CGN
A Leader in Clean Energy
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Preface
Greenhouse gas emissions, which are closely linked to energy production and consumption, have become the biggest environmental challenge for the world. Nuclear power, increasingly accepted as one of the most effective solutions to this challenge, provided 12% of the world’s electricity in 2014.

Chinese mainland began developing its first nuclear power plant in the 1980s, and has accumulated more than 30 years of experience in the construction and operation of nuclear power plants. It has a dedicated national policy of exporting nuclear power technology based on the development of the HPR1000 technology, with Chinese intellectual property rights and backed by full fuel cycle capability.

CGN, an integrated nuclear power technology and clean energy provider, is increasingly renowned for the design, construction and operation of nuclear power plants in China, and has been active in the global market for many years. We are capable of providing our customers with the HPR1000 nuclear power technology, as well as nuclear power plant construction and operation services.
CGN is a large clean energy group. Being an owner and operator of both nuclear power and renewable energy plants, CGN also provides customers with professional integrated energy solutions. These include nuclear power plant design, construction, operation, maintenance and nuclear fuel supply. It is comprised of a holding company, China General Nuclear Power Corporation, and 41 major subsidiaries with over 30,000 employees worldwide.
Business Overview

4 Business Sectors

- Renewable Energy
- Financing & General Services
- Nuclear Power
- Nuclear Fuel

3 Subsidiaries Listed on H.K. Stock Exchange

- Nuclear power
  - CGN Power
    - 01816.HK
- New energy
  - CGN Meiya
    - 01811.HK
- Nuclear fuel
  - CGN Mining
    - 01164.HK
Nuclear Power Business
Largest in China, known around the World

As of the end of July 2015

Units in Operation
13 units in operation with an installed capacity of 13.80GW

×13  13.80GW  61% of the total installed nuclear power capacity in China

Units Under Construction
13 units under construction with the capacity of 15.57GW

×13  15.57GW  56% of the total nuclear power capacity under construction in China
### Experienced NPP Developer

<table>
<thead>
<tr>
<th>Project</th>
<th>Installed Capacity (MW)</th>
<th>Project Progress</th>
<th>FCD of First unit</th>
<th>Date of Commencement Operation of First unit</th>
<th>Nuclear Power Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daya Bay NPP</td>
<td>2X984</td>
<td>🟢</td>
<td>1987.8.7</td>
<td>1994.2.1</td>
<td>M310</td>
</tr>
<tr>
<td>Ling’Ao NPP 1</td>
<td>2X990</td>
<td>🟢</td>
<td>1997.5.15</td>
<td>2002.5.28</td>
<td>M310</td>
</tr>
<tr>
<td>Ling’Ao NPP 2</td>
<td>2X1080</td>
<td>🟢</td>
<td>2005.12.15</td>
<td>2010.9.20</td>
<td>CPR1000</td>
</tr>
<tr>
<td>Ningde NPP</td>
<td>6X1089</td>
<td>🟢</td>
<td>2008.2.18</td>
<td>2013.4.15</td>
<td>CPR1000</td>
</tr>
<tr>
<td>Hongyanhe NPP</td>
<td>6X1119</td>
<td>🟢</td>
<td>2007.8.18</td>
<td>2013.6.6</td>
<td>CPR1000/ACPR1000</td>
</tr>
<tr>
<td>Yangjiang NPP</td>
<td>6X1086</td>
<td>🟢</td>
<td>2008.12.16</td>
<td>2014.3.25</td>
<td>CPR1000/ACPR1000</td>
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<tr>
<td>Taishan NPP</td>
<td>2X1750</td>
<td>🟢</td>
<td>2009.9.1</td>
<td>2016 (expected)</td>
<td>EPR</td>
</tr>
<tr>
<td>Fangchenggang NPP Phase 1</td>
<td>2X1080</td>
<td>🟢</td>
<td>2010.7.30</td>
<td>2015</td>
<td>CPR1000</td>
</tr>
<tr>
<td>Fangchenggang NPP Phase 2</td>
<td>2X1150</td>
<td>🟢</td>
<td>2015</td>
<td></td>
<td>HPR1000</td>
</tr>
</tbody>
</table>

- 🟢 Units in operation
- 🟡 Units under construction
- 🟡 Units to be built
The accumulated installed capacity stands at 25.82GW as of June 30th, 2015.

- **Nuclear**: 53%, 13.8GW
- **Wind**: 27%, 7GW
- **Hydro**: 6%, 1.47GW
- **Solar**: 3%, 0.65GW
- **Others**: 11%, 2.9GW

### Total Assets, Net Assets and Revenue

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Assets</th>
<th>Net Assets</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>31.8</td>
<td>3.24</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>57.7</td>
<td>23.1</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>145.6</td>
<td>51.5</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>225.2</td>
<td>69.8</td>
<td>0</td>
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<tr>
<td>2012</td>
<td>269.6</td>
<td>73.5</td>
<td>0</td>
</tr>
<tr>
<td>2013</td>
<td>315.6</td>
<td>86.2</td>
<td>0</td>
</tr>
<tr>
<td>2014</td>
<td>390.3</td>
<td>120</td>
<td>45.1</td>
</tr>
</tbody>
</table>
NPP Construction Achievements

- CGN ranks No.1 in the world in terms of both the number of units and the total capacity under construction (after First Concrete Date).
- From 1979 to date, CGN maintained uninterrupted nuclear power project construction, spanning over Gen II, Gen II+ and Gen III PWR technologies.
- CGN’s industrial safety accident rate per 200,000 hours worked is kept at a level as low as 0.014, which is outstanding by global standards.
- The average construction duration of CGN’s projects is 66 months.

Construction Duration of CGN Projects
NPP Operating Performance
Unit 1 of Ling’Ao NPP has been safely operated for 3487 continuous days as of the end of July, 2015, which ranked first among the 64 units under the same definition.

CGN keeps the world record of 4372 continuous days of operation without unplanned shutdown.

WANO Indicators

CGN delivers desirable results when benchmarking against other NPPs operated by the members of WANO in 2014.

6 Units in Daya Bay Nuclear Power Base

57% of WANO indicators

Reached the world’s top 10% (excellent level)

5 New Units in other Nuclear Power Bases

53% of WANO indicators

Reached the world’s top 25% (advanced level)
Overseas Business

Romania
Signing of MoU on Joint Development of Unit 3/4 of Cernavoda NPP.

US
Rooftop Photovoltaic Project in New Jersey

Africa
Active in the African nuclear power project development

- International Uranium development
- Overseas offices
- Major countries of nuclear power development
- International Clean Energy Partnerships
The UK government warmly welcomed CGN to invest in the Hinkley Point C project, agreed to develop a new nuclear project where CGN holds a controlling interest and have supported the use of HPR 1000 technology in the future.

Established a joint venture company in Uzbekistan to develop uranium mines, as the first foreign enterprise in Uzbekistan to obtain sandstone uranium mining area.

Husab Mine, the largest uranium mine currently under construction in the world, will go into production in 2016.

Set up a Joint Venture Semizbay-U LLP with the NAC Kazatomprom JSC.

Established a joint venture company in Uzbekistan to develop uranium mines, as the first foreign enterprise in Uzbekistan to obtain sandstone uranium mining area.

With the acquisition of EME, a listed uranium resources exploration company, CGN has obtained all qualifications necessary for trading natural uranium resources in Australia.

Integrate solar-biomass power generation project.

CGN’s first overseas wind power project, Morton’s Lane Wind Farm, is currently in operation.

Kazakhstan

Uzbekistan

South Korea

Jeollanam-do Yulchon Power Plant
Seosan Power Plant
Korean Fuel Cell Power Plant

Singapore

Australia

Namibia

Europe

Asia

Africa

Oceania
Core Nuclear Power Technologies

HPR1000

- Chinese Gen III nuclear power technology
- 1,150MW output, single reactor layout and double containments
- Under construction in Fuqing and in Fuchenggang, China
ACPR50S

- Offshore Small Modular Reactor
- 60WM output, compact reactor design, combined with mature marine engineering technologies

ACPR100

- Onshore Small Modular Reactor
- 100WM output, compact reactor design, combined with mature marine engineering technologies
CGN's Nuclear Energy Capabilities
Nuclear Project Construction Capabilities

Architect & Engineering

CGN takes full charge of the management and organization of project design, procurement, construction and commissioning, and facilitates comprehensive management of the preliminary planning, design, financing, procurement, construction, and commissioning phases.

Project Management

- Full set of project management procedures
- Well-established schedule, cost and quality management systems
- “Multi-project and multi-technology” management capability

Engineering & Design

- Formed a complete and effective nuclear power design and research system
- Developed 1000MWe-class NPP technologies: CPR1000, CPR1000+, ACPR1000, ACPR1000+ and HPR1000
- Developing small modular reactor: ACPR50S (offshore) and ACPR100
- Grasped specific design techniques (regular safety analysis, operation & maintenance optimization, etc.)
Effective construction organization and resource control through standardized project implementation system and resource guarantee system

Key primary equipment installation technologies, automatic welding of primary pipelines, etc.

Long term partnership with excellent nuclear construction contractors

Integrated nuclear power equipment supply capability

Long term partnerships with Chinese and global nuclear equipment manufacturers

Specialized teams for equipment manufacturing supervision worldwide

Equipment Localization, Procurement & Supply

Effective construction organization and resource control through standardized project implementation system and resource guarantee system

Key primary equipment installation technologies, automatic welding of primary pipelines, etc.

Long term partnership with excellent nuclear construction contractors

Construction Management

A set of standardized commissioning procedures and expertise

A sound managerial and technical system

Special test abilities (unit start-up test, system power down test, power supply switching test, etc.)

Equipment maintenance and troubleshooting analysis ability

Startup & Commissioning
Operations and Management Capabilities

CGN is committed to providing exceptional nuclear power operation management by using our experience to deliver customer value.

Uranium Resources

- Owner of nuclear fuel import and export licenses issued by the State Council of China.
- Secured over 307,700 tons of uranium, which meet the needs of refueling 30 1000MWe-class units for 30 years.
Human Resource Development

CGN has established a systematic and standardized training system for nuclear power and renewable energy projects, featuring “authorized to work, entire staff training and life-time education”.

CGN’s Training Organization

Talent Cultivation Strategy

Talent Management Strategy & Planning

Learning Resource (Curriculum Etc.) and Internal Trainer & Coach & Mentor

HR System-position/Performance/Development
Research and Development

CGN attaches great importance to nuclear power technology research and development, which not only effectively solve the material technical problems of the units in operation, but also enhance the safety and economy of the units under design or construction.

Strategic R&D project

- HPR1000: Chinese proprietary Gen III nuclear power technology
- SMR ACPR series: safe, flexible and highly effective
- Advanced power supply system
- Advanced nuclear fuel assembly technology
Financial Services

CGN provides various financial services such as capital settlement, insurance, rent financing, direct investment and overseas capital management for different project management patterns.

- Capital management platform
- Credit & financing services
- Asset management
- Investment banking
- Insurance & planning

Nuclear Safety Management Capabilities

Safety culture

CGN establishes its safety culture by:

- Abiding IAEA safety series No. 75- INSAG4
- Giving full authority to internal and external review
- Building multi-level safety supervision and management system
- Ensuring the full coverage, zero tolerance, strict implementation and effectiveness of nuclear safety supervision
CGN obtained over 400 copyrights, patents and industrial design rights in nuclear power plant design, equipment procurement, construction, commissioning, operation, and modification.

**Operational performance**

<table>
<thead>
<tr>
<th>Item</th>
<th>Indicators</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2012</td>
</tr>
<tr>
<td><strong>Nuclear safety</strong></td>
<td>Number of operation units</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Proportion of indicators entering into top 25% of WANO Key Performance Indicators</td>
<td>62.9%</td>
</tr>
<tr>
<td></td>
<td>Unplanned shutdown</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>License Operation Event (Level 1 or above)</td>
<td>0</td>
</tr>
<tr>
<td><strong>Radiation protection</strong></td>
<td>Over exposure</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Radioactive sources lost</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Internal contamination</td>
<td>0</td>
</tr>
</tbody>
</table>

**Safety Management Services**

CGN has established its nuclear safety management philosophy, based on the internationally accepted concepts "defense-in-depth and measured decision-making". CGN is ready to provide clients with:

- Evaluation and consultation of safety performance
- Consultation on standardization of safety facilities
- Planning of safety management program for nuclear power projects

**Intellectual Property Rights**

CGN obtained over 400 copyrights, patents and industrial design rights in nuclear power plant design, equipment procurement, construction, commissioning, operation, and modification.
A Brief Introduction to HPR1000

HPR1000 is a Gen III nuclear power technology developed by CGN. It draws on over 30 years of experience, technologies and expertise, applies mature and tested technologies, and satisfies:

- The Requirements of IAEA (SSR-2/1) and China (HAF102)
- Utility Requirements Documents (URD)
- European Utility Requirements (EUR)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Damage Frequency</td>
<td>$6.9 \times 10^{-7}$</td>
</tr>
<tr>
<td>Large Radioactive Release Frequency</td>
<td>$7.3 \times 10^{-8}$</td>
</tr>
<tr>
<td>Designed Lifespan</td>
<td>60 years</td>
</tr>
<tr>
<td>Refueling Cycle</td>
<td>12-24 months</td>
</tr>
<tr>
<td>Electric Output</td>
<td>1150 MW</td>
</tr>
<tr>
<td>Design Availability Factor</td>
<td>92%</td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>15.5 MPa</td>
</tr>
<tr>
<td>Fuel Assemblies</td>
<td>177</td>
</tr>
<tr>
<td>Safe Shutdown Earthquake</td>
<td>0.3 g</td>
</tr>
<tr>
<td>Solid Waste Generation</td>
<td>&lt;50 m³/year</td>
</tr>
<tr>
<td>Power Plant Layout</td>
<td>Single Reactor</td>
</tr>
</tbody>
</table>
Integration of Technological Advancement and Maturity

Technological Advancement

- Highly efficient digital control systems
- Leak Before Break (LBB) technology for detecting tube defect and preventing LOCA (Loss of Coolant Accident)
- IVR (In-Vessel Retention) technology relieving BDBA (Beyond Design Basis Accident).

Maturity

- Design: Proven design technologies
- Equipment: Reliable and mature NPP equipment supply chain
- Construction: Continuous construction experience over 30 years
- Operation: Excellent operational performance and stable safety record for more than 20 years
Safety is always the first priority during the design of the HPR1000 technology. The HPR1000 technology achieves a high safety level with reasonable costs.

### Safety

<table>
<thead>
<tr>
<th>Items</th>
<th>HPR1000</th>
<th>URD</th>
<th>EUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Damage Frequency/reactoryear</td>
<td>$6.9 \times 10^{-7}$</td>
<td>$&lt;1 \times 10^{-3}$</td>
<td>$&lt;1 \times 10^{-3}$</td>
</tr>
<tr>
<td>Large Radioactive Release Frequency/reactoryear</td>
<td>$7.3 \times 10^{-8}$</td>
<td>$&lt;1 \times 10^{-6}$</td>
<td>$&lt;1 \times 10^{-4}$</td>
</tr>
<tr>
<td>Fuel Thermal Margin</td>
<td>$&gt;15%$</td>
<td>$&gt;15%$</td>
<td>$&gt;15%$</td>
</tr>
<tr>
<td>Safe Shutdown Earthquake</td>
<td>$0.3\text{g}$</td>
<td>$0.3\text{g}$</td>
<td>$0.25\text{g}$</td>
</tr>
<tr>
<td>Operator Grace Time</td>
<td>$\geq30\text{ min}$</td>
<td>$\geq30\text{ min}$</td>
<td>$\geq30\text{ min}$</td>
</tr>
</tbody>
</table>

- Single unit provides better physical separation.
- Three-train physically separated and independent safety systems ensure high redundancy.
- Double-containment resists large airplane crash.
- Emergency Power system protects the unit from blackout accident.
- Safety equipment/systems are designed upon the feedback from Fukushima accident.

### Economy

#### Design & Engineering
- Advanced design concept
- Designed life span — 60 years
- Refuelling cycle — 12-24 months
- Designed availability factor — greater than 90%

#### Construction
- Short construction duration — 62 months
- Optimized project management system for schedule, quality and cost

#### Operation & Maintenance
- Reliable and high efficient NPP operation management
- Optimal fuel cycle and outage arrangement — 12-24 months fuel cycle
- Multiple reactor management
HPR1000 combines active and passive safety systems, which enable the reactor to come to a safe shutdown in case of a blackout like the one suffered by Fukushima.

Passive safety systems can be used to deal with the beyond design basis accidents.

- Prevention of heat buildup inside the reactor
- An alternate measure of heat discharged in time after reactor shutdown
- Keeping radioactivity inside the containments

The Passive safety systems include

- Secondary Passive Residual Heat Removal System
- Passive Reactor Cavity Injection System
- Passive safety injection tank

Active safety systems are highly effective and mature safety systems.

- Three independent trains of physically isolated safety systems
- Safety injection system
- Emergency boron injection system
Domestic Projects and Overseas Promotion

Projects in China

- Fuqing NPP units 5 and 6
- Fangchenggang NPP Units 3 and 4

Overseas Promotion

CGN has started the application of EUR certification since April, 2015. Our potential clients are mainly from:
- Southeast and South Asia
- South and East Africa
- East Europe
- the Middle East

HPR1000 in U.K.

- CGN will lead the Chinese nuclear industrial team to participate in the HPC project.
- CGN will take the leading role in the Bradwell B nuclear power project (HPR1000).
- CGN has started the application for Generic Design Assessment (GDA) on the HPR1000 technology in the UK.
HPR1000’s Value Added

Contribution to Economy and Employment

Both the construction of an HPR1000 NPP and the electricity produced by the plant result in a desirable increase in the local economy and labor demand.

<table>
<thead>
<tr>
<th>Construction Period</th>
<th>Operation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Costs</td>
<td>Electricity Produced</td>
</tr>
<tr>
<td>$2.88 Billion</td>
<td>83TWH</td>
</tr>
<tr>
<td>Increase in GDP</td>
<td>Increase in GDP/year</td>
</tr>
<tr>
<td>$2.97 Billion</td>
<td>$0.64 Billion</td>
</tr>
<tr>
<td>Increase in Aggregate Social Product</td>
<td>Increase in Aggregate Social Product/year</td>
</tr>
<tr>
<td>$8.76 Billion</td>
<td>$1.2 Billion</td>
</tr>
<tr>
<td>Increase in Job Opportunity</td>
<td>Increase in Job Opportunity</td>
</tr>
<tr>
<td>678,300 man-year</td>
<td>67,000 man-year</td>
</tr>
</tbody>
</table>

The data above is based on the performance of China’s nuclear power industry.

Reduction in Greenhouse Gas Emission and Pollutant By-products

Compared with a coal-fired power plant, an HPR 1000 NPP does not discharge greenhouse gases, sulfur dioxide, nitrogen oxides or other pollutants associated with the combustion of fossil fuels.

An HPR1000 NPP with 2 Units can reduce:
- the consumption of 6 million tons of standard coal
- the emission of 17 million tons of carbon dioxide
- the emission of 0.15 million tons of sulfur dioxide and nitrogen oxides

Equal to preserving 114,000 acre forest
Industry Participation and Localization

CGN has accumulated rich experience in NPP project localization over the past thirty years. It is willing to help the local government and enterprises fulfill their localization plans, by utilising R&D, equipment manufacturing, constructions, operation and maintenance of HPR1000.

- Local enterprises will be able to gain relevant capabilities and qualifications of NPP projects.
- The nuclear power industry of the importing countries will be driven ahead step by step.

Personnel Training

CGN provides systematic training programs that cover the whole life of HPR1000 projects to its local partners.

- Diversified HPR1000 training programs.
- Mixture of theoretical knowledge learning, experience feedback and simulation practice.
- Local partners will gain managerial and professional capabilities through development of the HPR1000 technology.
- A batch of local NPP technicians and experts specialized in R&D, projects management, commissioning, operation and maintenance will be cultivated.