



Technology and Innovation

Focusing on self-reliance in state-of-the-art technologies, we embrace innovation as the key driving force for development, promote the construction of incubators for home-grown technologies, and strengthen independent research and commercialization of core technologies to support high-quality development.



Technological Innovation System

At CNPC, we continue to deepen the reform of the framework for innovation governance, strengthen top-level design and overall planning and improve the technological innovation management system to enhance the ability of independent innovation. As of the end of 2022, the Company has set up a total of 95 research institutes and 14 national R&D & innovation platforms, including the national key laboratory on EOR and the national R&D (testing) center on shale gas. In view of production and research needs, the Company has developed a comprehensive R&D system, including 37 key laboratories, 19 testing bases and 23 R&D centers. The Company has nearly 30,000 scientific researchers.



Progress in Technology Platforms and Innovation

In 2022, CNPC’s EOR laboratory was included in the Ministry of Science and Technology’s list of the first 20 national key laboratories, and the national key laboratory on oil and gas drilling, production and transportation equipment was approved to begin construction. The National Engineering Research Center on Well Drilling and Completion, the only national innovation platform targeting well drilling and completion, was inaugurated. The Company’s entrepreneurship and innovation demonstration base was rated by the National Development and Reform Commission as one of the top entrepreneurship and innovation demonstration bases.



The first strategic cooperation agreement of Shenzhen New Energies Research Institute

On November 19, 2022, CNPC Shenzhen New Energies Research Institute and Huawei Digital Power Technologies Co., Ltd. signed a strategic cooperation agreement in Shenzhen. Under the agreement, the two sides will carry out all-round and in-depth cooperation on research and development to enable resource sharing and complementarity of respective strengths, so as to provide strong technical support for the green transition and high-quality development of CNPC.

The signing of this strategic cooperation agreement will promote in-depth cooperation between the two sides in areas featuring integrated development of new energies and hydrocarbons, such as intelligent micro-grid, energy storage, and hydrogen energy. It will also accelerate the construction of new energies demonstration projects in oil and gas fields and help CNPC implement its green and low-carbon strategy as well as bolster innovation capabilities regarding new energies technologies.

Major R&D Achievements

At CNPC, we implement actively an innovation-driven strategy focusing on major bottlenecks in key areas. Debottlenecking in core technologies and forward-looking, basic and strategic research are strengthened and commercialization of new technologies for productivity gains is accelerated. We have achieved a series of fruitful results marked by the “Top Ten Technological Achievements” in E&P, refining and petrochemicals, low-carbon and new energies, and oilfield services etc.

E&P: Geological theories and E&P techniques for ultra-deep oil/gas bolstered high-efficiency exploration and large-scale plus cost-effective exploitation; geological theories on the development of continental shale oil and key engineering techniques were applied in demonstration areas, i.e. Daqing, Xinjiang, Changqing and Dagang etc.; E&P theories and techniques for deep coal-seam methane, integrated techniques for gas flooding and underground gas storage, and geological theories for passive continental margins made breakthrough; major breakthroughs were achieved in multi-strata exploration in central Sichuan through refined characterization of the distribution of Sinian-Permian strike-slip faults in Sichuan Basin, innovation in trap/reservoir control and high-efficiency drainage in lithological strike-slip faults, and a new 3D model of reservoir forming and multiple accumulation.

Refining & Chemicals: The commercial production of low-viscosity polyalpha-olefin (PAO) facilitates an upgrade of lubricating base oils; a 20,000 t/a 1,4-cyclohexanedimethanol (CHDM) pilot project was successfully launched, making CNPC the third company in the world to have the full-industrial-chain capabilities for the manufacturing of PETG copolyesters; metallocene polyethylene production technology bolsters the development of high-end polyolefin industry; the proprietary flexible and high-efficiency catalytic cracking process and the high-carbon alpha-olefin polyethylene copolymer process and products made significant progress.

Oilfield Services: The industrial application of the one-click interactive 7,000-meter automated drilling rig made reliability improvements, i.e. a lower failure rate and an improved rig uptime; the CG STEER-150 geosteering-while-drilling system was widely applied with the purchase and service costs greatly reduced; the CG STEER-175-15 prototype was developed, demonstrating world-leading performance on all fronts; the 76mm ultra-high temperature, ultra-high pressure wireline logging equipment, and high temperature, high pressure azimuth electromagnetic wave imaging logging-while-drilling equipment were successfully applied in deep-layer hydrocarbon

Top 10 technological achievements in 2022

- Target appraisal techniques for pre-salt ultra-deepwater prospecting in passive continental margin basins and the major discovery at Curaçao
- Ultra-deep geomechanical techniques to support E&P in the deeper layers of Tarim Basin
- An important breakthrough in EOR techniques for low-permeability reservoirs using ion-matched nano-dispersion
- Intelligent zonal water injection for improved water flooding to enable fine and high-efficiency development
- Key technologies for preventing severe lost circulation and improving safety, quality and efficiency in drilling and completion
- OBN seismic exploration techniques and equipment innovation as a big step forward in marine operations
- Breakthrough and wide application of next-generation plug-and-perf techniques
- Major breakthroughs in key technologies for single-point mooring and offshore pipeline construction
- A major progress in domestic production of 1,4-cyclohexanedimethanol (CHDM)
- Metallocene polyethylene technology for the development of high-end polyolefin industry

exploration; intelligent zonal water injection technology promotes the formation of a fine and efficient development model with water flooding; key technologies for the prevention and control of severe lost circulation help to improve the safety, quality and efficiency of well drilling and completion; OBN seismic exploration technology and equipment innovation lead the leapfrog development of marine operations; R&D breakthrough and wide application of next-generation plug-and-perf techniques were achieved; significant breakthroughs have been made in key technologies for single point mooring and offshore pipeline construction; major progress was achieved in passive magnetic steering, 240 °C ultra-high temperature eco-friendly wellbore working fluids.

New Energies and Green & Low-carbon: Major progress was made in key technologies throughout the CCUS industry chain, integrated and high-efficiency utilization of geothermal energy, and manufacturing of wide-temperature, high-power lithium titanate battery materials and cells.

Frontier Technology: The Company has been developing new theories, methods and technologies in line with the development needs for the future and international tech trends.

Breakthrough progress was achieved in ion-engineered, micro-nano-dispersion water flooding to increase the displacement efficiency by more than 15%; the research on miscibility of hydrocarbon systems revealed the heat-assisted mechanism of “in situ cracking + bidirectional mass transfer” to reduce greatly the miscibility pressure and enable a significant improvement in gas injection based EOR; important advances were made in in-situ catalytic upgrading of high-viscosity crude oil, revealing the key deposition points and targeted modification mechanisms for asphaltene structures in ultra-heavy oil to enable a revolutionary technology for cost-effective ultra-heavy oil production; a new microflow reaction method for continuous polymerization of liquid rubber and the high-concentration polymerization technology were developed to bolster our strength and competitiveness in synthetic rubber; the catalysts for polar copolymerization were developed to produce ethylene-based polar copolymers such as ethylene methyl acrylate (EMA), so as to facilitate the development of new materials.



Green hydrogen technology innovation platform, RIPED

Digital Transformation and Intelligent Operation

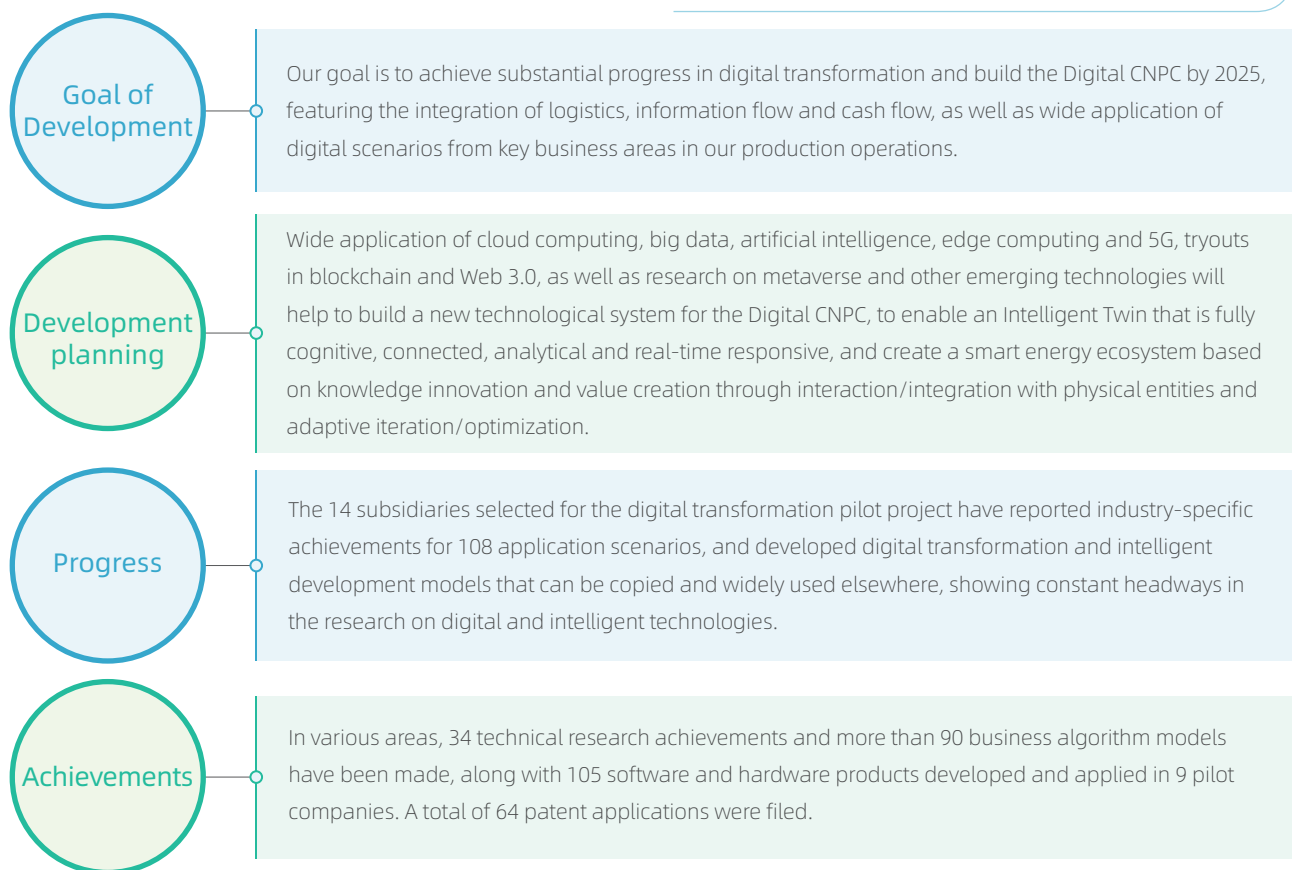
The Company takes an active approach to bring about digitalization and intelligent development, with a special focus on smart technologies and product innovation. At CNPC, we have embedded digital technology into our products, services and processes along the oil and gas value chains and integrated the Internet, cloud computing, big data and artificial intelligence with our business operations. We strive to promote intelligent oil and gas fields, intelligent refining and petrochemical production, intelligent marketing and intelligent oilfield services, to create new businesses, new operations and new business models that are an integral part of a “Digital CNPC”.



CNPC Intelligent Operation Center put into operation

On June 28, 2022, CNPC Intelligent Operation Center was officially opened after the final acceptance.

As a key project under CNPC’s 13th Five-Year Plan, the Intelligent Operation Center started construction in July 2020 and was completed on July 8, 2021 for trial operation. During the initial period, the Intelligent Operation Center provided strong support for CNPC’s “two-tiers-in-one-piece” production and operation management model, enabling centralized production and operation scheduling, coordinated emergency response, and operational visibility. The capabilities in data sharing, intelligent monitoring and business coordination were building up and the operations regarding production, refining, transportation, marketing, storage and trading were coordinated. All this helped achieve closed-loop management of optimization, planning, monitoring and early warning throughout the oil and gas industry chains, bolstered capabilities in production and operation planning and rapid response, and demonstrated strong leadership in digital transformation.





Inauguration of China Petroleum Engineering Intelligence Support Center

On August 30, 2022, China Petroleum Engineering Intelligence Support Center (EISC) was inaugurated in Beijing, marking a solid step towards digital transformation and intelligent development in engineering services.

In recent years, CNPC has maintained a focus on digital transformation and intelligent development in its top-level design and forward-looking planning. The digital transformation and intelligent development of engineering services is centered on business development, management reform and technology empowerment to support the transition towards the Digital CNPC.

With respect to international exchange and cooperation, CNPC played an active role in the technological cooperation in polymer flooding for enhanced oil recovery, and low-emission, iron-resistant catalysts under 12 strategic partnership frameworks with companies like TotalEnergies and Equinor.

S&T Awards and Intellectual Property Rights

In 2022, the Company continued its efforts in building standardization systems, and supported the preparation for the National CCUS Standardization Committee; 6 new international standards and 2 amendments led by CNPC were enacted.

In 2022, the Company filed 6,862 patent applications and was granted 2,625 patents. The Company received 3 silver prizes and 5 excellence prizes of the 23rd China Patent Award.

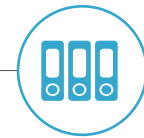
Technological Exchange and Cooperation

Pursuing mutually beneficial and win-win cooperation, the Company works closely with energy companies, associations and research institutes at home and abroad to carry out S&T exchange and R&D cooperation, in a bid to promote technological progress and innovation in the industry.

As one of the founding members of the innovation consortium of central SOEs for key components in major equipment, CNPC carried out joint research with Hefei General Machinery Research Institute and Shenyang Academy of Instrumentation Science under Sinomach; the Company also joined the innovation consortium of central SOEs for advanced metal materials and worked with CISRI on R&D. The Company pushed ahead with technological innovation under 14 strategic cooperation agreements with national ministries, government agencies, domestic enterprises, universities and research institutions, and made progress in the strategic cooperation projects with Peking University and China University of Petroleum, as well as the innovation consortium projects with Southwest Petroleum University etc., making important progress and reaching new milestones.

Patents applied

6,862



Patents granted

2,625

