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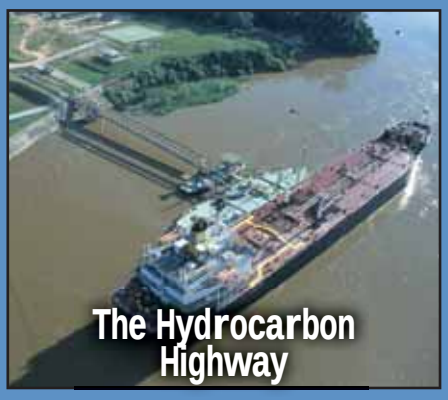
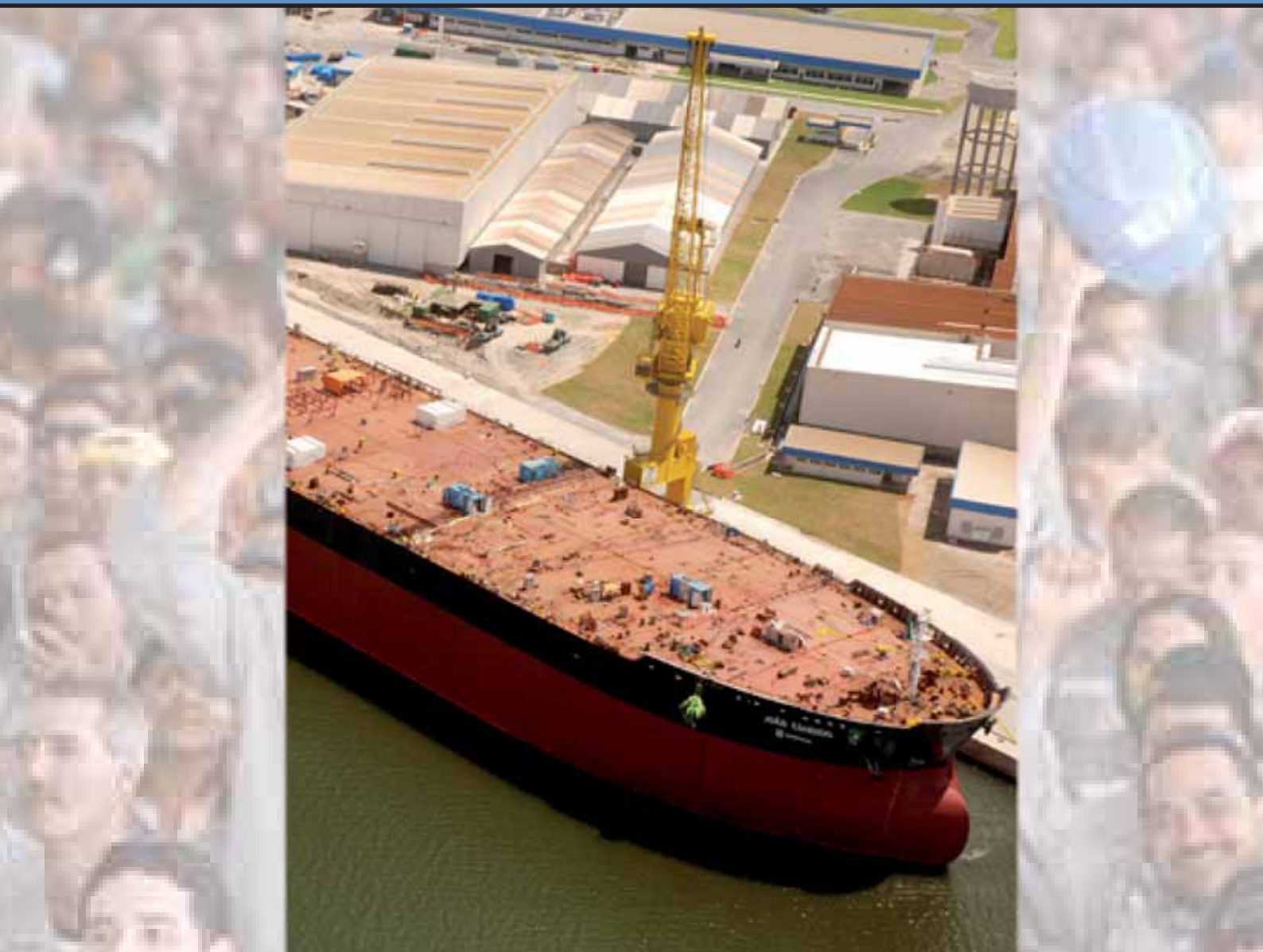
Petrobras Investments


Petrobras CEO Maria das Graças Foster


The Hydrocarbon Highway



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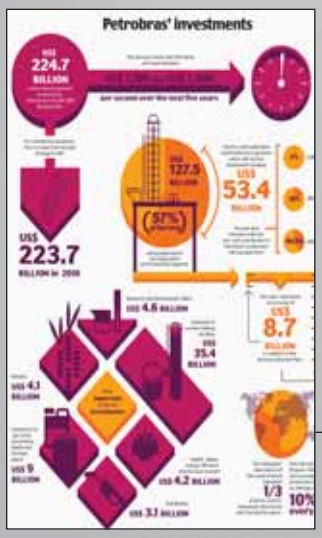
Contents



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Petrobras Start Production in Ultra-Deep Waters in the US Gulf of Mexico

The Cascade Field is located 250 kilometers off the Louisiana State coast, in the US Gulf of Mexico at an approximate depth of 2,500 meters. This Lower Tertiary reservoir is a promising offshore exploration area situated at a depth of about 8,000 meters.

Production began via the Cascade 4 well, which itself is connected to the BW Pioneer FPSO. This is the first Floating, Production, Storage and Offloading vessel to produce oil and gas in the US Gulf of Mexico. It can process up to 80,000 barrels of oil, and 500,000 cubic meters of gas per day, while also storing 500,000 barrels of oil.

The BW Pioneer is fitted with a 'detachable mooring system' enabling it to sail to sheltered areas during hurricanes and severe storms. This not only helps ensure the safety of the crew and environment, but also helps to protect the equipment.

The well is connected to the vessel platform by a system of subsea equipment and lines, as well as free-standing risers (vertical production lines). The oil shall be transported to land by shuttle tankers, and the gas through pipelines. Petrobras is the first company to develop an oilfield in the Gulf of Mexico using these technologies, which are systematically and successfully applied in Brazil.

The Cascade development project was implemented in full compliance with the company's Safety, Environment, Energy Efficiency and Health guidelines, and will continue to do so throughout the production phase which is now beginning.

Petrobras is the first company to develop an oilfield in the Gulf of Mexico using these technologies, which are systematically and successfully applied in Brazil.

Petrobras Total Oil & Gas Output in March Reaches 2.6 Million Barrels of Oil Equivalent per Day

Petrobras' combined domestic and foreign oil & natural gas output in March set an average 2,599,969 barrels of oil equivalent per day (boed). Output in Brazil averaged 2,346,477 boed and foreign output stood at 253,492 boed.

Of total domestic output, oil amounted to 1,993,222 barrels/day and natural gas 56.163 million m^3/day. In foreign fields, average oil production reached 151,077 barrels/day and natural gas 17.4 million m^3/day.

Maintenance shutdowns on platforms P-51 in Marlim Sul field, P-57 in Jubarte, and FPSO Brazil in Roncador, as well as the shutdown of the Campos Basin Frade field operated by Chevron, cut domestic output by 105,000 barrels/day, amounting to 5% of last month's figure (2,455,636 boed).

March Highlights

The extended well test (EWT) commenced in the Campos Basin post-salt layer in Olivia field, between the Pampo and Espadarte fields. The reserves in this area were discovered after drilling well 3-RJS-670 in May 2010, and recoverable volumes are estimated at 246 million barrels.

In foreign operations, the main highlight was the beginning of production in the Cascade field on FPSO BW Pioneer, moored some 250 km off the coast of Louisiana in the U.S. Gulf of Mexico, at a world record-breaking water depth of 2500 meters. Petrobras is the first company to deploy a floating production, storage and offloading (FPSO) platform in the Gulf of Mexico.

Petrobras is the first company to deploy a floating production, storage and offloading (FPSO) platform in the Gulf of Mexico.

Graça Foster Meets with Hillary Clinton in Brasilia

Photo: PETROBRAS NEWS AGENCY

In April, Petrobras CEO, Maria das Graças Silva Foster, met with the US Secretary of State, Hillary Clinton, in Brasilia. The meeting, which was promoted by the US government, took place 45 days after the US Deputy Secretary of State, William Burns, visited the Company's headquarters in Rio de Janeiro, where he was welcomed by the CEO.

On both occasions, there was a brief presentation on Petrobras' performance in the exploration and production in ultra-deep waters, especially as it is significant to the Company's advances in the pre-salt.

The Petrobras CEO considered the meeting very positive and highlighted the importance of dialogue to improve the relations between Brazilian and North American businesses in the energy sector.

At the meeting were the US Ambassador to Brazil, Thomas Shannon, and his counterpart the Ambassador of Brazil to the United States in Washington, Mauro Vieira. Also in attendance was the Director of the Department of Energy Foreign Ministry, Ambassador Mariângela Rebuá, and the US Secretary of the Interior, Ken Salazar.

The Petrobras CEO considered the meeting very positive and highlighted the importance of dialogue to improve the relations between Brazilian and North American businesses in the energy sector.

Petrobras' CEO 'One of the Most Influential People in the World', According to Time Magazine

Petrobras' CEO, Maria das Graças Silva Foster, was elected as one of the 100 most influential people in the world by Time magazine. The magazine's annual ranking is divided into categories that include artists, researchers, business people, political activists and heads of state.

Graça Foster is a chemical engineer and is the first woman to lead Petrobras. She took over from Jose Sergio Gabrielli as CEO in February 2012, after being selected by the board of directors. During her 32-year career with the Company, she has also been the CEO of Petrobras Distribuidora and the Director of Gas and Energy at Petrobras.

Commenting on the ranking, the CEO said, "Being chosen by Time magazine as one of the 100 most influential people in the world is much more than a reward for the battles I have won during my life, it is an acknowledgement of Petrobras' importance, a reason for Brazilians to be proud. I am proud of the company I represent and have been a part of for 32 years.

"I would like to express my deepest gratitude on behalf of the more than 80 thousand workers at Petrobras, and I am aware that this recognition brings with it an even greater professional responsibility on my part."

"Being chosen by Time magazine as one of the 100 most influential people in the world is much more than a reward for the battles I have won during my life, it is an acknowledgement of Petrobras' importance, a reason for Brazilians to be proud."

Focus on Maria das Graças Silva Foster

Maria das Graças Silva Foster was born in Caratinga in the state of Minas Gerais, Brazil, on 26th August 1953. She graduated in Chemical Engineering from Fluminense Federal University, and went on to complete her 'Masters' in Chemical Engineering at Rio de Janeiro Federal University (COPPE/UFRJ), where she also studied Nuclear Engineering. She also has an MBA from Brazil's prestigious Fundação Getúlio Vargas (FGV/RJ). She was elected to the post of Petrobras' Gas and Energy Business Director on 21st September 2007, and has been a Petrobras employee for 32 years.

In addition to her post as Petrobras Gas and Energy Director, Graça Foster is also CEO of Gaspetro (Petrobras Gás SA), and of the gas pipeline company TBG (Transportadora Brasileira Gasoduto Bolívia-Brasil SA), as well as TAG (Transportadora Associada de Gás SA).

Maria also sits on the Boards of Transpetro (Petrobras Transporte SA), Petrobras Biocombustível SA, Braskem SA and IBP (Brazilian Oil, Natural Gas and Biofuels Institute).

From May 2006 to September 2007, she was CEO of Petrobras Distribuidora SA, taking on the duties of Financial Director during 2007.

Prior to this, she was CEO of Petroquisa – Petrobras Química SA, a post she took up in September 2005. At this time, she was also acting as Executive Manager for Petrochemicals and Fertilizers as a member of Petrobras' Senior Management responsible for Provisioning.

From January 2003 to September 2005, Graça Foster was Secretary for Oil, Natural Gas and Renewable Fuels at the Brazilian Ministry of Mines and Energy. During this period, by Presidential Decree, she took up the functions of National Executive Secretary of the Federal Government Program for Mobilizing Brazil's Oil and Gas Industry (PROMINP), and Inter-Ministerial Coordinator for the National Program for Biodiesel Production and Use, another federal government initiative.

Prior to 2003, she held management positions at Petrobras, in the Gas and Energy division, at the Leopoldo Américo Miguez de Mello Research Development Center (Cenpes), and at TBG (Transportadora Brasileira do Gasoduto Bolívia Brasil).

In 2007, she was made a "Commander of the Order of Rio Branco" (Comendador da Ordem do Rio Branco), an honorary title awarded by the Foreign Affairs Ministry.

The following year, she was elected Finance Executive of the Year and received the "Equilibrista" trophy from the Brazilian Institute of Finance Executives (IBEFRJ). She was also named Cláudia magazine's 2008 Businesswoman of the Year.

In 2009, Graça Foster received the "Medalha Tiradentes", the highest award conferred by the Rio de Janeiro State Legislative Assembly, in recognition of her contribution as a Petrobras professional to the development of Brazil and the State of Rio de Janeiro.

In 2010, Mrs. Foster was listed in two international rankings. She is among the 10 most powerful executives in Latin America according to America Economia magazine, launched in Chile in 1986 and covering Latin American economics, finance and business. Moreover, according to the Financial Times, Graça Foster is among the top 50 female rising stars in business throughout the world.

According to the ranking put together by Valor Economico and executive selection company, Egon Zehnder, Graça Foster was one of the top 15 managers in Brazil during 2011. In the same year, she took part in the "Women at the Top" event, organized in China by the Financial Times and bringing together outstanding business executives from all over the world.

Also in 2011, on the recommendation of the Council for the Order of Naval Merit attached to the Presidency of the Republic, Graça Foster was made a "Commander of the Order of Naval Merit Reserve Staff" (Comendador do Quadro Suplementar da Ordem do Mérito Naval). The honor was bestowed in Brasilia during the commemorations on the anniversary of the Naval Battle of Riachuelo, a key date in the history of the Brazilian Navy.

Transpetro Receives First Oil Tanker Built in Northeastern Brazil

The first vessel built in Northeastern Brazil for the Transpetro Fleet Modernization and Expansion Program (Promef) began operation in May. The *João Cândido* was delivered by the Atlântico Sul Shipyard (EAS), and set sail on the 31st May for its first operation, to transport oil produced in the Campos Basin to the Almirante Barroso Terminal (Tebar), in São Sebastião (state of São Paulo).

Attending the ceremony was Petrobras CEO Maria das Graças Silva Foster, and the CEO of Transpetro, Sergio Machado. Also in attendance was José Lima de Andrade Neto, the CEO of Petrobras Distribuidora, and Eduardo Campos, the governor of Pernambuco state (in the Northeast Region of Brazil).

"The naval industry is leaving behind the stage of inertia. We will now execute the third pillar of this program, because we have already completed the first two: building vessels in Brazil and reaching a nationalization content of 65%. We must stand together to ensure productivity, sustainability and to put the Brazilian shipbuilding industry in the worldwide scenario," said the CEO of Transpetro.

Measuring 274 meters in length and capable of carrying one million barrels of oil – almost half of the daily domestic production – the *João Cândido* reached a domestic content level of 70%, higher than the 65% stipulated for the first phase of Promef. It is the first ship built by the new shipbuilding hub in Pernambuco, which, in addition to EAS, will have the STX-Promar shipyard, also made possible by orders placed under Promef.

Promef Vessels

The *João Cândido* is the second Promef ship to come into operation. The first, the *Celso Furtado*, was delivered to Transpetro in November 2011 by the Mauá Shipyard,

The delivery of the *João Cândido* is testament to the Program's vitality, which helped initiate the reconstruction of the Brazilian naval industry after a decades-long crisis.

"The sector is moving out of inertia, but the experience of these early years has shown that a productivity shock is needed in order for us to be able to reach the expected levels of modernity and competitiveness quicker."

in Rio de Janeiro. The next ship, scheduled for delivery in June 2012, is the *Sergio Buarque de Holanda* product vessel, also built by Mauá, which completed its sea trial successfully on May. In addition to the *Sergio Buarque de Holanda*, product vessels *Rômulo Almeida* and *José Alencar* are also in their final stages of completion at the Mauá Shipyard.

Promef has already ordered 49 vessels, with investments of R$10.8 billion. The delivery of the *João Cândido* is testament to the Program's vitality, which helped initiate the reconstruction of the Brazilian naval industry after a decades-long crisis. The Brazilian shipyards, which had less than 2,000 workers at the turn of the century, have more than 60,000 workers today.

"The sector is moving out of inertia, but the experience of these early years has shown that a productivity shock is needed in order for us to be able to reach the expected levels of modernity and competitiveness quicker. Only then will the new Brazilian shipbuilding industry be sustainable," said Sergio Machado.

Stages of Ship Construction

There are several traditional ceremonies which mark the key stages of shipbuilding within the global shipbuilding industry. These include the cutting of the first steel plate, the laying of the keel, the launch to sea, and delivery to the rigger. However, it is important to differentiate between the launch to sea and delivery to the rigger.

Launch to Sea – Once the hull has been built; the vessel is christened and launched to sea to be finished. The launch frees the dock in order for a new vessel to start being built. The vessel under construction is then transferred to the shipyard's quay. While at the quay, finishing work is done, the ship's various systems are interconnected and final equipment testing is performed. Before delivery, the vessel is usually taken back to the dock for hull cleaning. Finally, seaworthiness tests are carried out, consisting of short trips to test the vessel's overall performance.

Delivery – After all works and testing have been successfully completed, the vessel is certified by an independent maritime Certification Society and delivered to the ship-owner, at which time it can begin operating. Transpetro has launched a special site on the *João Cândido* vessel (www.promef-transpetro.com.br), where it is possible to take a virtual tour of the ship.

New Data Confirms the Continuity of the Carcará Discovery, in the Santos Basin Pre-Salt Region

From Petrobras News Agency.

Petrobras announced in May that new data obtained from the drilling of well 4-SPS-86B (4-BRSA-971-SPS), which is testing the prospect known as Carcará, reinforces the importance of the good-quality oil discovery in block BM-S-8, located in ultradeep waters in the Santos Basin pre-salt region.

It has been proven, so far, that there is a continuous oil column of 171 meters in reservoirs of excellent quality. New oil samples of approximately 320 API were collected from reservoirs located at depths of up to 5,910 meters, also confirming the continuity of the discovery that was reported to the market this March by the Consortium.

The well is located 232 km off the coast of São Paulo state, at a water depth of 2,027 meters. The well is currently being drilled, at a depth of 5,926 meters and still within the oil zone, to determine the lower limit of the reservoirs and the total thickness of the zones of interest.

The Consortium will continue with the activities and investments needed to assess the area in accordance with the Assessment Plan approved by the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP).

Petrobras is the operator of the Consortium (66%), in partnership with Petrogal Brasil (14%), Barra Energia do Brasil Petróleo e Gás Ltda. (10%) and Queiroz Galvão Exploração e Produção S.A. (10%).

The Consortium will continue with the activities and investments needed to assess the area in accordance with the Assessment Plan approved by the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (ANP).

Open Innovation Leads to Knowledge Sharing and Joint Technology Solutions

By Petrobras Staff.

There are fewer than 50 companies in the world capable of carrying out precise inspection of oil and gas pipelines to prevent leaks and corrosion. In the Southern Hemisphere, only one such company has the necessary expertise for the task: the Brazilian PipeWay Engenharia, based in Rio de Janeiro. The operation of equipment such as the Pig Corrosion, which detects structural faults in submarine pipelines operating under extreme pressures and temperatures, has enabled the company to provide its services to other firms that operate on a global scale. This only proved possible due to the collaboration between PipeWay and Petrobras, which, in 1998, began to transfer the technology to the company. At that time, PipeWay was a pilot project overseen by PUC-Rio (Pontifical Catholic University of Rio de Janeiro). The partnership, coordinated by the Petrobras Research Center – Cenpes – provided PipeWay with the technology and tools necessary to develop the Pig Corrosion. In turn, it not only provided the service, but also perfected new solutions based on those initial projects.

The experience uniting PipeWay and Petrobras is an exemplary case of open innovation. By opening its doors to outside collaborators (universities, suppliers, independent research institutions and even its competitors), sharing information and exchanging experiences, Petrobras is one of an ever-increasing group of companies that are developing technological solutions based on the open innovation concept, created by the American economist Henry Chesbrough in 2003. "To innovate means more than simply investing in scientific research. It also involves thinking about new business models, maintaining cooperation with customers and consumers and attracting the participation of external sources of knowledge", states Chesbrough. Based upon his observations of companies' practices, both large and small, since the 1960s, he defined the fundaments of the concept, that offers alternatives for the companies to meet the eternal challenge: how to innovate fast and effectively?

"Companies have realized a long time ago that they can't create everything they need on their own", says Bruno Rondani, the executive director of Open Innovation Center – Brazil. One of the solutions is open innovation, a model whereby companies can (and should) use outside ideas in conjunction with their own, as a way to furthering their current technological knowledge. To achieve this, their research departments must be open to develop projects in partnership with outside sources, to debate problems and to share inventions and products which previously had been guarded under lock and key. "On their own, companies are not able to face all the present-day challenges. Open innovation creates value and expands the platform of collaboration between companies, even between competitors, which is healthy for the development of any branch of industry," states Rondani.

The majority of technological advances during the 19th and 20th centuries were born of a model known today as "closed innovation" (a term also created by Chesbrough). Big companies invested large sums

"The closed management of innovation was widespread at the beginning of the 20th century due to the lack of involvement by universities and government institutions in research that had a commercial or industrial application."

in research centers which were responsible for the complete in-house development cycle of their products. "The closed management of innovation was widespread at the beginning of the 20th century due to the lack of involvement by universities and government institutions in research that had a commercial or industrial application", says Albert Meige, a French researcher of the École Polytechnique in Paris, director of Presans (which provides technological consultancy services) and the author of various papers on innovation. "It was a cycle in which companies invested internally in new products and processes and managed to recoup a large part of their investment in the creation of new technologies. But in order to do so, they had to keep their researchers for several years and the intellectual property needed to be protected."

This model drove the technological advance in the majority of companies in the western world during the last century and is still the norm today, if we think in terms of practical applications and products reaching the end consumer. One example is Apple, which maintains strict control of its trademark, operational systems and hardware solutions. However, changes in the markets and in the economy made it necessary to seek out alternative models. Even the big companies found it difficult, year after year, to hold on to their research personnel, who took with them their specific knowledge when they left. The proliferation of venture capitalists (investors that finance fledgling companies based on high-risk funds capital, allocated to speculative activity) permitted small entrepreneurs to create innovative technological projects. The corporations also noted that various products derived from internal research, which could previously linger for years with no practical application, could be licensed or transferred for other purposes. And suppliers began to demonstrate a much greater capacity to engage in dialogue with the customers they used to serve, sometimes even refining technologies created by these customers. These attitudes have been growing since the start of the 1960s. By comparing the way in which some of the main technology companies in the USA have dealt with these changes, Chesbrough was able to identify the precepts of open innovation.

Currently, companies need to discover which of the paths to innovation – more open or more restricted – are more suitable to their case. "There is still an intense debate on which is the ideal model. The fundamental requirement is to innovate, regardless of how," stresses Everton Bonifacio, internal corporate training coordinator at the Brazilian Capital Market Institute (Ibmec). "The business model of each corporation should be well thought out to identify exactly what can be done in-house and which complementary resources should be sourced externally. This way, the risks of loss of potential profits or exclusive user rights on determined technologies are minimized," he concludes.

Roberto Murilo Carvalho de Souza, Technological Strategy manager of the Petrobras Research Center, explains the situation in practice: "The decision also depends on the stage at which we find ourselves in

"Open innovation creates value and expands the platform of collaboration between companies, even between competitors, which is healthy for the development of any branch of industry."

relation to the desired technology objective. If we are well advanced, it can be worth our while to develop everything in-house. If it is a field which we are not fully familiar with, we may look for outside partners".

Carlos Tadeu da Costa Fraga, executive manager of Cenpes, says that Petrobras has practiced open innovation since the beginning of its technological development activities and training of R&D personnel, in the 1960s. "In the beginning of the Petrobras' research activities, one of the principal vectors was the rapid assimilation of refining technologies. We acquired the first projects, learnt from techniques developed in other countries, perfected it over the years and today we own various technologies developed by Petrobras itself," he says. The consolidation of the capacity for innovation in the company came a bit later, at the time of the discovery of the vast offshore reserves in the Campos Basin. According to the executive, the technology to extract oil from these ultra-deep fields did not exist, so it was necessary to develop it in conjunction with international suppliers. It helped to spread the culture of technological cooperation within the Company.

In Carlos Tadeu's opinion, at the present moment there is an intensification of this culture of cooperation with the external environment. Petrobras' technological strategy involves partnerships with universities, suppliers and other companies in various fields of knowledge, and also includes the interaction with other business segments in the search for innovative solutions. "For example, various technologies used in medicine are also used by the oil industry, for the imaging and diagnosis of rocks", he says. "It's important to access good ideas, wherever they come from. But in order to assess whether an idea is good for our business or not, we have to have the internal competence. We have to take pride in capturing good ideas from the outside as much as we do in developing our solutions in-house," he argues. Roberto Murilo seconds Chesbrough's thoughts when he states: "This is not just about technological development. Open innovation on its own isn't enough, it's necessary to keep an open mind. We have to switch on the radar and broaden our thinking to consider alliances throughout the world, including those outside the US-Europe axis".

Various Paths Lead to Innovation

There isn't one single model of open innovation. Everything depends on the origin of the idea, how it will be handled and in what form it will reach the market. Let's use the example of a scientist who, during the course of his research, makes a discovery that he considers interesting. If the company employing him chooses not to launch the product commercially, the open innovation concept recommends that he may, for example, develop the idea by himself. In another case, a company may create a product internally, but chooses a partner to launch it (thus gaining a foothold in a new market to which it otherwise would not have access). An innovative concept created by a start-up (a fledgling company with small and agile structure, usually acting in the technology market) can also be shared with another larger corporation which could provide the

necessary funds and personnel to manufacture and launch the end product. There is also the possibility of a large company who prefers to form another smaller company (a spin-off), either alone or in partnership, for the sole purpose of developing a particular innovation.

"Previously, there was the 'not invented here' paradigm, which caused companies to view any creation not invented solely by their internal R&D departments with suspicion", recalls Bruno Rondani. "The companies which embraced open innovation have adopted another paradigm: probably found elsewhere, indicating that the connection with new technologies from external sources is something to be appreciated."

Petrobras – Innovation Initiatives

Since its foundation, Petrobras has used open innovation initiatives in several of its projects, even before the trend became known by its present name. Up to the 1970s, it carried out research in association with other companies, internalizing knowledge on refining technologies. With the discovery of the oil reserves in the Campos Basin, in the 1980s, the Company intensified its cooperation with corporations such as Schlumberger and Halliburton and started the development of the first projects involving other research centers, specially in relation to the drilling of ultra-deep wells.

The present decade has seen the organization of the so-called thematic networks, groups of universities that receive support from Petrobras and carry out research in fields of interest to the Company. These networks produced projects such as groundbreaking platform stability tests – in cooperation with the Federal Universities of Rio de Janeiro (UFRJ) and São Paulo (USP) – and graphic computing solutions (along with PUC-Rio). The enormous challenges presented by the exploration of oil and gas in the pre-salt layer have led to many more partnerships. "Nowadays we have many models of cooperation", says Roberto Murilo Carvalho de Souza, Cenpes' Technological Strategy manager. "We are developing products in partnership with other companies, sharing costs; we are working with companies embedded in universities; and we are ready to receive the technological centers that are going to be installed in Rio de Janeiro by firms that work in partnership with Petrobras, such as Schlumberger, FMC and GE, among others".

PipeWay, referred to at the beginning of this article, fits into this scenario. In 2001, the company received the technology referred to as the "Pig", an inspection tool for pipelines that accumulate large quantities of dirt – hence the name. The Pig Corrosion was a solution created by Petrobras and presented to other companies (including PipeWay) with the objective of improving cleaning and inspection services in its own pipelines. "We received the technology, but we developed the know-how ourselves", recalls Vinicius Carvalho, PipeWay's director. We have been adapting and perfecting it for almost ten years. Nowadays, we use the Pig Corrosion and other solutions derived from it to provide services to other companies throughout the world, paying royalties to Petrobras". Murilo sums up by saying: "If we have spent resources developing a product and don't use it any more, why not license it?".

One of the principal examples of the Company's involvement with open innovation is the Procap Visão Futuro Program (Procap Future Vision). A pool of more than 40 institutions from all over the world, including companies and universities, is working in partnership to create new technological solutions relating to the exploration and production of oil and gas, involving production systems, well engineering, logistics, reservoirs and sustainability. Each solution is developed in workshops with the participation of contracted companies and universities. Evolved from programs initiated in the 1980s, Procap is currently engaged in testing projects involving the separation of fluids and multi-phase pumping (oil, water and gas) and the automation of platforms. The first laser drilling prototype is expected to be developed by 2013.

Another of Petrobras' pioneering initiative involves the Technological Program for the Mitigation of Climate Change – Proclima – in which a test methodology in the field of open innovation is currently being applied. "We ask our partners: what should we do with the carbon dioxide? What are the best solutions to transform it into a product and no longer view it as merely an emission? Is there a chemical solution? Or should we use biotechnology? That's what we are debating," says the Technological Strategy manager about the project, which unites Petrobras, representatives of academia (UFRJ and the National Institute of Technology) and industry (Dow Quimica, Dupont and Abiquim).

Petrobras Growth Stimulates Production Chain and Boosts Energy Sector Expansion

By Petrobras Staff.

With a Business Plan projecting Brazilian growth including a US$ 53.4 billion investment in the pre-salt and investments of US$ 224.7 billion between 2011 and 2015 as well as the greatest growth prospective within the world's energy sector, Petrobras is placing ever-increasing demands for products and services upon its production chain's suppliers. Nowadays Petrobras' chain of direct and indirect suppliers comprises about 20,000 companies. And the trend is for this number to increase even further: the company plans to increase its total oil and gas production, leaping from the current 2.7 million barrels of oil equivalent per day (boed) to 4 million in 2015 and 6.4 million in 2020.

More than half of the overall Business Plan investment (US$ 127.5 billion) will be destined for oil and gas exploration and production projects in operation. One of the companies participating in the development of exploration projects for the pre-salt layer is Engevix, involved in the energy sector since 1965. Based in the state of São Paulo, the company is currently building eight identical FPSO (Floating, Production, Storage, and Offloading System) hulls – vessels capable of producing, storing and offloading oil, to address the demand of the Petrobras pre-salt operations in the Santos Basin. This is the first time in the world that a company has commissioned the simultaneous construction of eight vessels of this size.

This serial production of "replicants", as they are known, will fasten the building process whilst also reducing costs. To develop the project, Engevix is using the Rio Grande shipyard, in the state of Rio Grande do Sul. This shipyard covers a total built-up area of 40,000 square meters and will house the largest dry-dock in Latin America. "This FPSO project alone will create five thousand direct jobs and a further fifteen thousand indirect jobs," says Daniel Peres, Engevix vice-president.

This pioneering project is a part of a greater whole: the revitalization of Brazil's shipbuilding industry. The former President of Petrobras, José Sergio Gabrielli de Azevedo, emphasized, "Brazil's shipyards, which accounted for 2,000 jobs five years ago, currently account for fifty-eight thousand. And a large part of that is due to Petrobras".

In 2010, the company fleet consisted of 190 ships, either owned by the Company itself or chartered, as well as 240 support vessels and drilling units. By 2017, a further 88 vessels should be delivered, providing more than thirty thousand direct and indirect job opportunities, besides

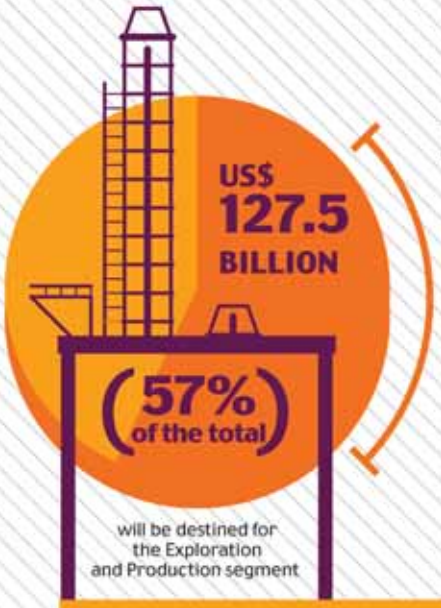
Petrobras' investments

US$ 224.7 BILLION is the total investment projected by Petrobras in its 2011–2015 Business Plan

This amount means that Petrobras will invest between US$ 1,100 and US$ 1,300 per second over the next five years

For comparison purposes, this is a value that exceeds Portugal's GDP

US$ 223.7 BILLION in 2010

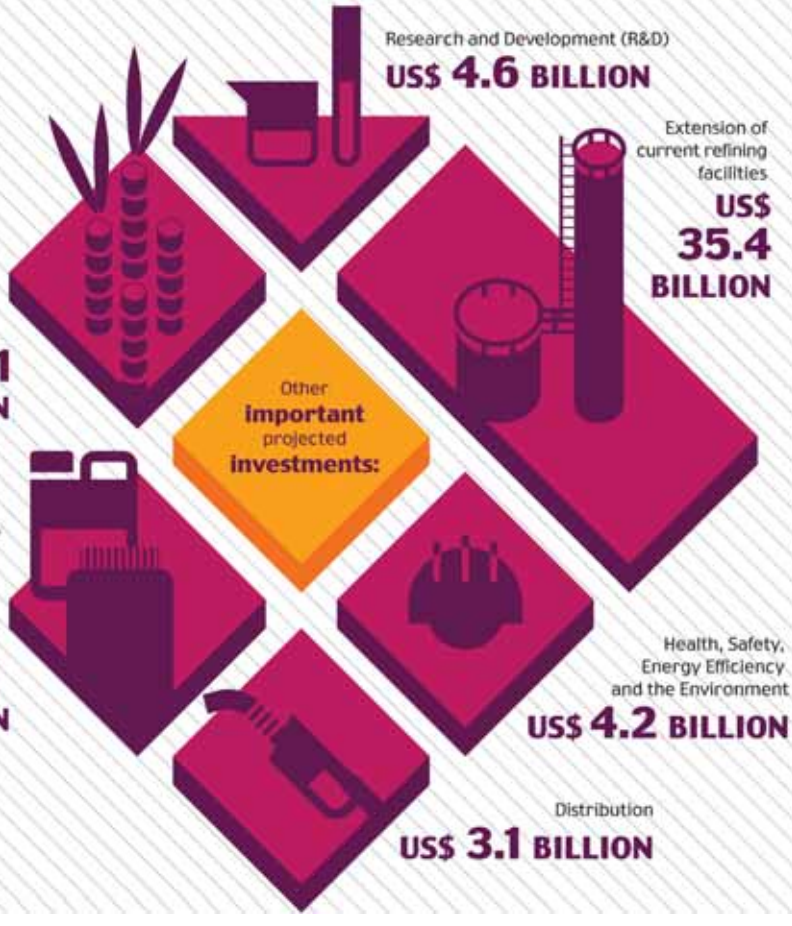


US$ 127.5 BILLION (57% of the total) will be destined for the Exploration and Production segment

The Pre-salt Exploration and Production operation alone will receive investments totaling US$ 53.4 BILLION

The new plan forecasts that the pre-salt contribution to Petrobras' production will increase from

This value represents an increase of US$ 8.7 BILLION in relation to the previous Business Plan.



The deepwater discoveries off the coast of Brazil represent 1/3 of all the world's deepwater discoveries over the last five years.

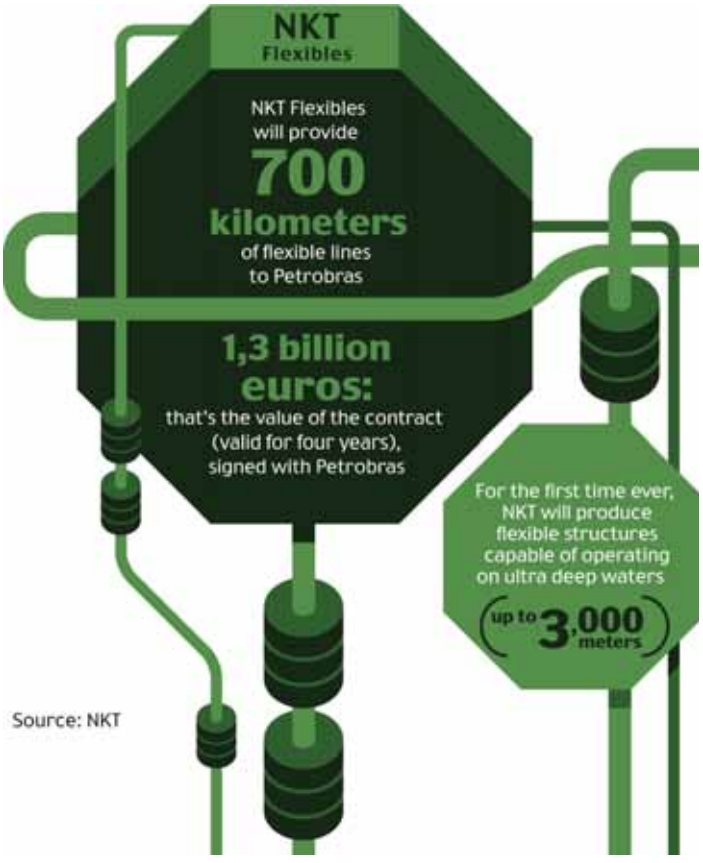
Over the last 30 years, Petrobras has increased its production by an average of 10% every year

"Our investment plan is known throughout the world and international companies are keen to gain a foothold in the market in partnership with Petrobras."

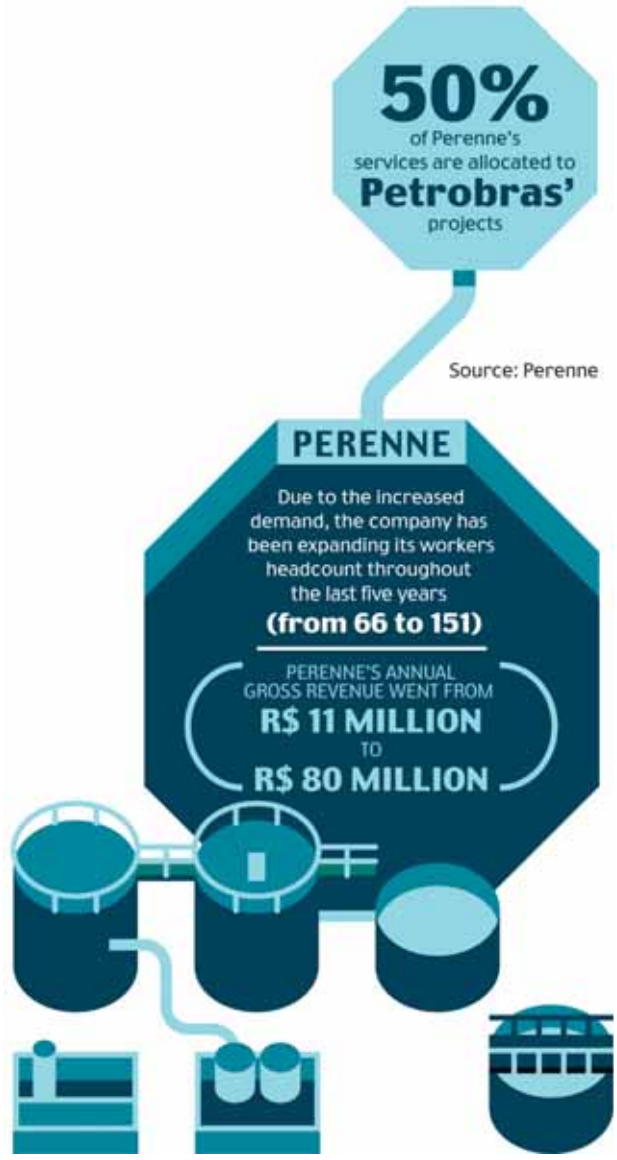
two thousand jobs during the operational lifetime of these vessels.

Roberto Gonçalves, Petrobras' executive manager of Engineering, explains how the stimulus to Brazilian companies works in practice: "We establish a percentage of the content to be produced in Brazil in our contracts, and by doing so, we are creating a market. The companies begin to produce, internally, goods that they had previously bought overseas."

The possibility of working in partnership with Petrobras also raises interest abroad. "Our investment plan is known throughout the world and international companies are keen to gain a foothold in the market in partnership with Petrobras," says Roberto Gonçalves. One example of an overseas company willing to invest in this approach is the Danish NKT Flexibles, a specialist in flexible structures for deepwater operations. The company is about to inaugurate a factory in Brazil – the first outside its homeland in more than a hundred years of existence. The Brazilian branch, which will benefit from an investment of US$ 200 million and create at least 400 direct job opportunities, will not be merely an industrial plant located nearer to its client. NKT's regional representative, Marcos Villela, explains that the unit will be an optimized



Specialized in products and services relating to the supply and treatment of water, effluents and residues, Perenne has invested almost R$ 2 million annually, since 2006, in the hiring and training of personnel and acquisition of equipment to comply with Petrobras standards.

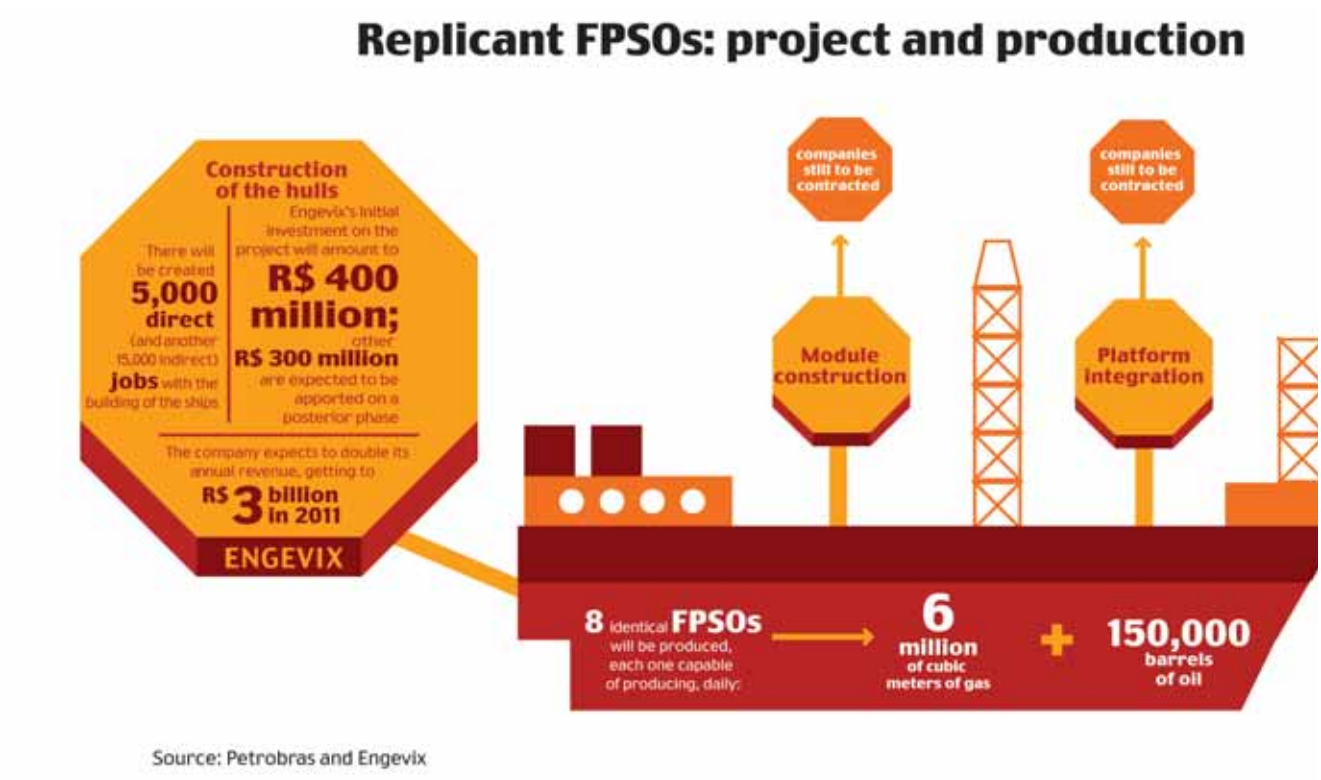


installation, with its own exclusive equipment, geared to develop structures not produced in Denmark, enabling it to create more complex products from carbon-fiber reinforced polymers. "This new plant will represent the cutting edge in our sector," states Villela.

The scale of Petrobras' investment plan and the complexity of its new projects also attract other companies not directly related to the oil and gas production chain. Specialized in products and services relating to the supply and treatment of water, effluents and residues, Perenne has invested almost R$ 2 million annually, since 2006, in the hiring and training of personnel and acquisition of equipment to comply with Petrobras standards.

"We were hired in 2008 to develop the engineering project for two sludge dryers for the Henrique Lage refinery (in São José dos Campos, in the state of São Paulo) – a world first. We blended the conceptual project of an Italian company, designed the engineering in Brazil and faced many challenges. Now we are looking forward to completing the assembly of the system to assess the results," explains Nelson de Oliveira Guanaes, Perenne's CEO.

Looking forward to further strengthen and expand its supply chain, Petrobras participates in programs that assist companies to obtain finance and improve their training of personnel. One such program is the



"Programa Progredir" ("Moving Forward Program") initiative, through which the company acts as an "anchor" to assist suppliers to obtain credit from financial institutions and the BNDES (National Bank for Economic and Social Development). "Programa Progredir" was launched in June last year and over fifteen companies have already obtained finance through it, exceeding US$ 85.2 million.

Along similar lines, the National Program for Mobilization of the National Oil and Gas Industry (Prominp), created to increase the participation of Brazilian industry in the implementation of projects within the sector, is another important initiative. Coordinated by the Ministry of Mines and Energy, Prominp focuses on actions that encourage technological development and professional qualification. Petrobras is a member of the Prominp Steering Committee, which offers free training courses for 175 professional categories within the energy sector. By the close of 2010, the Program had qualified 78,000 individuals for positions in the oil and gas industry and identified the need to qualify a further 212,000 by 2014.

Petrobras participates in programs that assist companies to obtain finance and improve their training of personnel.

emissions management

Greenhouse effect, global warming, climate change: governments and citizens are already facing these challenges. As an energy company, Petrobras is closely monitoring these issues and takes them into account when making decisions. Since 2005, climate change has been incorporated into Petrobras corporate strategy. The company has adopted a series of measures to maximize its energy efficiency and to reduce the intensity of greenhouse gas emissions.

1 Emissions Inventory

SIGEA®, the Atmospheric Emissions Management System, integrates all the Company's activities. The emissions of all equipment emitting greenhouse gases are measured, regardless of size or power. The values are calculated on a month by month basis to highly precise levels, as required for decision-making purposes.

2 Technology

Petrobras has created two programs to develop and implement technological solutions, such as the capture, transportation and geological storage of CO_2, to mitigate emissions in the company's processes and products:

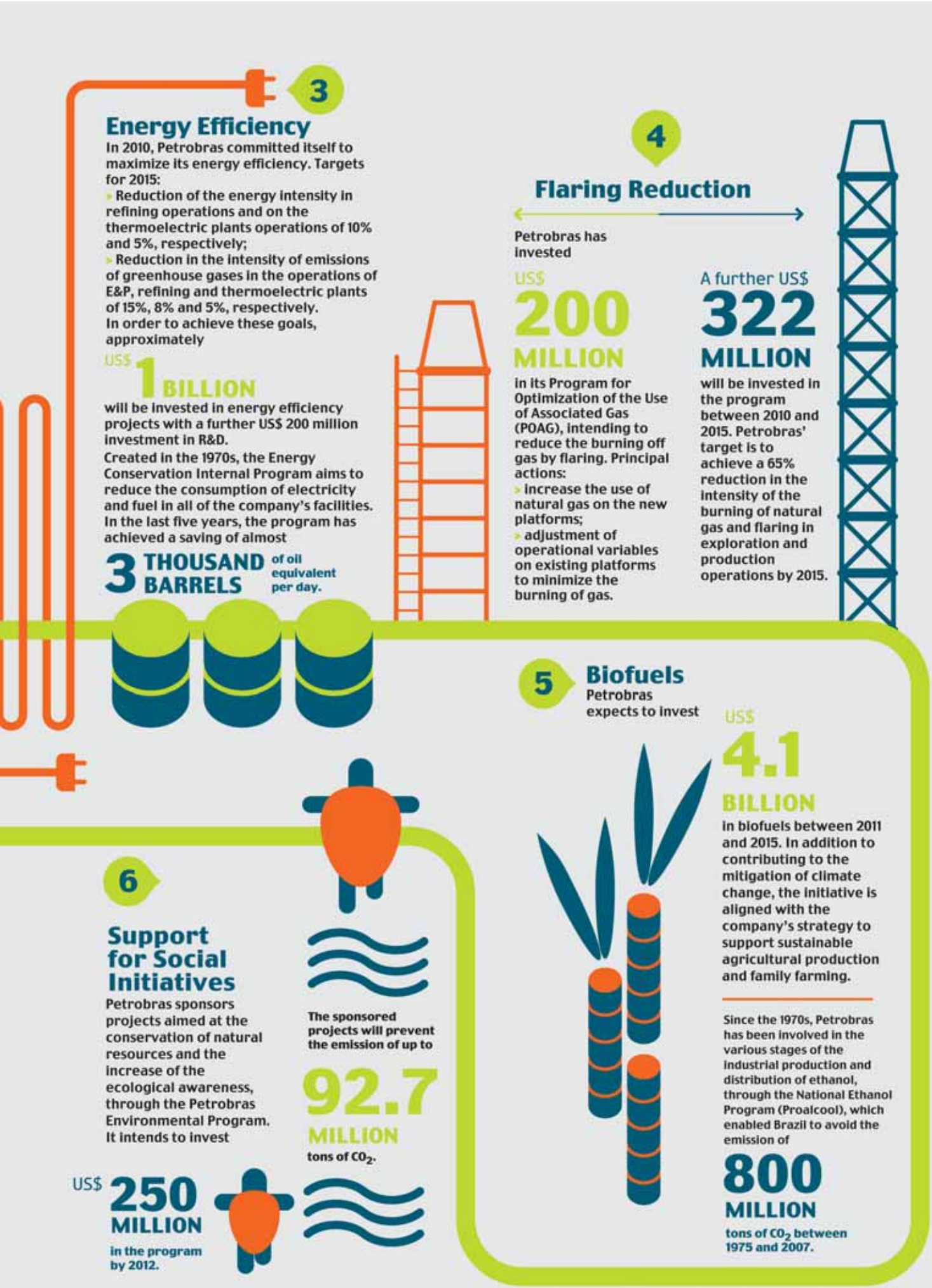
- PROCLIMA – Climate Change Technological Program;
- PROCO$_2$ – CO_2 Management Technological Program, intended to address the pre-salt challenges.

US$ **30 MILLION** was invested between 2006 and 2009 in the field of carbon sequestration and climate change and a further US$ **200 MILLION** will be invested in the 2010 – 2015 period.

Petrobras voluntarily undertook to avoid the release of CO_2 from its pre-salt operations into the atmosphere, prior to the issue of any regulations to that effect.

7 CONPET,

the Brazilian Program for the Rationalization of Use of Oil Products and Natural Gas, a Federal Government initiative coordinated by Petrobras, assesses the level of black smoke emitted by diesel vehicles and runs educational activities for drivers to encourage fuel economy throughout Brazil.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Energy Efficiency
In 2010, Petrobras committed itself to maximize its energy efficiency. Targets for 2015:
Reduction of the energy intensity in refining operations and on the thermoelectric plants operations of 10% and 5%, respectively;
Reduction in the intensity of emissions of greenhouse gases in the operations of E&P, refining and thermoelectric plants of 15%, 8% and 5%, respectively.
In order to achieve these goals, approximately
US$ 1 BILLION
will be invested in energy efficiency projects with a further US$ 200 million investment in R&D.
Created in the 1970s, the Energy Conservation Internal Program aims to reduce the consumption of electricity and fuel in all of the company's facilities. In the last five years, the program has achieved a saving of almost
3 THOUSAND BARRELS of oil equivalent per day.
4
Flaring Reduction
Petrobras has invested
US$ 200 MILLION
in its Program for Optimization of the Use of Associated Gas (POAG), intending to reduce the burning off gas by flaring. Principal actions:
increase the use of natural gas on the new platforms;
adjustment of operational variables on existing platforms to minimize the burning of gas.
A further US$ 322 MILLION
will be invested in the program between 2010 and 2015. Petrobras' target is to achieve a 65% reduction in the intensity of the burning of natural gas and flaring in exploration and production operations by 2015.
5
Biofuels
Petrobras expects to invest
US$ 4.1 BILLION
in biofuels between 2011 and 2015. In addition to contributing to the mitigation of climate change, the initiative is aligned with the company's strategy to support sustainable agricultural production and family farming.
Since the 1970s, Petrobras has been involved in the various stages of the industrial production and distribution of ethanol, through the National Ethanol Program (Proalcool), which enabled Brazil to avoid the emission of
800 MILLION
tons of CO_2 between 1975 and 2007.
6
Support for Social Initiatives
Petrobras sponsors projects aimed at the conservation of natural resources and the increase of the ecological awareness, through the Petrobras Environmental Program. It intends to invest
US$ 250 MILLION
in the program by 2012.
The sponsored projects will prevent the emission of up to
92.7 MILLION
tons of CO_2.

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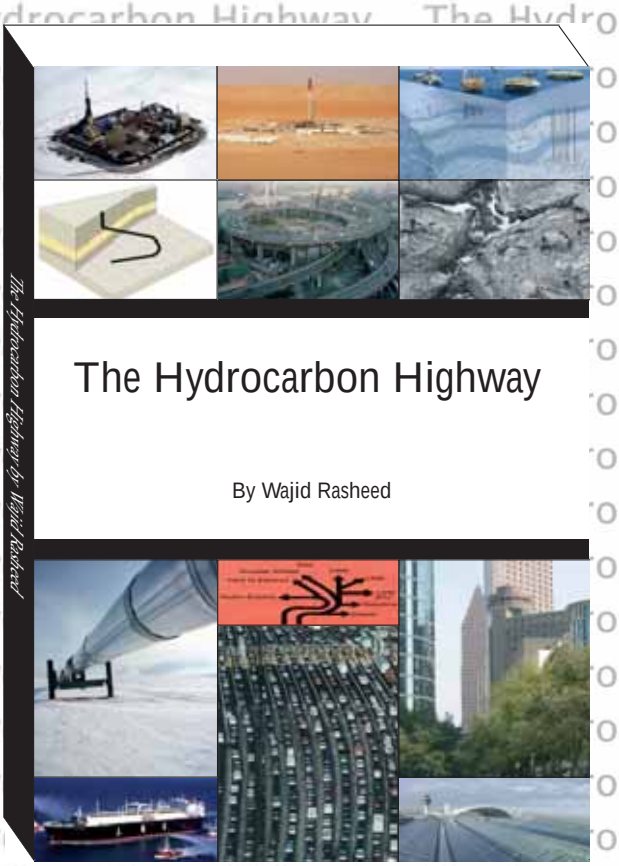

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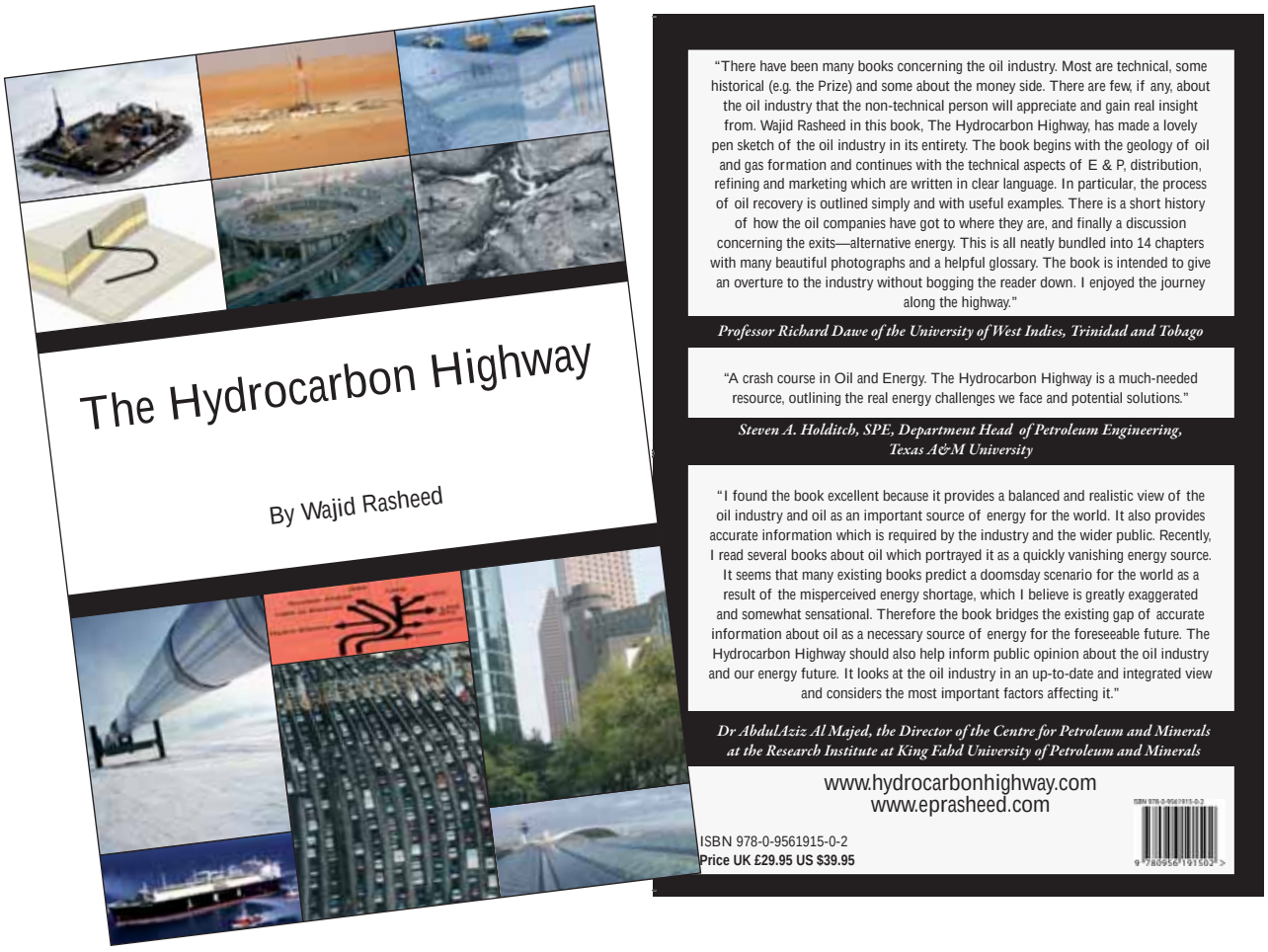
Pipelines and Tankers

A Chapter from The Hydrocarbon Highway, by Wajid Rasheed



Transportation of oil and gas is a key factor affecting the industry. Only rarely are oil or gas fields conveniently located next to consumers. This chapter looks at how oil, gas and products reach consumers.

Gas, which requires a huge distribution infrastructure, is particularly affected. Only recently have such solutions as Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG) tankers allowed many countries to export their natural gas. Qatar, Nigeria and Trinidad, for example, produce far more natural gas than their domestic market requires. The best solution for these countries is to convert their gas to LNG which can be transported to a variety of markets in the world by ship.

Although pipelines are recognised as one of the safest forms of hydrocarbon transportation and distribution, they require a high degree of monitoring and management.

Pipelines are the most common forms of transporting crude oil, natural gas, refined products, derivatives and ethanol. They are highly efficient and this is a major reason that oil and gas is such a popular energy source. In fact, pipelines are so efficient that coal companies have tested their use for transporting coal. The coal is ground up into small particles that are pumped within a liquid slurry from the mines to their principle destination, power generating stations or large industrial complexes.

Pipelines extend from oil and gas producing fields, which in turn receive oil and gas from many wellheads. The delivery point can be refineries, liquefaction facilities, petrochemical plants or ports for tanker shipping. Before transportation can occur, however, a complex network of pipelines and associated infrastructures must be in place. Pipelines range from small-diameter field flow lines and gathering lines to huge transcontinental lines.

Oil companies use complex software to visualise, plan, route and monitor pipelines.

While this allows routes to be visualised, any relevant geological and geotechnical features of the route will be subject to local inspections and using a 3D visualisation model developed from aerial photographs and topography data processing. Nowadays, where the use of technological innovation allows capturing, storing and processing a large amount of information, the features visualised on flat paper can be brought to life in 3D forms. Principal considerations range from socio-environmental factors to pipeline design and sizing, data transmission, control systems and leak detection[1].

Socio-Environmental Factors

Achieving a balance between transporting crude oil, natural gas and its derivatives and acting in a socially responsible manner is not easy. Although pipelines are recognised as one of the safest forms of hydrocarbon transportation and distribution, they require a high degree of monitoring and management. Such care is not only restricted to the oil company, but also encompasses the community that may be affected by the construction of a pipeline. In cases where this occurs, participation of communities that live near the pipeline is vital. If communities participate fully at the planning stages, recommendations can be made regarding the use of land that surrounds the pipeline. This contributes to maintaining harmonious relationships between operators and host communities and reduces the risk of conflicts developing years later. The aim is to maintain a positive co-existence between the populace, host communities and the pipeline network[2].

Pipeline Design and Construction

This involves new-build pipeline projects where designs aim to reduce costs, minimise environmental impact and ensure the safe operation of the pipeline. Often this involves the mapping and registration of any existing buried or submerged pipelines as well as the analysis of any likely structural problems. Pipelines installed in

For buried pipeline applications, new technologies are being developed and applied to improve safety and these include 3D visualisation and monitoring systems as well as the evaluation of the soil-pipeline interaction

unstable geological areas must undergo geotechnical surveys to determine the risk of soil movement or formation collapse. The interaction between the soil and the pipeline is constantly assessed in order to guarantee the structural integrity of the line. For buried pipeline applications, new technologies are being developed and applied to improve safety and these include 3D visualisation and monitoring systems as well as the evaluation of the soil-pipeline interaction[3].

In order to guarantee the structural integrity of the pipelines installed in these areas, it becomes necessary to survey and map all the unstable areas and study soil mass movements. Creep movements usually involve extensive areas and present slow speed. In general, they are difficult to detect through visual inspection. Natural subsidence, or compaction of shallow sediments, can cause extreme stress on buried lines that can result in damage or rupture.

Types of Pipelines

Oil and gas pipelines are often welded together in the case of steel pipes or specially connected in the case of composite materials. Inner diameters can reach 48 inches (121 cm) and pipelines may stretch for many miles onshore and offshore. Onshore pipelines may be placed within trenches a few feet below ground or they may be suspended off the ground using steel supports.

Offshore, pipe laying vessels such as barges are required to trench and lay pipelines. Pipelines may be created on site with pipe joints welded together on the vessel. Alternatively, pipe joints are often welded together on land into a continuous pipeline unit which is then floated out to the site for layout saving time and money.

The oil and gas is kept mobile within the pipeline by pumping and compressor stations which are carefully spaced along the pipeline according to mobility requirements.

Multi-product pipelines are used to transport two or more different products in sequence in the same pipeline. Usually in multi-product pipelines, there is no physical separation between the different products. Some mixing of products occurs, creating an interface which is removed from the pipeline at receiving facilities and

segregated to prevent contamination. If fluids are to be completely segregated from one another, a device called a 'pig' is inserted in the line between the two liquids. Pigs are pliable plugs that can be pumped through the line for long distances. They can negotiate bends in the line and are retrieved by a 'pig trap' that operates like an air-lock at the destination end.

Remote Operations and Control Compressor Stations

Compressor stations along natural oil and gas pipelines are often remotely operated. System and equipment status as well as any alarm data are exchanged with a Control and Supervision Centre (CSC) through a Supervisory Control and Data Acquisition (SCADA) system.

Supported by the SCADA software, operators receive immediate detailed information about what is happening in the pipelines. By monitoring the levels of flow, pressure and temperature of the oil and gas, and at the sign of any abnormality, the system allows for pumps to be switched on or off and valves to be opened or closed within any segment of the entire pipeline. This helps operators avert leakages, blockages and maintains the safe and productive operation of the pipeline.

Such systems can perform a range of control actions such as starting and stopping compressor units and stations as well as remotely setting pressure and flow control points[4]. In addition, most compressors and line pumps are instrumented with sensors and associated telemetry that monitors their 'health' status around the clock.

This can provide an early warning of dangerous operating conditions or impending failures and enable operators to take timely action.

Storage

Demand cycles particularly affect the gas industry. Gas, used primarily for home heating, sees widely fluctuating demand between summer and winter. Building a pipeline large enough to handle wintertime demand would be a waste of money because it would only be used efficiently for a few months each year. A system is needed that could accept a steady stream of natural gas all year long, storing it at the terminal end during the summer months against peak demand during the subsequent winter. Storing the huge volumes of gas in surface tanks was impractical and uneconomic so companies created gas storage fields. These consist of storage wells that access depleted oil or gas reservoirs, or large aquifers. Gas is pumped down into these wells in the summer and then produced into the distribution network in winter. Alternatively, large caverns can be leached into salt domes to form huge subterranean storage chambers.

Pipeline Systems

Pipeline rated operating pressures will be dictated by several factors including hydrocarbon type, pipeline length, pipeline integrity and others. Often stations are located along the pipeline and will typically use reciprocating compressors driven by gas engines. To provide efficient outflow of large volumes, pipelines with greater diameters and higher pressure ratings are required. Increasing steel burst strength by specifying different alloys means thinner pipe can be used. The benefits include saving steel by weight reduction, thereby reducing the costs of pipe purchasing, pipe construction and assembly[5].

Remote Data Transmission

This involves the monitoring of all operating parameters and events of station equipment and systems. Typically this includes:

• Operating data such as pressure, temperature, power consumption and flow rates, and

• Fire and leak detection with remote signalling.

All the data mentioned above has to be available as continuous, real-time information to CSC operators[6].

SCADA

This system is made up of two basic sub-systems: the control and supervision centre and the local operation station. The components of the control and supervision centre are described below:

• Real-time database server: All the current data is stored on redundant servers which continuously communicate with the local database on the compressor stations to receive process data and send operator commands
• Historical database server: These servers receive data from real-time servers, storing process data on hard disk and tape cartridges
• Human-machine interface: This is used by operators to supervise and control the pipeline. From these stations,

By monitoring the levels of flow, pressure and temperature of the oil and gas, and at the sign of any abnormality, the system allows for pumps to be switched on or off and valves to be opened or closed within any segment of the entire pipeline.

data can be accessed via real-time servers, historical servers and an advanced functions station
• Engineering station: This station is used for developing and testing purposes
• Advanced functions station: This workstation runs the pipeline simulator. Additionally, there are three software modules for pig tracking, inventory calculation (line-pack) and leak detection
• Very Small Aperture Terminal (VSAT) communication system: This system comprises a personal earth station at the CSC, a hub station at the provider's installations, and a personal earth station at each compressor station
• INMARSAT communication system: This is used for communication with the city gates where natural gas from a pipeline enters the smaller diameter distribution network. This system does not communicate continuously. The operation is periodic (every four hours) and by exception (from the city gates to the CSC)
• Leased lines: These lines are used as backup for the VSAT system at the compressor stations, and
• Global Positioning System (GPS): These systems are used to maintain each compressor station synchronised with the CSC.

The components of the local operation station, which is provided at each compressor station, are described below:
• Local database and operation station: This redundant server has the function of continuously gathering data from the programmable controllers, and sending data for the real-time database server at CSC. These stations can be used to operate the compressor station in case of communication problems with the CSC
• Programmable Logic Controller (PLC): The PLC is used for process control and interlocking. There is a PLC for each turbo compressor and one redundant Central Processing Unit (CPU) for utilities such as generator sets, switchgear, fuel gas systems, compressed air systems, etc.
• VSAT communication system: As described above for CSC
• Leased line: As described above for CSC, and
• GPS: This is used for time synchronisation between the compressor station and the CSC.

Operational stations continuously communicate with the CSC servers. From these stations, it is possible to

Figure 1 - Modern Pipeline, Shipping and Product Remote Operations Centre (Saudi Aramco)

access all the operational and maintenance data from the area of responsibility of each operational division[7].

Corrosion Management

By preventing corrosion-related failures, corrosion management technology increases operational reliability standards, reduces environmental damage and extends the lifespan of the pipeline network[8].

Systems Capable of Detecting Leaks

Oil companies can detect leaks more efficiently by pin-pointing oil, gas or other derivative leaks in pipelines. Overall, this improves profitability by reducing the loss of hydrocarbon products and any environmental impacts. Leak detection technology is used in oil and gas to minimise product losses with a consequent reduction in the environmental impact as well as the costs. A flow and leak detection simulation system for multi-purpose pipelines can be employed by the oil company for this purpose[9].

Rehabilitation of Pipelines

The reason for rehabilitating pipelines is to make the best use of existing resources and to minimise the need for new builds. This, however, requires integrity criteria to be met which will extend the lifespan of the pipeline network. Hydrostatic test methodologies, certification criteria and commonly available repair techniques are all employed. Oil companies are benefitting through higher pipeline utilisation factors, more flexible and economic pipeline repairs, reduced maintenance costs and enhanced safety. To repair in-service pipelines, welding of in-service pipelines and the use of composite materials are commonly used[10].

Pigging Technology

'Pigs' play a vital role in keeping the pipelines operational. Pigs are instrumented battery-powered devices that can be pumped through the pipeline to inspect for corrosion, cracking or buckling both internally and externally. Their usage helps ensure the integrity of the pipeline and keeps the flow of products going. Pigs also help reduce the risks of environmental damage and avoid emergency shut-downs.

Both onshore and offshore pipelines can be inspected using pigs.

Pipeline Material Technology

By using advanced materials, operators can reduce costs, increase reliability and extend the life of a pipeline.

Figure 2 - The Baku – Tbilisi – Ceyhan Pipeline is 1,099 miles (1,768 km) Long (Courtesy of BP)

High-strength steel has been developed for use in large pipelines in order to increase operational safety and reduce the costs of building new pipelines. Models for the simulation of pipeline structural behaviour are also used extensively in order to identify defects and their repair needs.

Coiled tubing can also be used as an effective tool for pipeline applications. This includes the transportation of pigs, removing organic deposits and hydrate plugs or sand and placing a patch or liner to repair minor leaks.

Transfer Systems

These solutions help ensure optimal production flow and supply to the oil and product markets. Studies and tests for the application of friction reducers are carried out for oil product pipelines and this has shown to be viable in various types of pipelines, especially those with utilisation factors close to capacity. The next challenge is the development of proprietary additives to further enhance transfer; for example, to facilitate the transport of heavy crude from the oilfields of Venezuela to the port

Leak detection technology is used in oil and gas to minimise product losses with a consequent reduction in the environmental impact as well as the costs.

terminal on the Caribbean Sea, a solvent is added to the crude to reduce its viscosity. This solvent is subsequently separated and retrieved at the terminal end and pumped back to the source to be re-used.

Tankers

Crude oil tankers make up many of the world's largest ships, hence the common term 'supertanker'. Vessels are classed as Ultra Large Crude Carriers or ULCCs (a handful of which are able to carry more than three million barrels [MMbbl] of oil) and Very Large Crude Carriers or VLCCs (which may carry approximately two MMbbl of oil).

Another fleet class exists at the one MMbbl mark and refers to ships that serve smaller ports where larger counterparts cannot berth[11]. Refined oil products are carried by far smaller vessels carrying half a MMbbl of oil to storage depots or other facilities. These vessels begin the distribution process of moving oil from the refineries to the tanks in consuming countries, from where the oil cargoes are fed by road, rail, pipeline and coastal tankers and inland tank barges to power stations and depots close to where the products are consumed.

Tankers are advantageous over pipelines as they can respond to market fluctuations much more quickly. Cargo can be distributed to any destination in the world that has berthing facilities. However, they are limited to carrying capacity and potential delays in delivery.

Modern tankers are usually built with a lattice construction and double hull to enhance safety. Tankers are often filled using onshore pumps, but are discharged using the tankers' own pumps.

LNG Tankers

LNG tankers must be specially designed to meet the needs of LNG transportation*. Special needs are generated by the very low temperatures that must be maintained to keep gas at a pre-determined liquefied state.

LNG companies mostly build LNG ships for a specific project, then own and operate them thereafter. Construction costs have dropped from US $280 million in 1995 (for a 138,000 m^3 capacity ship) to US $150 to $160 million in 2004. This is still more than double the cost of a crude oil tanker. Most added costs relate to the construction of insulated tanks[12].

LNG shipping costs vary based on the ship's operating and amortisation costs, the size of the cargo, and the distance transported. The costs of building and operating receiving terminals, unloading, storage, and re-gasification facilities vary by site. In the US, new onshore terminals built on existing designs are

Figure 3 - The Trans Alaska Pipeline (BP)

Figure 5 - The Nilza Tanker (Petrobras)

Figure 4 - Ultra-Large Crude Carrier (Saudi Aramco)

expected to cost US $400 million or more[13]. The cost of constructing offshore LNG facilities is substantially higher. LNG is transferred from the production facility to the tanker's storage tanks using specially constructed booms and pumps. Specially configured loading pipes are designed to withstand the very low temperatures necessary for liquefaction.

The two main designs are the membrane and spherical tanker type. The former has multiple tanks with linings made from thin nickel steel alloys capable of withstanding extreme temperatures. These tanks are integrated into the hull of the ship.

The spherical design tanker has characteristic circular

Oil companies are benefitting through higher pipeline utilisation factors, more flexible and economic pipeline repairs, reduced maintenance costs and enhanced safety.

containment tanks that are structurally supported by beams in the hull of the ship[14].

We have seen that the main ways to transport oil and gas are pipelines and tankers. But what happens to crude oil once it has been transported? What needs to be done to prepare the oil and gas for the end customer? How do we take crude oil and turn it into useable products? This is where refining fits in and turns crude into products and feedstock. Refining is core to delivering all the products that oil and gas has to offer; in other words, releasing its commercial value.

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