



SPIC

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Overview of SPIC >>



Wang Binghua
Chairman



Meng Zhenping
President

About Us

State Power Investment Corporation (SPIC) was established in June 2015 through the merger of China Power Investment Corporation and State Nuclear Power Technology Corporation (SNPTC). Aiming at state-owned capital investment, SPIC is committed to becoming a pioneer in SOE reform through building a new group with high standards and a high starting point.

SPIC is one of China's top five power generators, an integrated energy group with power as its core. It has a total installed capacity of 117 GW, including 71.46 GW of thermal power, 21.6 GW of hydropower, 4,475.2 MW of nuclear power, 7,118.4 MW of solar power and 11.98 GW of wind power, with clean energy accounting for 42.9% of the total, demonstrating a distinctive clean development feature. It supplies 396.9 TWh of power and 155 million GJ of heat per annum. It also owns a coal production capacity of 80.1 million tons per year (t/y), aluminum smelting capacity of 2.49 million t/y and railway transportation line of 627 km.

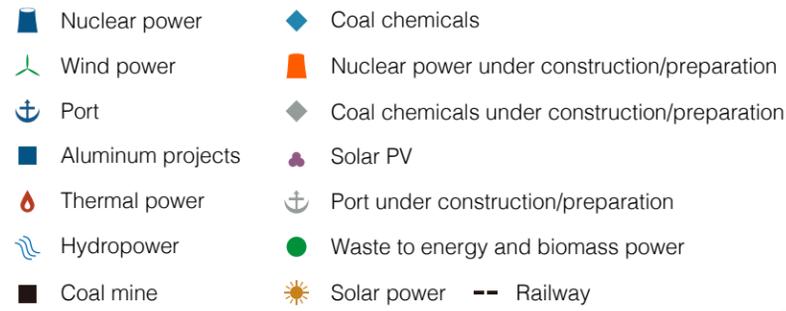
Being one of China's three nuclear power developers and operators, SPIC owns a number of nuclear power plants (NPPs) under construction or in operation, such as Hongyanhe NPP in Liaoning Province, and Haiyang and Rongcheng NPPs in Shandong Province. It has also reserved several project sites in both inland and coastal areas of China. SPIC is the main entity, carrier and platform for the self-reliant innovation of the Gen III nuclear power technology, and the leading entity for the national science and technology major project of large-scale advanced pressurized water reactor (PWR). Enjoying full industry chain and strong technological capabilities in the R&D, design, construction, operation and management of NPPs as well as manufacturing of nuclear power equipment and materials, it pursues a noble cause of self-reliant innovation, industrialization and internationalization of China's Gen III nuclear power.

SPIC has been a Fortune Global 500 company for five consecutive years, ranking the 342nd in 2016. It has a registered capital of RMB 45 billion (USD 6.49 billion), total assets of RMB 876.1 billion (USD 126.3 billion) and employees of 140,000. It holds nine listed companies and public limited companies, two of which are red chip companies traded in Hong Kong while five offer A-shares in mainland China. SPIC attained profits of RMB 13.21 billion (USD 1.9 billion) in 2016, ranking the first among China's top five power generators in terms of net profits.

SPIC is committed to global businesses. It has presence in 36 countries such as Japan, Australia, Malta, India, Turkey, South Africa, Pakistan, Brazil and Myanmar, with businesses covering power project investment, technical cooperation, EPC, etc. SPIC has 1,260 MW of controllable overseas projects in operation and 10.05 GW under construction. In 2016, SPIC successfully obtained A2, A and A- international credit ratings from Moody's, Fitch Ratings and Standard & Poor's respectively and issued USD 1.2 billion overseas bonds for the first time.

Looking forward, as China's economy steps into the "new normal", SPIC is committed to implementing the central government's strategic plan on deepening the reform of SOEs and restructuring nuclear energy enterprises. By expanding its energy markets at home and abroad, SPIC aims at becoming an international innovative and integrated energy group and modern SOE, which is driven by innovation of nuclear power and other advanced energy technologies and focus on clean energy development with the objective of becoming a state-owned capital investment company.

Asset Distribution in China



Total installed capacity

117 GW

Nuclear power

4,475 MW

Thermal power

71.46 GW

Solar power

7,118 MW

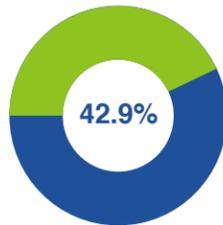
Hydropower

21.6 GW

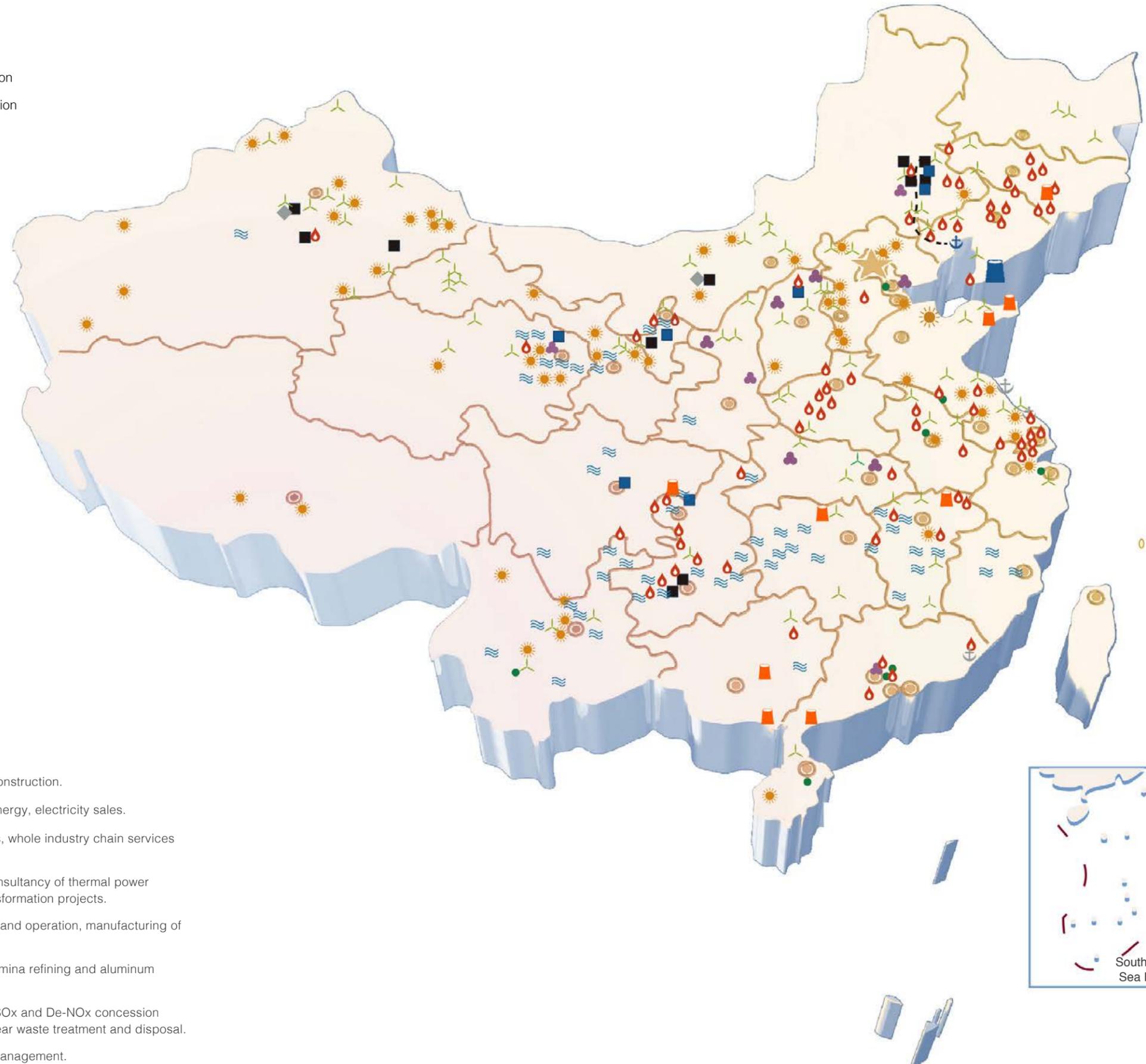
Wind power

11.98 GW

Clean Energy Share



Clean energy



Main Businesses

International business: design and consultancy, project investment and construction.

Thermal power: construction, production and operation, integrated smart energy, electricity sales.

Renewable energy: investment, operation and EPC of hydropower projects, whole industry chain services of solar power, investment and operation of wind power.

Power plant services: full industry chain services including design and consultancy of thermal power projects, EPC of conventional power projects, design of transmission and transformation projects.

Nuclear power: full industry chain services including R&D, EPC, investment and operation, manufacturing of equipment and materials, lifetime services, development of I&C systems.

Power-related industries: coal procurement, logistics, bauxite mining, alumina refining and aluminum smelting, PV manufacturing.

Environmental protection: EPC of environmental protection projects, De-SO_x and De-NO_x concession projects and product manufacturing, energy-saving technology services, nuclear waste treatment and disposal.

Finance: insurance brokerage, trust, futures, leasing, factoring, fund, asset management.

International Development >>

SPIC focuses on the development of green, high-efficiency and clean energy projects and power plant services in the course of implementing the "Belt and Road" initiative, where it has boosted the international cooperation in production capacity and equipment manufacturing and led the upstream and downstream enterprises in China's power industry to explore the international market together. As a result, SPIC's international development capability and profitability have improved significantly with its international development landscape taking shape.

By the end of 2016, SPIC had set up representative offices in 13 key countries, such as the United States, Australia, South Africa, Turkey and Pakistan, with overseas businesses covering 36 countries. Its overseas assets amounted to RMB 38.2 billion (USD 5.5 billion), including 1,260 MW of power capacity in operation, 10.05 GW under construction and 2,980 MW under preparation. SPIC is working on the EPC for 11 power plants with a total installed capacity of 13.5 GW and is providing design, consultancy and O&M services for 35 power plants.

SPIC's development goals for international development: By 2020, overseas installed capacity will reach 8 GW, accounting for 5% of SPIC's total. By 2030, overseas installed capacity will reach 40 GW, accounting for 13% of SPIC's total.

As of the end of 2016,

SPIC's overseas footprint covers

36 countries

Undertaking EPC for 11 power plants with a total installed capacity of

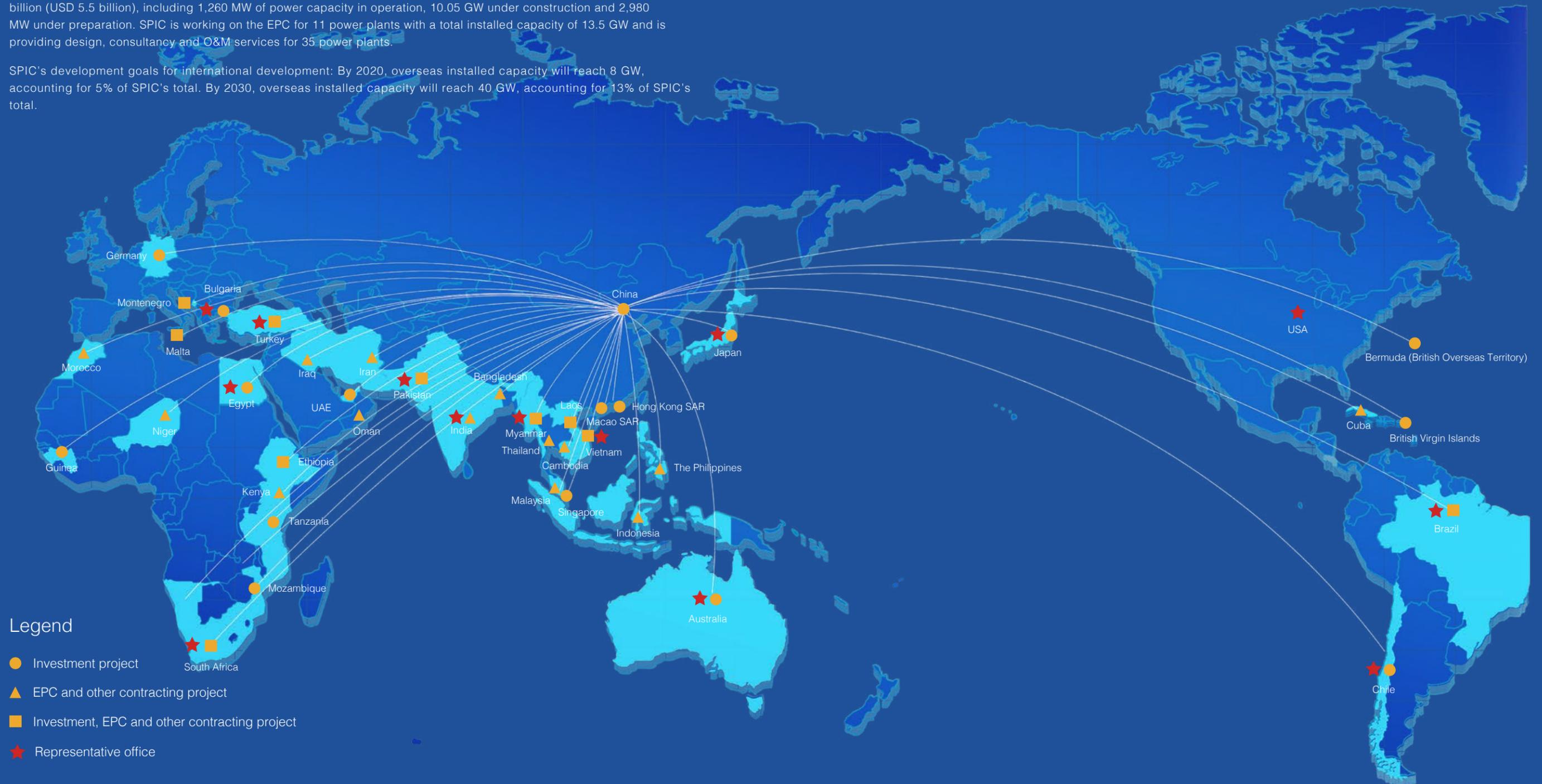
13.5 GW

Providing design, consultancy and O&M services for

35 power plants

Controllable investment projects under construction totaling

10.05 GW



Major Investment and Operation Projects

• Upstream Ayeyawady River Basin Hydropower Project in Myanmar

The Upstream Ayeyawady River Basin Hydropower Project in Myanmar consists of seven large cascade hydropower plants (HPPs) and a construction power plant (Chipwi Nge HPP), totaling 21.6 GW in installed capacity with an average annual electricity generation of 114 TWh. In September 2013, Chipwi Nge HPP (3 × 33 MW) began power supply to part of north Myanmar.



Chipwi Nge HPP

• Acquisition of K-Electric

Founded in 1913, the Pakistan-based K-Electric is a listed company with monopoly in power generation, transmission, distribution and sales in Karachi, whose businesses cover the full industry chain.

SPIC and the Abraaj Group signed the sale and purchase agreement of K-Electric in Beijing on October 28, 2016.

SEP's acquisition of 66.4% stake of Pakistan-based K-Electric was awarded the "Best Pakistan Deal" in 2016 by FinanceAsia, who highly complimented SEP's rationale of the acquisition that combines both the implementation of China's Belt and Road Initiative and the strategic move to expand into a fast-growing power market.



Acquisition of K-Electric



• 2 × 660 MW CPHGC Coal-fired Power Plant

The groundbreaking ceremony for the 2 × 660 MW CPHGC Coal-fired Power Plant co-invested by SPIC subsidiary China Power International Holding (CPIH) and its local partner was held in Hub, Balochistan of Southwest Pakistan on March 21, 2017. This symbolizes the official commencement of a new large-scale energy project in the China-Pakistan Economic Corridor.



• Acquisition of Pacific Hydro and Taralga Wind Farm

SPIC acquired the Australia-based Pacific Hydro and Taralga Wind Farm in 2016 and has since become the second largest wind power operator in Australia as well as the largest Chinese company and the third largest hydropower operator in Chile, with a combined installed capacity of 1,006.8 MW in operation and 108.7 MW under construction across Australia, Chile and Brazil.



Signing ceremony of the share sale agreement for Pacific Hydro

In January 2017, SPIC's acquisition of the Australia-based Pacific Hydro was awarded the "Cross-Border M&A Deal of the Year" by LatinFinance, an award granted to the leading issuer on the energy capital markets in 2016.



On November 22, 2016, President Meng Zhenping, Mr. Jose Antonio Valdes, Executive Chairman of Pacific Hydro Chile and Mr. Wang Hongzhang, Chairman of China Construction Bank, entered into an Agreement on Strategic Cooperation in Financial Services in Santiago, Chile.



Signing of the Agreement on Strategic Cooperation in Financial Services

Major EPC Projects for Overseas Power Plants

In 2016, SPIC undertook 11 EPC projects for overseas power plants with a total installed capacity of 13.5 GW spreading across Malta, Indonesia, Brazil, the Philippines, Turkey, etc. Major projects include:

Indonesia

EPC project for the 2 × 1,050 MW Shenhua Guohua Java No. 7 Coal-fired Power Plant in Indonesia undertaken by SNPTC subsidiary Shandong Electric Power Engineering Consulting Institute (SDEPCI). With the EPC Contract signed in July 2016, the project is the first overseas 1,000 MW class IPP thermal power project undertaken by a Chinese company, with the first concrete pour expected in June 2017 and commercial operation in October 2020.

EPC project for the Guohua Sumsel-1 2 × 350 MW Coal-fired Power Plant in Indonesia undertaken by SDEPCI. The EPC contract of the project was signed in October 2016.

Brazil

EPC project for the 345 MW PAMA Coal-fired Power Plant in Brazil undertaken by SDEPCI. The project was commenced in August 2015 and is expected to be put into production in July 2018. It is the largest project in the history of Sino-Brazil economic cooperation.

Malta

EPC project for oil-gas engine conversion works of Delimara 3 Power Plant undertaken by SPIC subsidiary Shanghai Electric Power (SEP). Phase I of the project was commenced in May 2016 and is planned to be completed in February 2017. Works for Phase II will commence in February 2017.

The Philippines

EPC project for the 2 × 135 MW Puting Bato Coal-fired Power Plant in the Philippines undertaken by SDEPCI. The project was completed and put into commercial operation in 2016, a successful case for China's 60 Hz power equipment to enter the overseas market.



2 × 135 MW Puting Bato Coal-fired Power Plant.

Major Overseas Consultancy, Design and Service Projects

In 2016, SPIC undertook consultancy, design and service projects for 35 overseas power plants, with a total installed capacity of 13.5 GW. Major projects include:

- 1. Survey and design for the 2 × 660 MW Sahiwal Coal-fired Power Plant in Pakistan undertaken by SDEPCI.
- 2. Survey and design for Phase II (4 × 660 MW) Guddalore Coal-fired Power Plant in India undertaken by SDEPCI.
- 3. Survey and design for the ±660 kV Matiari-Lahore Transmission Line in Pakistan undertaken by SNPTC subsidiary State Nuclear Electric Power Planning, Design and Research Institute (SNPDRI).
- 4. Survey and design for the 2 × 660 MW Payra Coal-fired Power Plant in Bangladesh undertaken by SNPDRI.
- 5. Survey and design for the 2 × 255 MW Soma Kolin Coal-fired Power Plant in Turkey undertaken by SNPDRI.
- 6. O&M supervision and instruction for the 2 × 600 MW Iskenderun Power Plant of Atlas Energy in Turkey undertaken by SEP.
- 7. O&M services for Phase I (4 × 330 MW) of Wasit Oil-fired Units, and production preparation and operation instruction services for Phase II (2 × 610 MW) of Wasit Oil/Gas-fired Units in Iraq undertaken by SEP.
- 8. Design and equipment manufacturing for the dry flu-gas desulfurization (FGD) works of the 1 × 350 MW Jerada Power Plant in Morocco undertaken by SPIC Yuanda Environmental Protection.
- 9. Technical and consultancy services for Block II (3.8 million t/y) of the Thar Open-pit Coal Mine in Pakistan undertaken by SPIC Mengdong Energy.



Delimara 3 Power Plant in Malta.

Nuclear Power >>

Being one of China's three nuclear power developers and operators as well as the leading nuclear power technology supplier, SPIC is appointed by the State Council of China to accomplish the introduction, assimilation and self-reliant innovation of Gen III nuclear power technology.

From researching and designing China's first NPP (Qinshan NPP) and first overseas NPP (Chashma NPP in Pakistan) to developing the world-leading Gen III Passive PWR CAP1400, SPIC is becoming a competitive player in the global nuclear power industry.

an industry group with majority shares held by SPIC, is the platform for consolidating nuclear power assets and businesses, which primarily include: nuclear power investment, development, construction and O&M; introduction, assimilation, R&D, application and promotion of Gen III nuclear power technology AP1000; implementation of national science and technology major projects, such as R&D, application and promotion of advanced nuclear power technologies like CAP1400 and small modular reactors; operation and lifetime services for NPPs, manufacturing of nuclear power equipment and materials, etc.

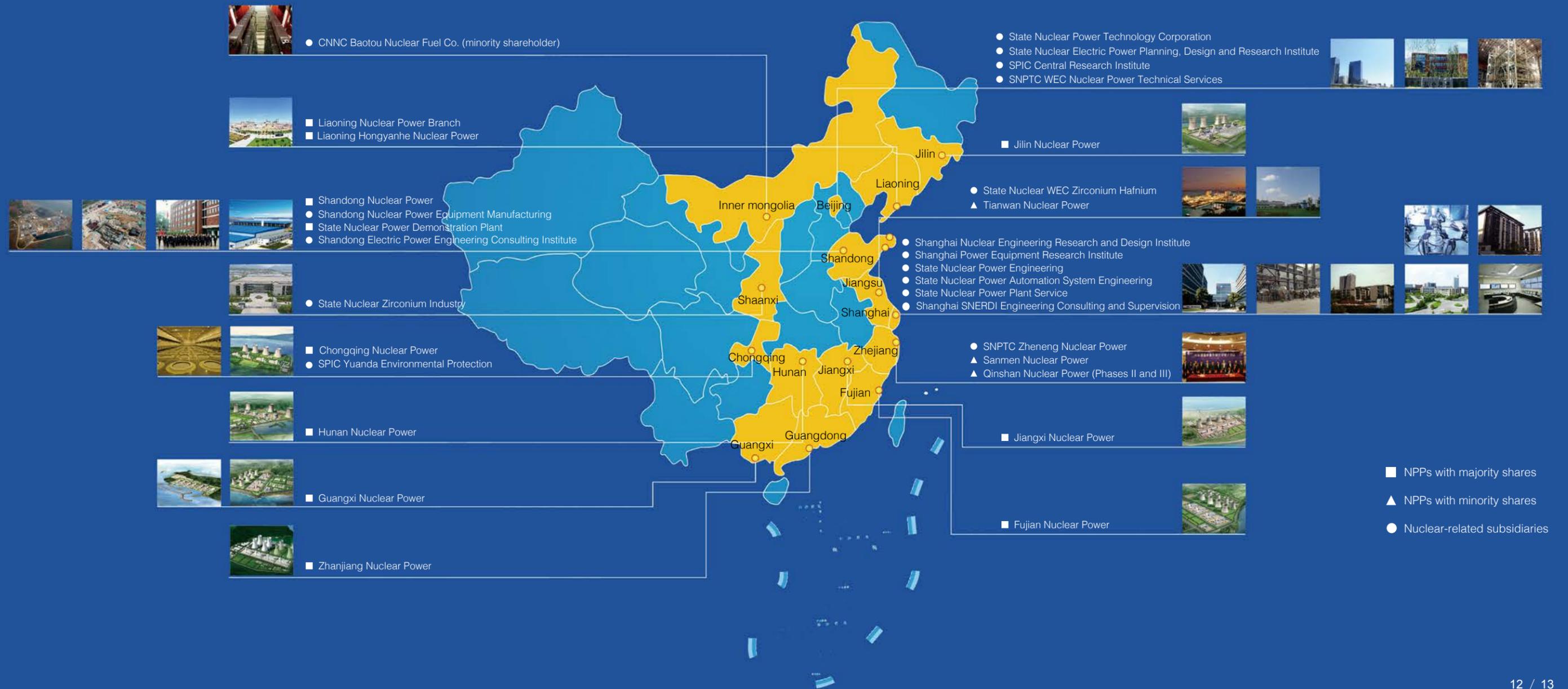
State Nuclear Power Technology Corporation (SNPTC),

Nuclear Power Development and Operation

SPIC owns a nuclear power capacity of 4,480 MW in operation and 4,740 MW under construction as a majority shareholder. It is also the minority shareholder of 1,080 MW nuclear power assets in operation, including Qinshan NPP Phases II and III, Jiangsu NPP, etc. Besides, SPIC owns a number of reserved project sites in both coastal areas of China like Bailong in Guangxi, Lianjiang in Guangdong, Lian Jiang in Fujian and inland areas like Pengze in Jiangxi, Chisong in Jilin, Xiaomoshan in Hunan and Fuling in Chongqing.

Planning and layout of SPIC's main nuclear power projects:

By 2020, the installed nuclear power capacity under construction and in operation will both reach 10 GW.





◀ Hongyanhe NPP

SPIC and China General Nuclear Power Group (CGN) are equal controlling shareholders of Hongyanhe NPP, which is located in Wafangdian, Dalian, Liaoning Province. The project is planned to build six 1,000 MW class PWRs. By now, Units 1 to 4 have been in commercial operation, while Units 5 and 6 are under construction in accordance with the schedule.

Introduction and Promotion of AP1000 Technology

- Steadily proceed with the construction of self-reliant AP1000 projects

Four AP1000 units are being built in Sanmen, Zhejiang Province and Haiyang, Shandong Province (Units 1 and 2 of Sanmen NPP and Units 1 and 2 of Haiyang NPP), marking the largest Sino-US cooperation in energy technology.

The largest Sino-US cooperation in energy technology: Haiyang NPP ▶





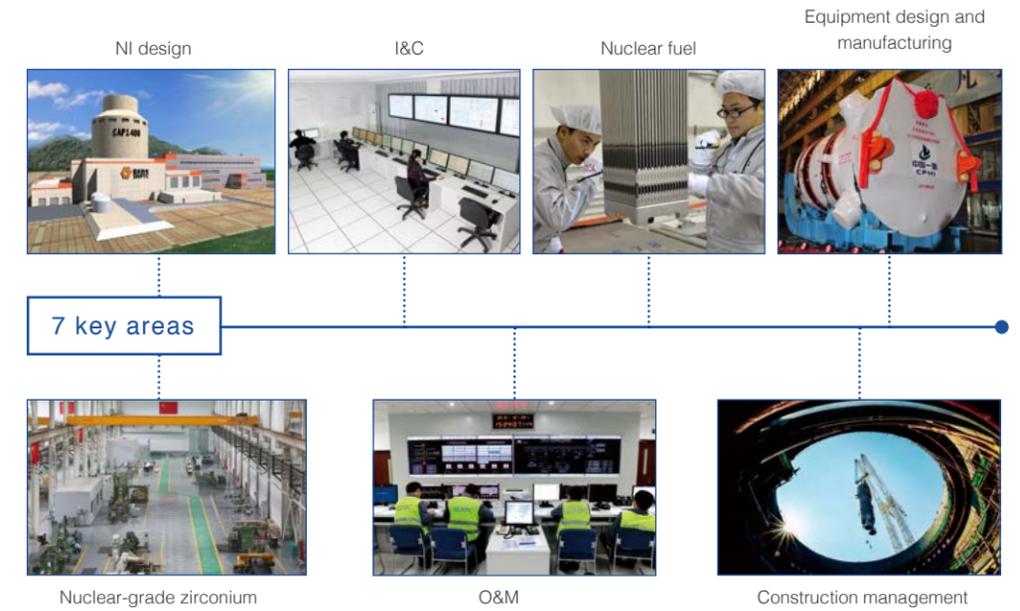
▲ Sanman NPP

Self-reliance program pays off—Mastering seven key technologies for AP1000 nuclear island (NI) construction and installation

- ① Continuous pouring of massive concrete for the base mat
- ② Modular manufacturing and construction
- ③ Steel containment vessel (CV) manufacturing, lifting, onsite heat treatment, pressure and leak rate test
- ④ Implementing civil works and installation simultaneously
- ⑤ Installation of main equipment for NI
- ⑥ Installation of integrally forged main pipes
- ⑦ Installation and commissioning of the protection and safety monitoring system (PMS)

SPIC has substantially localized the manufacturing of equipment and materials based on the experience gained during the assimilation of AP1000 technology and construction of self-reliant projects, and accomplished the localized AP1000 standard design (CAP1000 standard design) after enhancing the safety margin based on the lessons learned through the Fukushima accident, which strongly supports the big-volume construction of follow-up AP1000 projects.

• Transfer of AP1000 technology substantially completed



• AP1000 equipment and materials substantially localized

The average localization rate for the NI equipment of the four self-reliant project units reaches 55%, and that of the fourth unit, Haiyang Unit 2, reaches 72%. Comprehensive mastering of the manufacturing technology of AP1000 key equipment has strengthened the capabilities of the whole nuclear power equipment manufacturing industry.

Localization progress of AP1000 equipment

Equipment	Sanmen Unit 1	Haiyang Unit 1	Sanmen Unit 2	Haiyang Unit 2	
Canned Motor Pump	EMD	EMD	EMD	EMD	SBN / HPEC
Squib Valve	SPX	SPX	SPX	SPX	Sufa
Reactor Pressure Vessel	Doosan	Doosan	CFHI	SEC	
SG	Doosan	Doosan	SEC / HPEC		SEC
RVI	Doosan	Newington	SEC	SEC	
CRDM	Newington	Newington	SEC	SEC	
IHP	PCC	PCC	SNPEMC	SNPEMC	
Polar Crane	PaR	TZ	DHI	TZ	
Refueling Machine	WEC	DCW	SEC	DCW	
CV	WEC / SNPEMC	SNPEMC	SNPEMC	SNPEMC	
Main Pipe	BSIC	CNEG	CNEG	BSIC	
Pressurizer	SEC	DEC	SEC	DEC	
Accumulator	SEC	SEC	SEC	SEC	
CMT	SEC	HPEC	SEC	HPEC	

Development and Promotion of CAP1400 Technology

• CAP1400 demonstration project

The demonstration project, with majority equity held by SPIC, is located in Shidao Bay, Rongcheng, Shandong Province. It is the national science and technology major project of large-scale advanced PWR, with the plan of constructing two CAP1400 PWRs.

CAP1400 design principles

- Latest safety standards and requirements
- Adoption of the passive safety systems and severe accident prevention and mitigation measures
- Digital reactor protection system
- Modular design and construction
- Simplified system and proven components
- Full-range probabilistic safety analysis
- Design improvement from lessons learned in the Fukushima accident

As the world's most powerful passive PWR, CAP1400's safety, economics and environmental compatibility have reached world advanced level of Gen III nuclear power technology.

• Progresses in CAP1400 R&D

On the basis of China's over 40 years of experience in R&D, design, construction and operation of NPPs, combined with the introduction of AP1000 technology, SPIC developed the larger passive PWR NPP, CAP1400, with independent intellectual property rights. CAP1400 development and demonstration project has been listed one of the 16 National Science and Technology Major Projects.

Main innovative features of CAP1400

Independent R&D of the low-leakage reactor core with 193 fuel assemblies and MOX fuel

Independent, innovative design of reactor, steam generator (SG) and CV

Independent design of the advanced test loop system

Unit power 20% higher than that of AP1000

Low probability of reactor core meltdown

Supply capacity after 72 hours without human intervention

Ability to withstand the crash of a large commercial aircraft

Safety design needs no offsite emergency response

Highly reliable I&C and protection system

Mitigation of radioactivity at the source and better radioactive waste management system

Improvement of the overall system layout and the human-computer interface

Six test subjects

CAP1400 project established six test subjects with altogether 17 key tests and constructed the world-class test loops. So far, all the key tests of CAP1400 have been completed. Test data validates that the design is scientific and advanced.



CAP1400 demonstration project site

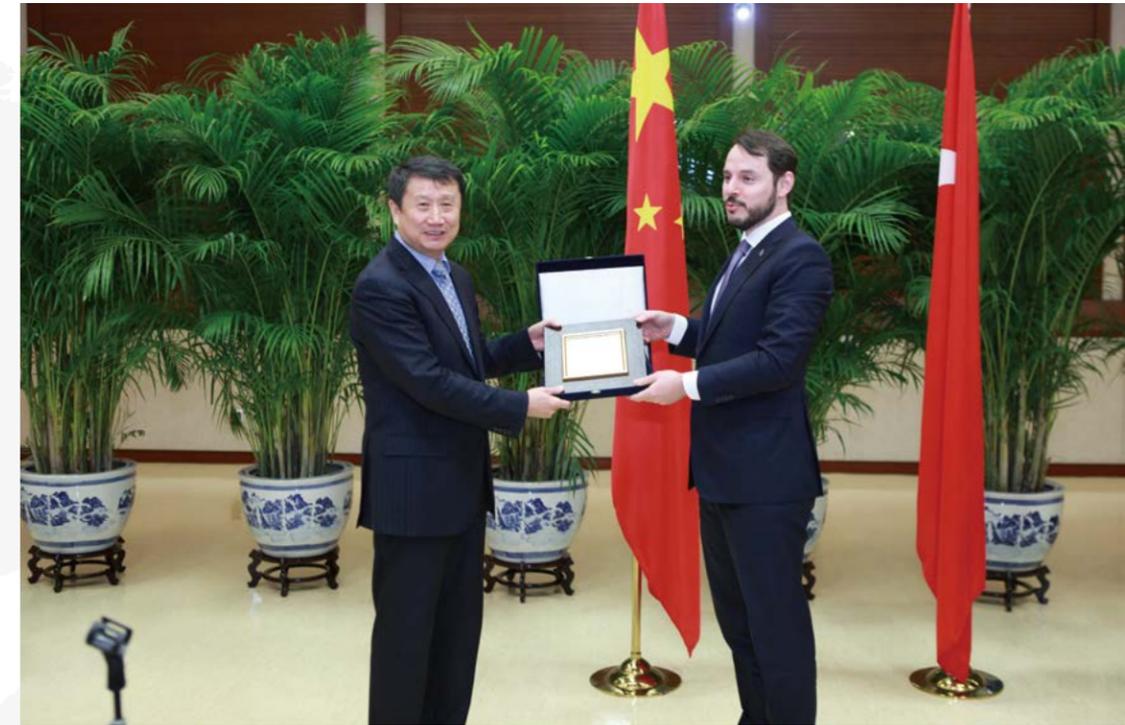
• Key milestones of CAP1400 demonstration project



• CAP1400 going global

The safe and advanced CAP1400 technology, together with China's competitive advantages in manufacturing and experience in localization and industrialization, has attracted intensive attention from clients in other countries interested in nuclear power development.

SPIC is committed to the globalization of CAP1400. Up to date, the marketing of CAP1400 has achieved progress in South Africa and Turkey.



Chairman Wang Binghua meets with Minister Berat Albayrak for Energy and Natural Resources of Turkey

Nuclear-grade valves reduced by 50%

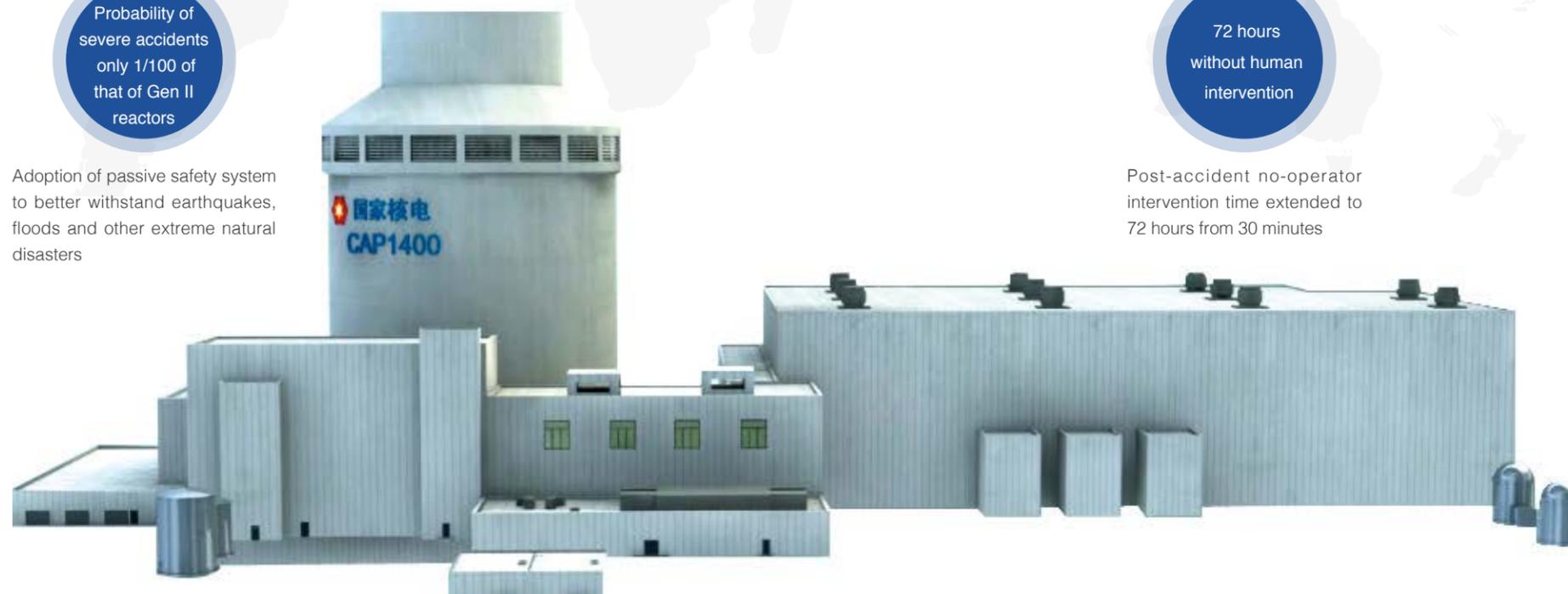
Earthquake-resistant structures, pumps, valves, pipes and cables greatly reduced and economics improved

Probability of severe accidents only 1/100 of that of Gen II reactors

Adoption of passive safety system to better withstand earthquakes, floods and other extreme natural disasters

Equipment designed for the service life of 60 years

Life of plant and main equipment extended from 40 years to 60 years



72 hours without human intervention

Post-accident no-operator intervention time extended to 72 hours from 30 minutes

Construction period shortened to 48 months

Modular construction has shortened construction period from 60 months to 48 months

Annual power generation per unit of 11.4 TWh

Output power is 1,500 MWe, and each unit's annual power generation reaching 11.4 TWh

Development of Gen III Nuclear Power Industry Chain

- Indigenous research and development of Gen III nuclear power equipment in the process

By organizing China's equipment manufacturing enterprises, on the basis of technology introduction, SPIC strengthened localization of key equipment, overcame difficulties of independent innovation, and comprehensively mastered the R&D, design and manufacturing technology of key equipment and materials for AP1000 and CAP1400. SPIC leapfrogged from Gen II to Gen III, which strongly supported the big-volume construction and international marketing of Gen III NPPs. Holding the concepts of "openness, cooperation, inclusion and win-win", SPIC cooperates with suppliers at all phases of Gen III NPP construction, and has established a complete qualified supplier management system.

Cooperating with American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronics Engineers (IEEE) and other partners, SPIC leads China's equipment manufacturing industry to follow the requirements for advanced nuclear safety culture, learn and apply international advanced industrial standards and improve quality assurance system.

As of today, SPIC has 159 qualified suppliers at home and abroad, covering six fields of machinery, electrical, materials, engineering, I&C and operation service. The AP/CAP Gen III nuclear power supply chain, globally oriented and shared by China and international partners, has been established.

SPIC has developed the capacity of supplying required equipment and materials for construction of six to eight AP/CAP nuclear power units per year.

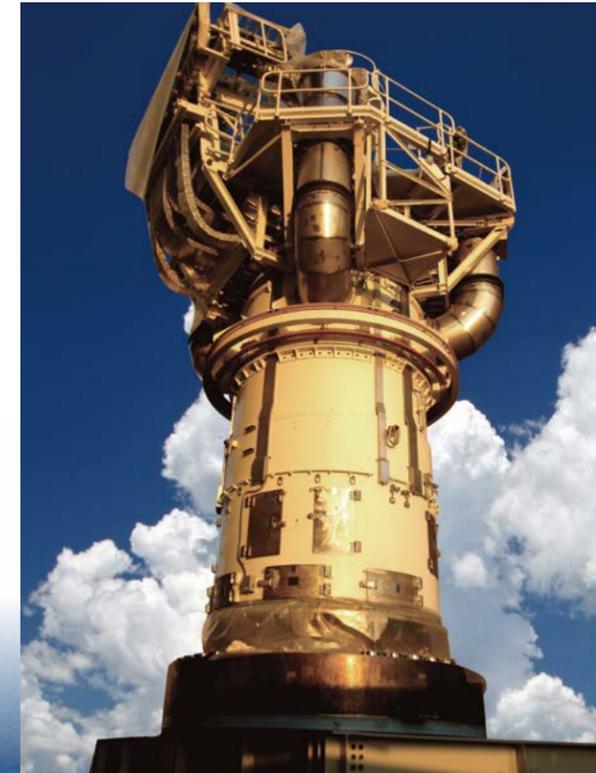
- EPC for Gen III nuclear power projects

SPIC subsidiary State Nuclear Power Engineering Co. (SNPEC) has the National Certificate (Grade A) for Nuclear Engineering Supervision, the National Certificate (Grade A) for Equipment Supervision, and the Shanghai Municipal Certificate (Grade A) for Engineering Supervision of Mechanical and Electrical Installation.

SNPEC is responsible for the construction and management of four units of the AP1000 self-reliant projects (two for Sanmen and two for Haiyang) and AP1000 follow-up units (Lufeng NPP). It also undertakes the construction of Shidao Bay CAP1400 demonstration project.

- Development of auxiliary industries for Gen III NPPs

To fill the gap of Gen III nuclear power technology and promote the upgrade of China's nuclear power industry, SPIC increased inputs into the fields of module manufacturing, nuclear-grade zirconium production, digital reactor protection system development, etc. and made great progress. SPIC has set up the world's first dedicated plant for AP1000 CV and modules, which is capable of fabricating the integrated head package (IHP), personnel air lock, equipment hatch and penetrations, etc. SPIC also built the first production line of nuclear-grade zirconium in China.



IHP



Nuclear-grade zirconium tube production line



CV bottom head



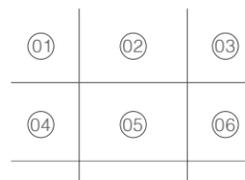
Haiyang NPP

• Technical support platform for the nuclear power industry

SPIC has established a complete disciplinary system covering 12 key technology fields, with four national-level and seven provincial- and ministerial-level scientific research institutes, eight certified national high- and new-technology enterprises, over 9,000 research and design personnel, and full capabilities in nuclear power R&D and design.

World-leading test and verification platform for Gen III nuclear power technology

Through the development of CAP1400 nuclear power technology, 22 test loops are constructed with advanced international standards, where six major test subjects are completed containing 17 key tests and independent tests for a total of 887 operating conditions. The safety and sophistication of CAP1400 is fully verified.



ACME test loop

CERT

IVR test loop

SG separation test loop

Hydraulic simulation test loop

FIV test loop

Advanced digital reactor I&C system

The independently-developed Nu series digital I&C system for NPPs is able to control 300 plus systems and nearly 10,000 sets of equipment, and exercise safety monitoring of and effective control over each equipment under operating conditions of the units.

<p>NuCON Plant Control System and Its Platform</p>	<p>NuBAC Diverse Actuation System and Its Platform</p>	<p>NuPAC New Generation FPGA Technology based Reactor Protection System and Its Platform</p>
<p>NuSIM Full-scope Simulator</p>	<p>NuTEC NPP Special Monitoring System and Seismic Monitoring System</p>	
<p>NuNIS In-core and Ex-core Nuclear Instrumentation System</p>	<p>NuRAD Radiation Monitoring System</p>	<p>NuRIC Rod Control and Position Indication System</p>

Key design analysis software for nuclear power with complete and independent intellectual property rights

SPIC developed China's first software series sufficiently competent in Gen III NPP design and safety analysis with completely independent intellectual property rights—COSINE (COre and System INtegrated Engine for design and analysis). The package contains 15 pieces of nuclear power design software in eight categories, covering more than 80 functions offered by its international counterparts.



World-leading qualification platform for nuclear power equipment and materials

The platform is capable of equipment qualification and test through facilities like loss-of-coolant accident (LOCA) test apparatus and high-parameter seismographic station. It meets the requirements for qualification of safety-related equipment and materials in the course of construction of AP/CAP NPPs and equipment localization.



Thermal Power »

Investment and Operation

High efficiency and large capacity to promote energy utilization. SPIC has a total installed capacity of 71,457 MW from thermal power. Currently SPIC owns fourteen 1,000 MW class units with 8 in operation, and forty-seven 600 MW class units with seven under construction, accounting for 56.9% of the total thermal power capacity, ranking the first among its Chinese counterparts.

Committed to clean development of thermal power. 100% of thermal power plants in operation are installed with De-SOx and De-NOx devices. Ultra-low emission rehabilitation projects are being carried out with the target of reaching or even exceeding the emission standards of gas-fired power plants.



Energy-saving representative project: Tianji Power Plant

Invested by SPIC subsidiary Shanghai Electric Power (SEP), Phases I and II of Tianji Power Plant successively won the Luban Prize, Classic Project of 35th Anniversary of China's Reform and Opening Up and the Gold Award for National Quality Engineering. The project utilizes several energy-saving technologies with the reheat steam temperature 20 °C higher than that of standard ultra-supercritical (USC) units, effectively boosting energy-efficiency.



"Triple-thousand engineering" representative project: Pingwei Power Plant

Invested by SPIC subsidiary China Power International Holding (CPIH), Pingwei Power Plant (Phase III) is the world's first project with 1,000 MW capacity per unit, 1,000 kV main transformer and 1,000 kV ultra-high voltage (UHV) transmission line at the same time. With a total capacity of 4,540 MW, it is the largest thermal power plant of SPIC.



Clean emission representative project: Caojing Power Plant

Caojing Power Plant of SEP is SPIC's first thermal power plant with 1,000 MW units. It won the Gold Award for National Quality Engineering in 2011 and was listed as one of the classic projects during the past 30 years since the award was established. The clean emission project of Unit 2, identified by the National Energy Administration (NEA) as one of the 13 demonstration projects for environmental protection rehabilitation on coal-fired units, was put into operation in February 2015.

• Representative project of circular economy

Huolinhe National Demonstration Industrial Cluster: Huolinhe Circular Economy Demonstration Project is listed as a national demonstration project. It takes efficient and circular utilization of resources as the core, "reduction of quantity, re-utilization and recycle" as the principle, and sets up the circular economy industrial cluster of coal, power, heat, aluminum, railway and port.

Classification of coal use. Low-grade coal is consumed on site to generate electricity for aluminum smelting; medium-grade coal is supplied to mine-mouth power plants, replacing coal transport with power transmission; high-grade coal is transported to fuel power plants near ports or railways. In this way, CO2 emission and loss of resources caused by coal transportation are sharply decreased.

Comprehensive utilization and conservation of water. SPIC establishes the three-level complementary way of water consumption: massive utilization of urban reclaimed water as the core consumption, maximum utilization of coal mine drainage as auxiliary consumption and minimum utilization of surface water as backup consumption, so as to reduce water consumption and protect the environment. The usage of urban reclaimed water and coal mine drainage is 3.65 million m3 and 1.5 million m3 per annum respectively.

Cogeneration. Thermal power plants generate electricity for aluminum smelting by consuming the low-grade coal while cogenerating, supplying and selling heat and power. With a heating area of 4.5 million m², cogeneration plants have replaced more than 40 inefficient coal-fired small boilers supplying heat to residents in the Huolinhe region,

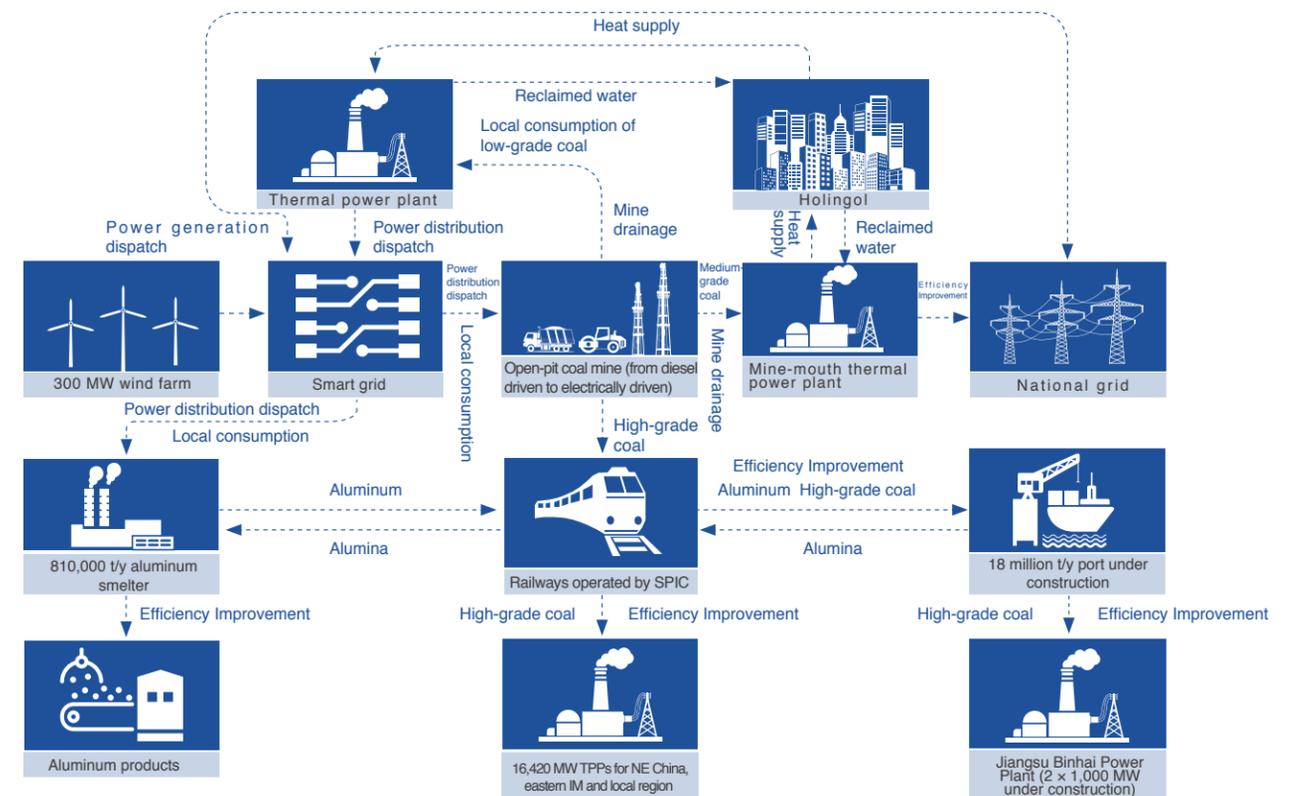
preventing air pollution caused by the boilers.

Storing energy in aluminum. Aluminum smelting transforms low-grade coal on site into energy that is effectively stored. The 810,000 t/y aluminum smelting capacity can store the energy of 10 million tons of lignite and 1 TWh of wind power into aluminum products.

Highly efficient utilization of clean energy by smart grid. With the goal of consuming all wind power, SPIC builds environment-friendly, economical, safe and reliable modernized smart grid, where peak load is regulated by thermal power plants along with the participation of aluminum load, while security and stability control, automatic dispatch, real-time monitoring and closed-loop control system operate jointly. Up to date, wind power penetration rate in the smart grid has reached 38.25%, exceeding that of Denmark, which has the highest utilization ratio of renewable energy in the world.

Joint operation of coal, power, railways and ports. SPIC realized the joint operation of coal, power, railways and ports through eastern Inner Mongolia's Tongliao-Huolinhe Railway, Chifeng-Daban-Baiyinhua Railway, Jinzhou-Chifeng Railway and auxiliary ports. Coal mining, transport and sales have been integrated and equilibrium has been achieved in both directions. The great passage for exporting the coal from eastern Inner Mongolia has been established with the flows of logistics, information and funds synchronized.

• Huolinhe National Circular Economy Demonstration Industrial Cluster



EPC

SPIC holds national Grade A qualifications for power plant construction, supervision, commissioning, engineering design and overseas EPC contracting. Besides, SPIC is also capable of providing engineering consultancy and bidding agency services, as well as supervision in equipment manufacturing, building construction engineering, port and navigation projects, mechanical and electrical installation and petrochemical projects. SPIC creates an EPC management model focusing on the design, establishes and optimizes a project management system complying with international standard and combining with advanced management concepts for nuclear power. SPIC is the EPC contractor for more than 160 thermal power units with a total capacity of over 57,000 MW.

• Performance in domestic market

- Technical modification of Jiugang Phase I and construction of Hongshen Phase II undertaken by SPIC won the National "Golden Key" Prize for engineering EPC.
- Meizhou Bay 2 × 1,000 MW Project won China Project Management Achievement Award.
- Banji 2 × 1,000 MW project broke the record of the longest operation days in the first operation of domestic 1,000 MW class units.
- Hequ 2 × 350 MW Project is one of the first-batch units with supercritical 350 MW circulating fluidized system in the world.
- Caojing Power Plant won one of the classic projects during the past 30 years and won the Gold Award for National Quality Engineering.
- Pingdingshan and Guqiao Power Plants won the Gold Award for National Quality Engineering.
- Kaifeng, Jingdezhen and Xinchang Power Plants won the Silver Award for National Quality Engineering.
- Garbage incineration power plants in Wuhu, Qinghe, Shentou, Hechuan, Ganjinzi Dalian and Haikou (SPIC) won National Superior Quality Project Award.
- Tianji, Baicheng and Yanshanhu Power Plants as well as Gongboxia, Heimifeng Hydro Power Plants won the Luban Prize of Chinese Architecture Engineering.
- Twenty-four projects including Pingwei, Dabieshan, Wuhu and Wusu Power Plants won the National Superior Quality Award for Electric Power Engineering.
- Unit 1 of Jingdezhen Power Plant established the benchmark for the construction period of 600 MW class units in China.
- SPIC was the EPC contractor for National Bio Energy's Shanxian Biomass Power Project, the first agriculture and forestry biomass power project and biomass power demonstration project in China, which won the National Superior Engineering Design Award, "Silver Key" Award for National Quality Turn-key Projects, National Superior Quality of Electric Power Engineering Award, etc.



Pingdingshan Power Plant established the benchmark for the investment control of 1,000 MW class units in China.

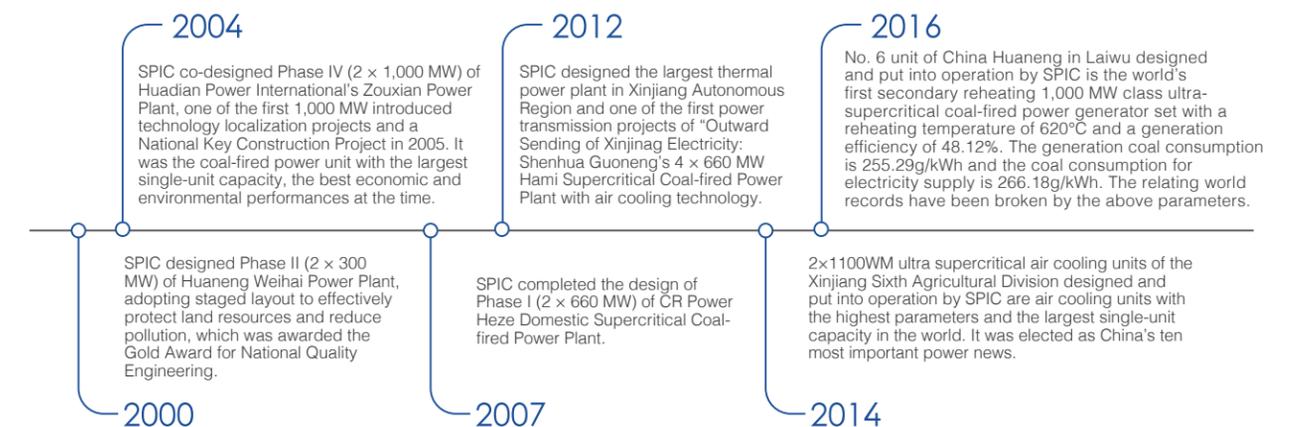


Huadian Power International's Laizhou Power Plant

Design and Consultancy

SPIC takes a leading position in the application of high-efficient coal-fired technologies in China, and holds the top-level design qualification in China, i.e. Class A Comprehensive Engineering Design Qualification, covering all types of generator units, all parameter levels and engineering conditions of thermal power generation. It possesses the capability of key technology research on 1,000 MW class ultra-supercritical units with high parameters as well as capabilities of planning and consulting, survey and design, technical modification and lifetime service. It also has top-ranking technologies and profound experience in operation optimization of power stations, energy saving and consumption reduction, and in boosting ecological environment protection level.

SPIC designed Phase I (2 × 1,000 MW) of Huadian Power International's Laizhou Power Plant, which is China's first smart zoology power plant with ultra-low coal consumption less than 270 g/kWh.



• Transmission and transformation project design:

SPIC is the major designer of UHV grid in China and a primary technology supplier for State Grid Corporation of China with comprehensive design capabilities for power transmission and transformation in various areas such as highlands, plains and different voltages including UHV, EHV, HV and LV distribution projects. SPIC undertook the design of China's first $\pm 1,100$ kV, 1,000 kV UHVAC and ± 800 kV UHVDC transmission lines and multiple 750 kV EHVAC, ± 600 kV EHVDC, 500 kV EHVAC lines. SPIC has designed a total of 22,000 km of 1,000 kV and lower voltage transmission lines.

- SPIC designed 500 kV Laiyang Substation, which was China's first 500 kV complete GIS substation, won the Gold Award for National Quality Engineering.
 - SPIC co-designed 500 kV East Line Transmission and Transformation Project in Shandong Province. The project won the Gold Medal of 10th National Quality Engineering Design Award.
 - 500 kV Muping Substation designed by SPIC won Luban Prize in China's architectural engineering industry. As the very first one of its kind in the history of grid construction in Shandong, the project was awarded Classic Project of 35th Anniversary of China's Reform and Opening Up.
 - SPIC designed the 800 kV Jinping–Sunan Transmission Line, which was one of the largest DC transmission projects with the highest transmission capacity and the longest transmission distance in the world.
 - SPIC participated in the R&D of the $\pm 1,100$ kV Huaidong–Huangdong UHVDC Transmission and Transformation Project, the world's record UHV transmission line with highest voltage, largest transmission capacity, and longest transmission distance, represents the highest level of the development of transmission technology in the world.
- Yuheng-Weifang 1000 KV Extra-high Voltage AC Transmission and Transformation Project co-designed by SPIC is one of China's "12 key transmission passages for expediting the atmospheric pollution control action plan".



- SPIC participated in the 1,000 kV Huainan–Shanghai (transmitting power from Anhui Province to the eastern region) UHVAC Transmission Demonstration Project, which was the world's first transmission project with AC double circuit transmission lines on the same tower and a landmark project for large-scale application of UHVAC technology. It has the highest load-carrying capacity in the world so far, incorporating the key points of the cutting-edge tower design technology and overcoming numerous technological difficulties.

<p>Laiyang Substation</p> <p>Gold Award for National Quality Engineering</p>	<p>Shandong East Line Transmission and Transformation Project</p> <p>Gold Medal of National Quality Engineering Design Award</p>	<p>Muping Substation</p> <p>Luban Prize in China's architectural engineering industry</p>	<p>Jinping–Sunan Transmission Line</p> <p>World record</p>
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EPC of transmission and transformation projects: as the first one in China to set foot in EPC, SPIC undertook the first EPC project in the power industry. The service covers power, steel and iron, transport, railway engineering, etc. The total capacity of transmission and transformation involved in EPC projects exceeds 4000MVA and 500km in line length.

- Power relocation and reconstruction of Beijing-Shanghai High-speed Railway (Shandong Section): The project was commenced in February 2009. Over 1200 power lines ranging from 220V to 500KV were relocated and reconstructed.
- Power supply system reconstruction in Jiabei Recycling Economy Industry Park: The project was commenced in July 2012, located in Jiuquan, Gansu. It includes ten 330KV and lower grade substations; about 40 km 110KV and lower grade transmission lines.
- EPC project for relocation and reconstruction of extra-high voltage lines in the new airport in Weifang and Weifang-Rizhao Expressway. The total length of the line is 36.3km in which the length of ± 600 KV line is 1.5km and that of 500KV line is 34.8km.

Renewable Energy »

Hydropower

SPIC has the qualifications for development and EPC contracting of hydropower projects. SPIC carries forward the development and construction of cascade hydropower plants (HPPs) on the upper reaches of the Yellow River and the Yuanshui River drainage basin in Hunan in an orderly fashion. SPIC has successfully built two cascade hydropower clean energy bases in the above two regions.

SPIC has 145 HPPs in operation with a total installed capacity of 21,600 MW, distributed in 12 provinces including Qinghai, Hunan, Yunnan, Guizhou, Guangxi, Sichuan, etc. as well as overseas regions such as Australia, South America and Burma. SPIC also has been authorized the development right for hydroelectric projects on the upstream of Ayeyarwady, Burma. The planned total installed capacity is 21,600 MW, and the annual average generation capacity is about 114 TWh.

The HPPs with capacity over 1,000 MW, which have been putting into commercial operation, include Longyangxia HPP, Laxiwa HPP, Lijixia HPP, Gongboxia HPP, Jishixia HPP, Wuqiangxi HPP and Sanbanxi HPP. Eleven hydropower plants are under construction with a total installed capacity of 840 MW.



Development of the cascade HPP cluster on the upper reaches of the Yellow River

There are altogether 16 cascade HPPs on the upper reaches of the Yellow River with a total installed capacity of 17.18 GW. So far ten HPPs have been built with a total installed capacity of 10.39 GW.



Development of the cascade HPP clusters on the Yuanshui River

There are altogether seven cascade HPPs on the Yuanshui River drainage basin with a total installed capacity of 4,140 MW, all of which have been put into operation.

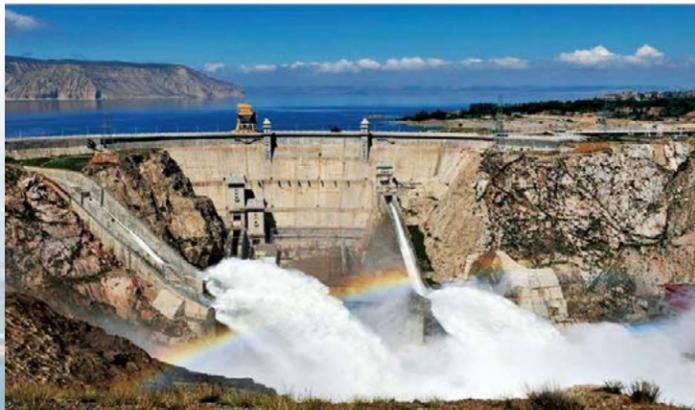
• Representative projects


Laxiwa HPP

Laxiwa HPP is located in North China with the highest dam, largest installed capacity and largest generation capacity. The unit capacity is 700 MW and the total installed capacity is 3,500 MW. In 2010, all five units were put into operation and the annual average power generation is 10.2 TWh. The dam is of a concrete double-arch dam. The maximum dam height is 250m and the total storage is 1.1 billion m³.


Tuokou HPP

Tuokou HPP is located 3.5 km downstream of Tuokou Township, Hongjiang, Hunan Province and 74 km away from Huaihua, Hunan Province. It is the fourth cascade HPP on the Yuanshui River and the largest HPP project under construction in the Province.


Longyangxia HPP

It is the large-scale hydropower project designed and built by China independently, representing the highest level of China's hydropower engineering in 1980s. The single unit capacity is 320 MW and the total installed capacity is 1,280 MW; the average annual power generation is 6 TWh.


Wuqiangxi HPP

It is the largest HPP in Hunan Province, with a single unit capacity of 240 MW and a total installed capacity of 1,200 MW. Its main function is to generate electricity, supplemented by flood control, navigation and other purposes.

Changzhou HPP

Located in the Pearl River Basin, due to its large scale and capacity, and large number of units, it is named as "world-class HPP with tubular turbines" by industry experts. It crosses two islands and three rivers, and is installed with 15 bulb type tubular turbines with a single unit capacity of 42 MW. Thirteen protection and drainage pumping stations were built in the reservoir area and two supporting substations were built.

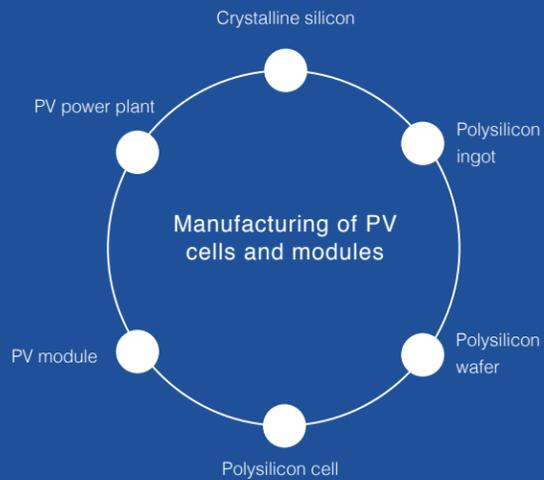


Solar Power

SPIC has the greatest total installed capacity of solar power in the world and owns a complete industry chain in PV power including R&D, planning and design, manufacturing of polysilicon, cells and modules, project construction, training, etc.

By the end of 2016, SPIC owned a solar power capacity of 7,118.4 MW, and has established large-scale new energy bases in Jiuquan, Gonghe, Golmud, Hami, Yancheng, etc. SPIC's solar power assets are located in 27 provinces and autonomous regions in China including Qinghai, Xinjiang, Hebei, Jiangsu, Gansu, etc. (overseas assets excluded).

Through the coordinated operation of hybrid hydro-solar, hybrid wind-solar projects and research on key technologies, SPIC successfully solved the problems related to the volatility, randomness and intermittency of daily PV power output. SPIC also improved the quality of PV power output and the stability of grid operation, which filled the gap of key technologies for large-scale hybrid hydro-solar projects in the world.



Manufacturing of PV cells and modules

Presently, SPIC is capable of manufacturing polysilicons, wafers, cells and modules with facilities to produce 2,500 tons of polysilicons, 200 MW of wafers, 200 MW of cells and 200 MW of modules each year in Xining, Qinghai Province, and to produce 200 MW of cells and 100 MW of modules each year in Xi'an, Shaanxi Province.

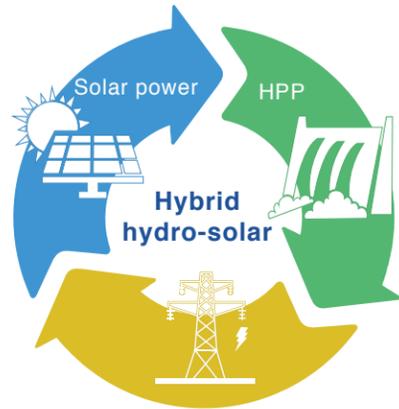


President Xi Jinping visited the PV cell plant of the Xining Branch of SPIC Solar Power during his inspection in Qinghai Province in 2016.

- Representative projects

Longyangxia Hybrid Hydro-Solar Project

With a total installed capacity of 850 MW, the project makes best of the complementarities between hydropower and solar power. The quick adjustment ability of Longyangxia HPP reimburses the active output from the PV power plant, so as to improve solar generating power quality.



Golmud PV Power Plant

Located in the Golmud Gobi Desert, Golmud PV power plant is the largest one-off PV investment in the world, with an installed capacity of 500 MW.

Jiangsu Jianhu Solar Power Plant

The Jiangsu Jianhu Hybrid Fishery-Solar Project has an installed capacity of 66 MW. The large-scale PV power plant was built on the local lake, intertidal zones and fish ponds. Multiple usage of land increases both the agriculture and fishery revenue, with promoting the integrated utilization efficiency of land.

100 MW Gonghe Solar Power Test and Validation Base in Qinghai Province

The 100 MW Gonghe Solar Power Test and Validation Base in Qinghai Province is a world first-class, inclusive, authoritative and industry-leading solar power test and validation facility.



Power-related Industries >>

Coal

SPIC has 16.2 billion tons of coal reserves, 80.1 million t/y of coal production capacity and 12 operational coal mines, including 7 underground mines (5.1 million t/y in total) and 5 10million t/y class open-pit mines (75 million t/y in total), mainly located in regions such as Inner Mongolia, Xinjiang and Guizhou. SPIC's overall coal self-sufficiency rate has reached 26.5%.

Huolinhe South Open-pit Coal Mine

The three 10 million t/y class open pit mines in Huolinhe, Inner Mongolia, i.e. the South Coal Mine, the North Coal Mine and the Zhahanur Coal Mine, have a total production capacity of 46 million t/y. Baiyinhua Green Energy Base is pictured below.



Wind Power

By the end of 2016, SPIC had a wind power capacity of 11,982.2 MW distributed in 25 provinces and autonomous regions including Qinghai, Xinjiang, Gansu, Inner Mongolia, Jiangsu, etc.

SPIC adheres to the principle of attaching equal importance to centralized and distributed utilization of wind power. Given the conditions of wind power consumption and technological development, SPIC expedites the distributed development of projects in China's central and southeastern regions, promotes large-scale onshore wind power bases, intertidal and offshore wind power in coastal regions step by step.

SPIC Jiangsu Electric Power is developing the Binhai Offshore Wind Farm in Yancheng, Jiangsu Province in three phases with a total installed capacity of 800 MW. Upon completion, the project will overtake the present world record holder—the London Array (630 MW) and become known as the Yancheng Array.

Meanwhile, as one of the earliest wind power designers in China, SPIC has completed the feasibility studies and construction drawings of more than 240 wind farms. SPIC is constructing the largest offshore wind power project in the world.

Jiuquan Gobi Wind Farm in Gansu Province ▶

With a total installed capacity of 1,070 MW, the wind farm is located in the Gobi Desert of Gansu.



Logistics

SPIC has one railway in operation (Chifeng–Daban–Baiyinhua Railway) with a length of 331 km, a Class I single-line local railway with a transportation capacity of 20.6 million t/y. Starting to operate in 2012, the annual transportation capacity reached up to 15.41 million tons in 2016. There is one heavy load railway under commissioning (Jinzhou–Chifeng Railway) with a length of 296 km, a class I single-line national railway with a transportation capacity of 22.29 million t/y. In October 2016, the heavy load trial run began. It is predicted to be put into operation by December 2017.

SPIC owns two ports under construction. A specialized coal marine terminal at Jinzhou Port, Liaoning: the designed shipment capacity is 35 million t/y. The shipment first stage capacity of the project is 18 million t/y. In October 2016, heavy load trial run initiated. It is predicted to be put into production in 2017. A specialized coal marine terminal at Binhai Port, Jiangsu: the designed annual unloading capacity is 20 million t/y and the designed annual shipment capacity is 19 million t/y. The first stage unloading capacity of the project is 12 million t/y and the shipment capacity is 5 million t/y. In December 2012, the project was commenced. In April 2017, heavy load trial run initiated.

The coal transportation channel consisting of Chifeng–Daban–Baiyinhua Railway, Jinzhou–Chifeng Railway and specialized coal marine terminal at Jinzhou Port will be put into operation at the end of 2017.

Aluminum

SPIC has an aluminum smelting capacity of 2.485 million t/y, mainly distributed in areas that are rich in resources and energy, such as East Inner Mongolia, Ningxia and Qinghai. With hydropower–aluminum and coal–power–aluminum industry chains, SPIC reduces production cost and promotes the efficiency of resource utilization.

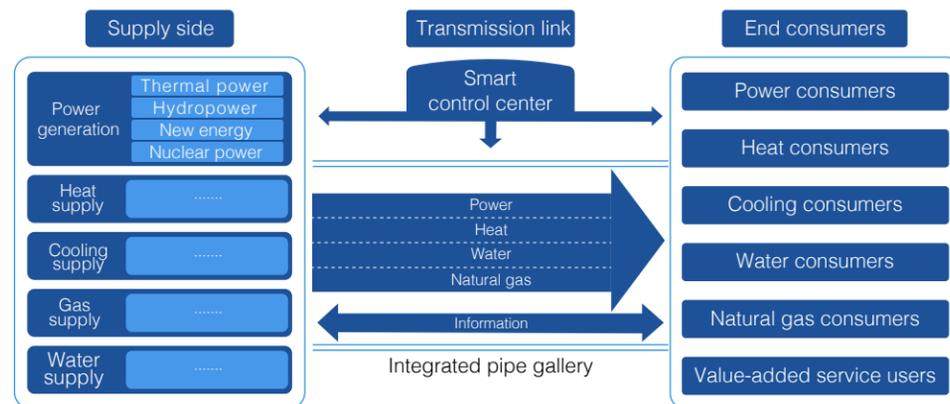
SPIC has an alumina refining capacity of 2.6 million t/y, and most alumina is produced in Shanxi. The total reserve of bauxite reached around 1.9 billion tons, mainly located in Guinea, Guizhou and Shanxi.

Integrated Smart Energy >>

SPIC is committed to supply-side structural reforms and innovative development of integrated smart energy.

Other than separated planning, design and operation of different types of energy, the integrated smart energy can provide regional integrated energy solutions with function blocks as base units. It can create production synergy, pipe synergy and demand synergy and achieve interaction between energy producer and consumer through horizontal integration of different energy products such as "power, heat, cooling, natural gas and water" and vertical integration of various energy supply links like "generation source, grid, load, storage".

Integrated smart energy features comprehensiveness, interaction, proximity, marketization, intelligence and low carbon etc. It reflects four revolutions, i.e. energy consumption revolution, supply revolution, technology revolution and system revolution.

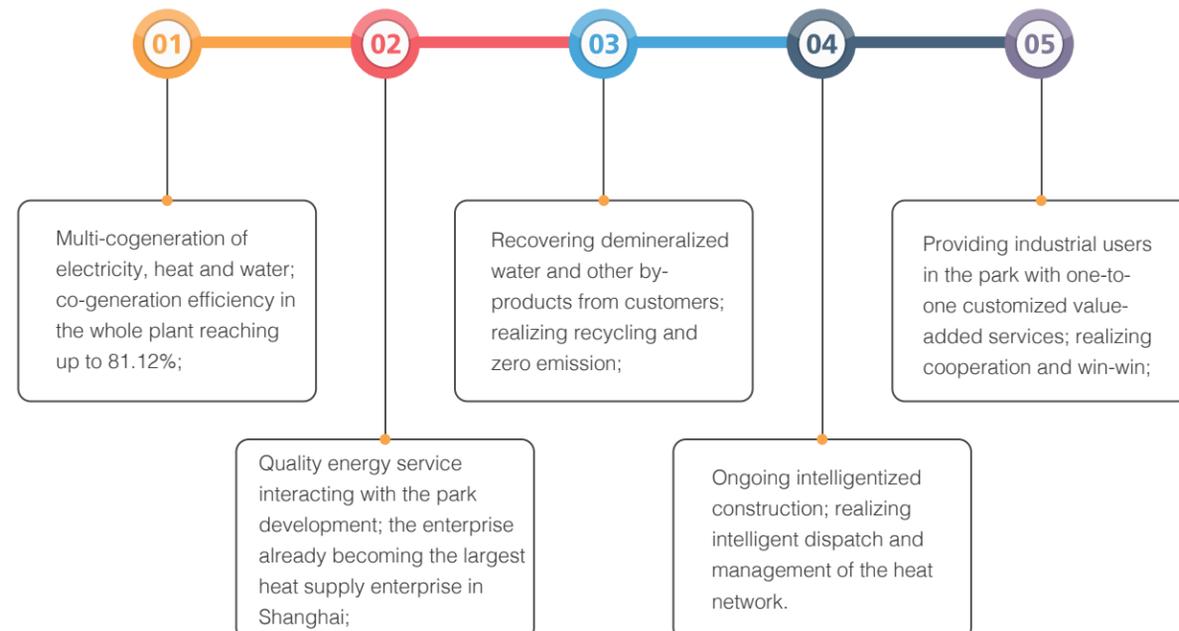


Representative projects

1. Multi-cogeneration of electricity, heat and water in Caojing, Shanghai

Shanghai Caojing Thermal Power Plant is located in the Chemical Industry Park in Shanghai. With two sets of 9F class gas turbines and supporting heat, water supply pipes, it provides the park with electricity, steam and demineralized water and other products as well as energy value-added services including energy-saving management.

Project features:



2. Multi-cogeneration of electricity, heat and water in Hengqin, Zhuhai

The project in Hengqin Zhuhai is intended to provide the whole island with a solution of integrated electricity, cooling, heating, gas and water. It is an important energy foundation for building eco-island and national low-carbon city (town) pilot project in Hengqin New District.

The project plans to build 8 gas co-generator sets. At present, there are two sets of 9F class gas combined recycling generator sets as well as supporting heat network and cold network systems. Relying on cascade energy utilization, the primary energy utilization rate can reach up to 73%.

It is proposed to build 9 refrigeration stations with a total installed capacity of 300,000 RT. The energy supply radius of each refrigeration station is about 1.5km.

The project is able to provide cooling (heating) for the whole Hengqin New District:

- Close-range direct cold supply
- Medium-distance ice storage for refrigeration
- Long-distance electric refrigeration



No. 3 Energy Station of Hengqin Energy under SPIC Guangdong Electric Power (under construction)



Hengqin Cogeneration Plant, SPIC Guangdong Electric Power

Environmental Protection »

SPIC Yuanda Environmental Protection Co., Ltd. is a listed company held by SPIC and specialized in energy saving and environmental protection. The stock is abbreviated as "Yuanda Environmental Protection" and the stock code is 600292.

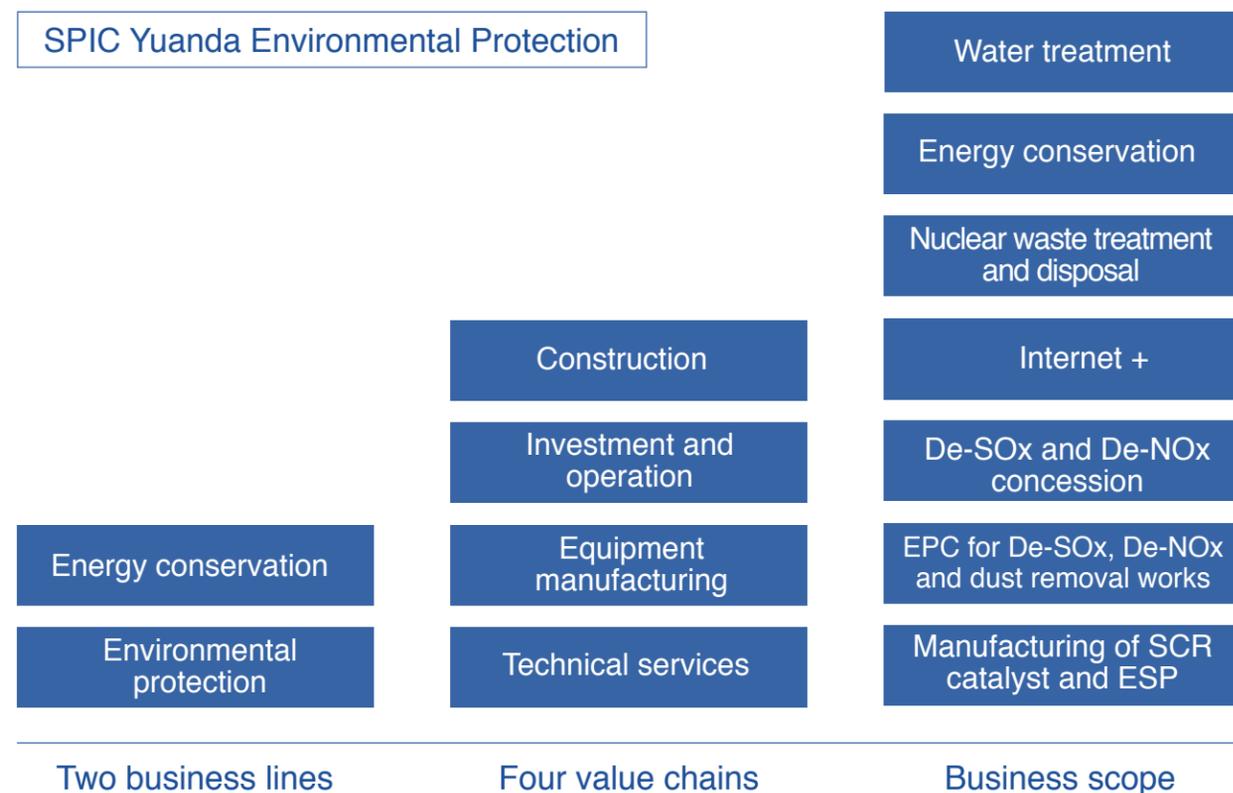
Yuanda Environmental Protection focuses on energy conservation and environmental protection. Yuanda has four value chains, i.e. engineering construction, investment and operation, equipment manufacture and technical service. The scope of business covers more than 10 sectors, including desulfurization, denitrification and dust removal project EPC, desulfurization and denitrification franchise, manufacture of denitrification catalyst and dust remover, nuclear environment protection, water affairs, energy conservation and Internet. The business is spread over 27 provinces, cities and municipalities in China as well as many foreign countries like India, Turkey, Indonesia, Vietnam and Russia.

Yuanda Environmental Protection owns China's largest untreated gas comprehensive test base, leading denitrification catalyst production line, the first set of ten thousand ton class gas CO2

catching device, largest active coke dry desulfurization and denitrification test rig and the first PM2.5 control technology pilot plant test system in the coal-fired power station. The completed catalyst detection center is China's first catalyst detection test approved by global labs. It owns two super clean emission technologies. It is one of the three Chinese companies having the design qualifications in nuclear industry (nuclear facility decommission and three radioactive wastes treatment). It owns 42 core environment protection processes and technologies, and has won 320 national patents including 77 invention patents.

By the end of 2016, the total assets of Yuanda Environmental Protection stood at RMB 8.7 billion yuan (USD 1.25 billion) and annual revenue RMB 3.3 billion yuan (USD 476 million). It owns 25 subsidiaries and has completed environmental protection works for a cumulative 200 GW power plants. Its production capacity of SCR catalyst is 10,500 m3/y; the cumulative capacity of De-SOx and De-NOx concession projects in operation amounts to 30 GW in total.

SPIC Yuanda Environmental Protection



Financial Business »

Obtaining High Grade International Credit Ratings

In 2016, SPIC successfully obtained A2, A and A- international credit ratings from Moody's, Fitch Ratings and Standard & Poor's respectively and issued USD 1.2 billion overseas bonds for the first time.

Making a New Breakthrough in Bond Financing Management

SPIC becomes a DFI member of the interbank bond market. It issued RMB 21 billion company bonds and RMB 4 billion renewable company bonds on the stock exchange market for the first time.

Financial Businesses Reaching a New Level

The business of SPIC Capital Holding covers insurance brokerage, trust, futures, leasing, factoring, funds and assets management. The assets spread over Beijing, Tianjin, Shanghai, Zhengzhou, Chongqing and Shenzhen. SPIC Finance Limited holds all operation qualifications specified in the Administrative Measures for Finance Company of Enterprise Group. It is a member of National Banking Industry Interbank Market, member of interbank currency market and member of National Association of Financial Market Institutional Investors. In 2015 and 2016, SPIC Finance Limited was successively appraised as class A (the highest comprehensive level) in industrial comprehensive rating organized by China National Association of Financial Companies. By the end of 2016, the total assets of financial industry reached up to RMB 96.164 billion; the operation revenue was RMB 5.83 billion; and the total profit exceeded RMB 3.39 billion.



In 2016, SPIC successfully issued overseas bonds for the first time.



On December 16, 2016, Xianrong Futures was listed in National Equities Exchange and Quotations.

Scientific and Technological Innovation

Scientific and Technological Innovation System

- Scientific and technological development plan in the 13th Five-Year Plan period

SPIC issued Scientific and Technological Development Plan of SPIC during the 13th Five-Year Plan Period, and completed the top design for scientific and technological innovation in the future five years, in order to provide instructions for the scientific and technological work of SPIC during the 13th Five-Year Plan period.

- R&D institutions

SPIC now owns 27 national high- and new-technology enterprises, eight national-level and 18 provincial- and ministerial-level (including industry-level) R&D institutions, two academician and expert working stations and seven post-doctoral working stations.

- Research team

SPIC has built a scientific and technological research team of high quality, and this team includes 7 experts of "thousand-talent plan", over 200 subject leaders, over 6000 R&D personnel and over 16,000 science and technology personnel.

Achievements of scientific and technological innovation

- Nuclear electrical field

NuPAC Platform

On January 5, 2017, SPIC announced at the press held in Beijing that China had NuPAC platform with fully independent intellectual property rights and approval of both State Bureau of Nuclear Safety and Nuclear Regulation Commission (NRC). It was the world's first nuclear power plant reactor protection system platform administratively approved by Chinese and American governmental nuclear safety regulation institutions.



COSINE software package

On February 21, 2015, SPIC released COSINE in Beijing successfully; COSINE was China's first set of nuclear design and safety analysis software for nuclear power plants and has fully independent intellectual property rights. The software symbolized the key breakthrough of China in independent work of nuclear power software. The COSINE open beta releases at this time included eight modules (thermotechnical hydraulic design and safety analysis, reactor core physical design, fuel design, shield design and source item analysis, major accident analysis, probability safety analysis, reactor Monte Carlo and group constant development), and 15 software. It covers over 80 functions of the similar software in the world, and has all core functions for nuclear engineering design and safety analysis of nuclear power plants - the functions have passed the pre-acceptance of technical achievements of the subject. The whole performance and technical indexes of COSINE software have reached the international advanced level and some key technologies have reached international leading level.



Ultra-wide duplex stainless steel

On April 6, SPIC Central Research Institute announced in Beijing that it had fully mastered the production technologies of S32101 ultra-wide duplex stainless steel plates and had conducted short run. These stainless steel plates fill up the blank page of special steel plates in China.

- Heavy-duty gas turbine

SPIC was appointed the leading entity to undertake the national science and technology major project of heavy-duty gas turbine. It has completed the top-level design for the project organization and management system, and the project proposal has been approved by the national government. The core technology team of China United Heavy-duty Gas Turbine Technology (CUGT) has been substantially established, which marks a concrete milestone for the capability building of the team. SPIC has since become the only central SOE that leads two national science and technology major projects.





Detection of metallic impurities on the surface of polysilicon material

• Environment protection

Test platform

SPIC subsidiary Yuanda Environment Protection owns China's largest untreated gas comprehensive test base, the first set of ten thousand ton class gas CO₂ catching device, largest active coke dry desulfurization and denitrification test rig, the first PM_{2.5} control technology pilot plant test system in the coal-fired power station and the first radioactive sewage treatment test platform in Chongqing and many other industrial leading scientific and research platform. It owns the first catalyst performance detection center approved by CNAS.

• Solar energy

Science and technology labs

Huanghe Hydropower Development has set up three labs, i.e. PV materials and equipment R&D lab, solar energy generation system demonstration lab and solar energy generation system design and research lab.

Polycrystalline silicon lab of Huanghe Hydropower Development is the first lab approved by China National Accreditation Service for Conformity Assessment in the silicon industry in China.

• Clean and high-efficient coal power

620 °C secondary reheat unit

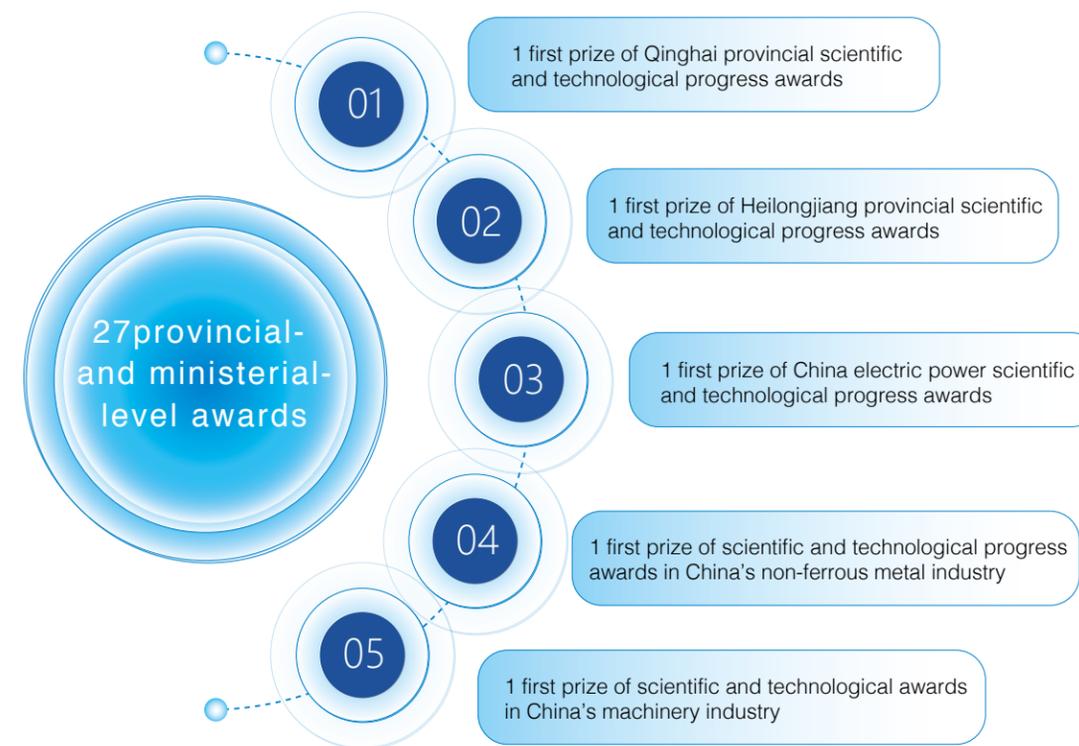
The 2 × 660 MW project of Tianji phase II is the China's first ultra-supercritical unit with 620 °C reheat steam temperature, and the effect of energy conservation is obvious. No. 3 unit was awarded to the title of "the optimal coal consumption unit" of State-owned Assets Supervision and Administration Commission. The average coal consumption for power supply is decreased by about 10g/kWh in contrast to the similar domestic units. Annually, about 6.27 t standard coal can be saved, 168,800 t CO₂ emission and 1,300 t SO₂ emission can be reduced respectively.

1,000 kV voltage output of Pingwei Power Plant

It was the first time in the world to boost the outlet voltage of million-class unit directly to 1,000 kV and connect it to the grid. The blank page both in domestic and abroad are filled up with the above research achievements.

• Prizes and honors

In 2016, SPIC won one Second Prize of National Scientific and Technological Progress, 27 provincial- and ministerial-level awards, including: one first prize of Qinghai provincial scientific and technological progress prize, one first prize of Heilongjiang provincial scientific and technological progress prize, one first prize of China Power scientific and technological progress prize, one first prize of scientific and technological progress prize in China's non-ferrous metal industry, and one first prize of scientific and technological prize in China's machinery industry.



Honeycomb-like wet electrostatic precipitator technology

Yuanda Environment Protection has developed the Yuanda honeycomb-like wet electrostatic technology (YD-HTW) with independent intellectual property rights. It can remove smoke and especially fine dust efficiently. It can make the smoke concentration at outlet smaller than 5mg/m³, and can remove SO₃ and mercury, etc. effectively. The technology has reached the national leading level, and has been applied in Xishui Erlang Power Plant and Shaanxi Weihe Power Plant successfully.

SCR catalyst regeneration techniques at coal-fired power plants

Yuanda Environment Protection has developed regeneration processes and techniques as well as dedicated key equipment for catalyst of different inactive catalysts. Yuanda has set up catalyst regeneration pilot plant test platform and production line while breaking the monopoly of few overseas manufactures over catalyst regeneration techniques. The investment of reloading catalyst has been reduced by over 40%. The techniques have been successfully applied in Shanghai Waigaoqiao 3rd Generation Company and Jiangxi Xinchang Power Plant etc.

Wet ESP mid-test facilities

• Intellectual property rights

After the merger and reorganization, SPIC won 457 patent authorizations in 2015, and won 476 patent authorizations in 2016.

• Technical specifications

In 2016, SPIC directed and participated in the drafting of 268 national and industrial technical specifications.



Cooperation under the “Industry–Academy–Research–Application” Model

- Strategic cooperation agreement

Signing strategic cooperation agreement with Tsinghua University

On November 22, 2016, SPIC and Tsinghua University held the signing ceremony for the framework agreement on scientific and technical cooperation in Beijing.

Signing strategic cooperation agreement with Chinese Academy of Sciences

On March 1, 2016, SPIC and Chinese Academy of Sciences held the signing ceremony for the framework agreement on scientific and technical cooperation in Beijing.



Tsinghua University



Chinese Academy of Sciences



Shanghai Jiao Tong University

Signing strategic cooperation agreement with Shanghai Jiao Tong University

On October 24, 2016, SPIC and Shanghai Jiao Tong University held the signing ceremony for the framework agreement on scientific and technical cooperation in Beijing.



- Partners

Establishing joint innovation center of intelligent PV power plant

Huanghe Hydropower Development in collaboration with Huawei Company set up Joint Innovation Center of Intelligent PV Power Plant, and conduct the research on innovative technologies of intelligent PV. Qinghai PV Engineering Technical Research Center has basically been completed. The center has provided support in improving overall conversion efficiency of PV power plant, applying new products and new materials and reducing project investment etc.



Establishing multi-energy complementary comprehensive energy management joint research center

SPIC subsidiary CPIH in collaboration with Tsinghua University established multi-energy complementary comprehensive energy management joint research center. They intend to accelerate the advancement of integrated smart energy project via multi-energy complementary key technical breakthrough and demonstrative application.

Corporate Culture >>



"Harmony" represents the highest pursuit of aesthetic appreciation by the Chinese people of universe and life, which is the essence of the traditional Chinese culture, and the origin of the corporate culture and core philosophy of SPIC. The "harmony" culture originated from the cultural inheritance of harmony between nature and humanity, from the value integration during corporate restructuring, from SPIC's nature that regards nuclear power as its feature and integrated energy as its character, and from SPIC's emphasis on cooperation and its pursuit of harmony.



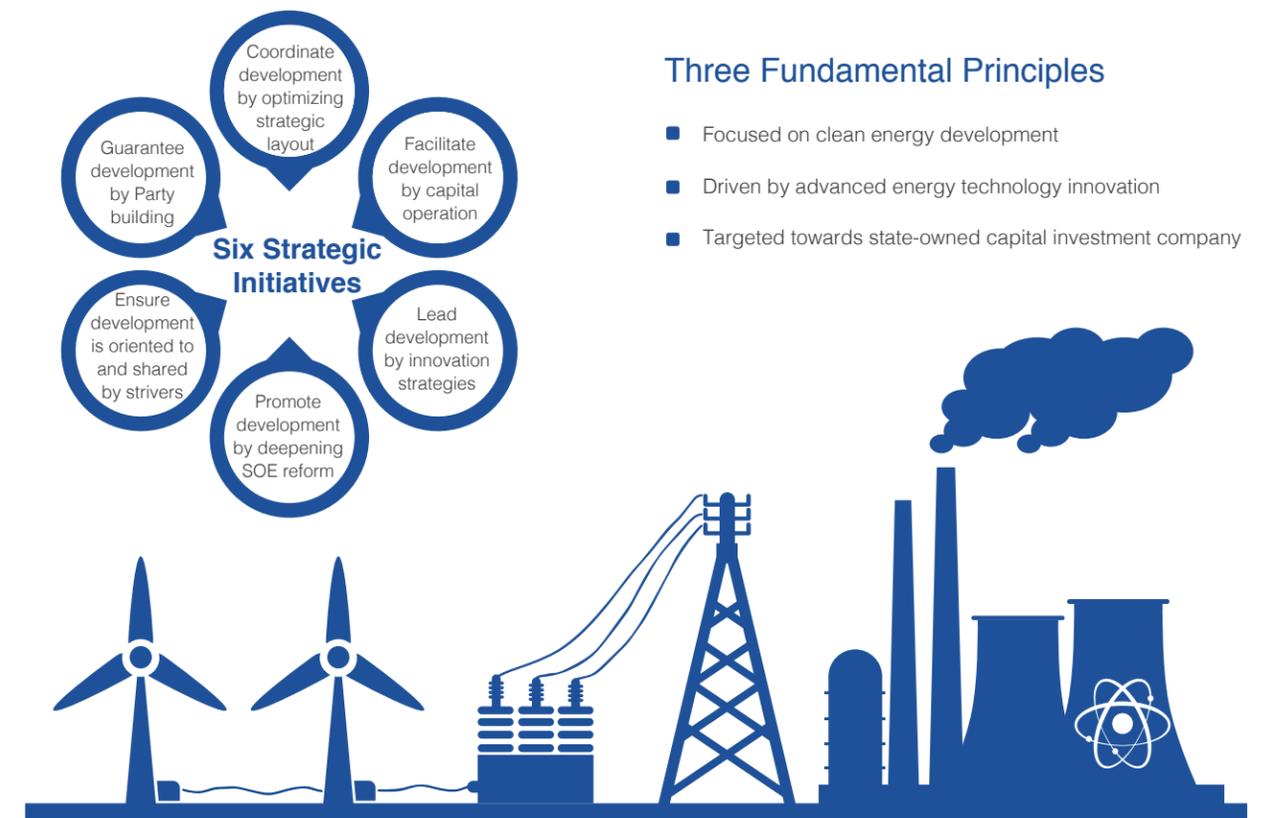
Development Goals >>

Firmly holding to the philosophy of innovation, coordination, green, openness and shared development, SPIC will proactively adjust to, grasp and lead the economic "new normal", center on improving quality and benefits of development, and coordinate the domestic and international markets. SPIC will make adjustment in the process of development and make advance in the process of adjustment. Taking scientific, technological innovation and system innovation as the internal drive, viewing the supply of nuclear power, new energy and comprehensive energy as well as internationalization, financing, environment protection and power station services as the new power source, SPIC will strive to realize "corner overtaking", to build SPIC into a leading international innovative and integrated energy group and modern SOE.

Development theme and goal: Corner overtaking

170 GW total installed capacity, 50% clean energy share, RMB 1.1 trillion (USD 159 billion) total assets, RMB 300 billion (USD 43.25 billion) annual revenue from primary businesses, RMB 26 billion (USD 3.75 billion) annual gross profits, RMB 14 billion (USD 2.02 billion) annual net profits, RMB 7.5 billion (USD 1.08 billion) economic value added (EVA), 75% assets securitized and debt to asset ratio under 78%.

- Competiveness improved significantly
- Transformed into an integrated energy supplier
- Innovation-driven becomes the fundamental feature
- International
- Substantially established the institutions of modern SOE
- International development becomes the important characteristic



A world-leading clean energy developer and provider

2016

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