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PRODUCED BY MARKETING AND SOLUTIONS DEVELOPMENT

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I have been looking back over the past four years and reflecting on the changes that have occurred in our industry since my first involvement with Impact in 2009. Over this period, the global energy market has been reshaped by world events, changes in government legislation and growing acceptance of the need to modify energy use and minimise the negative effects of climate change. Major social and political shifts in Asia, the Middle East and North Africa have contributed to the sense that we are living in changing times.

Impact naturally reflects these changes and this issue provides a clear snapshot of current issues and the challenges that lie ahead.

How an increasing focus on sustainable development by commercial organisations can complement and enhance the aid programmes run by governmental and charitable organisations in the developing world is illustrated by the article on page 4. This takes a look at providing access to cleaner energy solutions for the world’s poorest people.

We would all like to know what the future holds, but, unfortunately, crystal balls are none too reliable! In Shell, we use a scenario planning method that examines possible consequences of the current trends in our industry and in a global society that faces rapid population growth and surging demand for access to energy resources (page 6).

The greatly increased focus on industrial emissions and continuing reliance on fossil fuels mean that we need technologies to make coal a more attractive and environmentally sustainable fuel source for power generation. We look at one option on page 8.

Another challenge for operators relates to managing the refining–petrochemicals interface, particularly when it comes to a change on one site that will affect the other. However, taking such an integrated approach, such as to the catalyst selection process described on page 10, can deliver enormous value for the overall enterprise.

The downstream sector thrives on change and challenge. The past four years have been a particularly interesting time for everyone associated with the oil and gas industry and we should all be looking forward to the next part of the story.
The concept of sustainable development has become a highly visible and central part of commercial activities for many companies. But what is it?

The Sustainable Development Commission, the UK government’s independent adviser on this issue, defines sustainable development as “development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.”

The concept is open to interpretation, but, in essence, it is a framework for development that balances different and often competing needs against an awareness of environmental, social and economic limitations.

Shell’s contribution to sustainable development is about both what it does, i.e., supplying energy to meet growing needs, which, in turn, helps to support economic growth and development, and how it does it, i.e., bringing safety, environmental issues and local communities to the heart of its business.

For example, at a local level, Shell projects and facilities are a part of many communities around the world. The organisation aims to have a positive effect in those communities and, through its business, can create jobs and business opportunities, and support community development projects.

Shell also supports community development projects directly and indirectly through the Shell Foundation. Established in 2000, this independent, UK-registered charity has applied business thinking to tackling global development challenges. It focuses on job creation by small enterprises, making supply chains more sustainable, improving urban design and transport systems, and enabling access to energy services and products.

Access to modern energy continues to be a major challenge in many parts of the developing world. Worldwide, nearly three billion people rely on wood, coal, charcoal or animal waste to cook their meals or heat their homes, according to the World Health Organization. In addition, daily exposure to harmful smoke from traditional cooking practices is one of the world’s biggest, but least known, killers.

Nearly four million people die prematurely each year from illnesses such as pneumonia, chronic obstructive pulmonary disease and lung cancer that are related to indoor air pollution. In poorly ventilated dwellings, indoor smoke levels can be 100 times higher than...
The methane and sooty particles emitted by inefficient combustion in stoves are also powerful climate change pollutants.

Since 2002, the Shell Foundation has been a pioneer in addressing household air pollution and energy access through business thinking. This represents a radical departure from the more traditional solutions, which have seen non-governmental organisations and governments give away or subsidise improved stoves.

The principle has been to use a market-based approach: fostering a global market for clean and efficient household cooking solutions to make clean cooking more affordable and accessible. Over the past decade, the Shell Foundation has invested over $30 million to help establish a viable clean cookstoves sector, which is benefitting more than four million people. Over that time, the Foundation has helped to develop and scale up one of the world’s leading clean cookstoves businesses, Envirofit International, and is tackling critical market barriers such as product design and affordability; fostering market demand; and creating new distribution channels to reach the poorest customers.

In 2010, Shell and the Shell Foundation jointly founded the Global Alliance for Clean Cookstoves. The Alliance aims to improve access to cleaner energy solutions for the world’s poorest people and has the goal of enabling 100 million homes worldwide to adopt clean cooking solutions by 2020.

Building on the Shell Foundation’s support, Shell is providing $6 million in targeted funding to facilitate clean cookstove markets. This facilitation includes business expertise, for example, a secondee, to help develop global standards and make sure that customers can obtain good-quality cookstoves that are approved and tested in each local market.

David Martin, Shell Executive and Global Alliance Advisory Board member, says, “To date, our $6-million contribution to the Global Alliance for Clean Cookstoves has gone towards developing international standards for clean and efficient stoves, rigorous testing protocols and local testing centres. We have focused our support on Nigeria, China, South Africa and East Timor, and we will work with the Alliance to expand this support over the coming years.”

Impact readers who completed a recent questionnaire made a welcome contribution to the funding of the Global Alliance for Clean Cookstoves programme. For each completed questionnaire, Shell Global Solutions donated to the Global Alliance. Readers who took part in the survey raised a total of $1,200.
The decisions that we make today are the key to our future. This is true for individuals, commercial organisations and even nation states. Trying to predict which choices will be most beneficial can be extremely difficult, and these challenges become progressively harder as we look further ahead and try to assess the consequences of future events.

There is no doubt that we live in changing times. By 2050, the global population will be about nine billion and, with millions of people climbing out of poverty, global energy demand could be as much as 80% higher than it is today. That is one of the conclusions from Shell’s “New Lens Scenarios”, which were launched at the Center for Strategic and International Studies in Washington, USA, by Peter Voser, Chief Executive of Royal Dutch Shell, and Jeremy Bentham, Head of Shell’s Scenarios Team.

These new scenarios examine economic, political and energy supply trends to predict what might happen over the coming decades. Making predictions on this scale may seem an enormously ambitious task, but, for more than 40 years, Shell has been looking into the future and developing a systematic discipline of scenario planning to help it, and various governments across the world, to make better choices (see Impact Issue 1, 2013, page 6).

Covering a vast and complex subject area, the Shell Scenarios attempt to make sense of global trends and to promote wide-ranging discussions about the future. Bentham says, “The success of these scenarios lies not only in the strategic insights that they provide, but also in the approach they offer to developing and sharing these insights.”

The “New Lens Scenarios” document is subtitled “A Shift in Perspective for a World in Transition”. Bentham says, “[This] reflects current volatility and multiple transitions in economic, political and social spheres, and a heightened focus on issues around energy and environment. Given the transitions we are seeing at present, it is unrealistic to propose a single view of tomorrow’s world. From networks of power and the pace of change to the policy agenda and resource landscape, it is perspective that shapes perception.

“Our scenarios provide a detailed analysis of current trends and how we expect them to develop. They examine implications for the pace of global economic development, the types of energy we will use to power our lives and the anticipated growth in greenhouse gas emissions. Looking at what might happen over the next 50 years,” he continues, “we have identified two possible scenarios of the future, which we are calling ‘Mountains’ and ‘Oceans’. These scenarios take into account various paradoxes and pathways that we use as ‘lenses’ through which to view the world.”

The “New Lens Scenarios” identifies three major paradoxes: prosperity, leadership and connectivity. The prosperity paradox, for example, examines the balance between economic development and the associated environmental, resource, financial, political and social stresses that can undermine some of the benefits of prosperity. Private gains can flourish while
public costs mount, and greater comforts today may lead to greater risks tomorrow. In pathways, there are two distinct possibilities: “room to manoeuvre”, where financial, social, political or technological capital encourages early action and results in effective change or reform; and “trapped in transition”, where financial, social, political or technological capacity proves inadequate to withstand stresses. Behavioural responses delay change and cause conditions to worsen until, ultimately, a reset is forced or a collapse occurs.

Shell has drawn these paradoxes and pathways into two separate scenarios. The Mountains scenario sees a strong role for governments and the introduction of firm and far-reaching policy measures that help to develop more-compact cities and transform the global transport network. New policies unlock plentiful natural gas resources, thereby making gas the largest global energy source by the 2030s, and accelerate carbon capture and storage technology to support a cleaner energy system.

The Oceans scenario describes a more prosperous and volatile world where energy demand surges in response to strong economic growth. Power is more widely distributed and governments take longer to reach major decisions. Market forces rather than policies shape the energy system: oil and coal remain part of the energy mix but renewable energy also grows. By the 2070s, the world’s largest energy source is solar.

Some of the key factors the “New Lens Scenarios” consider are:

- intensified economic cycles related to the “great moderation” in advanced industrial economies;
- heightened political and social instability stimulated in part by economic volatility;
- tensions in the international order, as multilateral institutions struggle to adjust to shifts in economic power and other arrangements proliferate;
- significant demographic transitions involving ageing populations in some places and youth bulges in others, and relentless urbanisation in both fast-emerging and less-developed economies;
- surging energy demands driven by growing populations and prosperity, new energy supplies emerging while others struggle to keep pace, and greenhouse gas emissions increasing, particularly from growth in coal consumption;
- the deployment of technological advances enabling rapid growth in resources plays such as shale gas and liquid-hydrocarbon-rich shale;
- the advancement of technology for utilising renewable resources and a rapidly growing supply from a small, but established, base; and
- better defined and significantly challenged ecological boundaries, including pressures arising from the water–energy–food stress nexus in response to greater supply and demand tightness.

Faced with so many issues, is it really possible to create a useful model of the future? Bentham believes so. “Given these developments, any plausible outlooks that we come up with will be messy and patchy,” he says. “Nevertheless, we have found that these new lenses can help us view familiar landscapes from fresh angles, which helps us focus on and clarify possible futures. As always, drawing on the knowledge and imagination of a network of gifted people, both within and outside Shell, has been vital to the success of our scenario building efforts.”

Despite the complexity of the challenge, Bentham believes the “New Lens Scenarios” stay true to the ethos of Shell’s scenario building pioneers. “The early scenario developers embraced intuition, uncertainty and engagement,” he says. “They did not shy away from talking about what could be considered unimaginable. Today’s scenario builders do the same, although they use much more complex econometric models and sophisticated methodologies. The process now includes a huge range of short-, medium- and long-term portraits of global energy developments and individual country analyses. We also factor in the effects of major social trends such as urbanisation.”

Within Shell, scenario building is recognised as a useful and sophisticated tool, but that is only part of the story. “The other part of our challenge is to communicate the findings from our scenarios in a clear and compelling way,” Bentham explains. “The greatest benefits from the work we have done will only come once we have engaged the decision-making executives, shared what we have found and helped to influence how their decisions shape the future.”

For the full report, visit www.shell.com/global/future-energy/scenarios.html.

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A key step in emissions control for coal-fired power generation is being taken at Aberthaw power station, UK. The operator, RWE Generation SE, has partnered with Shell Cansolv to develop a 3-MW pilot plant for carbon dioxide (CO₂) and sulphur dioxide (SO₂) capture at the power station. The pilot plant, which started operation in January 2013, is the world’s first integrated CO₂/SO₂ capture facility.

Coal is the world’s cheapest and most abundant fossil fuel, but burning it releases CO₂ and SO₂ into the atmosphere. This has prompted calls for a radical reduction or even the abandonment of coal for applications such as power generation. However, the power-generation industry can now apply effective capture techniques to cut emission levels substantially at coal-fired power plants.

One solution is downstream scrubbing of flue gases to capture CO₂. This process, referred to as post-combustion capture, removes the CO₂ before the flue gases reach the atmosphere through the power station’s stacks. According to climate scientists, this approach could play a significant role in helping to reduce the effects of climate change. Estimates suggest that capturing CO₂ at emission points and storing it underground could deliver about 20% of the reductions that the Intergovernmental Panel on Climate Change has recommended to avert the worst effects of climate change.

RWE Generation SE and Shell Cansolv are using the combined plant at Aberthaw to test technology for treating flue gases. This work is a vital part of the research programmes on carbon capture. Devin Shaw, Global Sales Manager, Shell Cansolv, says, “The post-combustion plant at Aberthaw captures 50 tonnes of CO₂ a day. By using CANSOLV™ scrubbing technologies, this ground-breaking regenerable system can capture 90% of the flue gas CO₂ and essentially all of the SO₂.”

According to Shaw, there are other benefits to consider when using the regenerable system. “This technology means that the plant avoids the landfill disposal issues associated with conventional, non-regenerable scrubbing systems,” he says. “Reusing the absorbent by recycling cuts waste and reduces costs by minimising the need to restock. We believe that this makes CANSOLV technology applicable for a broad range of industrial applications.”

CO₂ and SO₂ scrubbing systems are proven technologies that have been used to clean gases in the oil industry for more than 80 years, but this is the world’s first application of an integrated CO₂–SO₂ capture system at a power-generation facility. Applying CO₂ capture to the flue gases of a coal-fired power plant is new and the scrubbing technique must be adapted to meet power plant conditions. For example, the flue gas streams of a coal-based power station contain 3–5% oxygen, whereas most of the gas streams dealt with in the chemical industry contain no oxygen, as they are pre-combustion streams. The Aberthaw project is a useful opportunity to test a new generation of CO₂ solvents and SO₂ solvent enhancements.

Aberthaw marks a significant point in the commercial application of combined CO₂ and SO₂ capture techniques. According to...
Mattias Hartung, Chief Operating Officer at RWE Generation SE: “This pilot plant at our Aberthaw power station is another step on the road to giving us the choice of technologies we need to create a modern, efficient and diverse energy portfolio that is capable of guaranteeing continuity of supply while reducing costs and CO₂ emissions.”

Shell Cansolv has developed a mini-plant to demonstrate the concept, but this system, which fits on the back of a truck, is too small to give realistic performance figures. The Shell Cansolv and RWE Generation SE pilot plant is large enough to fit into a commercial process environment and will deliver invaluable information on applying the process at a commercial scale.

The Aberthaw unit is designed to be modular and transportable on skids. Shell Cansolv had the unit designed in Canada and sourced all the necessary materials in North America and Europe before sending them to China for construction of the plant. Shell Cansolv employees went to China to supervise the construction and to ensure that the unit met the standards RWE Generation SE had defined. Once fabrication was complete, the system was sent to the UK for erection.

There were some technical and logistical challenges to be overcome. “One of the key issues was getting the two units, which operate in series, to work together as intended,” Shaw explains. This is obviously a crucial aspect of the work that we are doing at Aberthaw, and we are delighted to have achieved an effective solution. There were also some challenges in securing a licence to operate the system in the UK. This reflected the facts that the proposed system was the first of its kind, which required a complete examination of the technology by the regulatory authorities, and that it had been developed through a multinational design and fabrication process, which complicated the statutory process of checking component quality and standards.”

The initial feedback on the performance of the combined capture system at Aberthaw has been good. The units are performing as expected and a CO₂ removal rate of 90% has been achieved, along with well over 99% removal of SO₂. The pilot plant will also be run at various levels of CO₂ capture to help optimise the combined capture process with a view to applying it in larger units.

Shaw is looking forward to applying the combined capture process at full size in a commercial plant. “Using our system to manage all the flue gas emissions at a 150-MW plant will pose significant challenges in chemistry, engineering and operations. In terms of chemistry, the main challenge will be scaling up the capacity for CO₂ capture. The engineering and operational challenges will focus on minimising the energy use of the capture units. CO₂ scrubbing currently has higher energy requirements than we would like for deployment in power stations. The experience we gain in the Aberthaw pilot project will help us deliver improved scrubbing solutions that require less energy for CO₂ capture,” he concludes.

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OPTIMISING ENTERPRISE ECONOMICS

How a catalyst selection study for Pernis refinery’s hydrocracker also benefited the neighbouring Moerdijk petrochemical plant

The scope of a hydrocracking catalyst selection study is usually confined to improving the unit’s kerosene and gas oil output, the level of conversion and the cycle length. A recent study at Shell’s Pernis refinery in the Netherlands, however, had another level of complexity because the unit’s technologists were concerned about the potential for adverse affects on Shell’s nearby Moerdijk petrochemicals facility.

Pernis’ 9,000-t/d hydrocracker is a once-through, single-stage, stacked-bed unit. It generates a product slate that includes Jet A1 and ultra-low-sulphur diesel. It also yields hydrowax (unconverted oil) that can be sent to the refinery’s fluidised catalytic cracker but is preferentially routed to the 3,800-t/d steam cracker at Moerdijk, which is 35 km southeast of Pernis.

Jeroen Groenhagen, Senior Technologist, Shell Pernis, was responsible for the catalyst selection study and, later, for loading and starting up the hydrocracker after the new catalyst package’s installation. He says, “We wanted to evaluate installing a completely new cracking catalyst from Criterion Catalysts & Technologies called ZFX10, which uses a special zeolite technology designed to increase middle distillate yield, product quality and catalyst stability.”

However, the hydrogen content of the hydrowax was a particularly important parameter for Moerdijk because it has a big impact on the ethylene and pitch yields, and the furnace run length. If the new catalyst had altered the hydrowax’s hydrogen content, this might have adversely affected Moerdijk’s economics.

“The lower the hydrogen content in the hydrowax, the more easily the furnaces in the steam cracker coke up,” Groenhagen explains. “Even the slightest deterioration in hydrowax quality can have a huge impact on ethylene yield, furnace run length and coke make. We really needed to understand that parameter’s behaviour over the run length of the catalyst and what it would mean in margin or dollar terms.

“Because market economics change all the time and there is such a wide range of catalysts available, it is very important that one makes a detailed study of what package to select,” he continues. “Are any changes to product specifications anticipated? What does the feed look like? Are any market changes expected? There is a lot of complexity owing to the number of variables and the uncertainty associated with those variables.”

Early engagement with the numerous stakeholders, such as the Moerdijk steam cracker technologists and process and catalyst experts from Shell Global Solutions and Criterion, was crucial.

Groenhagen says, because much depended on their cooperation.

In addition, as this was the catalyst’s first commercial application, he was keen to verify how it would perform in the Pernis hydrocracker and with Pernis’ specific feed, which is relatively heavy with high nitrogen and metal contents.

A full pilot-plant testing programme was commissioned at the Shell Technology Centre in Amsterdam, the Netherlands, to compare the performance of the novel cracking catalyst with the existing catalyst. Shell and Criterion often recommend pilot plant tests whenever there is anything non-standard about an application, such as an unusual feed or a novel catalyst.
“This was important because it gave us confidence that the catalyst package would deliver what it was designed to,” says Groenhagen. “It also verified the quality of hydrowax that we would be sending to Moerdijk.”

The results of the pilot plant tests fed in to the design of the catalyst package. In the pretreatment section, where the impurities that could poison the sensitive cracking catalyst are removed, Criterion designed a combination of hydrodemetallisation, hydrodenitrogenation and hydrodesulphurisation catalysts. Criterion carefully tuned the package. Performance is continuously monitored by site staff and Shell Global Solutions technologists to help ensure that the unit achieves the targeted cycle length and quality.

Nine months into the cycle, the new catalyst had performed very well. It has helped Pernis to maximise its middle distillate yield: it now makes more kerosene and diesel than before, and less naphtha while operating at a similar conversion severity.

Crucially, the petrochemical plant has also benefited. The catalyst selection study enabled Pernis’ technologists to optimise the hydrowax quality specifically for Moerdijk’s processes, which has helped to enhance ethylene yield and maximise the furnace run length.

“Taking such an integrated approach added substantial complexity to the catalyst selection process, but it also delivered enormous value for the overall enterprise,” Groenhagen concludes. “We have calculated that it has enhanced the combined economics of Pernis and Moerdijk by some $5 million a year.”

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MEETING TOUGH LIMITS

Advanced sulphur removal technologies applied at PDVSA facilities in Venezuela

The need to meet or exceed changing product specifications is of great concern at a time when the global economy is lagging and refiners are focusing on minimising costs. This pressure, combined with decreasing margins and heavier and sourer crude feedstocks, is forcing refinery management and engineers to find new solutions and develop rigorous business and technology strategies. Dealing with sulphur is a major issue for many refinery operators and is driven by the need to manufacture low-sulphur products while minimising plant emissions.

PDVSA, the national oil company of Venezuela, is working on two projects in the north of the country that have both received World Bank funding. As a condition of World Bank involvement, the new facilities have to achieve a very demanding level of sulphur removal (99.98%) and meet the challenge of limiting atmospheric release of sulphur dioxide to levels below 150 mg/Nm³ (approximately 100 ppm).

The first project is an expansion at the El Palito refinery, which aims to double the refinery’s capacity, enable processing of heavy and extra-heavy crudes from the Orinoco Belt, and increase the production of clean fuel. The second is at the Centro de Refinación de Paraguaná. This refinery complex is an amalgamation of the Amuay, Bajo Grande and Cardón refineries, and accounts for more than 70% of the available refining capacity in Venezuela.

Shell Global Solutions will contribute to the projects by helping PDVSA to optimise the mid- and deep-conversion complexes. This is scheduled to involve adding two new hydrotreaters and two new deep-conversion units, including designing and deploying the most advanced Shell Global Solutions sulphur-removal technologies. The two Shell licensed hydrotreating units at El Palito will deal with two distinct fractions: the heavy oil and diesel streams. Hydrotreating removes impurities such as sulphur and nitrogen before processing begins. Hydrotreating also produces hydrogen sulphide, which is sent to a sulphur recovery unit.
In the sulphur recovery unit, hydrogen sulphide gas from the hydrotreating process is partly burned to form sulphur dioxide and water. The sulphur dioxide reacts with more hydrogen sulphide to form sulphur and more water. Two distinct streams emerge from the sulphur recovery unit: sulphur, which is cooled to form a liquid, and gases, which are sent for further catalytic conversion. The liquid sulphur recovered from sour crudes contains dissolved hydrogen sulphide, which could be problematic if it were to leave the liquid sulphur and accumulate. There would be the possibility of explosion or of the gas reaching a lethal (>10 ppm) concentration. Consequently, the hydrogen sulphide content of the sulphur has to be reduced to a lower level, and this is envisaged to be supported by using Shell Global Solutions’ degassing technology.

“PDVSA approached us for support in meeting the World Bank’s emissions target because we have global knowledge in deep sulphur recovery and technologies for hydrotreaters,” says Pankaj Desai, Licensing Sales Manager Americas, Shell Global Solutions.

“In addition, the World Bank limit for atmospheric release is less than 150 mg/Nm³ (approximately 100 ppm) compared with the United States Environmental Protection Agency limit of 250-ppm sulphur dioxide content. This is a significant step change and a conventional Shell Claus off-gas treating (SCOT™) unit would typically be unable to meet this specification,” says Desai. “As an alternative solution, we proposed Low-Sulphur SCOT (LS SCOT) technology as part of the sulphur recovery complex. The complex at these refineries will consist of an integrated sulphur recovery unit, a tail gas unit, a sulphur degasser, an acid gas removal unit and a water-stripping unit. This is the most advanced sulphur-removal technology we can offer PDVSA to help it meet the tight World Bank limits.”

With the regulatory pressure to reduce emissions, effective sulphur recovery is a vital tool for optimising environmental performance in refinery operations. Shell has provided high-level sulphur recovery unit designs for many years based on the SCOT process and has modified the design by considering increasingly stringent targets, as Desai explains. “We have optimised the SCOT process to treat sulphur recovery unit tail gas to very low concentrations of hydrogen sulphide at the outlet of the amine absorber,” he says. “Consequently, under certain favourable operating conditions and when permitted, the thermal oxidiser can be operated in a hot standby mode instead of in a continuous mode, thus saving fuel. In addition, to improve process economics,” Desai continues, “we have increased the process’s energy efficiency by introducing the new Low-Temperature SCOT (LT SCOT) reactor. In this configuration, a low-temperature hydrogenation reactor typically enables us to replace the standard in-line burner/reduced gas generator with a simple steam-driven heat exchanger. Consequently, fuel demand is likely to be reduced and costs to be lower.”

In many facilities, the hydrogen sulphide recovered by the degassing units is disposed of in an incinerator. However, the lower limits that apply to the PDVSA projects mean that this seems not to be a possibility when the overall recovery efficiency has to be met. Shell Global Solutions’ option involves degassing the sulphur and returning the hydrogen sulphide to the inlet of the recovery unit for a second cycle. This approach is designed to help PDVSA to keep its atmospheric release of sulphur dioxide below the stringent 150-mg/Nm³ level. This integrated tactic, coupled with the use of LS SCOT technology, is designed to help meet the necessary emissions levels and recovery targets. Nestor Andara, El Palito Refinery Expansion Project Manager, PDVSA, says, “These technologies should enable PDVSA to process difficult crudes while meeting stringent emissions standards and minimising air pollution in the region. Sulphur removal will make a key contribution to meeting our emission objectives at these facilities.”

Detailed engineering work is under way for the El Palito design, and, at Centro de Refinación de Paraguáná, Shell is working to deliver the basic design package for the same line-up. “Sulphur recovery units play a crucial role in refinery designs: they help to maintain our licence to operate. If our sulphur recovery units are not working, the refinery has to close down. This makes it critical that the sulphur removal technology we choose has a strong track record for safe and reliable operations,” concludes Jose Vega, Clean Fuels Project Manager, Centro de Refinación de Paraguáná.

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As refinery operators turn their attention to processing high-sulphur crudes, one of the key issues they face is how to manage the high-sulphur by-products. Refineries that produce large volumes of low-value, high-sulphur residues may perform capital-intensive upgrading to transform them into more valuable products and/or sell the residue as bunker fuel for the marine market.

New regulations for marine fuels, however, are making it harder for refineries to sell high-sulphur residue on the open market. In January 2012, the maximum sulphur content in ship fuel was globally reduced from 4.5 to 3.5%; from 1 January 2020, it will be cut to 0.5%. The sulphur content allowed in emission control areas, such as the Baltic Sea, the North Sea and the English Channel, is currently 1.0% and, as of 1 January 2015, this will fall to 0.1%. According to an International Maritime Organization study, vessel operators will largely have to abandon heavy fuel oils once the sulphur content limit falls below 1%.

Refinery operators are already planning for this eventuality, as Joe Gelder, Business Developer Oil and Gas, Shell Cansolv, explains. “With the market for high-sulphur marine fuel shrinking, refiners need an economic alternative for disposing of high-sulphur residue.”
residue streams, as opposed to blending it with low-sulphur distillates,” he says. “One option is to use it as heavy fuel oil to meet the refinery’s own energy requirements. However, this option requires an approach that ensures the refinery does not breach its emission limits.”

The Indian Oil Corporation Ltd (IndianOil), for example, is planning a grassroots refinery and petrochemical complex at Paradip in the State of Orissa, India, with the option to use some of its residue as utility fuel in its boilers. The refinery will be able to process high-sulphur and heavy crude oils such as Kuwait and Maya, and stay within the emission limits. As a part of the refinery project, IndianOil intends to install two regenerative flue gas desulphurisation units downstream of the utility boilers. SO₂ from the flue gases generated in the utility boilers firing high-sulphur fuel oil will be absorbed into a proprietary CANSOLV™ solvent. The rich CANSOLV solvent will be regenerated to recover the SO₂.

Shell Cansolv has provided a process design package for the SO₂ scrubbing scheme that will be used at the Paradip development. Gelder says, “The CANSOLV SO₂ Scrubbing System is suitable for all applications burning sulphur-containing fossil fuel. It should bring significant benefits to the Paradip refinery, as an IndianOil representative explains. “This technology will benefit IndianOil’s Paradip refinery and enable it to use high-sulphur fuel oil in its utility boilers while still maintaining environmental norms. We will capture most of the sulphur the fuel contains and transform it into saleable elemental sulphur.”

“There were a few challenges to be overcome while designing the Paradip installation,” says Gelder, “One of the main challenges was the design of the pre-scrubber to pretreat the flue gas before the CANSOLV absorber. The gas flow rate at Paradip will be high and will require adequate quenching; for this, we will have two levels of spray nozzles. The design also had to account for the potential loss of quench water, if this should happen, we have designed a set-up that enables the water coming from the cooling water system to supply a separate quench line for use in an emergency.

“The pipeline between the absorbers and the regenerator areas is very long, about 3 km each way. To reduce the cost of piping, our design combines the rich absorbent from both absorbers in a single pipe, and then splits it at the strippers. We applied the same method to the lean absorbent,” concludes Gelder.

The use of residue as a refinery fuel could become an established model for new and existing refineries seeking to become “bottom-less”. The method is particularly useful for refineries operating in gas-constrained locations where the cost of imported gas for utility fuel is prohibitively high.

“This is the first time in IndianOil’s refineries of using this option to meet our emissions mandate,” adds the IndianOil representative.

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