

Annual Business Review

Efforts were made to optimize production organization and resource allocation, and promote the harmonious integration of production, refining, marketing and trading, in order to maximize the overall efficiency.

Exploration and Production

In 2016, our E&P sector fulfilled all the set targets. Domestic oil and gas reserves and output remained stable. Our focus on exploration was to obtain reserves with economies of scale, optimize deployment schemes, and strengthen geological study and R&D of key engineering technologies, resulting in a number of significant discoveries and achievements. We focused on overall efficiency in oil and gas field development, improved yield structure and enhanced production management, maintaining smooth operation throughout the year.

Exploration

We obtained a new understanding of geological theories, strengthened preliminary prospecting and risk exploration of major basins and oil/gas-rich sags, and made an indepth evaluation of exploration potential, resulting in the identification of six 100Mt-grade uncompartmentalized oil zones and five 100bcm-grade gas zones. In 2016, 649.29 million tons of proven oil in place and 541.9 billion cubic meters of proven gas in place were added in China, exceeding 1 billion tons of oil equivalent in total for the 10th consecutive year, which laid a solid foundation for the sound development of our oil and gas business.

Newly proven oil in place (Domestic)

649.29 mmt



Newly proven gas in place (Domestic)

541.9



Reserves and operating data (Domestic)

	2014	2015	2016
Newly proven oil in place (mmt)	689.80	728.17	649.29
Newly proven gas in place (bcm)	484.00	570.20	541.90
2D seismic (kilometers)	19,170	15,909	24,885
3D seismic (square kilometers)	11,739	9,095	8,764
Exploration wells	1,584	1,588	1,656
Preliminary prospecting wells	910	924	865
Appraisal wells	674	664	791

Major Discoveries

Significant achievements were made in oil exploration, in that 370 million tons of oil in place was newly proved in multi-layer stereo exploration in Changqing; a dolomite reservoir was discovered and high-yield oil and gas flow obtained in the Tarim Basin, adding over 60 million tons oil reserves; 91.54 million tons of controlled and predicted reserves were identified in Mahu Sag and 160 million tons of proven, controlled and predicted reserves were identified in the Chefeng and Jinlong areas in the Junggar Basin; a 100Mt-grade reservoir was discovered in deep subsalt layers in Qinghai; and high-yield oil and gas flows were obtained from buried hill reservoirs in the Bohai Bay Basin.

Progress was made in natural gas exploration, including over 600 billion cubic meters of basically proven gas in place newly added in Sulige; over 200 billion cubic meters of controlled and predicted reserves identified in Shenmu and Longdong respectively; and two new gas bearing structures discovered in the Keshen area of Tarim Basin, adding 300 billion cubic meters of proven gas in place to the whole Keshen area. In addition, new gas bearing strata were encountered in Well Shuangtan-3 in northwest Sichuan, and a giant gas zone with 1.5 trillion cubic meters of gas in place took shape in the Gaoshiti-Moxi area in central Sichuan.

Development and Production

Domestic oil and gas production remained steady in 2016. Oil and gas field development continued to be based on a low-cost model with enhanced production management, as well as an optimized production structure and capacity deployment. We strengthened the evaluation of project returns and sought to maximize overall performance. We achieved production capacity increments of 10.32 million tons for crude oil and 10.9 billion cubic meters for natural gas, and produced 183.63 million tons of oil equivalent.

Crude Oil

In 2016, we focused on expediting some major capacity building projects in Xinjiang, Changqing, Tarim and Daqing. In order to maximize the potential of mature fields, efforts were made to improve matching technologies and implement key measures such as fine reservoir description, fine water-flooding, standardized design and construction of ground work, and restoration of long shut-down wells. We produced 105.45 million tons of crude oil throughout the year.

Daqing Oilfield produced 36.56 million tons of crude through strengthening fine water flooding, promoting tertiary recovery technology, optimizing polymer flooding and rolling out ASP flooding. Changqing Oilfield continued to improve the technology for low-permeability reservoir development, accelerated the commissioning of new wells, took measures to treat stripper wells and renovated long shut-down wells, achieving an annual output of 23.92 million tons. Xinjiang Oilfield focused Crude production (Domestic)

105.45



Natural gas production (Domestic)

38.1 bcm

on the optimization of resource structure and the development of light and shallow oil reservoirs, producing 11.13 million tons of crude. Liaohe and Tarim, among other oilfields, made proactive efforts to overcome the negative impact of new capacity cuts, adjusted their production structure and achieved annual targets.

Fine Water-flooding

We continued to develop matching technology of fine water-flooding, and promoted the regular practice of fine water-flooding and thus improved the outcomes of oilfield development in a sustained manner. The natural decline rate and composite decline rate were lower than 10% and 7% respectively, while the water cut growth rate remained below 0.7%.

The long-term effect mechanism of fine water-flooding was further improved, and progress was made in various indicators such as the separate-layer injection rate of injectors, the acceptance rate of separatelayer injection, and the water quality compliance rate. We have made headway in the R&D and field testing of fourth-generation zonal water injection and metering, and realized real-time monitoring of production parameters and automatic control of the water injection rate. In Daqing Oilfield, reservoirs were further layered for water injection, and fine waterflooding technology has been widely applied for more than seven layers. Tarim Oilfield continued to increase the scale of water-flooding and developed matching technologies for water injection per well and per unit, seeing a constant improvement in the water-flooding effect. Huabei Oilfield significantly lowered its natural decline rate and effectively controlled the water cut growth rate through implementing innovative moderate water-flooding measures featuring "multiple wells with less injection for an overall balance".

Pilot Development

In 2016, we focused on strategic replacement technologies and carried out development tests of key technologies to improve chemical flooding, explore gas flooding, and enhance per-well output of low-permeability reservoirs.

Chemical flooding entered the stage of industrial application. Polymer flooding was commercially applied in Daqing, Dagang and Xinjiang oilfields. Major breakthroughs were made in polymer/surfactant flooding in Liaohe, Dagang and Xinjiang oilfields where the composite water cut decreased and the oil recovery rate increased substantially. Technological obstacles for ASP flooding such as emulsification, scaling and produced liquid treatment were resolved and the technology was applied on an industrial scale in Daqing Oilfield. Gas flooding made great progress and pilot fire flooding projects facilitated an annual heavy oil output of 330,000 tons. Miscible gas injection and gravity flooding helped Liaohe, Tarim and Huabei oilfields slow production declines. Field application of CCS-EOR in Jilin and Daqing saw further improvements in miscible flooding mechanism and related techniques. R&D and testing of EOR technology for low-permeability reservoirs proceeded smoothly in Changqing Oilfield. Pilot air foam flooding in Jing'an Oilfield made progress in the control of water cut growth, with the production decline rate dropping from 23.2% to 3.3%.

Natural Gas

In 2016, CNPC made efforts to improve per-well output and development efficiency, optimize deployment schemes, and strengthen project management. Steady progress was made in key projects such as Sulige in Changqing, Tazhong in Tarim, and Longwangmiao in Sichuan. Our annual gas production totaled 98.1 billion cubic meters, an increase of 2.6 billion cubic meters year-on-year.

Changqing Oilfield, China's largest gas production and processing base, produced 36.5 billion cubic meters in 2016, around 37% of CNPC's total domestic gas production. Tarim Oilfield continued to accelerate gas development in Kuche region, especially in Kela-2 and Dina-2 gas fields, achieving an annual production of 23.6 billion cubic meters. Southwest Oil and Gas Field continued to accelerate the capacity building and maintaining the stable production of Longwangmiao Fm reservoir in

A 4Mt/a Industrialized ASP Flooding Base Built in Daqing

After more than 50 years of development, Daqing Oilfield has entered into the ultra-high water cut phase in the late stage of development. As a new generation of technology independently developed by Daqing, ASP flooding can enhance oil recovery by an additional 20 percentage points under the maximum limit of a 98% water cut. ASP flooding was successfully applied in 2011 and began industrial application in 2014, seeing an annual increment in crude production of 1 million tons since then. In 2016, 14 blocks using ASP flooding reached a combined capacity of 4 million tons.

Thanks to years of continuous technological R&D and field tests, Daqing Oilfield has overcome various bottlenecks, such as scaling in artificially lifted wells, cost-efficiency of surfactants, polymer solubility, adsorption loss of various chemical agents and treatment of produced liquid, and developed a sophisticated technological package for ASP flooding. Now the world's largest ASP flooding base of industrialized production has taken shape in Daqing, which boasts the most full-fledged set of matching techniques, the most productive ASP flooding application, and a world-leading position in the field of composite oil flooding technology.

According to the characteristics of produced fluid from ASP flooding, a combined treatment procedure was developed, featuring "air floatation - hydrolysis acidification/contact oxidation - two-stage sand filtration". We also developed a water quality stabilizer and demulsifier, as well as new treatment devices for free water removal and electric dehydration to ensure produced fluid via treatment reaches the reinjection standard.

Since its field test and large-scale application, ASP flooding has mobilized total reserves of 209 million tons and yielded 20.56 million tons of crude. The success of ASP flooding has substantively bolstered the sustainable development of Daqing Oilfield, and served as a role model in the effective development of similar reservoirs with 100 billion tons of reserves both at home and abroad.

Moxi Block, Changning-Weiyuan shale gas block and Luojiazhai gas field, producing 19 billion cubic meters throughout the year. Qinghai Oilfield took measures to increase production and enhance comprehensive water and sand control efforts, ensuring stable production at its major gas fields.

Sulige Gas Field

Located in the northern rim of Ordos Basin, Sulige is the largest uncompartmentalized onshore gas field in China. Since development started, a unique development and construction mode with 12 matching technologies has been formed, which enabled efficient commercial exploitation of low permeability, low pressure and low abundance tight gas reservoirs. In recent years, technological breakthroughs were made in horizontal and cluster well drilling and reservoir stimulation, realizing the transition from vertical well development to a factory-like development mode. In 2016, Sulige produced 22.7 billion cubic meters of natural gas and its cumulative production totaled 146.8 billion cubic meters.

Longwangmiao Fm Gas Reservoir

Located in the middle of the Sichuan Basin, Longwangmiao Fm gas reservoir in the Moxi Block of Anyue Gas Field is by far the largest monomer marine uncompartmentalized gas reservoir in China with proven gas in place of 440.38 billion cubic meters. Since its discovery in 2012, the development of the reservoir was accelerated and an annual capacity of 11 billion cubic meters



Gas processing plant of the Longwangmiao Fm reservoir at the Anyue Gas Field

was built up in 2015. In 2016, 10 new high-yield wells were completed and put into production, boosting its daily capacity to 33.5 million cubic meters. Throughout the year, the gas reservoir produced a total of 8.3 billion cubic meters of natural gas.

Exploration and Development of Unconventional Oil and Gas

In 2016, CNPC continued to carry out the exploration and development of CBM, shale oil and gas, tight oil and gas, and other unconventional hydrocarbons. Capacity building projects proceeded smoothly, innovations and improvements were made in key and matching technologies, and a series of important achievements were made.

CBM

In 2016, the CBM business registered solid growth with steadily increased production. Our focus was the Qinnan and Erdong areas, where efforts were made to constantly improve the exploration and development technology of different coal seams, optimize the drainage and extraction systems and enable dynamic production adjustments. Annual production reached 1.68 billion cubic meters. Well Hexihao-3 at Daning-Jixian block in Erdong yielded industrial gas flows during testing. The predicted gas reserve of coal measure strata was about 200 billion cubic meters in this area. Sweet spots featuring high pressure gas-enrichment were identified in the Benxi Formation for the first time, marking a major breakthrough in the stereo-exploration of coal strata in Erdong. Also for the first time, Baode field in Shanxi Province saw the annual output exceed 500 million cubic meters, becoming the model project of large scale CBM development in China. Hancheng block in Shaanxi Province witnessed big rally in well casing pressure, which demonstrated initial success in its comprehensive management.

Shale Gas

In 2016, based on experience in building demonstration zones in the Changning-Weiyuan and Zhaotong shale gas blocks, CNPC achieved large scale and profitable shale gas development and production through multiple modalities such as self-management, risk operation and international cooperation. The Changning-Weiyuan national shale gas demonstration zone was fully completed with daily capacity increasing to 7.6 million cubic meters. Meanwhile, construction of the Zhaotong demonstration zone proceeded smoothly. These two demonstration zones, with a combined annual capacity of 3 billion cubic meters, produced 2.84 billion cubic meters, an increase of 1.54 billion cubic meters compared with 2015.

Tight Oil

In 2016, we made progress in the R&D of tight oil exploration and development technologies, facilitating the large scale development of the Ordos, Sichuan, Songliao, Qaidam and Santanghu basins. Experiments on highly-deviated selective multi-stage fracturing and the reconstruction of vertical wells were carried out in Changqing, paving the way for the identification and exploitation of large-scale reserves. A field test of the CO2/sand dry-fracturing technique achieved success in a number of blocks, effectively saving water and enhancing efficient development of tight oil. R&D of horizontal well fracturing technology was strengthened in Tuha Oilfield, helping to build the Ma-56 block in the Santanghu Basin into a national demonstration base for the development of tight oil. Over the past two years, we have made 29.62 million tons of tight oil reserves in Tuha producible and achieved a total output of 213,000 tons of tight oil, with an annual capacity of 187,000 tons.

Joint E&P in China

In 2016, we continued to cooperate with international partners to explore and develop oil and gas resources in China. Most of the joint projects focused on low-permeability reservoirs, heavy oil, tidal and shallow water zones, sour gas, high-temperature and high-pressure gas reservoirs, CBM, and shale gas.

By the end of 2016, we had 38 joint E&P projects in operation, producing 3.13 million tons of crude oil and 7.5 billion cubic meters of natural gas, which totaled 9.13 million tons of oil equivalent.

Executive Summary of Major Projects

Zhaodong Oil Project

The project covers 77 square kilometers at the tidal and shallow water zone in the Bohai Bay Basin. New XCL-China LLC. and Australia's ROC Oil (Bohai) Company are our partners.

We have maintained safe and stable oil production since the takeover of operatorship in April 2015. The project produced 560,000 tons of crude oil in 2016, with the actual operating costs lower than expected.

Changbei Natural Gas Project

The project covers 1,691 square kilometers in the Ordos Basin. Shell Group is our partner in the project.

On January 1, 2016, CNPC officially became the operator of the phase-I project under the operatorship handover agreement, and we reached a natural gas sales agreement with Shell. In 2016, the phase-I project produced 3.6 billion cubic meters of natural gas, and the phase-II project with an annual capacity of 2.4 billion cubic meters proceeded in an orderly manner.

Chuandongbei Natural Gas Project

The project is located in the Sichuan Basin, covering an area of 876 square kilometers. Chevron is our partner in the project.

On May 27, 2016, Luojiazhai Sour Gas Field became fully operational. It is capable of processing 9 million cubic meters of natural gas per day and purified 1.1 billion cubic meters of gas in 2016.

In addition, we teamed up with MI Energy Corporation and Global Oil Corporation (GOC) to develop the Da'an project in Jilin. Measures were taken to stabilize oil production and control the water cut along with fracture-network fracturing. The natural decline rate and water cut growth rate continued to decline in mature wells. At the Hainan-Yuedong project in cooperation with Tincy Group Energy, we conducted steam stimulation tests in 58 wells, kicked off 47 wells, basically completed the development program, and pushed ahead with marine engineering work in an orderly manner. Changqing's South Sulige development project with Total and the Zhoushisan project in Daqing with Hong Kong-based Central Asia Petroleum proceeded smoothly.

In 2016, we signed product sharing contracts with BP on the Neijiang-Dazu and Rongchangbei shale gas blocks in the Sichuan Basin with a total coverage of 2,468 square kilometers. For the first time, CNPC served as an operator in the exploration stage. We also signed an MOU with Shell, aiming at jointly enhancing oil recovery by CO2 flooding in the Xinjiang Oilfield. In cooperation with EOG Resources, we carried out joint studies on oil and gas exploration in Shaximiao Formation in central Sichuan.

Crude output from joint E&P projects

3.13_{mmt}

Natural gas output from joint E&P projects



Natural Gas and Pipelines

2016 saw steady growth in our natural gas and pipeline business. Oil and gas pipeline networks were operated smoothly, and there was also progress in the construction of key pipelines. We made steady headway in natural gas utilization and market development, and completed the separation of oil and gas pipeline operation from natural gas marketing.

By the end of 2016, we operated a total of 81,191 kilometers of pipelines in China, including 18,897 kilometers for crude oil, 51,734 kilometers for natural gas, and 10,560 kilometers for refined products, accounting for 69.2%, 75.8%, and 42.3% of China's total respectively.

Pipeline Operation and Control

In 2016, we optimized operation schemes to strengthen prior control and process control, and ensured the safe and smooth operation of our crude oil pipelines. The Lanzhou-Zhengzhou-Changsha Pipeline completed the replacement of National V Standard refined products, effectively promoting the upgrading of refined products quality.

We adjusted domestic gas production according to market demand and seasonal changes. By purchasing LNG spot, making the best use of pipeline capacity, and increasing the injection/extraction volume of underground gas storages to enhance peak-shaving capability, we effectively balanced production and sales, and guaranteed safe and stable gas supply for winter heating and other special purposes.

Underground Gas Storages

We continued to expand our existing gas storage capacity to the maximum and build new storage facilities. We have built and operated 10 underground

Crude pipeline mileage in the nation's total



Natural gas pipeline mileage in the nation's total



storages including Dagang, Jintan, Xiangguosi and Hutubi with continuously enhanced peak-shaving capacities up to 6.1 billion cubic meters, which made us more responsive to potential emergencies. Shuang-6, the first underground gas storage in Northeast China, officially became operational.

Storage and Transportation Facilities

In 2016, we continued to optimize pipeline layout and build new pipelines. The eastern section of the Third West-East Gas Pipeline and the Baodi-Xianghe-Xiji connecting line of the Fourth Shaanxi-Beijing Gas Pipeline were completed and became operational. We commenced the construction the Fourth Shaanxi-Beijing Gas Pipeline, the Second Russia-China Crude Pipeline, and the Zhongwei-Jingbian connecting line of the Third West-East Gas Pipeline. Construction of the Jinzhou-Zhengzhou and Yunnan refined products pipelines proceeded smoothly.

The Third West-East Gas Pipeline

The pipeline has a total length of 5,777 kilometers, including one trunk, one major branch, three branches and one connecting line. It starts at Horgos in the Xinjiang Uygur Autonomous Region and ends at Fuzhou in Fujian Province. The 5,278 km-long trunk has a pipe diameter of 1,016-1,219mm, designed pressure of 10-12MPa and an annual transmission capacity of 30 billion cubic meters. It was constructed and put into operation on a section-by-section (eastern, middle and western sections) basis.

The western section runs from Horgos to Zhongwei in the Ningxia Hui Autonomous Region, with a total length of 2,445 kilometers. Construction of this section began in October 2012, and was completed on August 25, 2014. The eastern section runs from Ji'an in Jiangxi Province to Fuzhou in Fujian Province, with a total length of 817 kilometers. Construction of this section commenced in August 2013 and the section became operational on December 12, 2016. Construction of the Zhongwei-Jingbian connecting line began on May 21, 2016, and it is expected to be operational in 2017.

The Fourth Shaanxi-Beijing Gas Pipeline

The pipeline consists of one trunk and three branches. The truck runs from Jingbian in Shaanxi Province through Inner Mongolia and Hebei to Gaoliying in Beijing. The current phase of construction includes one trunk and one branch with a total length of 1,114 kilometers, pipe diameter of 1,016-1,219mm, designed pressure of 10-12MPa, and designed annual transmission capacity of 25 billion cubic meters.

Construction of the pipeline started on July 30, 2016, and it is expected to become operational by the end of October 2017.

The Second Russia-China Crude Pipeline

The Second Russia-China Crude Pipeline runs from Mohe in Heilongjiang Province through Inner Mongolia to Linyuan in Daqing. Running parallel to the First Russia-China Crude Pipeline, it has a total length of 951km, pipe diameter of 813mm, designed pressure of 9.5-11.5MPa, and an annual transmission capacity of 15 million tons.

Construction of the pipeline commenced on July 20, 2016 and it is expected to be completed by the end of October 2017. According to our contract with Rosneft, the crude supply from Russia to China will be increased by 15 million tons annually through the Second Line upon its commercial operation in January 2018.

Natural Gas Utilization and Market Development

With continuous improvement of our natural gas pipeline network, CNPC delivers natural gas to 32 provinces, municipalities, autonomous regions and special administrative regions. In 2016, we adopted a flexible pricing promotion strategy, advocating fair and open access to pipeline and network facilities, and improving the service quality to major direct supply customers. We prioritized resource allocation to highly profitable markets and high-end users. 70.1% of our gas was sold in Central China, the southeast coastal region, the Bohai Rim, and the Yangtze River Delta region. The percentage of urban gas and direct supply to industrial and power generating users rose to 91%. We signed 85 new long-term purchase and sales contracts with an annual contracted gas volume of 6.1 billion cubic meters. We marketed 131.5 billion cubic meters or 7.2% year-on-year.

We made new progress in tapping the natural gas terminal market. The sales growth of urban gas and LPG terminals reached 10.1% and 10.6% respectively year-on-year. Our gas projects became operational in Dali and six other cities. Branch pipeline construction proceeded in an orderly way, with the length of newly built pipelines reaching 280 kilometers. The Industrial Park branch under Qinzhou Petrochemical became operational, and the construction of Tengchong, Xiangyun and Shidian branches in Yunnan Province were basically completed. Construction of the Yangzhou, Bengbu and Taihe branches proceeded on schedule. Construction of four branches, including the Changsha-Liuyang and Lianyuan-Xinhua sections, commenced. We also vigorously implemented projects including substituting urban coal with gas, replacing industrial coal with fuel gas, and using gas instead of oil in industrial processes. Our CNG/LNG terminal marketing network was expanded through multiple channels, with more combined oil-and-gas stations being built.



Liquefied Natural Gas (LNG)

In 2016, we had 13 LNG plants in operation with a total annual capacity of 4.77 billion cubic meters and we produced 640 million cubic meters of LNG, an increase of 15% year-on-year. We had 438 LNG refueling stations in operation and 33 under construction. Our annual terminal sales of LNG totaled 1.35 billion cubic meters.

In 2016, our Jiangsu, Dalian and Tangshan terminals played a more important role in securing gas supply and peak shaving, receiving a total of 5.65 million tons of LNG. The Phase II projects of the Jiangsu and Dalian terminals were completed and became operational with their annual capacity rising to 6.5 million tons and 6 million tons respectively, which further ensured stable gas supplies to the West-East Gas Network and the Yangtze River Delta region in winter.

Refining and Chemicals

Our refining and chemical business achieved its best ever performance in 2016. We highlighted quality and efficiency, optimized production and operation, prioritized resource allocation for more efficient units and facilities, and increased the utilization of integrated plants. We continued to adjust the structure of refined and chemical products, reduce the dieselto-gasoline ratio and raise the percentage of highly profitable products, resulting in enhanced profitability.

Domestically, we processed 147.09 million tons of crude and produced 99.32 million tons of refined products. Output of profitable products registered a growth rate of 5.5 percentage points. Output of jet fuel, highgrade gasoline and aromatics was increased by 1.8%, 12.9% and 6.4%, respectively. Production of fuel oil decreased by 21%, and the dieselgasoline ratio dropped by 0.24.

We produced more highly profitable and better quality chemical products. Our ethylene units were running at an 11.1% higher utilization rate than the previous year, yielding 5.59 million tons of ethylene, an increase Crude runs (Domestic)

147,09

Refined products output (Domestic)

99.32 mmt



Refining and chemicals operating data (Domestic)

	2014	2015	2016
Crude runs (mmt)	150.16	151.32	147.09
Utilization rate of refining units (%)	82.6	84.5	80.9
Refine products output (mmt)	101.84	103.69	99.32
Gasoline	34.10	36.47	33.97
Kerosene	7.14	8.34	9.32
Diesel	60.60	58.88	52.03
Lubricating oil output (mmt)	1.58	1.21	1.16
Ethylene output (mmt)	4.98	5.03	5.59
Synthetic resin output (mmt)	8.07	8.32	9.20
Synthetic fiber output (mmt)	0.07	0.07	0.06
Synthetic rubber output (mmt)	0.75	0.71	0.76
Urea output (mmt)	2.66	2.57	1.90
Synthetic ammonia output (mmt)	1.89	1.85	1.53

of 11.1% year-on-year. We sold 26.8 million tons of chemical products throughout the year, an increase of 6%. In particular, sales of synthetic resin and synthetic rubber increased by 10% year-on-year.

Construction and Operation of Large Refining & Petrochemical Bases

In 2016, our major refining and petrochemical facilities in China maintained stable operation at a rate of 99.4%. Their 16 technical and economic indicators were better than those in 2015. In particular, the fuel and electricity consumption of ethylene fell by 17.6 kgoe/ton year-on-year. Both the energy and material consumption of polyethylene and polypropylene production decreased.

Construction of our new refining and petrochemical projects proceeded smoothly. The 10Mt/a refining unit at Yunnan Petrochemical was delivered and ready for operation. The refinery upgrading project at Huabei Petrochemical was well underway. The renovation of Liaoyang Petrochemical's Russian crude processing facilities was launched. Steady progress was made in projects at Guangdong Petrochemical.

Upgrading of Refined Products and Development of New Products

In response to severe air pollution, CNPC continued to accelerate quality upgrading of its refined products. In 2016, 23 quality upgrading projects were completed and became operational at Jilin, Sichuan and Lanzhou Petrochemicals. All of our 26 refining and petrochemical enterprises were capable of producing National V gasoline and diesel. We produced 26.11 million tons of National V gasoline and diesel, an increase of 109.9% year-on-year.

We continued to invest in the R&D of new chemical products. A total of 84 new brands/series were launched throughout the year with production of 1.03 million tons, including 788,000 tons of synthetic resin and 65,000 tons of synthetic rubber. Among them, 42 brands/series realized industrial production for the first time. Significant progress was made in the R&D of auto fuel tank materials and IBC barrel materials at Daqing Petrochemical, and medical materials and special materials for Goodyear tires at Lanzhou Petrochemical. We also succeeded in the market promotion of 10 new products, including Dushanzi Petrochemical's m-LLDPE, Daqing Refining and Chemical's PA14D-2, and Fushun Petrochemical's impact resistant plastics.



Dushanzi Petrochemical

Marketing and Sales

In 2016, we enhanced our ability to adapt to the needs of retail market. Refined products, pre-paid fuel cards, non-fuel products, and lube oil products were marketed in an integrated manner. Service stations were upgraded from oil retailers to comprehensive service platforms. As a result, our overall business operation improved.

Refined Products

In 2016, our domestic sales of refined products remained flat at 113.03 million tons. Sales of high value-added 98# gasoline and jet fuel increased by 689% and 11.3% year-on-year, respectively.

Marketing Network

We continuously optimized and expanded our marketing network, achieving both higher quality and greater coverage. In 2016, 467 service stations were built and 420 stations were put into operation, increasing our retailing capacity by 2.63 million tons. By the end of 2016, we had 20,895 service stations operating in China.

With more extensive and improved functions, the stations provide diversified services to satisfy customers' needs. Convenience stores were available at 89% of these stations, and 306 "25" car service shops opened. The stations also improved their retail services by means of "Internet +

Refined products sales (Domestic)



Service stations in China



Marketing" such as "Smart Service Stations", the "uSmile e-Station" app, Alipay and WeChat based mobile payment, and installed self-service terminals for pre-paid fuel cards. With the accelerated integration of online and offline marketing, we had a much greater capability to provide comprehensive services. In 2016, 19.39 million "Kunlun pre-paid fuel cards" were issued, increasing the total issuance to more than 100 million cards.

Non-Fuel Products

Our non-fuel products registered significant growth in both revenue and profit. Our convenience stores' shelf sales ratio and revenue grew by 7% and 43% respectively, thanks to optimized product selection and enhanced marketing. "2S" shops were deployed to push forward car services in cooperation with SAIC Motor. Revenue from self-produced products grew by 179% year-on-year as a result of enhanced marketing. We also explored emerging business and extended value-added services at a faster pace. In 2016, our non-fuel products reported revenue of RMB 14.4 billion and profit of RMB 1.7 billion, up 16% and 17% year-on-year respectively.

Lube Oil and Miscellaneous Refined Products

As a high value-added product, lube oil is becoming a new profit growth point. With continued exploitation of sales channels and enhanced market development, we secured more advantages in both brand and technology, and made breakthroughs in the research and development of new products. Gear oil for CRH trains was tested at a speed of 250-350km/h on multiple units running for 600,000 kilometers. Gearbox oil for wind turbines was tested in 1.5kW turbines, and its application was extended to wind turbines of up to 1MW. In 2016, we sold 1.17 million tons of lube oil. Sales of automobile lube and byproducts grew by 15% and 57% year-onyear respectively.

Our miscellaneous refined products became more profitable. By integrating crude supply and refined products purchases at local refineries, we increased sales of Venezuelan heavy oil by 52% year-on-year. By developing the end-user market, we accumulatively sold 7.12 million tons of asphalt, accounting for 25% of the domestic market total. We also introduced innovative modes of sale for distillates and slurry, and supplied a higher percentage of directly-supplied naphtha without consumption tax. In 2016, our miscellaneous refined products registered sales of 33.36 million tons, with pre-tax profits increasing by 16% year-on-year.



Overseas Oil and Gas Operations

Against the complicated international environment and uncertainties emerging from overseas investment projects, our operating results improved steadily in 2016, thanks to a holistic approach toward optimizing project management, reducing operating costs and conducting capital operation. Oil and gas exploration activities saw important results. Major overseas projects proceeded well and safely. Projects under construction went ahead smoothly. By the end of 2016, CNPC operated in more than 30 countries. In particular, there are 49 cooperation projects in 19 countries along the Belt and Road routes, which have become the main source of the company's oil and gas output and revenue outside China.

Exploration and Development

In 2016, our overseas oil and gas exploration activities were targeted at high-quality and readily producible reserves through the queuing and selection of suitable projects worldwide. Pursuing a low cost strategy, exploration investment focused on key projects, highlighting costeffectiveness and success rate. These activities resulted in a number of breakthroughs and progress, with newly added recoverable oil and gas reserves amounting to 96.23 million tons of oil equivalent.

Progressive exploration of high-quality reserves: A number of new oil reservoirs were discovered in the buried hill rocks in Chad; high-yield oil and gas flows were obtained from exploration at Hope Oilfield in the Pre-Caspian Central Block in Kazakhstan; new pay zones were identified at the western uplift of Jabung Block in Indonesia; and significant new reserves were achieved in Ecuador (Andes project), Kazakhstan (PK) and Oman.

Major progress in risk exploration: In Turkmenistan, two new gas reservoirs were discovered at the Amu Darya project; in Sudan, breakthroughs were made at the southern slope of the Sufyan Sag of Block 6 and a new oil-bearing bed series of Amal Formation was detected at the central uplift.

Breakthrough in deep-water exploration: In Brazil, well tests resulted in a high yield from the northwest section of the Libra Block, including well NW-3 with a daily capacity of more than 10,000 tons and well NW-2 with a 400m+ thick reservoir. A giant uncompartmentalized oil prospect with proven oil in place of up to 1.2 billion tons was basically confirmed.

Production

In 2016, our overseas projects achieved steady growth in oil and gas production by boosting fine management, development optimization, capacity building and cost control efforts. The full-year operating production reached 146.32 million tons of oil equivalent, of which CNPC's equity production was 76.01 million tons, an increase of 5.5% year-onyear. The operating production and equity production of crude oil were 121.51 million tons and 57.53 million tons respectively; and the operating production and equity production of natural gas were 31.1 billion cubic meters and 23.2 billion cubic meters respectively.

Central Asia and Russia: CNPC International in Kazakhstan accelerated development planning for its four major oilfields, optimized drilling workload and improved the production efficiency of new wells. The PK and Aktobe projects saw new progress in oilfield development and the Kashagan project went on stream. In Turkmenistan, CNPC Amu Darya Company sped up the construction of production facilities in new gas fields. The Phase III project at Block B proceeded smoothly with a daily gas processing capacity of 21 million cubic meters. In Uzbekistan, the Mingbulak project moved ahead steadily. In Russia, construction work of the Yamal LNG project was in full swing, seeing 75% of the project schedule completed by the end of 2016.

Latin America: CNPC America was able to maintain stable production with a focus on profit-generating output, production coordination and fine management. In Venezuela, the MPE3 project made significant progress in the integration of production and drilling services, with surface works advancing smoothly; the Zumano and Caracoles-Intercampo projects reduced the capacity of inefficient blocks and ensured that production was safe and well under control. In Ecuador, the Andes project saw the completion of 600Kt/a capacity building at the Johanna East Oilfield, signed exploration contracts on Block 79 and Block 83, and extended the service contract for Block 14 to 2025. In Peru, despite the adverse impact of El Niño, the planned targets for production were exceeded without new drilling activities.

CNPC's share in overseas crude production

57.53



CNPC's share in overseas natural gas production

23.2



Middle East: We completed business restructuring and realized smooth transition. New wells became operational as planned and water-flooding projects advanced well. Operating fields in Oman, and Al-Ahdab, Rumaila, Halfaya and West Qurna in Iraq saw production targets remarkably exceeded. Meanwhile, their production capacity grew steadily. The North Azadegan project in Iran was put into operation. The Abu Dhabi project and the restoration of Iran's MIS project proceeded smoothly.

Africa: CNPC International Nile adopted differentiated approaches to oil production in Sudan and South Sudan, with an emphasis on geological research and fine management. A total of 60 new wells started pumping to create a new capacity of 380,000 tons. In South Sudan, new well production picked up in Block 3/7 and workover operation was carried out efficiently. The average daily output per well reached a three-year high; and surface engineering work was completed to enable the timely treatment of produced fluid. In Sudan, a series of measures targeted at idle wells and unproductive wells were implemented to boost production in Block 6 and Block 1/2/4. In Chad, the Phase-2.2 oilfield project advanced steadily.

Asia-Pacific: In Australia, our local company achieved production and operation targets successfully despite the challenge of low oil prices. Sticking to a low-cost strategy, the Arrow project focused on the development of the Surat Basin. The Daandine Expansion project came on stream; and the Browse project restarted Concept Select. Our projects in Indonesia, Mongolia and Singapore actively implemented cost reduction and revenue generating measures to ensure steady and effective operations. Other regions: The Phase I MacKay River Oil Sands Project in Canada became operational with the targets of construction and steam injection achieved on schedule, laying the foundation for oil production and bitumen sales beginning in 2017. Located in northern Alberta, the project is expected to produce 35,000 barrels a day upon completion of Phase I.

Pipeline Construction and Operation

As of 2016, the company operated a total of 14,507 kilometers of overseas oil and gas pipelines including 6,604 kilometers of crude pipelines and 7,903 kilometers of natural gas pipelines, which transported 25.93 million tons of crude oil and 43.9 billion cubic meters of natural gas throughout the year. The Kazakhstan-China Crude Pipeline, the Russia-China Crude Pipeline and the Myanmar-China Gas Pipeline maintained safe and steady operation. The Myanmar-China Crude Pipeline was successfully connected with water transportation system; Line C of the Central Asia-China Gas Pipeline was fed with gas sources in Uzbekistan, with the annual transmission capacity of Line A, B and C totaling 51 billion cubic meters.

Key overseas pipeline projects made headway. The No.4 and No.8 compressor stations along the Kazakhstan section of Line C of the Central Asia-China Gas Pipeline became operational. The Second Kazakhstan-China Gas Pipeline reached an annual capacity of 6 billion cubic meters. The Chinese section of the Eastern Route of the Russia-China Gas Pipeline proceeded smoothly. In Kazakhstan, the subsea pipeline of the Kashagan Oilfield was thoroughly repaired to transport crude oil successfully for



The Yamal LNG project in Russia

North Azadegan Project in Iran Became Operational

On April 13, 2016, the North Azadegan project in Iran was put into official production and began to deliver crude oil.

Located 80 kilometers west of Ahvaz, the capital city of Khuzestan Province, the North Azadegan project is a major investment of CNPC in Iran. It has a production capacity of 4 million tons of crude per year and of 700,000 cubic meters of natural gas per day.

The project company adopted a number of innovative technologies to ensure the efficient development of the oilfield, including large-scale gas lift, 3D directional cluster well drilling and horizontal well drilling, as well as inclosed transportation and processing of crude. Meanwhile, an internationally leading data acquisition, monitoring and security system was put in place to enable automated production management and safety protection.

As the North Azadegan Oilfield is situated in a national wetland reserve, the project company kept improving its HSE system and emphasized the importance of ecological environmental accountability. No environmental accidents have been reported since the project was launched in 2009. The project company received an honorary certificate of environmental protection from the local government for its environmental efforts, making it the only holder of this certificate among foreign companies operating in Iran.

the first time. In Canada, the Phase I project of the Grand Rapids Pipeline System saw 100% completion of winter engineering and 90% completion of summer engineering, with stations along the route basically completed.

Refining and Chemicals

In 2016, CNPC's overseas refineries operated in a safe and stable manner and processed 44.57 million tons of crude. In Sudan, the takeover of equity and operatorship of the Khartoum Refinery was completed smoothly. In Niger, Zinder Refinery made significant progress in negotiations with Sonidep on sales and pricing of oil products and signed a new sales agreement. In Kazakhstan, Shymkent Refinery saw steady progress in its renovation and upgrading project.

Project Cooperation and Development

In 2016, driven by China's Belt and Road Initiative, CNPC continued to deepen and broaden its ongoing efforts in international oil and gas cooperation by signing a range of cooperation agreements and memorandums with the governments of Russia, Venezuela, Peru, Mozambique, Algeria, etc. and their energy companies.

In Central Asia-Russia, CNPC and Gazprom signed a Memorandum of Understanding on promoting cooperation in underground gas storage and gas power generation projects in China, in an effort to promote relevant collaboration and seek a wider range of joint venture and cooperation opportunities. The two sides also signed an agreement to cooperate in the mutual recognition of standards and conformity assessment results, and an MOU on feasibility study cooperation in the NGV fuels sector, in a bid to deepen cooperation in standardization and NGV fuels.

In Latin America, CNPC signed MOUs on cooperation progress with PDVSA, and on deepening oil and gas cooperation with the Ministry of Energy and Mines of Peru.

In Africa, CNPC signed a cooperation framework agreement with Mozambique's national oil and gas company ENH. Under the agreement, the two sides will step up collaborative efforts in oil and gas exploration and production, and natural gas processing and marketing. CNPC will not only participate in Mozambique's E&P projects and promote services cooperation, but also train technicians and managers for Mozambique's oil industry.

In addition, CNPC and Total signed a strategic framework cooperation agreement to promote cooperation in oil and gas investment and R&D, and strengthen exchange and cooperation in soft power such as corporate management and corporate social responsibility.

International Trade

With continuous efforts to consolidate and expand its overseas marketing network, CNPC promoted the overseas operation hubs which integrate trade, processing, transportation, and storage. On a global scale, we carried out international trade in crude oil, refined products, natural gas, petrochemicals, and carbon emissions, as well as marketing of overseas equity oil and futures on oil and refined products. The scope of trade covered major oil and gas resources and markets in more than 80 countries and regions around the world. Our annual trading volume was 450 million tons, worth USD 141.2 billion.

Our capabilities in resource mobilization in the crude oil sector were further enhanced. The import volume of the Kazakhstan-China Crude Pipeline reached 10.07 million tons. We signed an extended agreement with Rosneft on increasing the oil supply to 10 million tons per year. We also took full advantage of our global marketing network to increase sales of overseas equity oil. For the first time, the North Azadegan project in Iran began oil take and sales.

The scale of refined products processing has been expanding as we strived to develop high-end markets with greater efficiency. The annual quantity of processed and exported refined products was 9.94 million tons, an increase of 17% year-on-year. Efforts were made to further tap the retail market with a focus on ship refueling, airport fueling and gas station retail. The annual fuel oil sale of bonded ships in the Chinese market was 4 million tons, accounting for 45% of the national total. We expanded airport fueling services to 17 airports in six countries and regions with an annual supply of 4 million tons. Our market share of gas station retail in Singapore, Kazakhstan and Hong Kong was 21%, 16% and 12% respectively.

As for natural gas, we optimized the pipeline gas and long-term supply of LNG, with adjustment on import volumes, optimized the shipping schedule of LNG, and ensured stable supply of natural gas. Our LNG marketing network was further expanded to Argentina, Italy, and Dubai for supply. In addition, we also sourced from countries like Nigeria, Australia, and Russia, which also drove the growth of LNG ship chartering.

Chemicals trading became more technology-intensive, and we continued to raise the level of integrated operation. The delivery volume of our PTA futures contract ranked first at the Zhengzhou Commodity Exchange, which suggested a steady growth in market influence.

A variety of measures were taken to reduce shipping costs. We established cooperation with 40 ship owners around the world, which enabled direct transactions accounting for 50% of the total and thus reduced freight rates. To strengthen shipping safety management, we developed a process for marine accident analysis and feedback to ensure safe operations.



Overseas Operation Hubs

Based on three overseas operation hubs in Singapore, London and New York, CNPC continued to improve the capabilities of its global resource optimization.

Our Singapore branch further improved its market influence in Asia. In Malaysia, we took 55% of the ship refueling market. In Myanmar and Sri Lanka, our market share of refined products exceeded 40%. In Iran, our market share of gasoline was over 25%. We were also awarded an oil supply contract for 2017 by Ethiopia, which accounts for more than 35% of the country's market of refined products. Our Hong Kong branch expanded its refueling business in Dubai and Songshan Airport in Taiwan, and became the largest oil supplier for Hong Kong Airport for the fifth consecutive year. For the first time, our Japan branch exported inventory crude oil from Dalian to the Japanese market, actively promoted cost-cut and efficiency improvement of the joint venture refinery, and expanded LNG sales to end-users in Japan and South Korea. Our Kazakhstan branch maintained its position as the third-largest local retailer of refined products.

In Europe, our London branch further enhanced the operational capacity of Brent crude oil and local diesel, and further strengthened regional and local market expansion of refined products.

In the Americas, our branch sold crude oil to Venezuela through successful procurement of WTI. We signed new contract on USD 10-billion financing and oil supply, which further consolidated our resource advantage in the region.

Oilfield Services, Engineering Construction, and Equipment Manufacturing

In 2016, CNPC gave full play to its advantages in integrated operation to overcome difficulties caused by low oil price and a shrinking market. We continued to carry out geophysical prospecting, drilling, logging, downhole operations, and other technical services in oil and gas fields around the world with improved competitiveness. We made new breakthroughs in exploring high-end overseas market and worked on many engineering and construction projects in oil and gas field surface projects, large refining and petrochemical facilities, pipelines and storage tanks. We accelerated the transition to a "Manufacturing + Services" mode in our equipment manufacturing sector and sold petroleum materials and equipment to 82 countries and regions through a marketing network covering most of the world's oil producers.

Oilfield Services

In 2016, we had 5,988 crews providing oilfield services in 50 countries worldwide. By reducing the size of our operation crews, optimizing the investment structure and improving service competence and quality, we took a much larger market share in China and achieved revenue growth in overseas markets despite the downturn in the oil industry.

Geophysical Prospecting

In 2016, we deployed 132 seismic crew-times (61 2D and 71 3D) in 255 projects, acquiring data of 162,684 kilometers of 2D lines and 58,120 square kilometers of 3D profiles. With 100% acceptance for both on-site data

Geophysical prospecting operations

	2014	2015	2016
Seismic crews in operation	166	166	165
Domestic	96	96	96
Overseas	70	70	69
2D seismic data acquired (kilometers)	103,645	132,714	162,684
Domestic	42,798	22,521	35,919
Overseas	60,847	110,193	126,765
3D seismic data acquired (square kilometers)	63,990	47,219	58,120
Domestic	14,485	10,722	10,844
Overseas	49,505	36,497	47,276

acquisition profiles and final data processing profiles, the 2D and 3D surveys recorded shots per average day increased by 8.3% and 8.7%, respectively.

Efforts were made to promote the application of "wide azimuth, broadband and high density" technology, efficient data acquisition by vibroseis, and digital seismic crews in onshore exploration. We completed 3D shale gas prospecting at the Zi-201 well-block in Weiyuan of Sichuan Province, and the 2D MT project in Tajikistan. PDO in Oman and S77 in Saudi Arabia among other projects proceeded smoothly. We took the largest share of the global onshore market for the 14th consecutive year. As for deep water exploration, we focused on key market areas, optimized overseas market layout, and completed the Heare project in Papua New Guinea and the Buscador project in Mexico, with highly recognized quality. A number of new projects, including the NWAAM17 project in West Africa, were commenced smoothly. In terms of transitional zone prospecting, our enhanced management performance resulted in high operating efficiency at the KOC project in Kuwait and the S78 project in Saudi Arabia. In addition, we strengthened the R&D of special technologies such as borehole seismic, unconventional exploration, and integrated geophysical & chemical prospecting, seeing enlarged markets and an extended business reach.

New progress was made in the R&D of core software and equipment, and remarkable results were achieved in the application of packaged technologies. A new 3.0 version of GeoEast software was released, with great improvements in seismic-steering horizontal well design, reservoir prediction, facies-controlled property modeling, well-seismic combined sequence stratigraphic interpretation, and conventional structural interpretation. Functions such as the real-time monitoring of vibroseis, ADS (-TA, -TE) data analysis and large data volume transmission were added to KLSeis II software. Important breakthroughs were made in terms of charging speed, data downloading speed and high-precision synchronous sampling in the R&D of the eSeis node instrument, and the field acquisition test and physical test were completed. The EV56 highprecision vibroseis was developed successfully. The SN5-5 low-frequency wave detector was launched into large-scale application in China. The G3i and Hawk systems saw improvements both in stability and reliability.

In 2016, although investment in geophysical prospecting declined significantly in the international market, we obtained new contracts worth more than USD 100 million in established markets in Oman, Saudi Arabia and other countries in the Middle East. We won the deep-sea OBN project in Indonesia, and made breakthroughs in emerging markets like Egypt, Cuba, and Kyrgyzstan.

Drilling

In 2016, our 1,205 drilling crews drilled 9,232 wells and completed 9,328 wells, with a total footage of 19.5 million meters.

We advocated EPC in bidding for drilling projects and promoted the large-scale application of efficiency improving measures like deep well drilling, ROP speed up, factory operation, and horizontal drilling, which greatly boosted our drilling efficiency on projects home and abroad. Our Chuanging Drilling Engineering Company completed 13 deep wells at Anyue Gas Field in Sichuan, with an average well depth of 5,460 meters, and the average monthly drilling rate and ROP increased by 9.3% and 15.3% year-on-year. The average drilling period was 177 days, 27.5 days shorter compared with 2015. In particular, well Moxi-116 was completed at a depth of 5,475 meters within 124 days, the shortest drilling cycle in the area. By using the PCD system, Xibu Drilling Engineering Company obtained an oil flow of 273 tons per day and a gas flow of 10,000 cubic meters per day during the formation test at well Shi-1-3-1 in Qinghai Oilfield and effectively protected the reservoirs. Bohai Drilling Engineering Company completed six wells at Changning shale gas block in Sichuan by adopting factory drilling, of which well H8-2 created two technical records in the Changning Block: maximum hole deviation (98°) and the shortest drilling cycle (83.9 days) at a depth of over 4,800 meters. Great Wall Drilling Company completed horizontal well SEB-24 in Cuba at a depth of 7,300 meters, with a maximum extended reach of 6,167 meters, a Dep/TVD ratio of 3.39, and seven drilling records in Cuba.

Drilling operations

	2014	2015	2016
Drilling crews in operation	1,018	1,230	1,205
Domestic	824	979	943
Overseas	194	251	262
Wells drilled	12,286	9,387	9,328
Domestic	10,970	8,289	8,686
Overseas	1,316	998	642
Footage drilled (million meters)	24.92	20.89	19.50
Domestic	21.98	18.38	17.96
Overseas	2.94	2.51	1.54

The R&D and application of new technologies were strengthened and made remarkable achievements. A high-performance compound drilling bit was successfully developed and tested at well Shuang-66 and well Shuangshen-1 in Daqing Oilfield, registering a footage increase of 44%, a drilling rate increase of 53% and a cost reduction of 50%, with greatly improved performance. Newly developed multi-dimensional impact drilling tools, featuring pulsed jet and shock vibration drilling, can make both axial and rotational impacts to increase the average ROP by 56%, which is expected to substantially accelerate drilling in hard rock formations. Expandable open-hole liner sealing technology underwent a field test at well Ha-31-H3 in Liaohe Oilfield, succeeding in the one-time sealing of a 435m-long open-hole interval at 2,493-2,928m and showing excellent performance in sealing complex formations and addressing severe leakages. The intelligent closed-loop rotary steering system was field tested at four wells, and achieved the largest single-well footage of 1,150 meters at well Gang-1601 in Dagang Oilfield with an average ROP of 10.8 m/h.

In the international market, we won new drilling contracts in Algeria, Iraq, Venezuela, Pakistan, Turkmenistan and other countries. Our drilling rig utilization rate reached 100% at the Ahdab project in Iraq and projects in Venezuela.

Well Logging and Mud Logging

In 2016, CNPC deployed 797 well logging crews and completed 79,231 well-times of logging in 17 countries; and 1,223 mud logging crews and completed mud logging at 7,929 wells.

Satisfactory results were achieved in the application of mature logging technology, as evidenced by the EILOG "One-String" fast logging tools applied at Changqing, Tuha and Qinghai oilfields in China, with logging operations exceeding 5,000 well-times throughout the year. The LEAP800 logging system was applied in five countries and regions outside China.



Well logging operations

	2014	2015	2016
Logging crews in operation	760	803	797
Domestic	623	662	663
Overseas	137	141	134
Well logging operations (well-time)	93,533	88,926	79,231
Domestic	88,000	83,933	75,591
Overseas	5,533	4,993	3,640

Logging performance and efficiency for complex wells were further improved by using our unique techniques. We developed bypass casing well logging technology and applied it to highly-deviated well cementing guality assessment and open-hole horizontal well logging. In Changging Oilfield, this technology completed open-hole logging at 107 horizontal wells with average single-well operation efficiency increasing by 50%. Crawler technology was used to complete logging operations at 87 horizontal wells, increasing per-well operation efficiency by 64% compared with the conventional wet connector logging. Improved coiled tubing logging technology saw successful application in Iran and Irag. Storage type variable density logging tools connecting coiled tubing and drill tools helped us enhance well cementing guality assessment for large extendedreach wells and slim-hole wells in Liaohe Oilfield and shale gas wells in south Sichuan, with operation efficiency increasing by more than 50%. The "3+3" multi-level logging scheme was adopted at Mahu block in Xinjiang Oilfield, which reduced the tool sticking occurrence ratio from 22% in 2015 to 5.5% in 2016 during logging operation.

Downhole Operations

In 2016, our 1,914 crews completed 112,643 well-times of downhole operations and 8,515 layers of formation testing.

Our downhole operation performance was further improved through the application of new technology and techniques. We vigorously promoted the factory fracturing operation mode and continued to develop our shale gas reservoir fracturing technology, resulting in remarkable stimulation effects. The output from the fourth round of well testing in the Changning block in Sichuan was 112% higher than that in the first round. The second round of well testing in the Weiyuan block yielded 45% more shale gas than that in the first round. Annular sand fracturing by coiled tubing with a bottom sealing ring was tested in a number of fields. In Changqing Oilfield,

hydraulic jet fracturing was applied to 80 layers (intervals) in 20 wells, with a maximum of eight layers (intervals) being fractured in one trip. Snubbing operations for gas wells at a pressure higher than 21MPa (maximum 28MPa) were also made possible.

In 2016, we made major breakthroughs in the development of CO2 fracturing technology, especially CO2 dry fracturing technology. Techniques for CO2 energizing and injection as well as foam fracturing became more sophisticated. The key equipment, inclosed CO2 sand mixing device independently developed by CNPC, boosted the effective volume per single unit to 20 cubic meters with a maximum sand transmission rate of 0.8 cubic meters/minute. We developed a CO2 fracturing fluid system and established an evaluation method for CO2 dry fracturing fluid tests. We also had CO2 fracturing stimulation facilities in place, which enabled dynamic simulation and equipment performance testing under full operating conditions. We conducted CO2 foam fracturing and dry fracturing tests for 132 well-times, seeing a remarkable increase in oil and gas production.

Downhole operations

	2014	2015	2016
Downhole operation crews	2,090	2,153	1,914
Domestic	1,849	1,929	1,676
Overseas	241	224	238
Downhole operations (well-time)	143,405	128,879	112,643
Domestic	140,713	126,062	110,818
Overseas	2,692	2,817	1,825
Formation test (layers)	6,965	7,782	8,515
Domestic	5,099	5,051	5,555
Overseas	1,866	2,731	2,960



Construction of the Second Russia-China Crude Pipeline

Engineering and Construction

Despite a greatly reduced workload and a substantially shrinking market, we managed to enhance our competitiveness and profitability through reinforcing project management and process control, promoting standardized design, factory prefabrication and modular construction, emphasizing high-end business such as EPC, PMC, consultancy and design, and establishing a service system and management process that cover the entire process of feasibility study, investment and financing, and project implementation. At the same time, we continued to advance business transition and upgrading, and accelerated the shift from an EPC contractor to an integrated service provider.

CNPC has been closely following the nation's Belt and Road Initiative and made proactive efforts to tap market potential. We continued to optimize our domestic and international business layout, further consolidated the traditional domestic market, and expanded our share of overseas high-end markets, with a business development network covering regional markets and major countries in Central Asia, the Middle East, Africa, Asia-Pacific, and the Americas. In 2016, CNPC carried out a total of 60 major projects on oil and gas field surface engineering, refining and chemicals, long-distance pipelines, storage tanks and LNG, etc.

Oil and Gas Field Surface Engineering

CNPC maintained its domestic leading position in capacity building for onshore oil and gas fields. We possess a series of surface engineering technology packages for conventional oil and gas fields, complicated oilfields with high water cut, low permeability, ultra heavy oil or high condensate content, and gas fields with high formation pressure, high yield or high sulfur content. We are capable of building 20Mt/a oil production capacity and 20bcm/a gas production capacity.

In 2016, our major capacity building projects proceeded smoothly. The project for light hydrocarbon deep recovery from condensate gas in Tarim Oilfield was launched. The project to overcome bottlenecks at Block 3/7 in South Sudan was completed. A gas processing plant in Tanzania became operational and began to export commercial gas. Other projects were well under way including Phase-I of Mender Oilfield in Abu Dhabi, Phase-2.2 of Chad and the West Qurna Oilfield in Iraq, and MPE3 expansion in Venezuela. Preliminary work was carried out smoothly on the newly signed renovation project for Basra Gas in Iraq.

Construction of Refining and Chemical Facilities

CNPC is capable of designing and building 10Mt/a refining and 1Mt/a ethylene facilities. In China, we are the leader in independently developed technologies for the production of 400Kt/a ABS resin, 400Kt/a polyester, and 1.2Mt/a PTA. We have also developed technology packages for the production of 450Kt/a synthetic ammonia and 800Kt/a urea.

In 2016, projects on upgrading gasoline and diesel quality and technology renovation were completed at Changqing Petrochemical, Daqing Refining and Chemicals, Jinzhou Petrochemical and Urumchi Petrochemical. The 10Mt/a refinery at Yunnan Petrochemical and the 4Mt/a coal-tooil plant at Shenhua Ningmei were delivered. The fertilizer project in Ningxia approached completion and was ready for commissioning. The 10Mt/a refinery upgrading project of Huabei Petrochemical made steady progress. Overseas, the Phase-I renovation project of Shymkent Refinery in Kazakhstan was carried out in an orderly manner, and newly inked projects, such as expansion of Algiers Refinery and polypropylene production in Malaysia, were underway.

Pipeline and Storage Tank Construction

With regard to long-distance pipeline construction, we have mastered an entire set of design and construction technologies for pipelines featuring large diameter (Ф914-Ф1219mm), high pressure, high grade steel (X70, X80), and thick wall (14.5-33mm). We also possess the design technology for the orderly transmission of refined products as well as design and laying technologies for shallow-water pipelines. We are capable of designing and building 150,000m³ oil tanks and 10,000m³ spherical tanks, with an annual construction capacity of 26 million cubic meter for oil tanks and 16 million cubic meters for refined products. In addition, we can design and build natural gas liquefaction plants and LNG terminals, as well as cryogenic LNG tanks with per unit capacity of 200,000 cubic meters.

In 2016, we completed and put into operation the eastern section of the Third West-East Gas Pipeline, the Baodi-Xianghe-Xiji connecting line of the Fourth Shaanxi-Beijing Gas Pipeline, and the directional crossing of the Lantau-Changzhou Island subsea pipeline in Hong Kong. Other projects were proceeding as planned, including the Jinzhou–Zhengzhou and Yunnan refined products pipelines, renovation of the Tieling-Dalian Crude Pipeline, and the Chinese section of the Eastern Route of the Russia-China Gas Pipeline. Construction commenced of the Fourth Shaanxi-Beijing Gas Pipeline, the Zhongwei-Jingbian connecting line of the Third West-East Gas Pipeline, and the Second Russia-China Crude Pipeline. Outside China, we completed the refined products pipeline in Kenya and the Majinoon FCP Gas Pipeline in Iraq. In addition, we were awarded the pipeline construction projects such as the rerouting of the Ras Tanura Pipeline in Saudi Arabia and building of a gas pipeline in the Cordoba province of Argentina.

In 2016, new progress was made in storage tank and LNG engineering projects. The LNG project of Huagang Gas in Jincheng Shanxi was completed and put into operation. The Shandong Dongming LNG project was commenced. Three modules of Russia's Yamal LNG project were loaded for shipping. The refined products depot in Mozambique was completed and became operational. The Nassiriya oil depot in Iraq and the expansion of Angola's products depot proceeded steadily. In addition, new projects were signed, such as the national refined products reserve storage in Hubei.



CPP601 pipe-laying vessel in operation

Offshore Engineering

CNPC has the capability to provide integrated and comprehensive services for offshore production, well drilling, well completion, well cementing, production test, downhole operation, design and construction of marine engineering, as well as vessel services.

In May 2016, the CPOE 17 jack-up drilling rig was officially delivered and arrived at its designated place in the waters of the Yellow Sea to start operations. By the end of 2016, we had 16 offshore drilling and operating platforms and 25 vessels. Our vessels provided service for 4,783 working days throughout the year, with the vessels of 4,000HP or higher duty utilized at a rate of 61.7%.

Our major projects in the Bohai Sea, the Yellow Sea, the Persian Gulf and other sea areas were proceeding smoothly. We completed the Zhenhai-Mamu sea-crossing water pipeline of the Phase-III Zhoushan water diversion project in Zhejiang and the sewage drainage project of the Liaodong Bay New District. Low permeability reservoir fracturing in pilot wells at the BZ25-1 Oilfield of the Bohai Bay was successfully completed with a total liquid injection volume of 1,967 cubic meters and a total sand injection volume of 163 cubic meters, becoming the largest offshore fracturing project in China. The total footage of our offshore drilling operation in 2016 amounted to 44,000 meters.

Our Qingdao offshore engineering construction base and Tangshan production support base were further developed with enhanced capabilities. The Qingdao base completed the construction and delivery of MWP4, MWP10A and FWP1D project packages for the Yamal LNG project. In addition to the previously concluded FWP5 project package, we have delivered all Yamal LNG modules as contracted.

Petroleum Equipment Manufacturing

In 2016, the "Manufacturing + Service" mode was adopted in our equipment manufacturing sector. We promoted international cooperation in production capacity, enhanced product lifecycle management, expanded our business into maintenance, repair, and remote diagnosis, and increased exports of our core products such as drilling rigs and steel pipes. Our overseas marketing networks were further optimized. Our petroleum materials and equipment were exported to 82 countries and regions around the world.

We pushed forward steadily with major equipment projects. The manufacturing of 12 fast-moving desert rigs for Abu Dhabi National Drilling Company (NDC) was completed. By the year end, we delivered a total of 39 fast moving desert rigs to NDC. We manufactured and delivered 14 drilling rigs to PDVSA, and provided 64,000 tons of spiral pipes for Saudi Aramco's Phase-I gas pipeline extension project, as well as 110,000 tons of piling pipe for Port Said in Egypt. Also, we proceeded well with line pipe manufacturing for the GAIL pipeline project in India. Breakthroughs were made in the R&D and promotion of new equipment. Trial manufacturing of new drilling and production equipment achieved successes, including the BOMCO subsea tree, the ZJ30DB automatic drilling rig, and the 2500 fracturing unit. R&D efforts were carried out to develop new products such as SEW 80SS anti-corrosion casing, and the 7-inch BJC-I special spiral casing pipe. We developed the 46m ultra-long pile pipe, Φ2420 mm water pipe and CT110 coiled tubing among other innovative products. In particular, Φ1219×22mm spiral submerged arc welded pipes of X80 steel grade were widely applied at major pipeline projects such as the Fourth Shaanxi-Beijing Gas Pipeline and the Zhongwei-Jingbian connecting line of the Third West-East Gas Pipeline. Field tests of power generating units were held and proved successful of Jichai's 175 diesel genset for electric rigs and the 140 diesel genset for supplementary power generation at well site.

In 2016, we kept expanding overseas markets and realized entry into Paraguay for the first time. We signed contracts with clients from 44 countries and regions, including the contract on selling power generators to Peru and the PC contract on the construction of the Asia Steel Pipe Plant.

In addition, we also stepped up international cooperation in production capacity and technology development. The main project of the warehouse and maintenance center in the US was completed. Construction of a steel pipe plant and an equipment manufacturing base in Kazakhstan was well underway. Agreements were reached with GOES of Germany and GE of the US to jointly produce coiled tubing units, liquid nitrogen pumping equipment and electric drive centrifugal compressor units. We also signed a framework agreement with Schlumberger to further expand the scope of our cooperation based on previous projects, and carry out all-round joint efforts in the R&D, manufacturing, supply chain, and sales of high-end petroleum equipment.





