NAVIGANT

# Oil & Gas Market Notes

Contents



## Riding the 7Cs of Success: The Seven Rules to Establishing LNG as a Road Transport Fuel

### Background

This month, we turn to the complex challenge of creating the new market for liquid natural gas (LNG) as a heavy duty transport fuel.

Road transport—the function of moving people and goods from A to B along highways and byways—has been a fundamental building block of economic prosperity over the last 100 years. Over this time, road transport has evolved through waves and waves of innovation around a fundamental core anchor of liquid gasoline and diesel. Vehicles have become more efficient and safer, roads more durable (and safer), refuelling facilities faster and more convenient, and logistics more sophisticated—but fundamentally, the fuel of choice has been remained predominantly diesel for heavy duty transport and a mix of diesel and gasoline for light duty. This predominance has been underpinned by a dominance of crude oil as the primary energy source of choice.

The use of natural gas in vehicles stretches back to the advent of the internal combustion engine in 1860, but the growth of natural gas vehicles has varied significantly by country. Compressed natural gas (CNG) vehicles have emerged as significant parts of the vehicle mix in Venezuela, Pakistan, Iran, Brazil, India, and the Middle East. However, LNG as a heavy duty transport option has mostly been limited to buses, where the supply chain is relatively simple, with vehicles refuelled through a home base. In addition, the nature of the owner-operator structure for heavy duty vehicles in many markets has made the economics challenging.

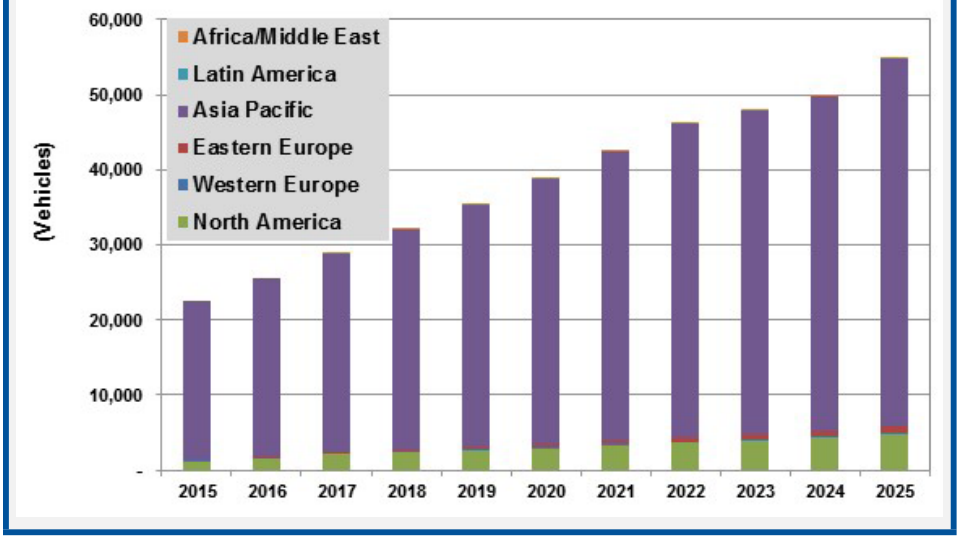
Today, these fundamentals are being challenged. The emergence of cheaper shale gas and the need for accessible and scalable lower emissions solutions (driven by vehicle and fuels regulation) have created conditions for the emergence of new vehicle and fuel solutions, be they electric or gas-based, each requiring unique refuelling infrastructures. This change presents some fundamental challenges.

The level of interest in LNG as a heavy duty transport solution started to grow at the end of the last decade, encouraged by the emergence of shale gas and the knowledge that of the two options, LNG is potentially a more attractive offer for long haul trucks, given its ability store 2.5 times as much equivalent energy in the same volume compared to CNG.

However, despite developments in California; Canada's green corridors; and in France, Germany, and The Netherlands, progress has been slow. Based on these current trends, Navigant Research's *Natural Gas Vehicles* report predicts limited growth in LNG heavy duty vehicle sales in the next 10 years. As the table below shows, globally LNG vehicles sales are expected to grow from just over 20,000 per year to 55,000 between 2015 and 2025. This equates to a marginal increase in their penetration of all medium and heavy duty vehicles, from 8% to 9%.

This raises the question: What would it take to change the paradigm and accelerate the creation of new markets for LNG as a heavy duty transport fuel?

**SALES OF LNG MEDIUM DUTY AND HEAVY DUTY VEHICLES, WORLD MARKETS: 2015-2025**




The aim of this article is to introduce a framework of the 7Cs—7 rules to establishing LNG as a road transport fuel. These rules are drawn from learnings in other sectors and an understanding of the challenges in the LNG transport sector.

## Understanding History

To understand some of the challenges in building the LNG road transport market, we should turn to some of the lessons learned from the relatively simpler task of introducing a new fuel. While these learnings are predominantly drawn from the light duty sector, the fundamental challenges between light duty and heavy duty are not that dissimilar.

In the 20th century, the three major milestones in fuel evolution were lead removal, desulphurisation, and the introduction of biofuels. So what have we learned?

» *100% commitment*: First, all key stakeholders need to be completely aligned, fully agreed, and 100% committed to the change. Regulators play a key role in defining the specific fuel regulation, which then creates the framework that allows commercial players along the value chain to invest accordingly.

» *Timing is key:* Second, coordination between all the key players on the timing of introduction is critical. Investment by one commercial player too far ahead of introduction leads to capital inefficiency, while investing too late delays the benefit capture (be that financial or environmental) and can lead to real issues for customers.

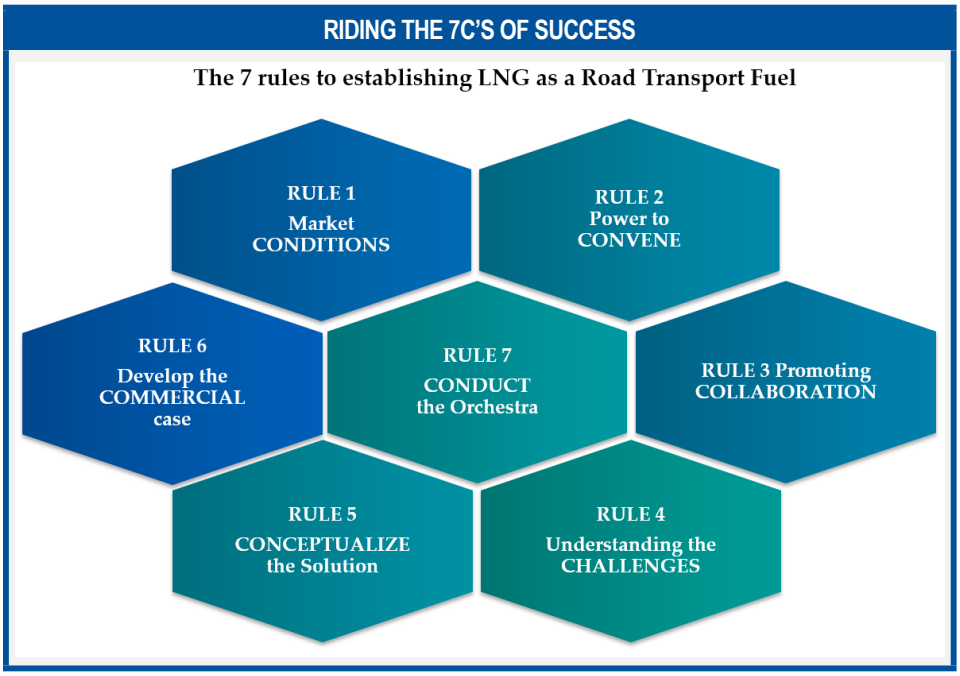
» *Don't forget the incumbent*: Third, in some cases there needs to be a solution for the legacy fleet, as in the case of lead removal.

» *Information is king*: Finally, it is critical to inform and educate all stakeholders well in advance of any introduction.

A case to consider is the introduction of the E10 blend in Germany in 2011. In response to European fuel regulation and with the support of the German government, original equipment manufacturers (OEMs), and fuels suppliers, a specification was set to blend 10% ethanol into road transport gasoline. However, the introduction was deemed a fiasco by motoring experts and the media.

The root cause was that while only a minority of vehicles were non-E10 compatible, customers were not sufficiently informed ahead of the introduction of whether their vehicle was one of the exceptions. What's more, this information was not available to customers at the pump at the point of introduction.

This very quickly resulted in a significant customer backlash, with up to 70% of customers rejecting the fuel at the forecourt. After substantial recovery activity, a level of customer confidence recovered, but the product never achieved the level of penetration aspired to at launch.




## Gas in Transport Strategic Framework

The strategic framework for creating a gas-in-transport sector consists of seven golden rules, known as the 7Cs of success—conditions, convene, collaborate, content, conceptualize, commercialize, and coordinate & conduct. (The focus here is on LNG as a heavy duty solution, but the framework is equally relevant to CNG in the light duty sector.)

**Rule 1 – Fundamental Market CONDITIONS**

One of the fundamental rules is that of compelling market conditions. The starting point for an assessment of the potential to establish a gas in the transportation sector needs to be an understanding of whether the trilogy of market fundamentals exist in a geography to support the initiation of the opportunity: stimulants, economics, and product availability. Without these interrelated elements, invariably there is no case to proceed.

The entry point is to understand whether the two core stimulants—technology and industry capability and legislation—are in place or will be in the near future. In terms of technology and industry capability, the key questions are whether the currently available technology supports the promotion of LNG in road transport versus the alternatives (hybrids, advanced diesel, etc.), and whether the LNG supply structure is in place or predicted.

Turning to legislation, in the case of the majority of new fuel introductions, it provides either the mandate to require a new fuel's introduction and/or the incentive to enable the new fuel to be commercially viable. In the case of LNG for heavy duty transport, a key question is whether there is the existing national, regional, or local legislation that would actively promote switching to LNG as a heavy duty transport fuel.

Beyond these stimulants, the fundamental economics need to be sufficiently attractive to support the case. Two of the critical questions for commercial players are whether there is sufficient potential scale to support the required level of investment—the materiality test—and whether the market pricing fundamentals will support customer conversion from the diesel incumbent to LNG. However, given the complexity of the value chain and the criticality of aligned timing of investment, there needs to be a clear understanding early on that there is a sufficient margin for each key player to support the necessary investments.

This is critically important for LNG given the complexity of the players involved, including the specialist vehicle technology providers, vehicle manufacturers, vehicle owners and operators, and those involved in the gas supply chain, from liquefaction through retailers of the fuels. The critical financial driver is the current and future available spread between the liquid and gas fuel prices (i.e., between the West Texas Intermediate [WTI] crude price and the Henry Hub gas price). It is this spread that fundamentally creates the incentive for vehicles switching from conventional fuels to natural gas.

The final piece of the trilogy is product availability—looking across the LNG supply chain, is there appropriate access to product, either through domestic supply or import capabilities?

**Rule 2 – The Power to CONVENE**

Assuming the market fundamentals indicate that the conditions are right to create an LNG-in-transport market, then the other rules can be applied.
Given the complex nature of the value chain surrounding LNG in transport, rarely can a single player consider the opportunity in isolation. There needs to be a third-party catalyser, an independent intermediary, with the vision to see the opportunity and the ability to convene sufficient players with a motivation to see the market created.

Invariably that would include players associated with vehicle production and conversion, LNG supply chain players, and LNG refuelling infrastructure players (i.e., fuels retailers). Each player will be concerned about the issues and risks associated with the creation of this new market, most notably whether there will be sufficient sustained margin to support capital investment and whether the other players will be willing to make the required investments at the right time. This is the inevitable chicken and egg issue. The independent catalyser needs to be able to help ensure that there is sufficient senior-level commitment within each of the players' organizations to build and sustain momentum.

**Rule 3 – Promoting COLLABORATION**

Once the players have demonstrated commitment, the catalyser plays a critical role in facilitating collaboration between them. Early engagement and collaboration builds a shared understanding of the ultimate prize, and from this a developing commitment to a shared success is created. A key objective of this early stage collaboration is the building of trust between the players themselves and with the catalyser. One of the requirements here is to help ensure that no single player has the ability to exert preferential power over the others, which requires the catalyser to be independent from all of the players. This is why in cases where one of the players has been the initial catalyst, they need the maturity and confidence to bring in a third party to move the collaboration forward.

**Rule 4 – Understanding the CHALLENGES**

One of the major drivers of strong and successful commercial organizations is their ability to understand and be ruthlessly focused on their own part of the market, be that developing vehicles, building and operating retail stations, or supplying fuel. However, when these players turn to an opportunity that requires collaboration, they learn that it is critical to really understand the technical, financial, commercial, and operational challenges the other players face and their role in positively or negatively influencing this.

In the case of E10, the retailer could have better understood the needs of customers in terms of whether their vehicles were compatible and worked with the OEMs to ensure that the information was widely available in advance of the launch.

For LNG in heavy duty transport, the challenges include understanding the complex relationships between vehicle owners (and the financing arrangements around their ownership) and the vehicle operator, who are often different. The operators of refuelling sites often face the challenges of committing significant capital in advance of wide penetration of vehicles.

**Rule 5 – CONCEPTUALIZE the Solution**

To bring the solution to market requires multiple players to execute interrelated activities, often at the same time. The LNG supply chain needs to be fully established, the vehicles need to be available, customers need to be identified and demand created, and the refuelling infrastructure needs to be developed. Even on a small geographic scale, this is a significant challenge. The end-to-end integrated offer needs to be conceptualized and all players must clearly understand their role in delivering that offer.

In the case of LNG, the vehicles need to be promoted to both the purchasers and users (if they are different), and success will require the OEM to be able to sell the whole solution, including the location of refuelling facilities. This requires that these facilities are in the right location for the customers. It is this interrelated nature of solution elements that demands that the players come together and conceptualize the complete system, both its initial incarnation and how it will develop. The catalyser plays an important role in facilitating this conceptualization.

**Rule 6 – Developing the COMMERCIAL case**

Once the system is conceptualized and all players understand the challenges, how to resolve them, and ultimately what is required from them to realise the opportunity, the next stage is the development of individual commercial business cases. Ultimately, of course, all players need to make a sufficient return to support their investment.

A critical value equation is the relative payback of a heavy duty LNG truck versus the diesel alternative. According to Navigant Research, in the case of the United States, the incremental cost of an LNG vehicle is recoverable in 2 years. With fuel cost per mile being significantly cheaper, significant savings can be generated from that point on.

The catalyser plays an important role in facilitating this process, understanding if and when the business case for one or more players is not sufficiently compelling. In some markets, this may then require engagement with government on the need for incentives, especially where LNG has a demonstrable benefit on $CO_2$ emissions.

It is critical that each player is realistic early on in the engagement of the achievable economics and the catalyser plays a key role in driving this message. For example, if the refuelling infrastructure provider is overly optimistic on the site economics and realizes too late that it is unable to get the site costs down to the required level and hence to deliver the required returns, not all refuelling facilities will be built, with the effect of substantially undermining the overall offer. Another challenge is the changing arbitrage between LNG and crude prices, which, as mentioned above, is one of the critical drivers of conversion.

Ultimately, the players must be confident that, despite the inevitable movement in prices and the lack of a direct link between the two pricing structures in most markets, a sufficient spread will remain in the medium term.

**Rule 7 – CONDUCTING the Orchestra**

Finally, the catalyser plays an important role in conducting the process. With multiple commercial organisations working to execute individual parts of the proposition, each player needs to remain aware of, and confident in the progress of, the other players. This is often a substantial program management challenge, especially in LNG, where the key players may be facing significantly different timelines to market.

## Conclusions

The pathway to building a market for LNG in road transport is complex and unpredictable. History tells us that the introduction of new fuels and other transportation solutions is fraught with significant challenges. These involve a complex value chain of players who must each perform an important role in delivering an integrated offer to customers.

The starting point is the confirmation that the fundamental market conditions are in place to create the case to progress. Then a third-party catalyser needs to be able to convene key players and drive early stage collaboration to create sufficient commitment. Players then must understand each other's challenges and understand their role in creating and helping to address these challenges.

They must also be able to conceptualize the overall integrated offer to customers and create both collective and individual commercial business cases. The sharing of value across the network to ensure that all players make a sufficient return is critical. Finally, throughout this process, the catalyser must be able to conduct the orchestra of players to ensure that all are appropriately aligned and able to deliver their part of the offer.

As the case of E10 in Germany shows, the introduction of new fuel products can be undermined by the failure to follow the 7 golden rules.

Whilst the 7Cs of success have been applied here to help show the pathway to successfully introducing LNG in transport, they can equally be applied to the development of other complex decarbonising transport solutions, including hydrogen fuel cells and electric vehicles, both of which involve complex value networks with multiple players and significant capital investment required. What is clear, though, is that we will continue to see innovative players, facilitated by catalysers, working together to create new markets for low-carbon transport solutions.

## How Can Navigant Help?

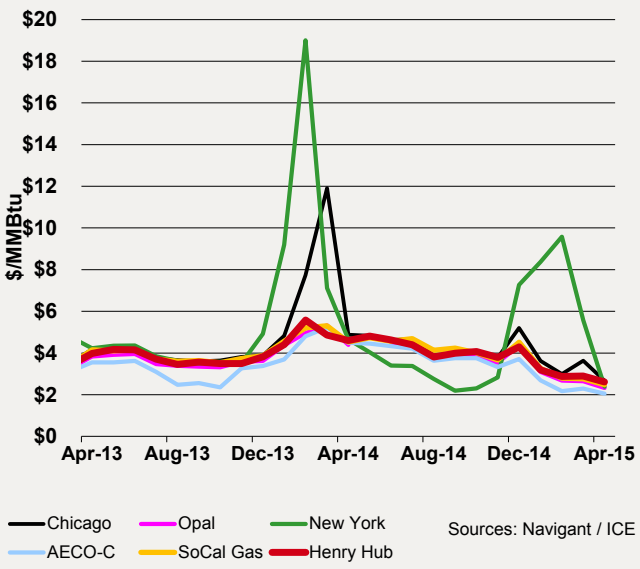
Navigant's team of energy and mobility experts use their in-depth knowledge and experience in LNG, gas markets, road transport, and supply chain and refuelling infrastructures to help clients understand the issues and develop complex new business solutions, often working with multiple stakeholders to create win-win outcomes.

— *Nick Allen*

About the Author »
Nick Allen is a Director in Navigant's Global Energy Practice.

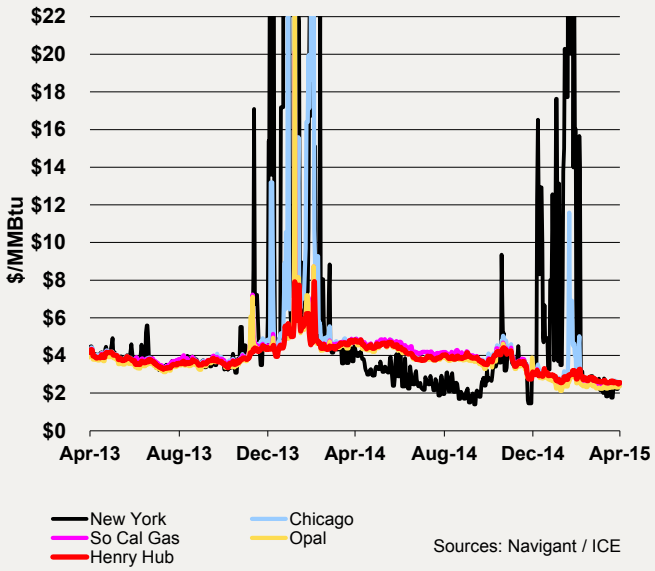
## Natural Gas Market Charts

### MONTHLY GAS INDEX PRICE



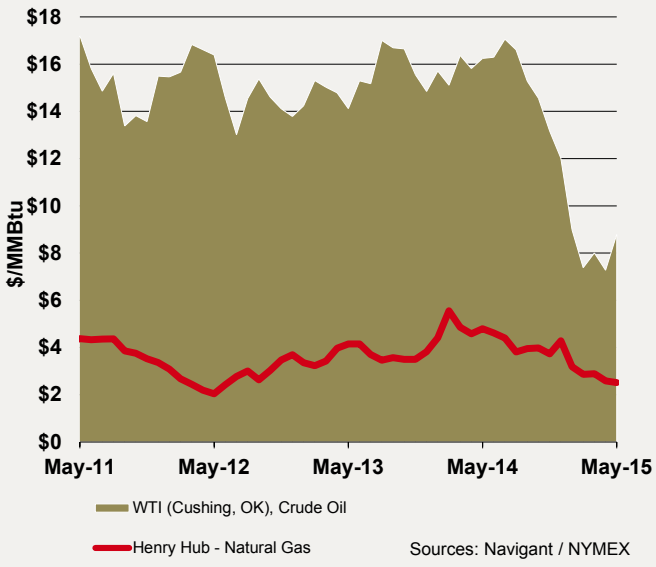

Monthly index gas prices decreased 10% last month, with Henry Hub at $2.61/MMBtu for April versus $2.90/MMBtu for March. The April 2015 price was below the April 2014 price of $4.59/MMBtu by $1.98/MMBtu.

### DAILY GAS PRICE



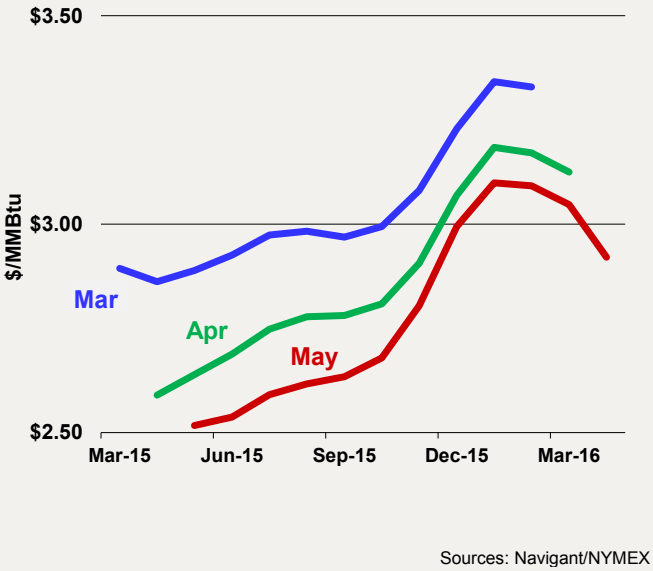

The daily spot prices ended April down 2% versus the end of March, with Henry Hub at $2.56/MMBtu versus $2.61/MMBtu.

### MONTHLY PRICES: OIL AND NATURAL GAS GULF COAST




The most recent gas/oil price ratio increased to 3.5 times, with Henry Hub natural gas price at $2.52 versus WTI crude oil price at $8.79. The ratio one year prior was 3.4 times.

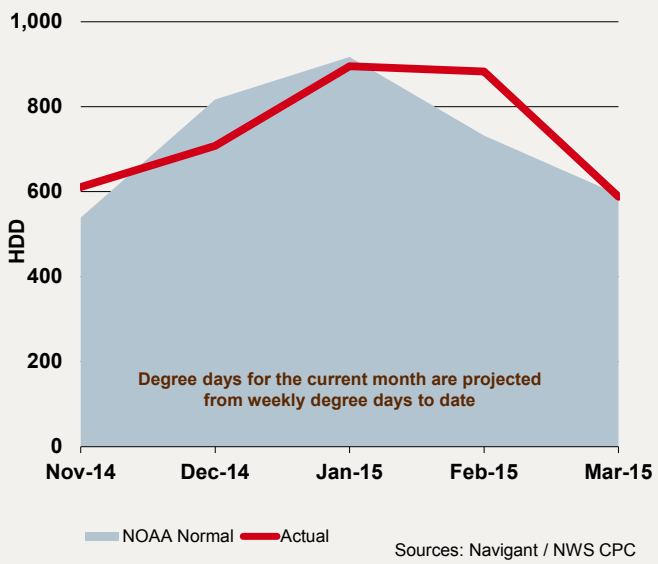
### NYMEX FUTURES SETTLEMENT PRICES AT CLOSE




The average 12-month strip price decreased by 8 cents, or down 3%, to $2.79/MMbtu for the strip starting May 2015.

## Natural Gas Market Charts

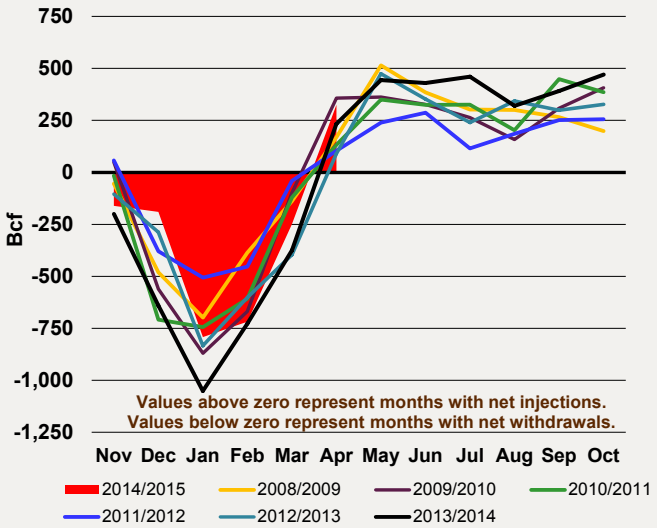
### U.S. POPULATION-WEIGHTED HDD




Sources: Navigant / NWS CPC

The cooling degree day season began with a slightly warmer than normal April.

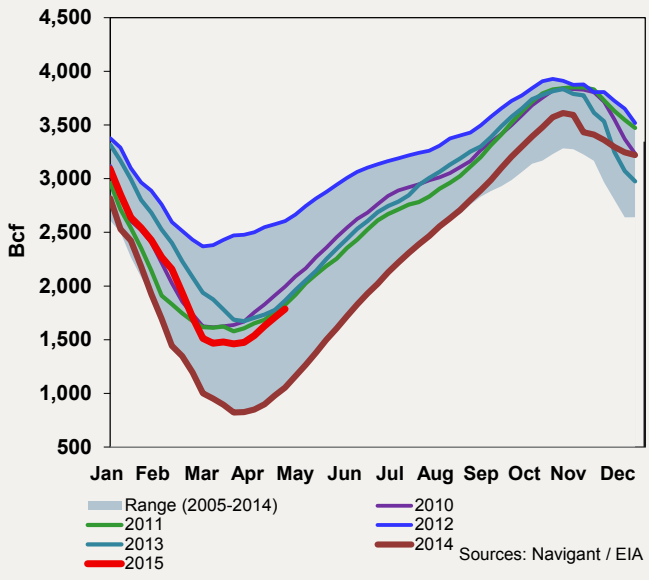
### MONTHLY U.S. STORAGE ACTIVITY




Sources: Navigant / EIA

Warm weather in April brought storage injections close to the maximum for the prior ten years at this time, at 325 Bcf versus 357 Bcf, and 90% greater than the 172 Bcf average over the prior ten years.

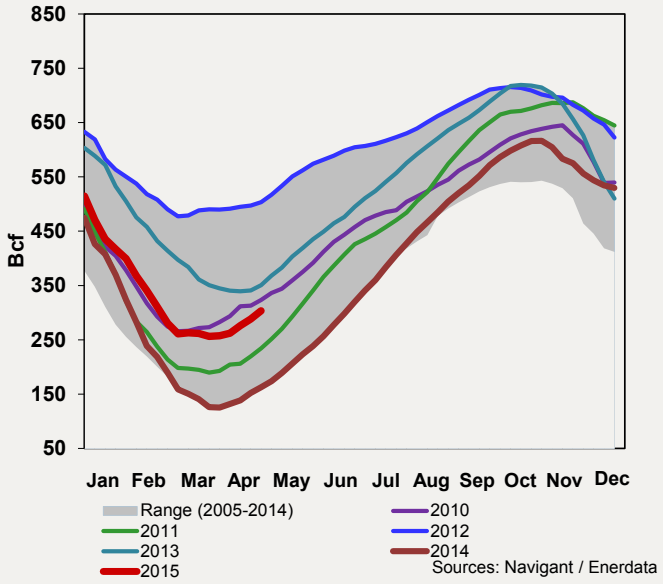
### U.S. GAS STORAGE




Sources: Navigant / EIA

U.S. storage inventories increased in April to 1,786 Bcf, within 0.4% of the average of the prior ten years at this time.

### CANADA GAS STORAGE

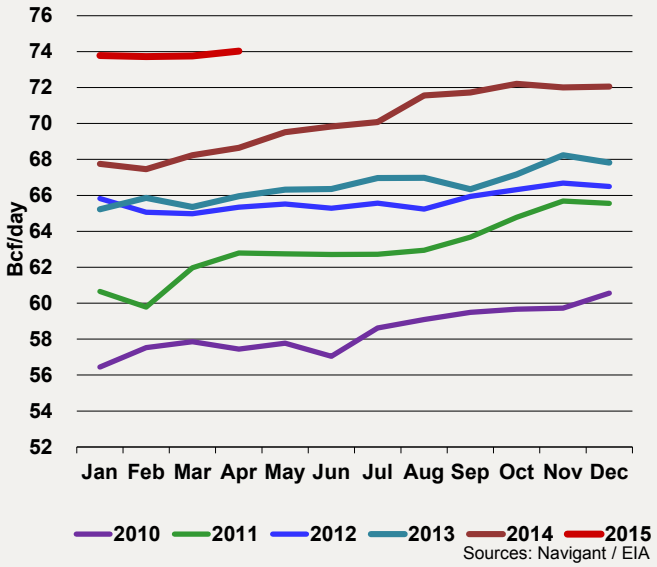



Sources: Navigant / Enerdata

Canadian storage inventories increased in April to 305 Bcf, about 8% above the 282 Bcf average for the last ten years at this time.

## Natural Gas Market Charts

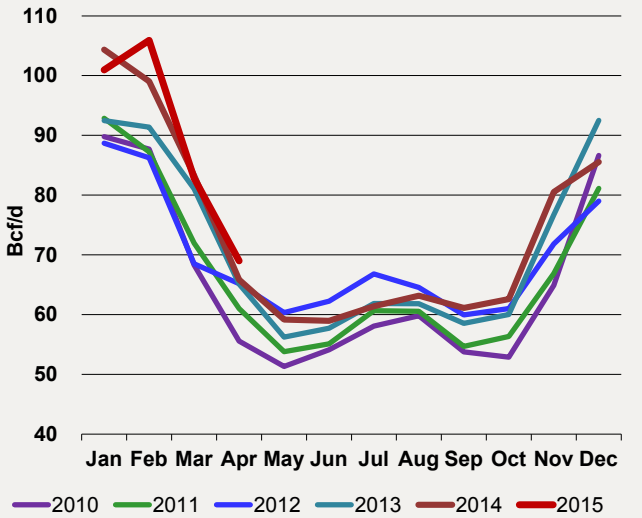
### U.S. DRY GAS PRODUCTION




Sources: Navigant / EIA

U.S. dry gas production continued at all-time high levels, at just above 74 Bcfd.

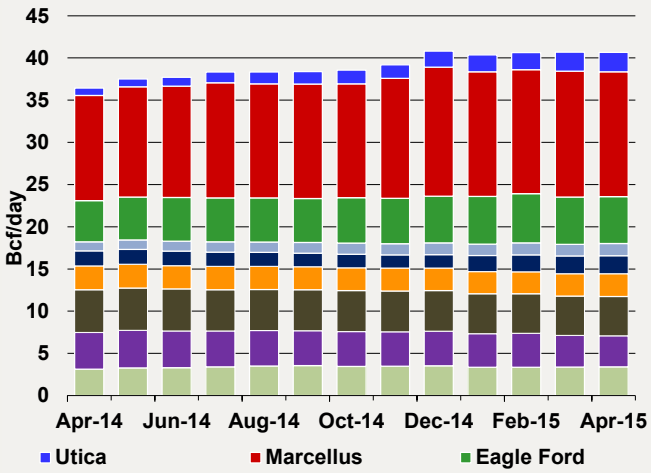
### U.S. MONTHLY NATURAL GAS DEMAND




Sources: Navigant / EIA

U.S. gas demand moved to an all-time high for the month of April at 69 Bcf, about 5% greater than the prior high occurring last year.

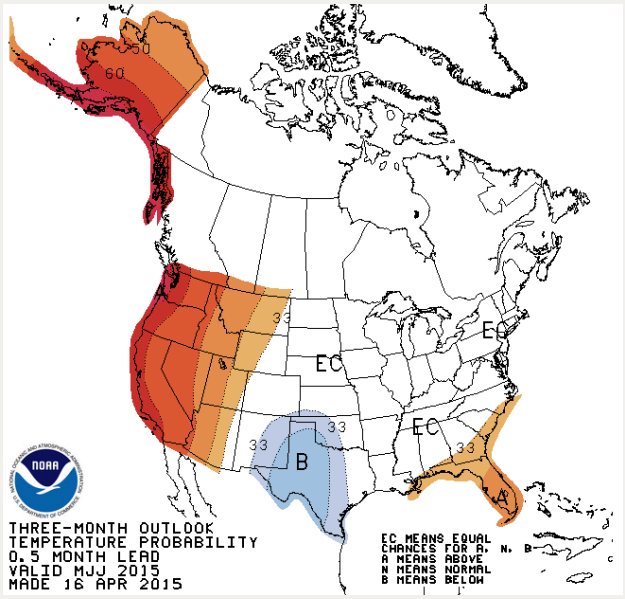
### U.S. WELLHEAD SHALE GAS PRODUCTION




Sources: Navigant / LCI

U.S. shale gas production maintained a fifth straight month above 40 Bcfd, at 40.7 Bcfd.

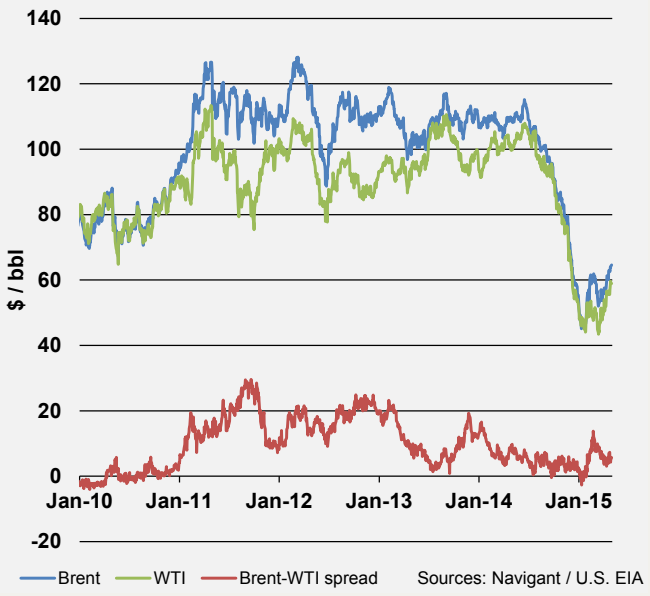
### U.S. TEMPERATURE OUTLOOK




The temperature outlook is for above normal temperatures for the U.S. coastal Southeast and areas west of the Rockies. Below normal temperatures are favored from eastern New Mexico through the Texas and Oklahoma panhandles to the Gulf Coast in central Texas.

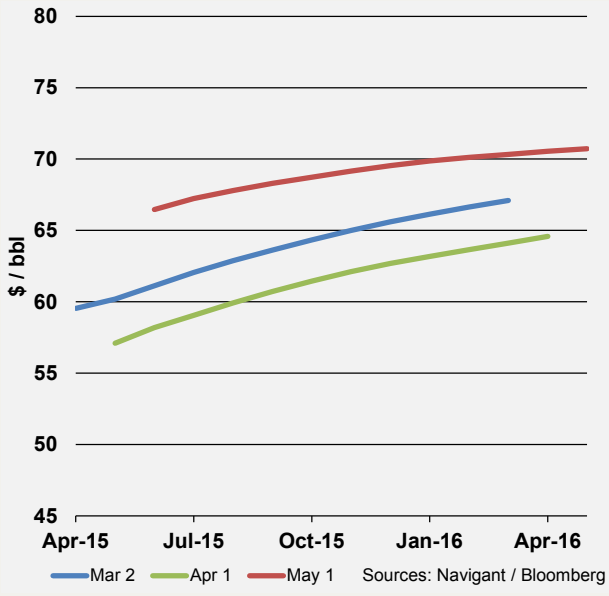
## Oil Market Charts

### SPOT CRUDE PRICES



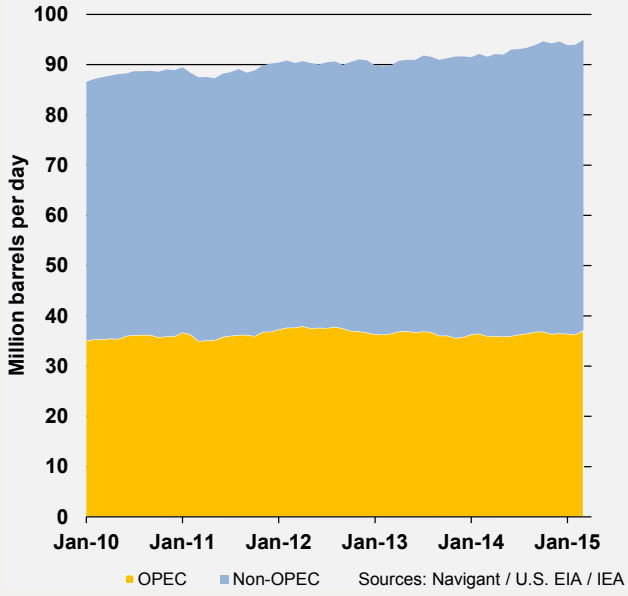

After three years of relative stability in the $90-110/bbl range, crude prices plunged 60% from June 2014 levels. Prices have since recovered slightly to average $60/bbl (Brent) and $54/bbl (WTI) in April 2015.

### ICE BRENT FUTURES CURVE



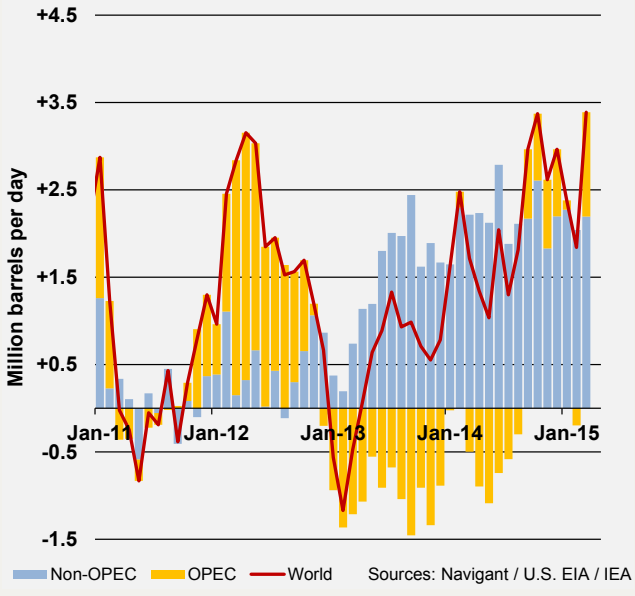

The average 12-month strip price at the beginning of May was $69/bbl, a rise of 12% from the previous month.

### OPEC & NON-OPEC OIL PRODUCTION




Global oil production increased from 91.6 million barrels per day a year ago to an estimated 94.9 million barrels per day in March 2015, of which 39% was supplied by OPEC.

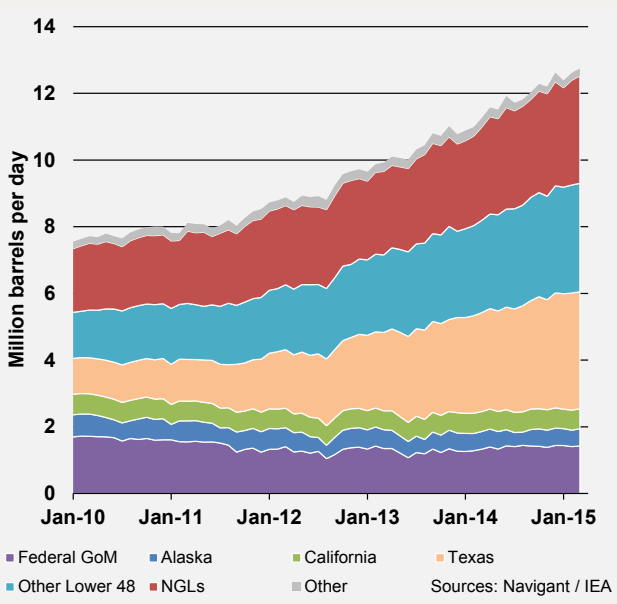
### YEAR-ON-YEAR CHANGE IN OIL PRODUCTION




Oil production growth in recent years has been led by non-OPEC countries, particularly the U.S.

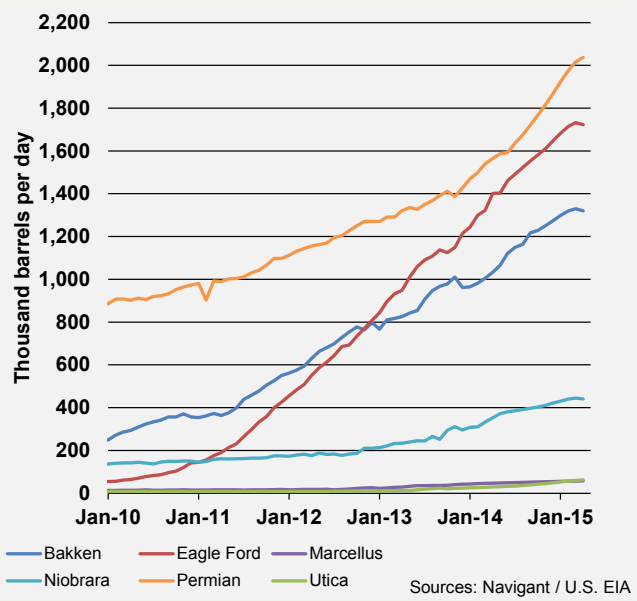
## Oil Market Charts

### U.S. OIL PRODUCTION



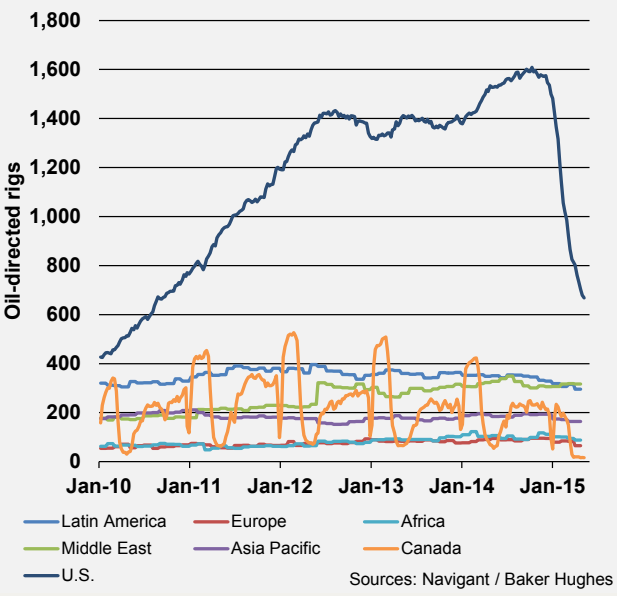

In the United States, oil production climbed by 13% over the year to an estimated 12.7 million barrels per day in March 2015. Increases have come mainly from crude produced in the lower 48 states (especially Texas) and NGLs.

### OIL PRODUCTION IN KEY U.S. REGIONS



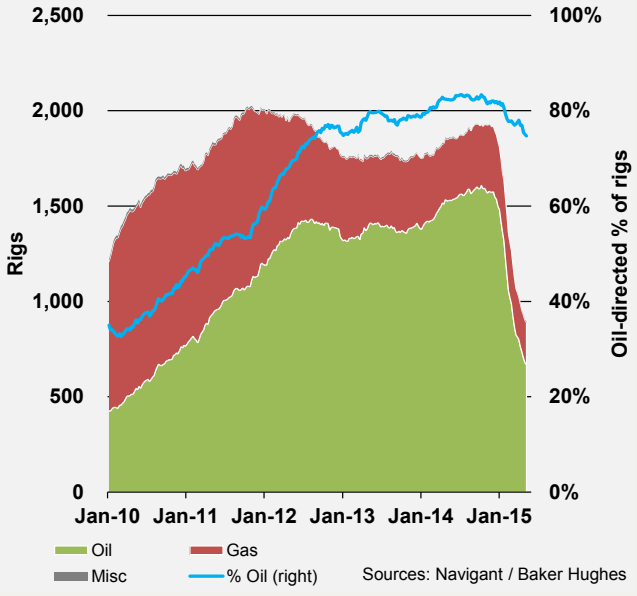

In April 2015, oil production reached an estimated 2 million barrels per day in the Permian (+30% YoY) but production started to slow in Eagle Ford, Bakken and Niobrara.

### OIL-DIRECTED RIG COUNT BY REGION




Rig counts have continued to fall in response to lower crude prices. The U.S. had 668 active oil rigs at the start of May 2015, a level last seen in September 2010.

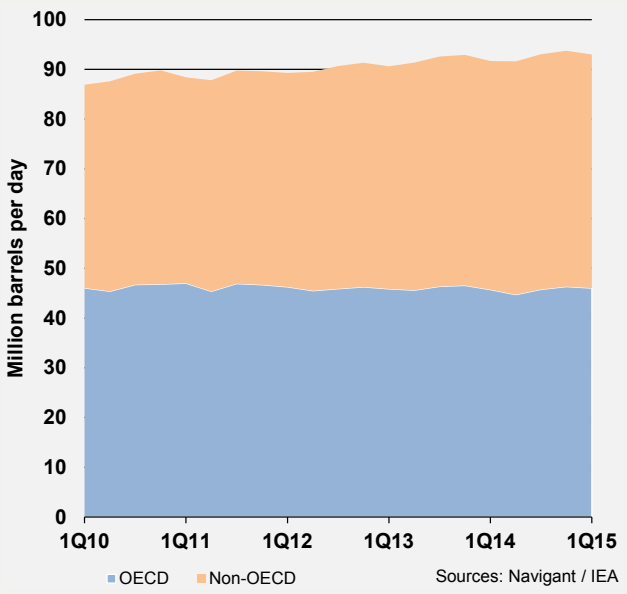
### U.S. RIG COUNT




75% of U.S. rigs were oil-directed at the start of May.

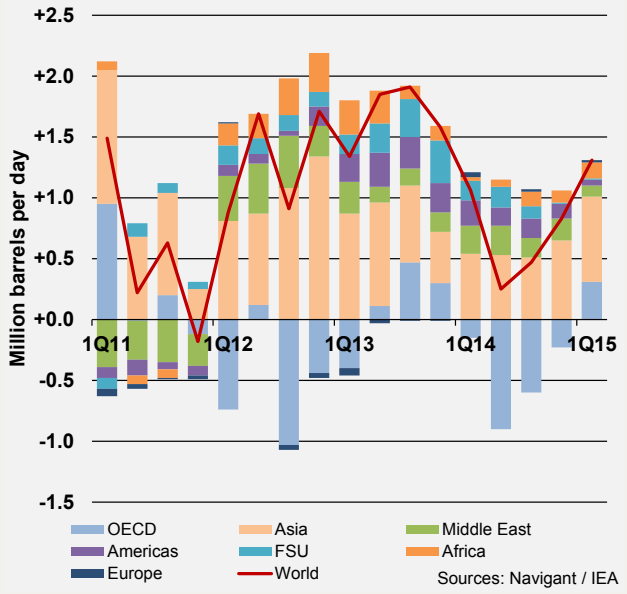
## Oil Market Charts

### OECD & NON-OECD OIL CONSUMPTION



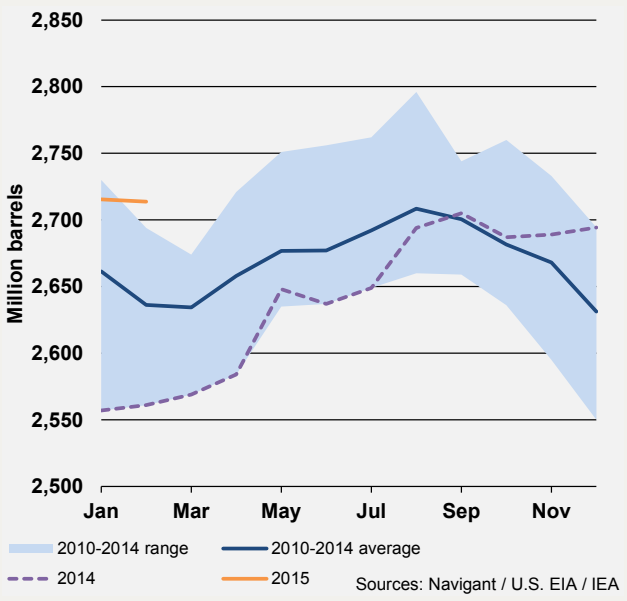

Global oil consumption increased from 91.7 million barrels per day in Q1 2014 to an estimated 93 million barrels per day in Q1 2015, of which 49% was consumed by OECD countries.

### YEAR-ON-YEAR CHANGE IN OIL CONSUMPTION



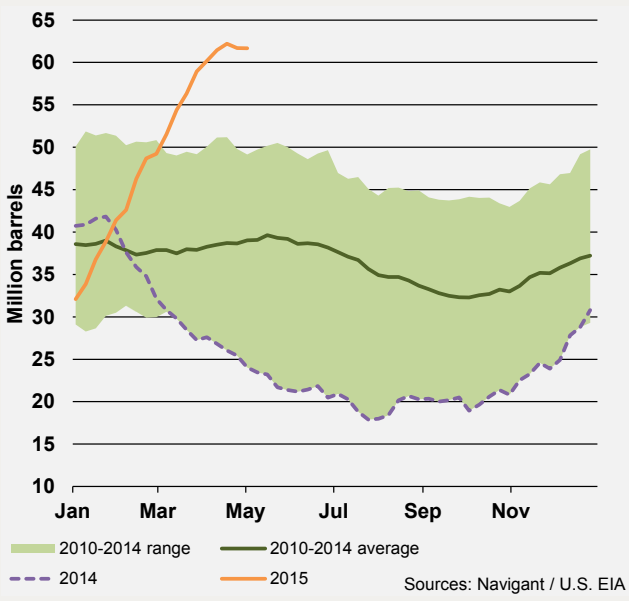

Oil demand growth in recent years has been led by non-OECD countries, particularly in Asia (e.g. China).

### OECD COMMERCIAL STOCKS OF CRUDE & PRODUCTS




OECD commercial inventories rebounded during the second half of 2014 to reach an estimated 2,714 million barrels of crude and products in February 2015, just above the five-year range.

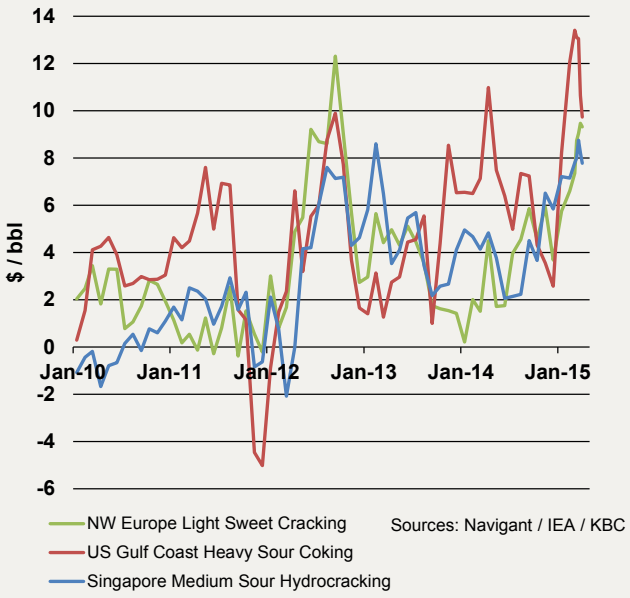
### CRUDE STOCKS AT CUSHING, OKLAHOMA




Crude inventories at the Cushing hub (the delivery point of the WTI contract) have accumulated rapidly in 2015 to reach 61.7 million barrels at the start of May, 58% above the five-year average.

## Oil Market Charts

### INDICATOR REFINING MARGINS




In April 2015, indicative refining margins were $9.32/bbl for NWE light sweet cracking (+$4.83/bbl YoY), $9.73/bbl for USGC heavy sour coking (-$1.25/bbl YoY) and $7.78/bbl for Singapore medium sour hydrocracking (+$2.95/bbl YoY).

### EU CARBON ALLOWANCE PRICES


EU carbon allowances have recovered to €7.60/tonne from the lows of April 2013.

### U.S. ETHANOL RIN PRICES


U.S. ethanol RINs began May at 75 cents/gallon for the 2014 vintage and 74 cents/gallon for the 2015 vintage.

### U.S. BIODIESEL RIN PRICES


U.S. biodiesel RINs began May at 80 cents/gallon for the 2014 vintage and 84 cents/gallon for the 2015 vintage.

## Legislative and Regulatory Highlights

## National

**FERC Adopts Several Changes Proposed in Gas-Electric Coordination Proceeding**

On April 16, the Federal Energy Regulatory Commission issued Order 809 approving a Final Rule addressing the coordination of scheduling practices for the natural gas and electric industries. While the Final Rule does not adopt the proposal to move the 9:00 am (CCT) start of the gas day to 4:00 am, it does make several changes proposed by the North American Energy Standards Board (NAESB). Specifically, Order 809 moves the Timely Nomination Cycle deadline from 11:30 am (CCT) to 1:00 pm (CCT), and adds a third intra-day nomination cycle during the gas operating day to help shippers adjust their scheduling to meet changes in demand. The Final Rule takes effect 75 days after publication in the Federal Register.

**NERC Estimates 60 GW of Additional Gas-Fired Generation by 2020, Accelerated by EPA's Clean Power Plan**

On April 21, the North American Electric Reliability Corporation released its assessment of the potential reliability risks of the U.S. Environmental Protection Agency's proposed Clean Power Plan. NERC's assessment focused on evaluating electric generation and transmission adequacy, with one particular area being the likely change in generation mix. The study estimated the Plan would accelerate an on-going shift away from coal-fired generation and toward natural gas-fired generation, with an additional 60 GW of gas-fired generation in place by 2020, and an additional 80 GW by 2030. NERC noted that such changes will require gas infrastructure and pipeline capacity additions, which will require time beyond the 2020 interim target dates currently proposed in the Plan.

## Gulf

**Toho Gas to Purchase Additional LNG Volumes from Cameron LNG Project**

On April 23, Japanese utility Toho Gas announced its execution of a Heads of Agreement with a Mitsubishi Corporation subsidiary for liquefied natural gas supply produced by the Cameron LNG project in Louisiana. The proposed 20-year agreement is for 200,000 tons per year of LNG, linked to U.S. natural gas prices, delivered Ex Ship to Toho Gas' receiving terminals. The agreement follows a prior Toho Gas agreement to purchase 300,000 tons per year of output from Cameron LNG from Mitsui & Co.

**Freeport LNG Announces Financing for Third and Final Liquefaction Train**

On April 28, Freeport LNG announced that it has secured $4.56 billion in financing for its third liquefaction train at the Quintana Island, Texas project, allowing for construction to begin on the final train. The project has issued a full notice to proceed on the third train to its contractors. The first two trains are already under construction, with expected commercial operation in by Q3 of 2018, and operations for the complete facility by Q3 of 2019.

## Oregon

**FERC Targets February 2016 for Oregon LNG Final EIS**

On April 17, FERC issued its Notice of Schedule for Environmental Review for the Oregon LNG bi-directional terminal and associated pipeline, with the Final EIS targeted for February 12, 2016. The schedule notice follows the issuance in September 2012 of the Notice of Intent to prepare an EIS, after which the scoping period occurred. The project entails a 1.3 Bcfd liquefaction terminal and an 87-mile, 36-inch natural gas pipeline connecting the project to Northwest Pipeline near Woodland, Washington. The Notice of Schedule includes Northwest Pipeline's planned expansion of its system between Woodland and Sumas, Washington with 140 miles of 36-inch pipeline loop and additional compression.

## Midwest

**NGPL Signs Precedent Agreements for Chicago Expansion Project**

Natural Gas Pipeline Company of America announced on April 14 the execution of binding precedent agreements with shippers for 238 MMcfd of incremental firm transportation capacity on its Gulf Coast mainline system, as part of its Chicago Market Expansion project. The project will add capacity to points north of the Gulf Coast interconnect with the REX pipeline in Moultrie County, Illinois. The shippers are Antero Resources, Nicor Gas, Northshore Gas, and Occidental Energy Marketing.

## British Columbia

**TransCanada Concludes Project Agreement with Gitanyow First Nations on PRGT Pipeline**

On April 21, TransCanada Corp. announced the conclusion of a Project Agreement with the Gitanyow First Nation of northern B.C. with respect to TransCanada's 900-km Prince Rupert Gas Transmission pipeline project, which is intended to move feedstock to the proposed Pacific NorthWest LNG facility near Prince Rupert. The agreement will provide benefits to the Gitanyow First Nations, and confirms their support for the project.