China National Nuclear Corporation

Integrated Solution Provider

Your Reliable Partner

Sao Paulo, Brazil
Oct, 2015
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2. Integrated Solutions
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1. CNNC Introduction
2. Integrated Solutions
CNNC Introduction

- Founded in 1955;

- Over 100 subsidiary companies and institutes with more than 100,000 employees;

- Engaged in R&D, design, construction, operation, equipment supply, investment, etc. in nuclear electricity generation, nuclear fuel cycle and nuclear technology application;
CNNC Introduction

- The major body in the nuclear power technology R&D of China;
- The main nuclear power plant exporter in China;
- The general contractor of nuclear design and engineering of China;
- The only nuclear fuel supplier in China;
- The major investor of nuclear power plants in China;
- The nuclear power operation services provider of China.
A Complete Nuclear Industry

- NUCLEAR ENVIRONMENTAL PROTECTION
- NUCLEAR SCIENTIFIC RESEARCH
- NUCLEAR FUELS
- NUCLEAR INSTRUMENTATION AND EQUIPMENT
- NUCLEAR POWER
- URANIUM MINING & METALLURGY
- NUCLEAR TECHNOLOGY APPLICATIONS
- URAMUM GEOLOGY
CNNC Introduction

NPPs in Operation (13 units, 10.75GWe)

QinShan Phase I
1x 320MWe PWR

QinShan Phase II
4x 650MWe PWR

QinShan Phase III
2x 728MWe PHWR

Tianwan NPPs
2x 1060MWe PWR

Fuqing NPPs
2x 1080MWe PWR

Fangjiashan NPPs
2x 1080MWe PWR
NPPs Under Construction (9 units, 9.31GWe)

- Hainan Changjiang1&2
  2×650 MWe

- Zhejiang Sanmen1&2
  2×1250 MWe

- Fuqing 3&4&5
  2×1080 MWe, 1×1150MWe

- Tianwan3&4
  2×1100 MWe
CNNC Nuclear Power Design

- **1980s**
  - Starting with self-reliance and introduction of NPP
    - CP300
      - Qinshan phase I
    - M310
      - Daya Bay

- **1990s**
  - Promoting self-reliance and localization
    - CP600
      - Qinshan phase II

- **2010s**
  - Advanced G-III technology
    - ACP1000
      - Based on CP1000 design, overall technical scheme finalized in Aug. 2010
      - Adopting the active & passive design
      - Feedback of Fukushima accident

**Long-term self-reliant technology development plan**

**CP1000**
- R&D started in 1997
- Standard design completed in Apr. 2010
- Construction drawings design, performance test and equipment procurement started in Oct. 2010
ACP series—(HPR1000, ACP600, ACP100), the G-III nuclear power technology

- A safe, reliable technology with economic competitiveness
- Evolutionary design based on proven technology
- Satisfying the requirement of latest nuclear safety codes and standards
- Fulfilling the utility requirements for advanced light water reactor (URD, EUR)
- Integrating the feedback of Fukushima accident
A Complete Nuclear Fuel Cycle System
Nuclear Fuel Cycle Services

- Front End to Back End
- Uranium Conversion and Enrichment
- Nuclear Fuel Manufacturing
  - Complete nuclear fuel manufacturing system.
  - Most major types of fuel in the world.
- CF series fuel
- Life-cycle nuclear fuel supply of new NPPs
Nuclear Mining and Metallurgy

Technologies of conventional milling, heap leaching and in situ leaching are widely adopted in uranium mining and metallurgy. As a result, the production capacity has been significantly enhanced and the production of uranium has increased year by year.
Fuel Fabrication

The quality of nuclear fuel elements has reached the international advanced. Different types of nuclear fuels are supplied for all the NPPs in operation in China.

<table>
<thead>
<tr>
<th>Type</th>
<th>Nuclear Power Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>300MWe NPP</td>
<td>Qinshan Phase I</td>
</tr>
<tr>
<td>AFA3G</td>
<td>Qinshan Phase II, Guangdong Daya Bay NPP</td>
</tr>
<tr>
<td>VVER-1000</td>
<td>Tianwan NPP</td>
</tr>
<tr>
<td>PHWR</td>
<td>Qinshan Phase III</td>
</tr>
<tr>
<td>AP1000</td>
<td>Sanmen NPP and Haiyang NPP</td>
</tr>
<tr>
<td>HTGR</td>
<td>Shidaowan NPP</td>
</tr>
<tr>
<td>CF3</td>
<td>Fuqing NPP Unit 5&amp;6</td>
</tr>
</tbody>
</table>
Spent Fuel Reprocessing

The pilot spent fuel reprocessing plant has been built up and a large nuclear spent fuel reprocessing plant is under planning.

Pilot spent fuel reprocessing plant

Storage Pool of Spent Fuel Assembly
CNNC Introduction

- **Nuclear Technology Application**

  CNNC has sharpened its competitive edges in the fields of **isotope** and related products, **irradiation processing** and services and **ray application instrumentation**, and has fostered a group of key high-tech enterprises.
CNNC has developed a high level platform of basic scientific and technological research, and built up a R&D system in a comprehensive range of specialties.
Advanced Experimental Facilities

- China Experimental Fast Reactor:
  - 65MWt/20MWe
  - May 2000-Jul. 2010

- China Advanced Research Reactor:
  - 60MWt
Advanced Experimental Facilities

- Comprehensive Experimental Facility for Nuclear Power Equipment
- Medium and Large-scale thermo-hydraulic test facility
CNNC Introduction

- **Strong R&D Capability**

  - **25 Research Institutes:**
    - China Institute of Atomic Energy
    - Nuclear Power Institute of China
    - China Institute for Radiation Protection
    - Research Institute of Nuclear Power Operation
    - China Nuclear Power Engineering Corp.
    - Beijing Research Institute of Uranium Geology
      - ...

  - **R&D staff:**
    - 17 Academicians
    - 29 senior experts for central government
    - 110 Ph. D supervisors
    - 33,000 scientific & technical professionals
Nuclear Power Equipments Services and Supply

- RPV (Reactor Pressure Vessel)
- Turbine
- Generator
- Steam Generator
- DCS system
Human Resources Development

- Training services for Pakistan, Nigeria, Sudan, Saudi Arabia, League of Arab States, etc.
- International Educational Programme
- HRD proposal for nuclear new build
Human Resources Development

- Training Center Building
- FSS Development
- Multifunctional Simulators
- NPP Equipment modules
- 3D Teaching Tools
- Anti Human Error Training Systems

CNNC Introduction
Human Resources Development

- Contract for Nuclear Staff Training
- The basic theory training
- Workshop for league of Arab states
- Visit China Experimental Fast reactor
- Visit to Qian shan NPP
- On the job training for uranium mining
Renewable Energy

CNNC has paid great attention to develop renewable energy projects like wind power generation and solar power generation.
CNNC carries out extensive international cooperation in nuclear power, nuclear fuels and nuclear technology applications and has established trading relations with over 40 countries and regions.

<table>
<thead>
<tr>
<th>Country</th>
<th>Reactor Type</th>
<th>Units</th>
<th>Build time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>Heavy Water Research Reactor</td>
<td>1</td>
<td>1992</td>
</tr>
<tr>
<td></td>
<td>Miniature Neutron Source Reactor (MNSR)</td>
<td>1</td>
<td>1989</td>
</tr>
<tr>
<td>Pakistan</td>
<td>CP300</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chashma Unit 1 (C1)</td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>Chashma Unit 2 (C2)</td>
<td>4</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td>Chashma Unit 3 (C3)</td>
<td></td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>Chashma Unit 4 (C4)</td>
<td></td>
<td>2017</td>
</tr>
<tr>
<td></td>
<td>HPR1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K2/K3</td>
<td>2</td>
<td>2014</td>
</tr>
<tr>
<td>Iran</td>
<td>Miniature Neutron Source Reactor (MNSR)</td>
<td>1</td>
<td>1994</td>
</tr>
<tr>
<td></td>
<td>Heavy Water Zero Power Reactor</td>
<td>1</td>
<td>1997</td>
</tr>
<tr>
<td>Ghana</td>
<td>Miniature Neutron Source Reactor (MNSR)</td>
<td>1</td>
<td>1995</td>
</tr>
<tr>
<td>Syria</td>
<td>Miniature Neutron Source Reactor (MNSR)</td>
<td>1</td>
<td>1996</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Miniature Neutron Source Reactor (MNSR)</td>
<td>1</td>
<td>2004</td>
</tr>
<tr>
<td>Jordan</td>
<td>Subcritical Facility</td>
<td>1</td>
<td>2012</td>
</tr>
</tbody>
</table>
CNNC Introduction

Birine Nuclear Research Center in Algeria

MNSR in Ghana

Sub-critical Assembly in Jordan

CHASNUPP- 1&2

CHASNUPP- 3&4
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Integrated Solution

- **Project Solution**

  - Self-Reliance Generation III nuclear technology Series (HPR1000, ACP600, ACP100)
  
  - Various Contract Models (EPC, EPCM, BOT, BOO, etc.)
  
  - Technical Services covering the entire fuel cycle (Feasibility Study, Technical Consulting, Life Extension, System Upgrading, NPP operation, HRD etc.)
## Financial Solution

### Flexible Financing Options

- With the great support of Chinese Government and financial institutions, CNNC could provide wide range of competitive financial packages for the NPPs.

<table>
<thead>
<tr>
<th>I. Government support</th>
<th>II. Financing Source</th>
<th>III. Flexible Models</th>
<th>IV. Financing Terms</th>
<th>V. Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Preferential policy</td>
<td>- Large scale</td>
<td>- Export &amp; Import Credit</td>
<td>- Competitive interest rate</td>
<td>- Risk sharing mechanism</td>
</tr>
<tr>
<td>- State guarantee</td>
<td>- Reliable</td>
<td>- Equity investment</td>
<td>- Medium and long term</td>
<td></td>
</tr>
<tr>
<td>- Foreign strategy</td>
<td>- Multiple Channels</td>
<td>- Strategic investors attraction</td>
<td>- Multiple Guarantee conditions</td>
<td></td>
</tr>
</tbody>
</table>
Financial Solution

CNNC has jointed effort with major Financial Institutions

- Brazil is one of the founding member of Asian Infrastructure Investment Bank and BRICKS New Development Bank.
- All the financial institutions are paying close attention to China NPP oversea market.
### Integrated Solution

#### Pre-Project Phase Services

CNNC’s integrated offer includes a full set of services and solution needed to establish a nuclear infrastructure for efficient and responsible governance and regulation of a sustainable national nuclear power program, including **Project Management, Human Resources Development, Safety and Security, Emergency Response, Public Acceptance, Stakeholder Involvement, Human and Environment Protection, Grids Considerations and Site Selection.**

| **Site Selection**       | • Survey of potential sites  
|                         | • Selection of candidate sites  
|                         | • Site Characterization, etc.  |
| **HRD**                 | • Necessary knowledge and skills identified  
|                         | • Develop and maintenance of HR base planned  
|                         | • HRD master plan for nuclear new build  
|                         | • Training, Technical exchanges and educational programme  |
| **Localization**        | • Localization Guideline  
|                         | • Joint assessment of local industries  
|                         | • NPP technology development plan  
|                         | • Cooperation proposal on localization  |
Integrated Solution

Ability to Provide Integrated Solution

Industrial Solution
- Equipment Supply
- Nuclear fuel Supply
- Maximum Localization Ratio

Nuclear Management
- Infrastructure Establishment
- Site selection
- Project Management Support

Nuclear Technology Transfer
- Nuclear power
- Nuclear fuel

R&D
- Cooperation in Research and Design
- Research and Test Facilities

NPP Project
- Advanced NPP design
- NPP construction and life cycle management support
- Life extension & Consultation
- Operation & Maintenance support
- Various Contract Models (EPC, EPCM, BOT, BOO, PPP etc.)

Financial Solution
- Government support
- Flexible Financing Options

HRD
- HRD Services
- Joint educational program
THANK YOU FOR YOUR ATTENTION!