Summary
The continuation of low oil prices has presented long-term challenges for those operating in the downstream sector of the oil and gas industry. With tightening profit margins, little growth and a lot of unpredictability, downstream players are finding a variety of ways to confront the many difficulties they face in a volatile environment. Key to maintaining success is improving productivity and efficiency at the plant level, which can be accomplished by hiring experienced workers, fostering operational practices that reduce downtime, adopting state-of-the-art technologies and utilizing research to get useful insights from other industries, and more.
The crude oil price collapse in mid-2014 was a boon to many in the downstream sector, with refinery profits margins benefiting from the spread between crude oil and refined product prices. Larger, integrated oil companies were able to offset some of their losses in the upstream. Independent refiners enjoyed a net benefit. Still, downstream operators are now struggling, warranting a rethink of how the refining business in particular is operated.

Achieving operational excellence in the downstream sector, however, is not simply about turning profit margins around. While increasing production revenue is important, so are operational efficiency, reliability, and health and safety in a high-risk environment—and all of this against the backdrop of volatile energy markets.

Other than the modest boom for refiners in 2015, margins have been down across the globe. This is the continuation of an ongoing trend. Refining margins began to decline in the mid 1990s, with refiners losing close to 60 percent of gross margins by 2009. At the time, several oil majors responded by increasing integration. Vertical integration, in turn, helped these companies offset the initial shocks to profits from upstream assets in 2015. But integration has its limits, and for independent refiners the option is simply not available.

Instead, a renewed focus on technology and efficiency will improve profit outlooks. Much like other sectors of the oil and gas industry, a lot can be learned from process efficiency in other sectors of the economy, as well as more effective data management and analysis to reduce loss from unscheduled downtime.
Reversing downward trends
Profitability of the downstream segment, as with other areas of the energy sector, is vulnerable to an array of factors both within and outside operators’ control. These can be broadly understood as:

1. crude pricing
2. (un)planned downtime
3. operational efficiency
4. regulatory environment

According to Emerson, a global engineering company, the difference between a “well-run refinery” and the global average is around $12.3 million annually for a 250,000 barrel per day facility. And yet even facilities with well-functioning operational processes, well-maintained equipment, and high levels of efficiency still suffer from avoidable losses.

Responding to volatile crude markets
Declining crude prices, while giving an initial boost to refiners in 2015, are now eroding the profits of downstream operators as well. More importantly, the sector is experiencing a period of volatility and, as a result, unpredictability. This is a problem given that the price of crude oil and the price of refined products are the two single most important factors affecting downstream profits. BP’s annual Energy Outlook predicts that while petroleum product demand will continue to grow globally—driven by Asia in particular—that volatile downstream margins are likely to remain the norm.

Lower petroleum product prices, and resulting drop in revenue, are also in part the result of a global oversupply. When profits were high, refiners added capacity, while global demand remained low. U.S. gasoline and distillate stocks are at record levels. China’s independent refineries, or “teapots,” have also experienced inventory oversupplies and logistical bottlenecks at ports.

Still, for Asian and European refiners there is a silver lining. The narrowing spread between Brent crude prices (generally used as a proxy for international oil prices) and West Texas Intermediate prices (a proxy for the U.S.) has caused a convergence of profits between refiners in the U.S. and those operating globally.

Increased integration of upstream and downstream segments has mitigated the impact of low oil prices for larger companies, but it is not a long-term solution. A strategy for sustainable growth and operational excellence must look at the factors on the ground—assets, human resources, logistics—as well as ways to better cope with a more volatile market in terms of oil prices, crude supplies, and demand for petroleum products.

(Source: U.S. Energy Information Administration)
Reducing loss from unscheduled downtime

Unplanned disruptions are expensive. Refinery operators find themselves paying for both repairs and production losses, often for equipment failures and maintenance issues that could have been avoided. The cost of a large-scale incident could run to hundreds of millions of dollars. The cost of missed production for an average U.S. refinery has been estimated at between $340,000 and $1.7m per day6. A study of U.S. Department of Energy data found there were more than 1,700 shutdowns at refineries in the U.S. between 2009 and 20127. Of these, an estimated 46 percent were due to mechanical breakdowns, 19 percent the result of electrical disruptions, 23 percent maintenance related, and 12 percent other causes (such as fires). Around 92 percent of maintenance-related shutdowns were unplanned.

Unscheduled outages are often caused by faulty equipment, such as leaky pipes. The resulting downtime is costly to operators and consumers. In 2015, a leaking pipe at the BP Whiting Refinery, the largest petroleum refinery in the U.S. Midwest, meant a shutdown of 50 percent of the crude distillation unit capacity and a 30 percent spike in gasoline prices in the region8. In 2005, an explosion at the Fort McMurray refinery in Canada cost operators $870 million9. A 2015 explosion at a Czech petrochemicals plant cost an estimated $177 million. While avoiding this type of large-scale accidents is critical to optimizing profit, ensuring health and safety, and minimizing environmental risks, most downstream operators seeking to maximize profits on a consistent and sustainable basis should also focus on the smaller issues, such as proactive maintenance. These are the key to achieving operational excellence.

Technological innovations are seeking to resolve some of these issues, particularly in regions where downstream capacity is increasing, such as Asia. Leaking pipes, for example, are a major cause of accidents, meaning financial losses and safety risks. Yet one study found that a steel composite regularly used in pipes (AISI 316L), which commonly lasts 100 years in noncorrosive environments, had a life cycle of just one to five years in a corrosive chloride environment10. Changing the material to one with a higher alloy content or adding nickel or ferrite would mitigate the problem. This is just one example of the importance of advances in material science, systematic equipment monitoring, and knowledge and implementation of design best practices can help mitigate financial and health, safety and environmental risks.

Power outages

Electrical equipment failure was to blame for over half the power outages recorded at U.S. refineries, including faulty or failing circuit breakers, switchgears, transformers, and substations. In many cases, more thorough and proactive maintenance could identify and resolve the problem before complications arise. In others, upgrading equipment could reduce the likelihood of outages. Minimizing impacts associated with equipment failure requires spend time and money on improving plant monitoring and on resources to quickly identify and develop solutions to minimize impact when failures occur.

In addition, reducing the dependence on third-party utilities would remove one factor that is currently outside operators’ control. In terms of improving the reliability of power supply—and thus reducing power outages caused by third party suppliers—downstream operators could consider on-site power, such as renewable energy, microgrids, and cogeneration. However, assuming the responsibility for power supply would entail an additional operational (and financial) burden for the plant, with risk factors of its own.

Ageing assets have also been identified as a major risk factor in the scale and frequency of explosions at refineries. Some experts have suggested that low oil prices may also have put pressure on operators seeking to mitigate profit losses by compromising on best practices and pushing equipment beyond its lifespan.
From predictive to proactive maintenance standards
Avoiding unscheduled downtime, increasing safety standards, and reducing costs frequently comes down to improved maintenance practices. The notion is that while regular maintenance is important in identifying and replacing aging equipment, it is not as effective in detecting less predictable failures, such as cracking or corrosion. Based on studies conducted by NASA and the U.S. Navy, ARC Advisory Group argued that so-called “preventative maintenance”—regularly scheduled reviews and repairs—is only appropriate in 18 percent of cases. The key to improving operational excellence in this area can be understood as a move away from rigid maintenance schedules and towards a system of real-time monitoring, feedback, and analysis, and eventually real time remote (or even automated) response. This is where technological advances in sensors, data management, and systems modeling are invaluable. These methods can help identify such issues as leaking and corrosion, as well as wear-and-tear and larger systems malfunctions, before they became a threat. But it also requires quick action and identification of the best engineering solution(s) to the problem.

Resilience in an unpredictable climate
Weather-related shutdowns are often viewed as unavoidable. Yet with the climate becoming less predictable, and weather events more frequent and severe, this will likely become a more significant issue for downstream operators in the coming years. Along the Gulf Coast of the U.S., where 45 percent of U.S. petroleum refining capacity is located, the frequency, duration, and severity of tropical storm activity has been steadily increasing since the 1980s. Severe storms not only cause damage to the plants themselves but storm surges and flooding also affect transportation routes along the coast. The results are costly equipment repairs, downtime, production loss, and logistics delays, not to mention the risks to staff health and safety and potential environmental impacts.

It is not simply the Gulf Coast that is at risk. Superstorm Sandy in 2012 caused an estimated $56 million in damages to the Phillips 66 refinery in New Jersey. Additional revenue loss as a result of a three-week shutdown has been estimated at $650 million. To reduce the both the financial and HSE impact when future storms occur will require investment in developing new engineering designs and configurations for upgrading plant infrastructure to withstand more frequent and more severe future storm events.

Increasing operational efficiency
The downstream sector, like other areas of the energy industry, can improve operational efficiency through streamlining processes both vertically and horizontally. In some cases, companies are finding ways to integrate operations across different downstream segments, aligning refinery, gas processing, and petrochemical businesses. This means looking at costs—in particular feedstock costs including crude oil but also human resources, engineering and material science technologies, logistics and transport—as well as exogenous factors, such as regulatory frameworks, environmental risks, and health and safety measures. Downstream operators could learn from more mature process-oriented industries, such as aviation or pharmaceuticals, making the case that access to multidisciplinary research and technological information can be of great benefit, as the upstream oil and gas industry has shown with the application of seismic and other geophysical technologies.
Highly trained and experienced workers are critical to ensuring operational excellence, from equipment maintenance, to management, to on-site health and safety. However, like other sectors of the oil and gas industry, downstream operators are also vulnerable to the forthcoming "great crew change." One in four senior employees will be eligible to retire in the next 5 to 10 years. Around 70 percent of all workers are over 50. More worrying is the gap between workers aged 35 and 50, and the lack of midcareer professionals to take over.

There are three factors at play: a large number of experienced workers are retiring, operations are becoming increasingly complex, and belts are tightening. As such, companies are attempting to do complete more complex tasks with fewer and less experienced workers. With the "great crew change", downstream operators will need to find innovative ways to ensure their younger, less experienced workers have access to the right tools and technologies to help them get up to speed and be able to quickly and safely resolve issues that may arise.

**Regulatory uncertainty**
Fuel regulations and changing consumer behavior have had an impact on the demand for petroleum products, particularly in the U.S. and Europe. Slower growth in China has also been significant. Moreover, a global shift towards hybrid and electric vehicles, as well as biofuels and the growth of natural gas as a transport fuel, has contributed to lower demand. Emissions guidelines mandating plant upgrades will have an effect on refiners around the globe.

In the U.S., for example, new, more stringent standards will impact refiners’ activities in the coming years. In particular, U.S. refiners will need to meet requirements to lower the sulfur content of gasoline under the Tier 3 program starting in 2017. In addition to management of air emissions, management of water resources and wastewater discharges are a significant cost for refineries and petrochemical plants to manage. In drought prone areas, finding innovative ways to use non-potable water inputs and treat and reuse recovered water are imperative, but can be significant costs savings even for those operating in regions where access to water is less of an issue.
Conclusions and outlook

In light of global trends towards diminishing margins and slower demand growth, downstream operators must look at the plant level for efficiency and productivity gains. While operators across the oil and gas industry seek greater stability, the best defense for refiners and petrochemical operators in the face of oil price volatility is agility.

Many exogenous factors are difficult to predict—such as environmental and political landscape, and oil prices—however, this is where refiners and petrochemical producers can increase operational agility and flexibility. A complex regulatory landscape with changing emissions standards and health and safety rules is another challenge that downstream operators will continue to face, but being prepared to address these challenges quickly and effectively may be the best way to overcome these challenges.

Yet other factors are well within companies’ control; Keeping up-to-date and leveraging the best engineering technologies and innovations can improve equipment reliability, improve maintenance standards, extend equipment longevity, reduce unscheduled and scheduled downtime, reduce energy and water consumption costs, as well as and reduce emissions and waste. With the right information and technical data, downstream operators can remain agile and improve their operational excellence, ensuring that they are not only only profitable, but operating as efficiently, productively, and as safely as possible.

7 Ibid.
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