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An Integrated Energy Perspective
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Moderator

Our keynote speaker comes to us from Houston, Texas where he is the head of Bain & Company's Oil & Gas practice in the Americas. With a PhD. from the Massachusetts Institute of Technology, an MBA from Harvard Business School, and more than 20 years of industry experience, advising top business leaders across a number of industries. He brings a wealth of experience to such functional areas as: corporate and business unit strategy, organizational design and effectiveness, customer-supplier and supply-chain management, new product development, marketing, mergers and acquisitions, and post-acquisition integration. He is known for helping clients achieve significant shareholder returns by improving strategic and financial position, achieving operational excellence, and maximizing organizational effectiveness. Here with us this morning to give us a look at the impact of shale gas on the energy and petrochemical industries, please extend a warm welcome to a partner of Bain & Company, Jorge LEIS.

Jorge Leis, Partner, Bain & Company

Thank you very much for that introduction. That sounds a little bit like my mother wrote that one. As you heard, the subtitle of my presentation is *Framing the Impact of Shale Gas on the Energy and Petrochemical Industries*. And so very much it's going to take a global view, but none-the-less through the lens of what is happening really in North America as a starting point. So as such I'll begin with a brief review of the shale gas and title phenomena in North America.

It's important to keep in mind that these supply shocks are behind the major trends and sources of uncertainty that are driving the evolution of the global energy landscape. In describing these and introducing a framework to deal with what we do in a time of unprecedented uncertainty are two key objectives of this material. Finally I will highlight general implications for the oil and gas and the petrochemical industries.

The natural gas market in the U.S. has experienced what can only be called a "supply shock" in recent years driven by shale gas. The data on the left shows U.S.

natural gas supply in 2000 and expectations for this year. Shale gas, virtually non-existent as a supply source just a dozen years ago, is now the leading source of natural gas supply in the United States. The sheer magnitude and location of the supply have led to U.S. natural gas prices decoupling from oil prices which in turn has created widely divergent gas prices across the major regional trading hubs in the US, Europe, and Asia, and has opened up international arbitrage opportunities. A domestically abundant low-cost natural gas has led to significant switching from coal to natural gas in the power-generation sector.

A similar boom is underway in U.S. tight oil. On the left we see data for U.S. crude supply by type in 2010 and again expected for 2013. In these data we see that tight oil is by far the fastest growing crude oil supply in the US. As in the case of shale gas, the magnitude and location of tight oil has ripple effects that can be felt on a global scale. Mid-stream constraints led to an unprecedented decoupling of the major US oil price benchmark (West Texas Intermediate) from other national, international, benchmarks. And while WTI discounts have partially recovered from historic highs, lower priced domestic crude continues to displace imports. Meanwhile the US has become a net exporter of refined products.

As natural gas prices have fallen, rig counts have shifted fairly dramatically from dry to wet plays. This shift has led to short-term oversupplies of natural gas liquids (NGL) and as a result NGL prices have decoupled from oil and from one another as can be seen from the data on the slide. With the benefit of low-cost NGLs US petrochemical manufacturers have gone from being some of the highest cost producers, just a decade ago, to some of the lowest cost producers today, having a dramatic impact on international flows.

Despite its undeniable impact though, the sustainability of tight oil and shale gas production is subject to much debate. Now this debate is not purely academic, it very much complicates the ability of companies to plan by introducing vastly different expectations of the future production levels for oil and gas. North American production forecasts out to 2030, as shown here for both crude oil and natural gas, vary from a net reduction to a doubling versus today.

Now I am not here to tell you which point of view is correct. In fact it's Bain's position that expending too much effort to uncover the so-called "best baseline forecast" may actually be misguided. The reason is because the type of uncertainty we are dealing with actually leads to structurally different outcomes.

I am here to propose what we truly believe is a better way to account for this unprecedented degree of uncertainty as you develop your long-term strategic plans. Bain's approach is based on developing a set of plausible scenarios which are driven by potential supply shocks and inter- and intra-fuel substitutions. The model takes into account the inter-linkages between supply sources and markets and intermediaries in order to capture how supply and demand imbalances, or intermediary constraints, influence prices and drive fuel substitutions.

Supply shocks are captured along three major vectors: oil, natural gas, and renewables. While important components of the energy mix, we do not consider coal a nuclear as potentially disruptive in this window, and have modeled them as dependent on oil, gas, and renewable volumes and prices.

As this cube indicates permutations of supply levels for oil, gas, and renewables define the eight corner scenarios that make up our framework. Let me describe them very briefly. The front face of the cube, scenarios one through four, are consistent with high and low production volumes of crude oil on the vertical, driven by tight oil production, and natural gas on the horizontal driven by shale gas.

- So for example scenario one, which we call Hydrocarbon Starved, is the scenario where neither shale gas nor tight oil production is sustainable.
- Likewise scenario four, which we call Hydrocarbon World, is the scenario where both shale gas and tight oil are abundant and sustained.

The back face of the cube adopts the same assumptions with respect to shale gas and tight oil but layers in more aggressive assumptions for renewables regarding cost reductions and the potential for a technological breakthrough in utility, grade, energy storage. While this would be a game-changer for renewables, our analysis concludes that this breakthrough would not happen until the back half of the 20s. And for the sake of brevity I will limit my comments to oil and natural gas here this morning.

Collectively these scenarios cover a wide range of forecasted volumes and prices as shown here.

- In the case of crude oil production varies from roughly 8 ½ to about 13 ½ million barrels per day with prices varying from about $130 to as low as $60 per barrel.
- In the case of natural gas production varies from as little as 60 to as much as 125 Bscf per day, with prices ranging from a little over 12 to just under $4 per MMbtu.
- And natural gas liquids have an even greater range of potential production outcomes due to the variability in wetness of the various shale plays.

While these results give us comfort that our model captures a wide range of possible outcomes, it places even more importance on defining leading indicators to monitor the evolution of the energy ecosystem.

- One very important set of leading indicators are “experience curves” which indicate how costs may decline in the future. An example of an experience curve for shale gas is shown in this diagram on the left. Arguably you could have anticipated a time when production costs would have declined below market prices, as was the case in 2007. Now we all know that hind-sight is 20/20, so we want to be careful about what we say hear. We are not saying that you would have predicted the shale boom had you had access to this data in 2007. We are saying that this approach should have prompted you to build a plausible scenario of a shale gas supply shock and study its implications.
- As second set of key variables are “substitution barriers.” As the examples on the right demonstrate, in order to really understand inter- and intra-fuel substitution you need to have a perspective on competitive prices and on the viability of transporting and utilizing one supply source for another. Understanding where substitution barriers exist and whether they are being erected or dismantled is critical to being able to anticipate market dynamics.

To highlight how experience and substitution drive our corner scenarios and lead to structurally different outcomes, I will use the construct of a simplified supply curve which essentially stakes sources of crude oil left-to-right on a volume-cost diagram as shown on this slide. In this diagram the width of each supply source equates to production volume and the height to the range of production costs associated with that volume. Using the EIA 2030 base case as a starting point, our Hydrocarbon Starved scenario (as a reminder defined as the scenario in which tight oil production is not sustained) predicts a decrease in tight oil volumes and a slight decrease in imports driven by an overall reduction in demand for crude oil in the U.S.

But by applying the Experience Curve to the more optimistic estimates for technically recoverable tight oil reserves, our model predicts a substantial increase in tight oil production potential, enough to displace all non-North American imports. And it is precisely this effect that would extend the impact of North American tight oil well beyond our borders.

By introducing the tight oil production increase, implied in the oil rebirth scenario, onto the global supply curve effectively pushes higher cost sources of supply off the supply curve. And by that we mean to the right of the forecasted global demand. Such a scenario could put the world in a state of structural oversupply leading to significant price reductions. I say that because in the last 30 years we have been in five oversupply situations. The impact on global crude oil price ranges from a drop of 30% to a drop of 70%. I am sure that you would agree that price drops of these magnitudes would certainly be felt in every corner of the oil and gas and related industries.

Using the construct of the supply curve for natural gas tells a similar story even possibly more dramatic. Again, beginning with the Hydrocarbon Starve scenario in North America (in which shale gas production growth is not sustained), shale gas volumes decrease slightly from today and the U.S. returns to net import status while overall demand increases only slightly. But under the Gas Land scenario in which shale gas is abundant and production growth is sustained, shale gas volumes could very well push-out all other sources of domestic supply and still provide significant quantities for export, in spite of growing domestic demand by nearly 30%.

So let's take a closer look at the implications of these two corner scenarios for the US exports of natural gas in the form of liquefied natural gas (LNG), and to the petrochemical's industries more broadly. Despite the robust global demand outlook for LNG there is significant uncertainty around how much LNG the U.S. will ultimately export. Currently these data indicate that at least 10 Bcf/day of hard demand exists for U.S. LNG but that number could double or be halved depending on several factors. On the upside already robust forecasts for global LNG have recently been edging upwards from roughly two to roughly two and a half times today's volumes in 2030. EPC constraints, which I'm sure you are well aware, which could significantly inflate construction costs of liquefaction facilities and support infrastructure, could certainly put a damper on the entire industry. But there is an argument to be made that the U.S. is best positioned to manage these major projects and has the added benefit with starting with several brownfield sites which are proving to be much less costly.

So while there are many planned international projects with lower rated landed cost positions to age, for example, than from the U.S., the ability of these international projects to deliver on-time and on-budget could be a game-changer for the U.S.

Finally China is a bit of a wild card. The very aggressive policy push towards the use of more natural gas is spurring three-pronged approach to securing adequate supply.

Given its size and growth, how China's supply strategy plays out could materially impact global LNG flows.

As you are aware one of the most important natural gas liquids in wet US plays is ethane. Abundant, low-cost supplies, have spurred unprecedented investment plans in ethane crackers; by one count, doubling domestic capacity by 2020 as shown in this chart. Now most of this additional capacity is projected to come on line from 2016 to 2018.

The question I want to raise is "How robust are these capacity expansion plans to plausible high and low cases of ethane supply?" And the answer I think is quite revealing. Allowing for lead-times, capacity expansion plans more-or-less mimic the EIA base case forecast for ethane supply. Aside from the obvious supply-demand imbalances implied by the high and low cases for ethane, these data also demonstrate what I would call your attention to is a bias that exists not only within an individual company but collectively as an industry and that is to adopt a deterministic baseline on which to build strategic plans.

In my own experience, even for the set of companies that have adopted scenario analysis as a strategic planning tool, the cultural bias is to build the strategic plan around the scenario with the maximum likelihood of materializing. As I'll share in a moment we believe there is a better way to preserve the robustness inherent in scenario planning.

As with any intricately linked ecosystem, second order effects can be just as important as the initial disruption. As this graphic demonstrates, the shift to ethane cracking has left byproducts from naphtha cracking in short supply. In particular butadiene and aromatics are two such byproducts that are receiving a great deal of attention as import opportunities from various international sources.

The second and third most plentiful natural gas liquids are propane and butane. Combined, their volume nearly equals that of ethane in U.S. shale plays. Whereas the vast majority of ethane is used in the petrochemical's industry, the majority of propane is used for heating and as a fuel. Roughly only one-third of U.S. propane demand is for petrochemical's feed stock. The percentage is even lower for butane as the majority of butane is used in gasoline and blend-stocks.

Taking the appropriate demand markets into account the consensus view is that the U.S. will be in an oversupply situation for propane and butane. Now since propane and butane can be shipped overseas as liquefied petroleum gas (LPG), planned LPG export facilities are forecast to add significantly to export capacity, far more than the mid-case would require, as shown on the diagram on the right, and almost enough to satisfy the most aggressive case of LPG over-supply. The question then is whether global LPG markets can support new seaborne supply from the U.S. At least short-term the answer seems to be "no," these data support the short-term contention that the world will be long propane. What the slide doesn't show is that both Europe and Asia are planning to convert much of their naphtha based ethylene feed stock to LPG. And while using LPG as an ethylene feed stock is less economical than using ethane, it is more competitive with these prices than using naphtha. This slide also doesn't show that there are large global propane price disparities that favor the U.S. and have driven a 500% increase in propane exports since 2008.

The U.S. petrochemicals renaissance is being felt outside the purely NGL chains, if you will, as this graphic shows low natural gas prices have also sparked domestic methanol demand, and even to a greater extent, domestic production. I am not sure if Methanex is in the crowd but it's interesting to note that the Methanex supply contract for natural gas is actually indexed to the price of methanol, effectively converting its methanol plants into tolling operations with a guaranteed gross margin. This is an example of a creative hedging strategy that buyers can use to offload some of the risk inherent in uncertain supply scenarios.

Another interesting example of second order effects is the resurgence of domestic ammonia manufacturing. After 20 years of no new builds in the US, 14 ammonia plants are being planned to come on line in the next three to five years at a total investment of nearly 10 billion $s. Again the driving force behind these, and the other aggressive plans we have seen, is the expectation of abundant low-cost supplies of natural gas and natural gas liquids. And as we have seen the long-term sustainability of these supplies are subject to much speculation leading to wildly different future expectations.

So how do you respond to this level of uncertainty?

- Let me begin by asserting that strategy, as traditionally designed, is about setting direction and aligning the organization to execute a plan.
- The process tends to be static in that once the vision is set it has a certain half-life within which the focus of the organization is on developing and executing the plan. Changes in the environment need to wait for the next planning cycle in order to be incorporated.
- The process tends to be deterministic. The vision is designed to achieve optimal results based on the best guess for what the future holds.

It's our contention that the static and deterministic nature of traditional strategic planning have limitations in periods of heightened uncertainty and introduce certain biases that fall into two common traps: under-confidence and overconfidence.

- Examples of under-confidence are treating uncertainty as unknowable or focusing only on those things that can be controlled. In both cases, leaving a great deal of potential insights by the way side.
- Examples of over-confidence include overinvesting in developing that deterministic view. A better-based case than anyone else, if you will, fueled by the belief that greater effort guided by superior intelligence will produce a competitively advantaged result.

Our contention is that strategy in an environment of high uncertainty requires a different approach. The hallmarks of this approach are developing plausible scenarios based on an intergraded view of the entire energy ecosystem and shed light onto the underlying mechanisms that will propel us into the future. Clarity on these mechanisms will allow you to build and compare appropriate strategies, define and track the signposts that really matter, and develop a set of a priori responses that can be initiated as the environment pulls certain triggers. And as the graphic implies, the process is dynamic.

The primary objective of this approach is not to come up with the one best strategy but to develop robustness, flexibility, and agility in where, how, and when you react to changing market conditions.

We believe that strategies using this approach have a number of key advantages.

- They are robust under multiple scenarios. Now keep in mind that this advantage usually comes at the expense of adopting a what could be called “sub-optimal” strategy for any single scenario.
- But the strategies have a built-in element of optionality.
- And the process improves an organization’s capability to monitor the environment.
- Done properly, clear decisions developed with sufficient foresight are triggered when signposts flash red prior to imminent changes in the environment, allowing greater time to execute and adjust.

I look forward to hearing the views from the other speakers and I guess taking questions from you at the end of this morning’s session. That concludes my comments. Thank you again for having me and for the time and your attention.