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The US petrochemical industry is expanding at a rapid clip, due largely to the growth of natural gas. But how long can this last? Gordon Cope, Contributing Editor, explores the opportunities and challenges facing the sector.

Clean diesel: the new generation
Allen Schaeffer, Diesel Technology Forum, USA, explains how today’s ultra low sulfur diesel fuel, advanced engines and effective emissions control have combined to create a smoke free, clean diesel technology that achieves near zero emissions.

Risky business
Jörg Isenberg, AUMA Riester GmbH & Co. KG, Germany, explains the key requirements for valve actuators used in safety instrumented systems in downstream applications, with a focus on risk reduction.

Modern detection

Gas on film
Kristof Maddelein, FLIR Systems, Belgium, examines how optical gas imaging technology has been successfully applied in the downstream industries to help improve worker safety and prevent costly production shutdowns.

The safest support
Cynthia Spitzberger and Lindsay Deal, DNV GL – Oil & Gas, USA, outline the benefits of risk-based decision support for the safe operation and control of hydrocarbon processing facilities.

FCC-RR design hurdles
M. Senthilnath, Mehul B Dholakia, Avedhesh Gupta and Pradeep Darji, L& T-Chiyoda Limited, India, examine the best approach and challenges encountered when designing an FCCU integrated reactor regenerator (RR) section.

Upping the voltage
Mark Wheeler and Christopher Molnar, Chromalox, Inc., USA, explain how medium voltage technology greatly reduced installation, operating and maintenance costs for a multitude of thermal processes throughout an entire LNG facility.

Working with wastewater
Kirill Utkhanov, GE Water & Process Technologies, Russia, describes how advanced membrane technology is helping a Russian refinery to meet stringent wastewater requirements.

All about accuracy
Werner Arts, LAR Process analysers AG, Germany, evaluates the effectiveness of true total organic compound (TOC) analysers in two separate downstream facilities.

Fuel goals
Eric Stafford, Thierry Tison and Harrie Neefs, Heurtey Petrochem, France, examine optimum operating conditions with regard to heat efficiency for refinery, petrochemical and syngas applications.

Lifting the lid on black box technology
Brazed aluminium heat exchangers are still often viewed as a black box technology in some quarters. Paul Shields, Chart Industries, Inc., UK, and Sam Thigpen, Chart Lifecycle, Inc., USA, introduce a new approach for optimised performance and longevity in the downstream processing industries.

The drive to success
George Buckdee, Metso, USA, looks at the key aspects of condition monitoring, and how these can help drive reliability and process improvement in refineries and petrochemical facilities worldwide.

Tried and tested
Tyler Brower, Ebara International Corporation, USA, discusses the evolution of the submersed motor pump for use in the hydrocarbon and petrochemical industries.

Control valve evolution
Massimiliano Di Febo and Pasquale Paganini, IPC, Italy, and Antonio Folcando and Michele Coniglio, Bellino S.r.l, Italy, discuss the recent developments in downstream control valve technology.

Join the industry.

Pumps, Valves & Seals Review
Hydrocarbon Engineering provides an overview of some of the downstream oil and gas industry’s most advanced pumps, valves and seals technologies.

15 questions with...
Hydrocarbon Engineering talks to Michele Budd, Manager, BP Lubricants Global Supply Chain, about chemical engineering, technological developments and encouraging young people to join the industry.

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COMMENT

The results are in, and, in a vote that has sent shockwaves around the country, and across the world for that matter, the 23 June 2016 will forever mark the historic moment that Britain chose to leave the European Union, in the first UK-wide EU Referendum since 1975.

Following an intense period of campaigning that has inspired citizens, politicians, world leaders, industries, organisations and companies, ranging from small business owners to multi-national corporations, to fight animatedly for their chosen camp, be it 'Leave' or 'Remain', voters backed 'Brexit' by a margin of 51.9% to 48.1%.

While 'Leave' supporters rejoiced, as UK Independence Party (UKIP) leader Nigel Farage dubbed 23 June as Britain’s 'Independence Day', in the hours before this issue was sent to press, the news was saturated with economic horror stories. As the referendum outcome emerged on 24 June, the value of the pound plummeted, at one stage reaching US$1.3236, a fall of more than 10%, which has not been seen since 1985, according to BBC News Market Data. Furthermore, the London stock market experienced a significant hit, falling by more than 8%. BBC statistics showed that, during the opening minutes of trade, the FTSE 100 Index fell more than 500 points before regaining some ground.

So, while there is currently a large question mark hanging over the UK’s economic health, what implications will this historic vote have upon the oil and gas industry?

In the run up to the referendum, many argued that a 'Brexit' vote would have no significant impact on the oil and gas sector, at least in the short term. In the Aberdeen & Grampian Chamber of Commerce’s 24th Oil and Gas Survey, 45% of respondents noted that it was difficult to reach a clear view about whether a vote for ‘Brexit’ would be a positive development for the sector or not, and a further 20% said it would make little difference. “One thing about which the majority of the industry is united is the impact of the European referendum. Most are ‘unfazed’ at the outcome,” noted Uisdean Vass, Oil and Gas Partner at Bond Dickinson.

Despite this somewhat nonchalant attitude, uncertainties for the energy industry are undoubtedly clear, as Douglas-Westwood (DW) notes. In 2013, the UK became a net importer of petroleum products – traditionally, the predominant sources of UK imports are from EU countries. The depreciation of the pound, which has already become dramatically apparent, could result in increased uncertainty over future energy supply, due to higher import costs. According to DW, this scenario could be a ‘double edged sword’: UK oil and gas businesses would see relatively lower operating costs compared to US competitors; however, companies with revenues in sterling will most likely face elevated repayments of dollar denominated debt.

Skilled labour is also a major concern. Following the vote, the Institution of Engineering and Technology (IET) called for an urgent discussion to mitigate the impacts of leaving the EU on the engineering sector. The IET previously stressed that a vote to leave could result in an exacerbation of the UK’s engineering and technology skills shortage by making it more difficult for companies to recruit from other EU countries. Access to global markets and companies, a decline in funding for engineering and science research, and a weakening of the UK’s influence on global engineering standards, were also identified as key issues.

In terms of foreign trade, the outlook is currently unclear. David Johnson, Managing Director of Tudor International Freight, highlighted three alternative trade scenarios following the ‘Brexit’ vote: a Norwegian-style free trade agreement with the union; a series of bilateral trade treaties with it on the Swiss model; and the UK and EU nations charging each other the import duties they apply to other countries in the World Trade Organisation, with which they lack free trade agreements.

“Whatever new system results, however, administration, time or cost increases for oil and gas sector companies trading with EU-based organisations are certain,” Johnson said.

The current climate is one of marked uncertainty. There will, of course, be implications for the UK oil and gas industry; however, according to DW, the current low oil price environment is likely to play a much larger role in shaping the energy industry over the coming years.
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Liberia | Refinery feasibility study

KBR, Inc. has been awarded a bankable feasibility study (BFS) contract by ECOWAS Refinery Liberia Limited (ERLL) for the development of a 100,000 bpd refinery located in Buchanan, Liberia. Under the terms of the contract, KBR will provide a market study, refinery configuration development and Environmental, Social and Health Impact Assessment (ESHIA) study. This work is expected to be performed over five months, with KBR configuring the optimal refinery configuration and developing the financial model, including capital and operational cost estimates, supported by China Huanqiu Contracting and Engineering Corporation (HQC), a subsidiary of China National Petroleum Corporation (CNPC). HQC is advising in tailoring the BFS product for potential future phase Chinese investment. Revenues associated with this contract, which have not been disclosed, will be booked into backlog for the Technology & Consulting business segment in 2Q16.

Canada | Gas plant construction contract

WorleyParsons Cord has been awarded a contract to provide module assembly and field construction services for the Cutbank Ridge Partnership (CRP) Program’s 15-27 Saturn Phase 2 Sweet Gas Plant Project at an approximate contract value of CAN$130 million. The plant is located approximately 25 km northwest of Dawson Creek, British Columbia. The contract will be led and executed by the WorleyParsons Cord Edmonton, Alberta, operations, which have been delivering modularization and construction services to western Canadian hydrocarbons, power and chemical sectors for several decades. WorleyParsons Cord will be working with communities and local businesses located in northeastern British Columbia during the field construction phase of the project.

The CRP is a partnership between Encana and Cutbank Dawson Gas Resources Ltd., a subsidiary of Mitsubishi Corporation. CRP is managing the construction of the project on behalf of Veresen Midstream Limited Partnership, which is providing midstream services to CRP.

Sweden | Advanced residue conversion technology

Preem and Beowulf Energy Sweden LLC (US), who recently signed a cooperation framework agreement, will examine the possibilities of a new residue hydrocracking plant, licensed by Chevron Lummus Global LLC (CLG), to better meet the demand for transportation fuels at Preem’s Lysekil refinery. CLG’s innovative LC-SLURRY technology upgrades as much of the heavy oil as possible to sulfur free gasoline and diesel, while also meeting the new rules for sulfur content in bunker fuel. With LC-SLURRY technology, Preem will produce 100% ultra low sulfur products from its vacuum residue. CLG, a joint venture between Chevron and CB&I, expanded its technology portfolio in 2015 to include Chevron’s slurry residue hydrocracking technology and CB&I’s coking and SDA business. This gave CLG the most extensive heavy oil upgrading portfolio available, and with the application of LC-SLURRY technology at Preem, the most advanced residue conversion complex.

CLG will provide its technology, design and permitting support through CB&I for this project. CLG and Preem previously worked together on a hydrocracker that successfully started operations 10 years ago.

Worldwide | Digital LNG solutions

GE Oil & Gas and Technip have signed a Memorandum of Understanding for a joint project to explore areas to co-develop digital solutions for the LNG industry, with a particular focus on the design and build phase of new LNG projects. The two companies will work together to evaluate the application of digital solutions to the engineering, construction, commissioning, startup and operation of LNG facilities. All solutions under consideration would encompass Technip and GE Oil & Gas expertise in digital tools and be powered by Predix, the world’s first and only cloud-based operating system built exclusively for industry by GE.

This is the first digital collaboration between the world’s first digital industrial company and a leading integrated services and equipment company to explore areas to develop Predix-based solutions. GE has a strong track record in providing equipment reliability solutions for a number of LNG facilities around the world, through sensors, advanced analytics and diagnostic expertise. Technip brings its unique expertise in the engineering, procurement and construction (EPC) phases of LNG and LNG new frontier projects.
Saudi Arabia | Engineering services contract

Jacobs Engineering Group, Inc. has received a three year contract from Sahara Petrochemicals to provide general engineering services at Sahara’s Jubail Industrial City facilities in Saudi Arabia.

Under the terms of the contract, Jacobs is expected to provide engineering, procurement, construction supervision, project management, pre-commissioning and commissioning support to a range of small to medium sized capital projects for Sahara’s propane dehydrogenation, polypropylene, chlor alkyl, ethylene dichloride and peripheral utilities operating facilities.

Jacobs has had a presence in the Middle East for many years, serving the oil, gas, buildings and infrastructure sectors. The contract enables the company to expand its presence in Jubail as part of its overall commitment to providing high quality services to customers across the region.

USA | Major petrochemical complex project

Shell Chemical Appalachia LLC has taken the final investment decision to build a major petrochemical complex, comprising an ethylene cracker with polyethylene derivatives unit, near Pittsburgh, Pennsylvania. Main construction will start in approximately 18 months, with commercial production expected to begin early in the next decade.

The complex will use low cost ethane from shale gas producers in the Marcellus and Utica basins to produce 1.6 million tpy of polyethylene.

The facility will be built on the banks of the Ohio River in Potter Township, Beaver County, about 30 miles northwest of Pittsburgh. As a result of its close proximity to gas feedstock, the complex, and its customers, will benefit from shorter and more dependable supply chains, compared to supply from the Gulf Coast. The location is also ideal because more than 70% of North American polyethylene customers are within a 700 mile radius of Pittsburgh.

The project will bring new growth and jobs to the region, with up to 6000 construction workers involved in building the new facility, and an expected 600 permanent employees when completed.

Oman | Electrostatic separator installation

General Atomics Electromagnetic Systems (GA-EMS) has received an order for an 18 module Gulftronic™ Electrostatic Separator for installation at the Oman Oil Refineries and Petroleum Industries Company SAOC (Oripc) Sohar refinery in Oman. The Gulftronic system will replace an existing mechanical filtration system installed in 2008 at the refinery in order to meet the plant’s operational demand.

Modern refineries rely on residual fluidised catalytic cracker (RFCC) to convert heavy crude oil into gas products. The conversion process creates slurry oil/decant oil, a byproduct containing catalyst fines. Through a unique electrostatic process, Gulftronic separators capture and remove all solids from the process stream, resulting in higher value clarified oil products, less downstream contamination, and significantly reduced maintenance requirements.

IN BRIEF

RUSSIA

Ame Foster Wheeler has announced a contract for the engineering and material supply of a steam reformer heater for hydrogen production at the JSC Orsknefteorgsintez refinery in Orsk, Russia. The heater will be based on Ame Foster Wheeler’s proprietary Terrace Wall™ design and form part of a new 75,000 Nm³/hr hydrogen production unit to be installed at one of the leading refineries in Russia. Ame Foster Wheeler’s scope of work is scheduled to be completed by 31 March 2017.

UAE

Johnson Matthey has acquired MIOX as a key technology within Johnson Matthey’s Water Technologies business, which is part of the company’s New Businesses Division. The acquisition of the MIOX electrochemical generation business broadens Johnson Matthey’s portfolio of water purification products and services.

UK

NEL has announced the completion of the latest upgrade phase of its wet gas test facility, the UK’s only independent commercial test service that can generate wet gas flows using water and oil simultaneously. The newly upgraded test facility has been designed to more accurately simulate the increased flowrates experienced during production and processing, reducing uncertainty, and minimising an operator’s financial exposure.

SAUDI ARABIA

The Dow Chemical Company has become the first company to receive a trading license from the Government of Saudi Arabia, allowing 100% ownership in the country’s trading sector. The license advances Dow’s ability to deliver products that will benefit Saudi Arabia in the areas of sustainable development, energy efficiency, oil and gas, alternative energy and water.
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South Korea | Propane dehydrogenation project

Clariant has reported the successful performance of its catalysts during the startup of the largest propane dehydrogenation (PDH) unit in South Korea. Located in Ulsan on the southeast coast, the PDH plant is a joint project between SK Gas Corporation Ltd and Advanced Petrochemical Company. The facility is designed to produce 600,000 tpy of propylene using CB&I’s Catofin® catalytic dehydrogenation technology, which is based on Clariant’s Catofin catalyst.

The Catofin process operates at optimum reactor pressure and temperature to maximise conversion of propane for a high yield of propylene and correspondingly low investment and operating costs. The PDH plant in Ulsan has achieved a fast startup time with on-specification propylene produced within one day of propane feed introduction. 100% of the design capacity was available in less than 15 days, and the plant is currently operating slightly above 100% capacity. Design conversion rate has already been reached at lower than expected temperatures. These highly favourable startup results mirror those achieved in previous startups.

USA | New natural gas processing plant

Enterprise Products Partners L.P. has announced plans to build a new cryogenic natural gas processing facility and associated natural gas and natural gas liquids (NGL) pipeline infrastructure to facilitate continued growth of NGL-rich natural gas production in the Delaware Basin of West Texas and southeastern New Mexico. The site for the new processing plant, which will have a nameplate capacity of 300 million ft³/d and the capability to extract more than 40,000 bpd of NGL, has yet to be determined. The project is anchored by long term commitments from a major producer. The facility is expected to begin service in 2Q18. In addition to providing new gas processing capabilities, the scope of the project will include the construction of rich natural gas gathering lines, a residue pipeline to Waha and an NGL pipeline to Enterprise’s Mid-America Pipeline system. These assets will be designed to integrate with the rest of the company’s Delaware Basin infrastructure.

UAE | Ethylene facility expansion

Wiscon Engineering has kicked off its first engineering procurement and construction (EPC) project in the United Arab Emirates. Located in the west of Abu Dhabi, it is part of an ethylene plant expansion project, run by a leading provider of innovative, value creating plastics solutions. Wiscon’s scope of work includes EPC services for the project, which is scheduled for mechanical completion in October 2017. The project signifies the company’s breakthrough into the core Middle Eastern market, and showcases its recognition among project owners and operators in the region. To offer more customised services to local project owners, the company has established a project execution centre and set up a local design, procurement and project management team in Abu Dhabi, which will allow Wiscon to allocate its resources more efficiently and respond faster to local project needs.
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**API | Rising petroleum demand**

A suggestion was made to raise taxes on energy and pick winners and losers in the marketplace at the Senate Finance Committee hearing titled Energy Tax Policy in 2016 and Beyond on 14 June. According to API Executive Vice President Louis Finkel, this is backward facing, and could threaten America’s energy revolution and harm consumers. “America’s oil and natural gas industry pays some of the highest tax rates among US businesses, generating billions of dollars every year in revenue for the federal government. Instead of calling for higher taxes that discourage domestic production, policymakers should follow pro-development energy policies that create jobs, improve our broken and outdated tax code, and help our nation provide affordable and reliable energy for consumers. “A strong domestic oil and natural gas sector provides hundreds of thousands of workers with well paying jobs and indirectly supports millions of additional jobs. By embracing America’s energy renaissance, we embrace America’s role as an energy super power — and any changes to the tax code should support this,” Finkel noted.

**IEA | Global oil market update**

Outages in OPEC and non-OPEC countries cut global oil supply by nearly 800 000 bpd in May. At 95.4 million bpd, output stood 590 000 bpd below a year earlier. Non-OPEC supply growth is expected to return in 2017 at a modest 200 000 bpd, after declining by 900 000 bpd in 2016, according to the International Energy Agency’s (IEA) Oil Market Report for June.

Refinery runs in 2Q16 are suffering from deepening outages. Throughput is nearly flat year on year, as refiners finally catch up with maintenance postponed from 2015. The seasonal ramp-up to 3Q16 is expected to be the largest on record, surging by about 2.3 million bpd quarter on quarter.

**MEI | LNG oversupply predicted**

McKinsey Energy Insights (MEI) predicts in its latest research that LNG oversupply could last until 2024. As a result, this could mean that few LNG projects will reach final investment decision (FID) in the next 12 to 18 months.

MEI’s research shows that the current global LNG supply glut is exacerbated by the 100 million tpy of new export terminal capacity currently under construction in the US and Australia. Furthermore, by 2019, oversupply will peak at 60 million tpy.
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The US petrochemical industry is expanding at a rapid clip, due largely to the growth of natural gas. But how long can this last? Gordon Cope, Contributing Editor, explores the opportunities and challenges facing the sector.
The US petrochemical sector is in a virtual renaissance. According to the US Energy Information Administration (EIA), in 2012, domestic ethylene nameplate capacity stood at approximately 29 million tpy. Between 2013 and 2015, a series of 15 projects involving capacity expansions, feedstock conversions or restarts added approximately 2 million tpy of nameplate capacity (and 140,000 bpd of ethane throughput capacity) to the industry. They include Dow Chemical’s restart of the Hahnville, Louisiana, plant, LyondellBasell’s expansion at LaPorte, Texas, and Westlake Chemical’s feedstock conversion at Calvert City, Texas.

In addition, five new plants are expected to come onstream in 2017:

- Dow Chemical is building a 1.5 million tpy facility in Freeport, Texas.
- Oxychem/Mexichem will start up a 544,000 tpy plant in Ingleside, Texas.
- Chevron Phillips and ExxonMobil are on pace to open their own 1.5 million tpy projects in Baytown, Texas.
- Formosa Plastics will cut the ribbon on its new 1 million tpy plant in Point Comfort, Texas.

In all, the 2016 expansions and 2017 greenfield projects will add over 7 million tpy of nameplate
capacity (and 400,000 bpd of new ethane throughput capacity). By the end of 2017, the US ethylene nameplate capacity is expected to exceed 38 million tpy, which represents almost 40% growth.

And, there is much, much more in the hopper. “We have compiled a list of 264 new chemical industry projects due to the shale gas revolution,” said Melissa Hockstad, Vice President, Petrochemicals, at the American Fuel and Petrochemical Manufacturers (AFPM). “They represent US$164 billion in capital investment. 40% of these have already been completed or are underway. They include everything from ethane crackers to propane dehydrogenation.”

Over half of these projects are by companies based outside of the US, according to Hockstad. “They realise that this is the place to be.”

There are several reasons for the unprecedented growth. Demand for plastic and related materials is booming. According to IHS Chemical research, petrochemical demand is expected to grow 40% worldwide in the next 10 years. “The world needs what the petrochemical industry makes, and it will need much more in the future,” said Daniel Yergin, Vice Chairman at IHS.

A stable political and social climate, resurgence in post-recession demand and proximity to markets are all important factors, but when it comes to the US’ burgeoning petrochemical industry, one reason stands head and shoulders above all the rest: the price of natural gas.

**Shale tale**

Natural gas plays an essential role in the petrochemical industry, as both the source of feedstock and a flexible energy supply. It takes about 20,000 ft³ of ethane feedstock and the equivalent of another 26,000 ft³ of natural gas to make 1 t of ethylene. A decade ago, when the US was producing less than 50 billion ft³/d, the cost was over US$12/million Btu, too expensive for most plant operators to turn a profit.

That all changed when advances in horizontal drilling and rock fracturing opened up immense resources. The Texas Barnett shale was the first major source of unconventional gas, and now supplies around 5 billion ft³/d. Other shale plays, including the Marcellus formation that underlies West Virginia, Pennsylvania and Ohio, soon followed. The EIA estimates that gross natural gas production in the lower 48 US states will reach a record high of almost 75 billion ft³/d. As a result, prices have plunged. Since 2008, prices have fallen to under US$3/million Btu, and are not expected to increase greatly for the next several years.

In addition, drillers are increasingly targeting the fluids-rich portions of shale. The Eagle Ford shale, for instance, was originally a gas play but quickly evolved into a fluids play; since 2010, oil, condensate and natural gas liquids (NGLs) production from this one Texas formation alone has grown from virtually nothing to almost 1.4 million bpd.

Total US NGL production (ethane, butane and propane combined), which stood at 2.2 million bpd in 2011, reached 3.86 million bpd in 2015. Of that, ethane forms approximately 1.2 million bpd of production. While petrochemical plants can be retrofitted to handle either naphtha or ethane, most jurisdictions do not have a large ethane supply and dedicated infrastructure. Asian and European plants rely on naphtha, but naphtha is almost four times as expensive a feedstock. Ethane, which is currently selling for under US$0.2/gal. (US$150/t) in North America, is a tremendous bargain. A plant with a capacity of 1 billion lb/y (450,000 tpy) saves approximately US$680 million/y by using ethane, instead of naphtha, as feedstock.

The US Gulf Coast (USGC) also has sufficient infrastructure to deliver vast amounts of ethane. Ethane is fractionated (or stripped) by running natural gas through a turbine; as the gas expands, it chills to -100°C, the liquefaction point of ethane. Most Gulf Coast fractionation facilities are located in the Mont Belvieu, Texas, region; Enterprise Products Partners, for instance, has been adding NGL fractionators, and now has over 1 million bpd of fractionation capacity system-wide in the region. In addition, Enterprise recently completed its Aegis Pipeline network expansion. The 400 km line can deliver up to 425,000 bpd of pure ethane to 20 petrochemical customers located between Beaumont, Texas, and Napoleonville, Louisiana.

Once the ethane arrives at a petrochemical plant, it is used to make ethylene (also called ethene by the International Union of Pure and Applied Chemistry). Ethylene is a colourless, flammable gas. The primary conversion process is steam cracking, where steam heated to 900°C is used to break down ethane into the ethylene alkene compound (a hydrocarbon with double carbon bonds).

Ethylene is useful in many different ways. Polymerisation converts it into polyethylene plastic for packaging and rubbish bags. Oligomerisation makes detergents and lubricants. Oxidation produces ethylene oxide, which is used to make anti-freeze glycols. Oxychlorination makes polyvinyl chloride (PVC), a rigid plastic used in piping.

**Tribulations**

The petrochemicals sector in North America is not without its challenges. The US Environmental Protection Agency (EPA) has proposed and enacted a wide range of emissions standards for hazardous air pollutants at industrial sites, from refineries and petrochemical factories to storage vessels and transfer facilities. “Since 2000, the EPA has added 19 new rules; each one has cost over US$1 billion in compliance each year,” said Hockstad. “And, over the last 12 months,
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API: CARBON REGULATIONS MUST BE FLEXIBLE
According to API Senior Director of Regulatory & Scientific Affairs, Howard J. Feldman, the EPA’s proposed Clean Energy Incentive Programme (CEIP) under the Clean Power Plan (CPP) must embrace the effectiveness of natural gas in reducing carbon emissions.
For further information go to www.energyglobal.com/downstream

EIA: GAS-FIRED ELECTRICITY TO EXCEED COAL BY 2022
For further information go to www.energyglobal.com/downstream
There has been a significant increase in environmental regulations. The Ozone National Ambient Air Quality Standard (Ozone NAAQS) and the Clean Power Plant Act will add over US$100 billion in new costs.

This, according to Hockstad, makes it difficult for the US to compete internationally. “The industry incorporates all the newest technologies in order to ensure that the impact on the environment is as little as possible. But there is a true need for regulatory reform. There is far too much duplication, prematurity and conflicting regulations.”

Permitting delays are also a challenge. “When you are building a new facility, you need to be able to establish a time frame for when you can expect various permits,” Hockstad noted. “You need a certain amount of certainty.”

There are many reasons for delays, which can occur at local, state or federal level. “As an example, a few years ago, there was a shutdown of the federal government that lasted two weeks,” said Hockstad. “One of our members was waiting for an environmental permit; that two week shutdown resulted in a delay of two months.”

Delays increase uncertainty and cause budget creep, Hockstad highlighted. “When you are planning a major project, you put together teams for certain aspects. If you are planning on one year for permits, and delays push that out to 18 months, then it adds significant costs.”

Recently, there has been some positive news on permitting. “In 2015, Congress passed the FAST Act, which stands for Fixing America’s Surface Transportation,” said Hockstad. “It is designed to improve America’s roads, bridges, rails and other surface infrastructure. It includes an important streamlining aspect. Our members need reliable transportation to move raw materials and final products, and this is a step in the right direction.”

Also on the positive regulatory side, the petrochemical industry is supportive of recent updates to the Toxic Substances Control Act (TSCA, which was first passed in 1976). “It is a law that covers the handling and production of chemicals,” Hockstad said. “There have been a lot of changes to the industry over the last 40 years, and we have been pushing to modernise the bill. Both the Senate and Congress reviewed and approved versions in 2015, and we are awaiting a combined version. There have been a number of positive changes, everything from federal pre-emption to updating of confidential information components. We are very much in favour of the reforms.”

**Skilled workforce**

An ageing workforce is one of the major issues facing the petrochemical sector. “We need new workers,” said Hockstad. “The average age for a welder is 55, and so we are going to see significant retirement in the next 5 - 10 years. Unfortunately, we are not seeing younger members interested in the skilled workforce. We need to work with the industry to attract young workers.”

In 2015, the AFPM launched their Recruitment Challenge programme. “We approached 10 colleges and universities in the US with the proposal to support student class projects,” Hockstad said. “These projects asked communications, marketing and business majors to come up with recommendations on how to communicate career opportunities to millennials, those in the 18 - 34 age bracket. The winning teams recommended that we focus on a number of initiatives, including the increased use of social media, one on one opportunities to interact with members of the petrochemical sector, and increasing the amount of information available about the industry.”

**Whence natural gas**

Although most signs are bright for the sector in the near future, new petrochemical plants can take five or more years to go from the planning stage to commissioning. If a cheap, bountiful source of feedstock is the most important factor affecting a project's profitability, what are the prospects for natural gas (and ethane) in North America over the latter half of this decade, and beyond?

While the EIA is reporting record high oil production for 2015, longer term prospects are uncertain. The low price for oil has affected drilling in oil rich prospects such as the Eagle Ford shale in Texas. At the beginning of 2015, the rig count for the Eagle Ford was 200; it has since shrunk to under two dozen. Oil shale wells have decline rates as high as 70%/y, and production, which peaked at 1.6 million bpd in late 2015 has now dropped to 1.3 million. Observers expect it to be around 1 million bpd by the end of the year. While the decline may help rebalance supply and demand for oil, the play also features NGLs, including ethane; as shale oil plays decrease in production, so does petrochemical feedstock.

Demand for natural gas is also increasing in other sectors. In 2015, gas overtook coal as the primary source of fuel for electricity generation in the US. A decade ago, coal accounted for approximately 50% of all generation, but has since fallen to the point where it now stands at 33%, and natural gas at 34%.

Part of the gas to power (GTP) trend is due to low gas prices that are encouraging switching (Henry Hub spot prices fell below US$2/million Btu in early 2016), but part is also a structural shift in the industry. Since the beginning of 2015, operators have shut over 17 000 MW of coal plants as stringent new environmental rules make it uneconomic to upgrade them. A sustained trend of switching will help bring gas supply and demand into balance, portending a rise in prices.

Exports of natural gas and NGLs are also increasing. Cheniere Partners, which owns an LNG import terminal in Sabine Pass, Louisiana, has been contracting with...
various international firms to ship LNG to Europe. Construction of Cheniere’s US$6.5 billion liquefaction train finished by 2015, and the company began its first exports. Mexico is also becoming a significant destination for US natural gas, as the country’s electricity sector switches generation from fuel oil to natural gas. Exports averaged 3 billion ft$^3$/d in 2015, and may triple within the decade.

Earlier this year, the first waterborne shipment of ethane left the US from facilities at Marcus Hook, Pennsylvania. A second ethane export facility is being built in Morgan’s Point, Texas. “The EIA expects to see approximately 80,000 bpd exports in 2016, and 90,000 bpd in 2017,” said Hockstad.

There is also a growing public concern over hydraulic fracturing, one of the key technological advances that makes shale gas economically viable. During the process, several million litres of water are forced at high pressure down the well and into the shale to create a network of tiny fractures that allow the gas to escape. The water itself is often treated with proprietary chemicals in order to decrease the viscosity (and thus increase penetration) of the water. Various jurisdictions are concerned that these chemicals, some of which are known carcinogens, could leak into adjacent groundwater aquifers and contaminate drinking supplies. Several states and municipalities have imposed moratoriums and bans; if too many regions follow suit, the shale gas revolution could be severely constrained, causing gas prices to rise.

While all of the above factors have the ability to put upward pressure on North American gas prices, the continued expansion of unconventional gas supplies is expected to continue for several years to come, as current plays are fully exploited, and new plays in relatively untapped basins continue to add to the supply chain.

In the meantime, US petrochemical companies will increasingly export production to countries less blessed with low feedstock prices. Monthly production of high density polyethylene (HDPE), for instance, rose from approximately 1.5 billion lb in January 2015, to 1.6 billion lb in January 2016. Comparing the same two months, exports rose from 200 million lb to 300 million lb. Major destinations included Mexico, China and Canada. Export growth is expected to increase in double digits for the next several years. “There is no shortage of issues, but we know that growth will continue going forward. It is a great time to be involved,” Hockstad concluded.
That was a sample of Hydrocarbon Engineering July Issue

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