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Civil Nuclear Status in China
1.1 Energy Challenges & China Choice

Ever growing demand for sustainable energy

Imminent & rigorous requirements for lower emissions to improve environment

Increase the share of both renewables and nuclear power in the energy mix
1.2 Current Status on World Nuclear Power Development

Number of operating nuclear reactors as of March 2020, by country

- **54** under construction units
- **47** operating units in the world

**Total Number of Reactors: 441**

Source from WNA
1.3 Forecast for World Nuclear Power Development

Number of planned nuclear reactors globally as of April 2020, by country

- Uzbekistan
- USA
- United Kingdom
- Ukraine
- Turkey
- Russia
- Romania
- Pakistan
- Japan
- Iran
- India
- Hungary
- Finland
- Egypt
- Czech Republic
- China
- Bulgaria
- Argentina

Source from WNA
1.4 Nuclear Power Development in China

- In 2018, China became the first country in the world to put two new-design reactors – AP1000 and EPR into commercial operation.

- China has become largely self-sufficient in reactor engineering and construction, as well as other aspects of the fuel cycle.

- China is commencing to export HPR1000, a large Gen. III reactor with full proprietary rights, which has already been under batch construction in China.

- A new and ambitious Development Plan for Chinese Nuclear Power is now under discussion.
As of April 2020, China has

- **47 units** in operation with an installed capacity of **48.8 GWe**
- **12 units** under construction with an installed capacity of **12.24 GWe**
- **44 units** planned with an installed capacity of **50.96 GWe**
- **90 units** firmly proposed, **106.9 GWe**
- **78 units** further proposed
CGN Overview
One of world’s largest clean energy groups with more than 40 subsidiaries and 43,000 employees worldwide, capable of providing integrated solutions for nuclear new builds.
2.1 Corporate Culture

**Vision**
To Build a World-class Clean Energy Group

**Mission**
Developing Clean Energy to Benefit Mankind

**Core Value**
Doing Things Right in One Go

**Basic Principle**
Safety First, Quality Foremost, Pursuing Excellence
2.2 Business Layout

- As of December 2019, the total assets reached around **$108 billion**
- **Business structure** includes four plus X sectors
- Full range of premier nuclear capabilities and extensive experience in all aspects of nuclear power plants

```
“4+X” sectors

Nuclear power
Renewable energy
Nuclear fuel
Finance

X
(Nuclear technology, Public utilities …)
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3 HK stock listed companies, 2 Shenzhen stock listed companies

CGN Power 003816.SZ
CGN Power 1816.HK
CGN New Energy 1811.HK
CGN Mining 1164.HK
CGN Nuclear Tech 000881.SZ
```
2.3 Installed Capacity and Power Generation

Total installed capacity 58.18GW, as of December 2019

- Nuclear: 27.14 GW (47%)
- Renewables: 31.04 GW (53%)

On-grid power generation in 2019 is 262.17 TWh

- Nuclear: 178.97 TWh (68%)
- Renewables: 83.2 TWh (32%)

Installed Capacity Growth

- 2011: 11 GW
- 2012: 12.47 GW (13.4% growth)
- 2013: 17.07 GW (36.9% growth)
- 2014: 23.34 GW (36.7% growth)
- 2015: 29 GW (24.3% growth)
- 2016: 43.71 GW (50.7% growth)
- 2017: 45.11 GW (3.2% growth)
- 2018: 49.67 GW (10.1% growth)
- 2019: 58.18 GW (17.1% growth)
One of the fastest growing nuclear energy companies in the world
### 2.4 Current Status on CGN Nuclear Power Business

#### Units in operation

<table>
<thead>
<tr>
<th>Number</th>
<th>Power (GW)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>27.14</td>
<td>56%</td>
</tr>
</tbody>
</table>

#### Units under construction

<table>
<thead>
<tr>
<th>Number</th>
<th>Power (GW)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6.96</td>
<td>12%</td>
</tr>
<tr>
<td>6</td>
<td>6.96</td>
<td>43%</td>
</tr>
</tbody>
</table>

#### HPR1000 units planned by 2030

- **x18 in China, x2 in UK**
- **24GW**

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**Nuclear Power O&M Services**

- Maintenance Service
- Training Service
- Spare Parts Management
- Operation Preparation

**Nuclear Power Engineering & Construction Services**

- Engineering Design
- Engineering Procurement
- Construction Management
- Testing & Commissioning

*(As of April 2020)*
2.5 Domestic NPP Layout

- **24 units** in operation with an installed capacity of **27.14GWe**
- **6 units** under construction with an installed capacity of **6.96 GWe**, including **4 HPR1000 units**
- **20 HPR1000 units** planned by 2030
CGN Capabilities
With over thirty years of continuous development of nuclear power, CGN has acquired the following capabilities:

<table>
<thead>
<tr>
<th>🛒 Strong investment and financing capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>🍴 Leading innovation-driven and matured HPR1000 technology</td>
</tr>
<tr>
<td>🍽 Rich project management experience with good track record</td>
</tr>
<tr>
<td>🔄 Excellent operation performance</td>
</tr>
</tbody>
</table>
3.1 Strong Investment and Financing Capabilities

- Competitive core business
- CGN’s competence
- Investment and financing expertise
- Strategic partnership with financial institutions
- Belt and Road Initiative
- Chinese government support
- Other international cooperation mechanism
3.1 Strong Investment and Financing Capabilities

**UK**
- 33.5% shares of HPC, the largest nuclear power project in the UK, and 20% shares of SZC nuclear new build.
- 66.5% shares of BRB nuclear new build with HPR1000 technology to be applied.

**Namibia**
- The investment in Swakop Uranium, Husab Uranium Mine, is the single biggest asset investment by China in Africa so far.

**Malaysia**
- Acquired EDRA which is the second largest independent power producer in Malaysia and the largest in Egypt and Bangladesh with 6,620 MW installed capacity in total.
3.2 Leading innovation-driven and matured HPR1000 technology

HPR1000 Features

- Based on over 30 years’ experience of continuous design, construction and operation of nuclear power plants in China
- Integrated innovation by adopting matured technologies
- Fukushima nuclear accident feedback has been taken into full consideration
- CDF <1x10^{-6}; LRF <1x10^{-7}
- 10 units are being built in China and overseas, and many more are being prepared in China
### HPR1000 Features

#### Single Unit-Layout
- Optimized Single Unit-Layout
- Better for physical separation
- Easy for construction, Operation and Maintenance

#### Double Containments
- Double Containments with large volume
- Ventilation System in double containments
- Resistance to impact of large airplane crash

#### Active + Passive Systems
- Secondary Passive Residual Heat Removal System
- Passive Reactor Cavity Injection System to prevent the melting accidents

#### Three Safety System Trains
- 3x100% redundant systems for safety safeguards, fully independent and physically separated
- Effective resistance to accidents and internal and external hazards

#### Advanced I&C
- Digital I&C
- Diverse Auction System
- Advanced MCR with Emergency inhibition system

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**Advanced Gen. III nuclear power technology**
3.2 Leading innovation-driven and matured HPR1000 technology

3D Engineering & Design
3.2 Leading innovation-driven and matured HPR1000 technology

--- HPR1000 units under construction ---
2 in China

- Fangchengang
  - 3
  - 4

- Huizhou
  - 1
  - 2

--- HPR1000 units planned ---
18 in China, 2 in UK

- Cangnan
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6

- Huizhou
  - 3
  - 4
  - 5
  - 6

- Lufeng
  - 3
  - 4
  - 5
  - 6

- Ningde
  - 5
  - 6

- Taishan
  - 3
  - 4

- BRB
  - 1
  - 2
3.2 Leading innovation-driven and matured HPR1000 technology

HPR1000 Certification Worldwide

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Eur

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GDA

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2017 | 2018 | 2019 | 2020

Application | Preparation | Assessment | Finalization

Step 2 Entry 16/11/2017

Step 4 Entry 18/3/2020

GDA Commencement 19/01/2017

Step 3 Entry 15/11/2018

Step 4 Entry 13/2/2020

DAC, SoDA 2022
3.3 Rich Project Management Experience with Good Track Record

1. Large pool of technical and engineering professionals

2. Strong R&D capabilities for project execution

3. Superb performance on project controls for nuclear new builds
3.3 Rich Project Management Experience with Good Track Record

Over 15,000 experienced nuclear engineers in CGN

- DCS Design and Production: 750
- Reactor Operators: 800
- R&D: 2100
- Operation Support: 2100
- Nuclear Design: 2300
- Nuclear Fuel: 3000
- Construction, Procurement and Commissioning: 4200
3.3 Rich Project Management Experience with Good Track Record

Work closely with top universities on both talent cultivation and scientific research projects
3.3 Rich Project Management Experience with Good Track Record

Tsinghua University International Master's Program in Nuclear Engineering and Management (TUNEM)

- Tsinghua University is no.1 university of science and technology in China, top 20 in the world.
- 2-year professional degree program launched in 2016, supported by the National Energy Administration of China, the Ministry of Education of China and Chinese nuclear power companies including CGN, with a full Chinese Government Scholarship (CGS).
- First batch of students graduated in July 2019.
3.3 Rich Project Management Experience with Good Track Record

1. Large pool of technical and engineering professionals

2. Strong R&D capabilities for project execution

3. Superb performance on project controls for nuclear new builds
3.3 Rich Project Management Experience with Good Track Record

15 R&D centers, including 6 national-level energy R&D centers

- Nuclear classified equipment R&D
- Life Assessment & Management R&D
- Nuclear Fuel Assembly R&D
- Nuclear safety related R&D
- Nuclear Construction R&D
- DCS R&D
3.3 Rich Project Management Experience with Good Track Record

1. Large pool of technical and engineering professionals
2. Strong R&D capabilities for project execution
3. Superb performance on project controls for nuclear new builds
### 3.3 Rich Project Management Experience with Good Track Record

Superb performance on project controls for nuclear new build projects. The average construction duration of nuclear new build GW-level projects by CGN is **66.2 months (from FCD to COD)**.

<table>
<thead>
<tr>
<th>Unit Name</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yangjiang Unit 4</td>
<td>52</td>
</tr>
<tr>
<td>Fangchenggang Unit 2</td>
<td>69</td>
</tr>
<tr>
<td>Hongyanhe Unit 4</td>
<td>85</td>
</tr>
<tr>
<td>Ningde Unit 4</td>
<td>65</td>
</tr>
<tr>
<td>Yangjiang Unit 3</td>
<td>61.5</td>
</tr>
<tr>
<td>Hongyanhe Unit 3</td>
<td>67.7</td>
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<tr>
<td>Ningde Unit 3</td>
<td>65</td>
</tr>
<tr>
<td>Yangjiang Unit 2</td>
<td>72</td>
</tr>
<tr>
<td>Hongyanhe Unit 2</td>
<td>65</td>
</tr>
<tr>
<td>Ningde Unit 2</td>
<td>65.9</td>
</tr>
<tr>
<td>Yangjiang Unit 1</td>
<td>65</td>
</tr>
<tr>
<td>Hongyanhe Unit 1</td>
<td>65.1</td>
</tr>
<tr>
<td>Ningde Unit 1</td>
<td>63.5</td>
</tr>
<tr>
<td>Ling’ao Phase II Unit 2</td>
<td>59.5</td>
</tr>
<tr>
<td>Ling’ao Phase II Unit 1</td>
<td>59.5</td>
</tr>
<tr>
<td>Ling’ao Phase I Unit 2</td>
<td>57</td>
</tr>
<tr>
<td>Ling’ao Phase I Unit 1</td>
<td>70</td>
</tr>
<tr>
<td>Daya Bay Unit 2</td>
<td>60.4</td>
</tr>
<tr>
<td>Daya Bay Unit 1</td>
<td>78</td>
</tr>
<tr>
<td>Average Duration of Similar Units in the World</td>
<td>71.8 months</td>
</tr>
</tbody>
</table>

Average duration:

- **FCD to COD**: 66.2 months
- **Average Similar Units in the World**: 71.8 months
3.3 Rich Project Management Experience with Good Track Record

Number of Units under Construction Per Annum

Units

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
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<td>2000</td>
<td>2</td>
</tr>
<tr>
<td>2001</td>
<td>2</td>
</tr>
<tr>
<td>2002</td>
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<tr>
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<td>2017</td>
<td>9</td>
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<td>2018</td>
<td>8</td>
</tr>
<tr>
<td>2019</td>
<td>6</td>
</tr>
<tr>
<td>2020</td>
<td>5</td>
</tr>
</tbody>
</table>
3.3 Rich Project Management Experience with Good Track Record

Safety & Quality Level on Projects

- Poor (L1, L2, L3, L4, L5)
- Average (L6)
- Good (L7)
- Excellent (L8, L9, L10)

We Are Here

International Benchmarking

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3.4 Excellent Operation Performance

Operating Units Second-Year Capacity Factor

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Capacity Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ling Ao 3#</td>
<td>88</td>
</tr>
<tr>
<td>Ling Ao 4#</td>
<td>90</td>
</tr>
<tr>
<td>Hongyanhe 1#</td>
<td>88</td>
</tr>
<tr>
<td>Hongyanhe 2#</td>
<td>87</td>
</tr>
<tr>
<td>Hongyanhe 3#</td>
<td>83</td>
</tr>
<tr>
<td>Hongyanhe 4#</td>
<td>85</td>
</tr>
<tr>
<td>Ningde 1#</td>
<td>88</td>
</tr>
<tr>
<td>Ningde 2#</td>
<td>86</td>
</tr>
<tr>
<td>Ningde 3#</td>
<td>96</td>
</tr>
<tr>
<td>Ningde 4#</td>
<td>100</td>
</tr>
<tr>
<td>Yangjiang 1#</td>
<td>82</td>
</tr>
<tr>
<td>Yangjiang 2#</td>
<td>88</td>
</tr>
<tr>
<td>Yangjiang 3#</td>
<td>92</td>
</tr>
<tr>
<td>Fangchenggang 1#</td>
<td>90</td>
</tr>
<tr>
<td>Fangchenggang 2#</td>
<td>100</td>
</tr>
</tbody>
</table>
3.4 Excellent Operation Performance

Operating Units WANO Indicator Performance

- Matured units: 73.5%
- Newly built units: 78.5%
- World top level (top decile)
- World advanced level (top quartile)
Summary

- Strong Investment & Financing
- Premier EPC Project Management
- Advanced Gen Ⅲ Technology
- Rich Experience of Localization
- Customized Technology Transfer
- Robust Supply Chain
- Abundant Human Resources & Training
- World-class Operation & Maintenance Capability
- >30 years of Continuous Construction Experience

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CGN Perspective on International Projects
4.1 CGN Presence in International Nuclear Energy Market

- **Project in execution:** UK
- **Projects under negotiation:** The Czech Republic, Romania
- **Projects closely followed:** Slovakia, Slovenia, Poland, Kazakhstan, Thailand, Indonesia, Malaysia, Vietnam, Cambodia, Philippines
4.2 Full-range Solutions for International Partners

- Preliminary Consultancy
- Technology transfer
- Construction
- O&M
- Localization
- Regional Cooperation
- Financing & Investment
- Fuel supply
4.3 Strategic Cooperation Framework

• Customized Technology Transfer

• Project Delivery Model Experience Sharing and Consulting

• Full-range Training including on-job Training in CGN Projects

• R&D Cooperation in any related field of common interest

• Localization Plan and Supply Chain Cooperation

• Financing Support

• Project Management with Both Local and International Partners
4.4 Supply Chain Cooperation with the Czech Republic

Current Cooperation

- Two units of CGN’s Taishan nuclear power plant are the first ever EPR units put into commercial operation in the world.
- Unit 1 commercial operation in 06.2018, Unit 2 in 06.2019.
- The reactor internals were supplied by Skoda JS.
4.4 Supply Chain Cooperation with the Czech Republic

Current Cooperation

- In April 2019, CGN signed an agreement with Environment Commerce CZ s.r.o. on waste water treatment cooperation.
- The first project is being implemented in Xiangyang, Hubei Province, China.
### 4.4 Supply Chain Cooperation with the Czech Republic

**Future Cooperation on Dukovany Unit 5 and CGN’s other projects**

| Identification and screening of more than 60 Czech potential suppliers for: |
| --- | --- | --- | --- |
| NSSS | Heat Exchangers | I&C Equipment | Construction |
| TG | PMC | Ventilation | Third party supervision |
| Valves | Electrical | Crane/Hoist | etc. |
| Vessels | Pumps | Piping System | |

**Signing of agreements with 9 Czech companies in 2019**
Conclusion

✓ Throughout over thirty-year’s continuous development of nuclear power, CGN has been capable of bringing the projects on schedule and under budget.

✓ CGN provides its partners and clients with full-range solutions, including the advanced HPR1000 nuclear power technology, investment and financing, project management, O&M service etc.

✓ China has been and will continue to be the biggest nuclear market worldwide in the future with HPR1000 being deployed on a large scale.

✓ China has established a complete nuclear industrial chain and is ready to engage in cooperating with the Czech supply chain to contribute to move ahead with the Czech nuclear industry.
Together, let’s meet energy challenges – NOW AND IN THE FUTURE.
THANK YOU.