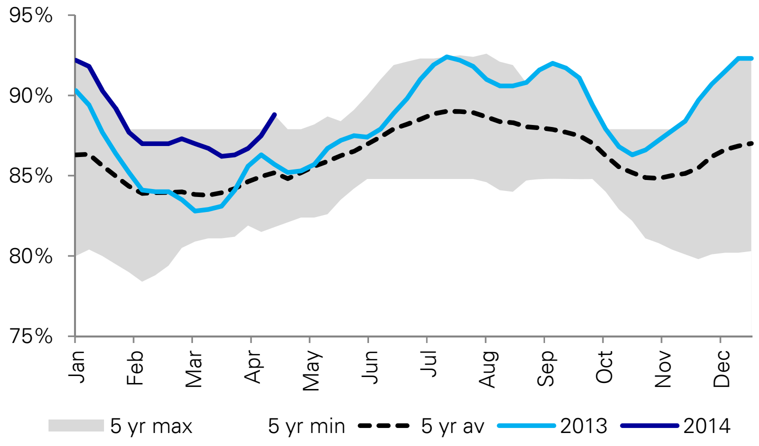
Energy & Refining

Capacity Utilization Likely the Driver.

The prohibition on exporting US crude oil does not extend to refined products. As such we have witnessed an increase in product exports and a continued rise in refining capacity utilization rates as excess product finds a market offshore. For natural gas this has likely proven the most significant demand driver as the impact of higher utilization rates flows through to higher natural gas demand for existing facilities.

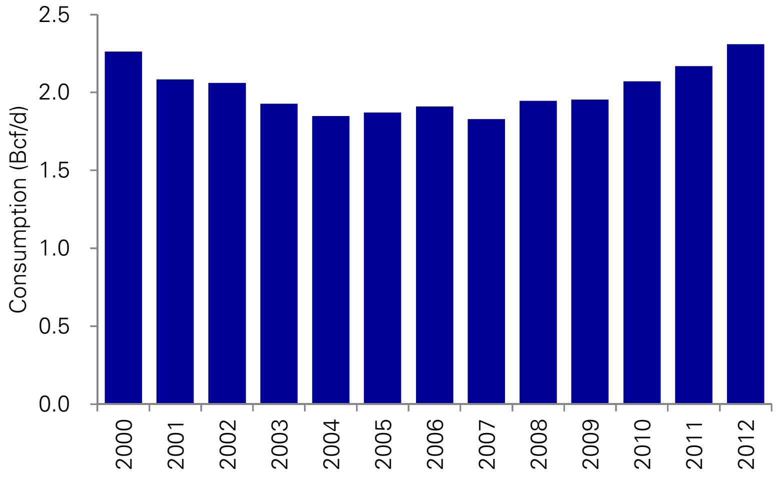
- The EIA discloses fuel usage by the refining segment in addition to natural gas. While only disclosed annually, 2012 saw total consumption return to levels not seen since 2000 with ~2.3 Bcf/d of demand. This is up from ~1.85 Bcf/d in 2007 and growing at a 6% CAGR.

Figure 100: US refining capacity utilization



Note: Data spans 2009-2013
Source: EIA, Deutsche Bank

Figure 101: Natural gas consumption by US refineries



Source: EIA, Deutsche Bank

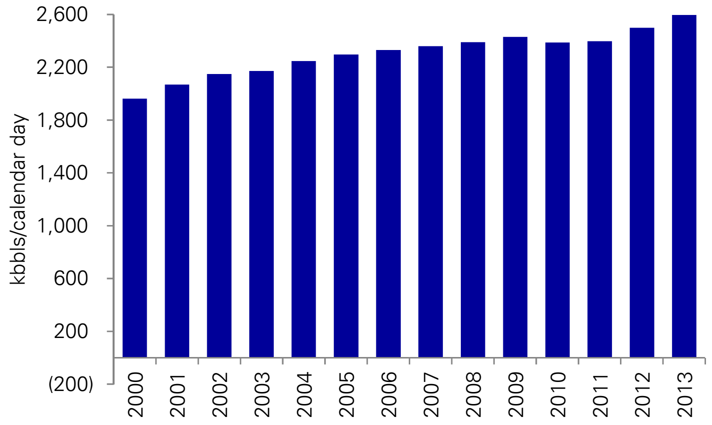
Energy & Refining

Hydrogen and its role in heavy oil conversion

Another key driver of US natural gas demand within the refining segment is associated with heavy oil conversion projects. The early 2000s saw a significant build out of heavy oil process (coking) capacity amongst US refineries as the crude slate skewed heavier (lower API) while domestic product demand (primarily gasoline) was still growing. The investment cycle that ensued saw an increase in heavy oil capacity, which further stimulated natural gas demand as either a fuel and as a feedstock for hydrogen production.

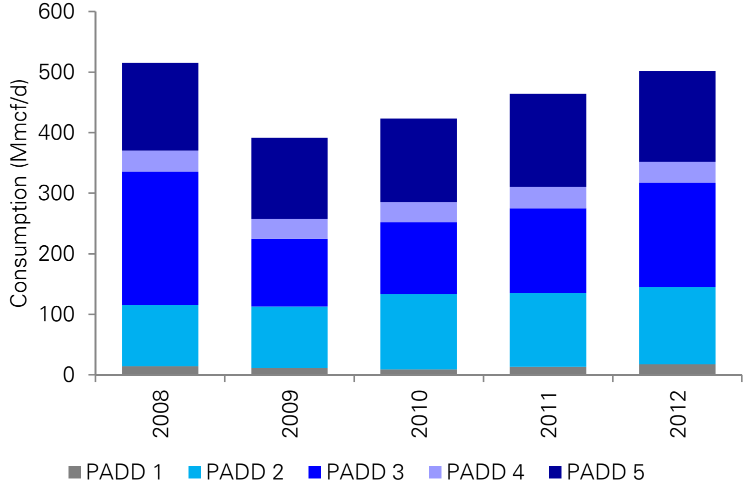
- Ultra low diesel fuel specs increased the demand for complex refining capacity and saw an increased build-out of hydrogen production capacity in order to fuel conversion capacity. Simply, natural gas is an input via hydrogen in the process to convert complex hydrocarbons to simpler light fuels.
- Aggregate hydrogen demand has likely slowed as the push to convert heavy crude to light products slowed. Incremental coking projects have recently been added to the US refinery slate including Marathon's Detroit and BP's Whiting facilities.

Figure 102: US refinery coking capacity



Source: EIA, Deutsche Bank

Figure 103: Natural gas consumption for hydrogen production by district



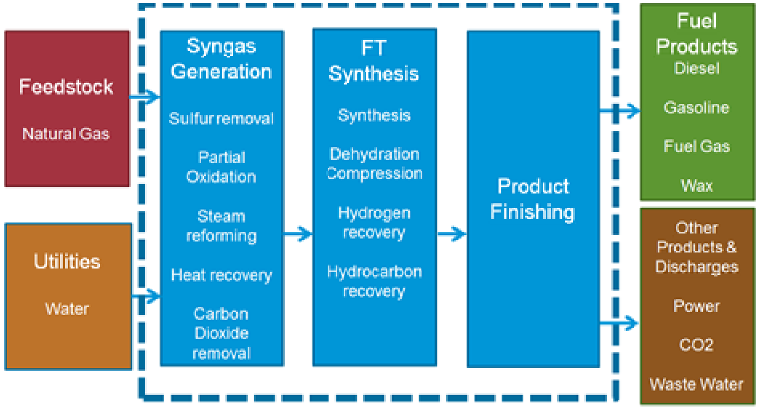
Source: EIA, Deutsche Bank

Energy & Refining

Gas-to-liquids

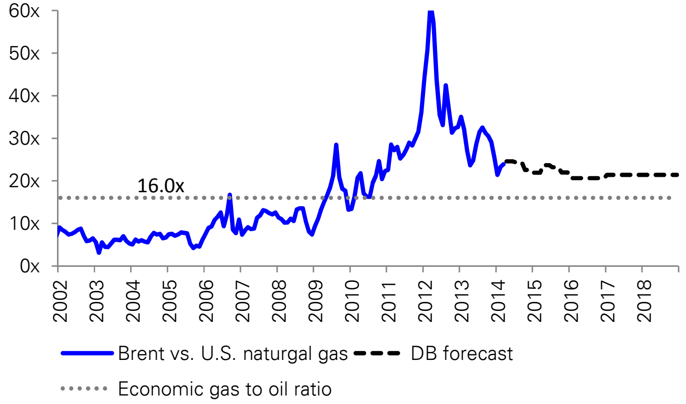
Industry taking notice of low natural gas prices, and projects envisioned. While technology risks are prevalent, the spread between domestic natural gas prices and global liquids fuels prices have again raised interest in GTL. While encompassing a number of different potential technologies, gas-to-liquids (GTL) is a process that uses natural gas to produce liquid fuels including gasoline, jet fuel, diesel and various waxes. The primary technology includes Fischer-Tropsch (F-T) synthesis. Currently there are just 5 world scale facilities globally, located in Malaysia, Qatar and South Africa, with an additional project under construction in Nigeria. Three plants have been proposed in the US. The value proposition for GTL facilities is higher quality petroleum products – clean burning diesel and kerosene without the need for refining. GTL products are compatible with current engine technology and infrastructure.

Figure 105: Fischer-Tropsch process



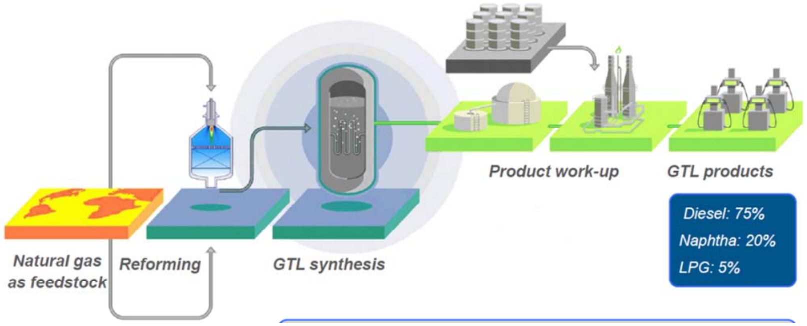
Source: EIA, Deutsche Bank

Figure 104: Ratio of Brent oil to natural gas prices (BTU equivalent)



Source : Bloomberg Finance LP, Deutsche Bank (forecast based on 12M strip)

Figure 106: Gas-to-liquids process



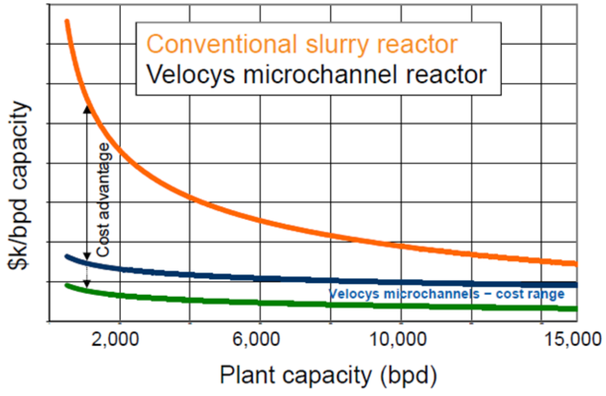
Source: Sasol, Deutsche Bank

Energy & Refining

Gas-to-liquids: facility build out

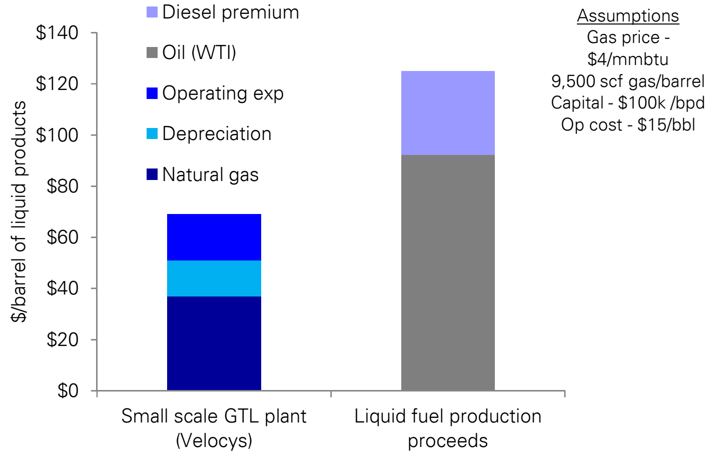
Shift away from problematic large-scale GTL facilities toward smaller facilities. Large-scale models rely heavily on availability of infrastructure and considerable volumes of natural gas (significant capex and resource demands) and generally have a lead time of 5+ years after final investment decision. Further, large projects have struggled with capacity utilization and reliability. Promoters of smaller scale GTL projects, in contrast claim lower capital intensity, a ~2 years post FID construction cycle and the flexibility to be deployed in remote locations. The benefit is less risk overall in terms of cost overruns, delays and permitting. Due to technology and permitting risks we classify large scale GTL projects as part of our upside natural gas demand scenario (all post-2018) while we have included some small modular projects in our base forecast.

Figure 107: GTL cost curve – large vs. small facility



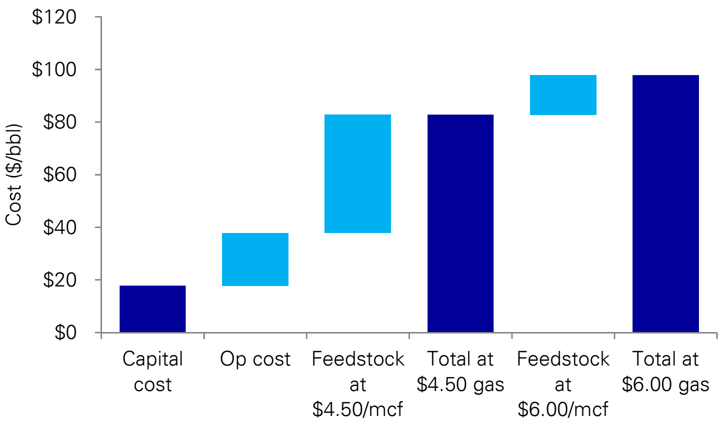
Source : Velocys, Deutsche Bank

Figure 108: GTL cost curve – large vs. small facility



Source: Velocys, Deutsche Bank

Figure 109: Large – scale GTL operating cost at various natural gas prices



Source: Sasol, Deutsche Bank

Energy & Refining

Figure 110: Refinery Expansion, Ethanol, and GTL Project Queue

Company	Location	Online	Energy	Facility	Type	Capacity (MTPY)	Status	Gas demand (mmcfd)
Valero	Port Arthur, TX	2013	Petroleum	Hydrocracker	New	20,800,000	Operational	34.2
BP	IN	2013	Petroleum	Refinery	Expansion	73,000,000	Operational	21.4
Valero	St. Charles, LA	2013	Petroleum	Hydrocracker	New	21,900,000	Operational	36.0
BP	IN	2013	Petroleum	Hydrotreater	Expansion	36,500,000	Under construction	10.7
DuPont	Nevada, IA	2014	Biofuels	Ethanol	New	90,000	Under construction	0.2
Calumet Specialty Products	Karns City, PA	2014	Petroleum	GTL	New	43,000	FEED	9.3
Calumet Specialty Products / MDU JV	Stark County, ND	2015	Petroleum	Refinery	New	7,300,000	Under construction	4.3
Sundrop Fuels	Rapides Parish, LA	2015	Petroleum	GTL	New	140,000	Announced	7.6
Calumet Specialty Products	Great Falls, MT	2015	Petroleum	Hydrocracker	New	3,650,000	Under construction	6.0
Marcellus GTL	Duncansville, PA	2015	Petroleum	GTL	New	78,000	Announced	16.8
Natgasoline LLC	Nederland, TX	2016	Petroleum	GTL	New	475,000	Applied for permit	102.6
NCRA	McPherson, KS	2016	Petroleum	Hydrotreater	New	5,500,000	Under construction	3.2
Pinto Energy	Ashtabula, OH	2016	Petroleum	GTL	New	139,440	Under construction	30.2
Valero	Port Arthur, TX	2018	Petroleum	Hydrocracker	Expansion	5,500,000	Planning	9.0
Valero *	St. Charles, LA	2018	Petroleum	Hydrocracker	Expansion	5,500,000	Planning	9.0
Sasol*	Westlake, LA	2019	Petroleum	GTL	New	1,040,000	Feasibility	224.6
Sasol*	Westlake, LA	2020	Petroleum	GTL	New	1,040,000	Feasibility	224.6
Sasol*	Westlake, LA	2021	Petroleum	GTL	New	1,040,000	Feasibility	224.6
MDU Resources/Calumet Specialty Products*	Dickinson, ND	2014	Petroleum/diesel	Refinery	New	855,803	Under construction	0.5
MHA Nation*	Makoti, ND		Petroleum	Refinery	New	855,803	Planning	0.5
Dakota Oil Processing*	Marley Crossing, ND		Petroleum/light gas	Refinery	New	855,803	Planning	0.5
Total GTL						3,995,440		167
Total hydrocracker / hydrotreater						179,650,000		32
Total						**183,735,440**		**198.2**

Source: IHS Chemicals, Wood Mackenzie, DB Chemicals team, Deutsche Bank
*Note: Natural gas demand assumes utilization rate of 90%, GTL gas intensity of 240 mmcfd/mmtpy, hydrocracker gas intensity of 2 mmcfd/mmtpy, hydrotreater/ethanol gas intensity of 1 mmcfd/mmtpyEnergy – hydrocracking; *Projects with risked capacity and natural gas demand in DB forecast*

Appendix 1

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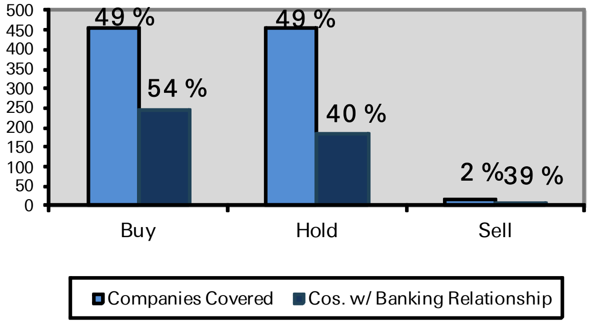

North American Universe

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