China’s Nuclear Energy Development and SF Management Plans

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Content

1. Nuclear energy in China
   background, history, status and plan

2. Experience and plans of spent fuel (SF) management
   accumulation, interim storage, transportation and reprocessing

3. Scenario analysis of SF management

4. Conclusion
Part 1: nuclear energy in China

1. Nuclear energy in China
   development environment of energy/nuclear energy
   analysis of energy demand/supply
   role of nuclear in energy mix
   nuclear energy state: in operation/construction/planned
   impact of Fukushima nuclear accident
   scenarios of nuclear development

2. Experience and plans of spent fuel(SF) management
3. Scenario analysis of SF management
4. Conclusion
China is a nuclear country with "young" history:
- First nuclear weapon test in 1964
- One of five nuclear-weapon nations
- In terms of peaceful utilization, first Nuclear Power Plant (NPP) in commercial operation in 1994

Qinshan Phase I:
- **Type:** CNP-300, PWR
- **Grid Connection:** 15 Dec. 1991
- **Location:** Haiyan, 100km southwest to Shanghai
Development environment of nuclear

The overall elec. development after 1990

Source: Amb. William Ramsay, China’s power sector reforms, 2006
Electricity supply and demand

Electricity shortages since 1980s

In 1997, balance between power demand and supply was first maintained

Since 2000, severe power shortages has occurred and spread:
In 2002, 12 Provinces suffered from the lack of electricity.
while 2003, 22; 2004, 24; 2005, 26

Economy loss around 1 trillion RMB
Projections of electricity development

• To ensure the electricity supply and keep high economic growth
• Focus on energy policy
• Future demand and supply were estimated by various research groups
• Future demand based on
  – estimated electricity consumption per capital
  – or estimated electricity consumption per $ GDP
  – or constant annual growth rate of consumption
Demand forecast to 2020

- Typical forecast of elec. consumption in 2020

<table>
<thead>
<tr>
<th>Organization</th>
<th>Date</th>
<th>Electricity Demand in 2020 /TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Information Agency</td>
<td>2006</td>
<td>4,256</td>
</tr>
<tr>
<td>State Grid Corporation of China</td>
<td>----</td>
<td>4,400</td>
</tr>
<tr>
<td>Development Research Center</td>
<td>2004</td>
<td>5,226</td>
</tr>
<tr>
<td>China Development Bank</td>
<td>2005</td>
<td>5,280-5,780</td>
</tr>
</tbody>
</table>

More than doubled electricity will be required based on the consumption in 2004 (2,187 TWh)

Source: Fredrich Kahrl, et al., 2006
Coal occupies dominant place in elec. supply

- Largest coal production and consumption nation
- In 2004, coal-fired electricity was 1,807 TWh, accounting for 82.6% of total generation
- Elec. generation will continually rely on coal heavily

Coal-fired building rate
China Vs U.S.

Source: ecopolitology.org/2010/08/26/chinas-massive-coal-fired-power-plant-boom-visualized/
Supply forecast to 2020 (2)

Percentage of coal-fired elec. to gradually decrease due to ....

- Pollutions from mining, transportation, storage and consumption
- Human cost
Hydro is preferred to be expanded explosively

- Regarded as a clean and renewable energy
- Enormous hydropower potential, No. 1 worldwide.
- In 2004, hydro elec. generation was 328 TWh, accounting for 15.0% of total generation
- Explosive increase is expected

Three Gorges dam:
Largest hydro station in term of installed capacity (22.5 GWe)
Dam body completed in 2006
However, around 1.3 million people displaced for its construction
Other alternatives

– Oil and gas
  • Accounting for small parts of elec. generation in 2004
  • Limited due to their increasing dependence on imports

– Wind, solar and biomass
  • Steady and large-scale development can be expected
  • Only amount to a small share in term of electricity generation.
Motives to develop nuclear

- **An inevitable complement**
  - Net growth of elec. demand is 2,100~3,500 TWh
  - Insufficient net growth of supply from other fuels
  - Gap between demand and supply is around 350~650 TWh

- **Large capital investment**
  - mainly from central finance
  - strong stimulation to local economic growth

- **Excellent safety record**
  - no severe reactor accident from 1986 to 2004
  - regarded as clean, safe and economic energy
### Change of nuclear plans(1)

#### Proposed nuclear plans 2007-2011:

<table>
<thead>
<tr>
<th>Time</th>
<th>Organization</th>
<th>In operation 2020 /GWe</th>
<th>In construction 2020 /GWe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct. 2007</td>
<td>National Development and Reform Commission</td>
<td>40</td>
<td>18</td>
</tr>
<tr>
<td>Mar. 2008</td>
<td>National Energy Administration</td>
<td>&gt;50</td>
<td></td>
</tr>
<tr>
<td>Jun. 2008</td>
<td>State Council</td>
<td>86</td>
<td>16</td>
</tr>
<tr>
<td>Jun. 2010</td>
<td>Unknow</td>
<td>70-80</td>
<td></td>
</tr>
<tr>
<td>Jan. 2011</td>
<td>China Daily</td>
<td>86</td>
<td></td>
</tr>
</tbody>
</table>
Change of nuclear plans (2)

After Fukushima nuclear accident:

• **16 March 2011:**
  – All approval process of new projects to halt
  – The Shidaowan HTR, though ready for first concrete, was also delayed
  – Safety checks of operating plants, as well as those in construction, were undertaken

• **March 2011:**
  – HUANG Xiaojing, Fujian province governor: "Fujian has three nuclear power plants, and that is enough. Projects that have not been completed must not be continued"
Change of nuclear plans (3)

After Fukushima nuclear accident:

- **Aug 2011:**
  - Safety checks completed
- **Feb 2012:**
  - A report on nuclear safety approved by the state council
  - Nuclear power plants in construction and operation at the highest levels of safety
- **March 2012:**
  - China Daily: “China will soon resume the approval and construction of nuclear power plants”
Growth of nuclear capacity

Speed slow

– First units in operation: 1994
– Today, 14 units in operation
– Total 11.5GWe in commission after 18 years (<0.7G/a)

Case in the U.S.
1959: 1st nuclear unit in operation
1967: 25.6 GWe in operation
1974: 66.9 GWe in operation
3.2 G/a or 4.4 G/a, in average
## Units in operation

<table>
<thead>
<tr>
<th>Unit</th>
<th>Net capacity /MWe</th>
<th>Type</th>
<th>First commercial operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daya Bay 1&amp;2</td>
<td>900*2</td>
<td>PWR (French M310)</td>
<td>1994</td>
</tr>
<tr>
<td>Qinshan Phase I</td>
<td>300</td>
<td>PWR (CNP-300)</td>
<td>1994</td>
</tr>
<tr>
<td>Qinshan Phase II, 1</td>
<td>600</td>
<td>PWR (CNP-600)</td>
<td>2002</td>
</tr>
<tr>
<td>Qinshan Phase III, 1</td>
<td>700</td>
<td>HWR (Candu 6)</td>
<td>2002</td>
</tr>
<tr>
<td>Ling’ao Phase I, 1</td>
<td>1000</td>
<td>PWR (French M310)</td>
<td>2002</td>
</tr>
<tr>
<td>Qinshan Phase III, 2</td>
<td>700</td>
<td>HWR (Candu 6)</td>
<td>2003</td>
</tr>
<tr>
<td>Qinshan Phase II, 2</td>
<td>600</td>
<td>PWR (CNP-600)</td>
<td>2004</td>
</tr>
<tr>
<td>Ling’ao Phase I, 2</td>
<td>1000</td>
<td>PWR (French M310)</td>
<td>2004</td>
</tr>
<tr>
<td>Tianwan 1&amp;2</td>
<td>1060*2</td>
<td>PWR (VVER)</td>
<td>2007</td>
</tr>
<tr>
<td>Qinshan Phase II, 3</td>
<td>650</td>
<td>PWR (CNP-600)</td>
<td>2010</td>
</tr>
<tr>
<td>Ling’ao Phase II, 1</td>
<td>1000</td>
<td>PWR (CPR-1000)</td>
<td>2010</td>
</tr>
<tr>
<td>Ling’ao Phase II, 2</td>
<td>1000</td>
<td>PWR (CPR-1000)</td>
<td>2011</td>
</tr>
<tr>
<td>Qinshan Phase II, 4</td>
<td>650</td>
<td>PWR (CNP-600)</td>
<td>Apr. 10, 2012</td>
</tr>
</tbody>
</table>
Units in construction and planned

• **26 units in construction**
  – 26.2 GWe in total
  – Started construction in 2007~2010
  – Scheduled to operation in 2012 ~2015

• **27 units planned**
  – 14 projects with 28.6 GWe in total
  – Including HTR and 3 inland projects (Taohuajiang, Xianning and Pengze)

• **Additional ~120 units proposed**
layout of China’s nuclear units

- Operational
- In construction
- Planned
Scenarios of nuclear development

• Assumption and envisaged cases
  – All 26 units (26.2 GWe) current in construction will be in operation without significant delay.
  – High case: 60GWe in 2020, 150 GWe in 2035
    • 60 GWe: 11.5 GWe in operation, 26.2 GWe in construction, and most (22.3 of 28) planned units
    • Linear increase between 2020 and 2035
  – Low case: 50GWe in 2020, 100 GWe in 2035
    • 50 GWe: 11.5 GWe in operation, 26.2 GWe in construction and some of (12.3 of 28) planned units
    • Linear increase between 2020 and 2035
Scenarios of nuclear development

Nuclear capacity growth in two envisaged cases

<table>
<thead>
<tr>
<th>Year</th>
<th>Low Case /GWe</th>
<th>High Case /GWe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>11.47</td>
<td>11.47</td>
</tr>
<tr>
<td>2020</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>2025</td>
<td>66.7</td>
<td>90</td>
</tr>
<tr>
<td>2030</td>
<td>83.3</td>
<td>120</td>
</tr>
<tr>
<td>2035</td>
<td>100</td>
<td>150</td>
</tr>
</tbody>
</table>
Part 2: Experience of SF management

1. Nuclear energy in China

2. Experience and plans of SF management
   - mass of discharge SF: calculation
   - SF transportation
   - interim storage: AR and AFR
   - reprocessing

3. Scenario analysis of SF management

4. Conclusion
The detailed data of discharged SF is not available.

The mass of SF can be estimated be the expression

\[ M = \frac{Q}{B_d} = \frac{Pe \cdot CF \cdot 365}{\eta_{th} \cdot B_d} \]

where:
- \( M \) is the mass of unloaded SF per year, tHM/a
- \( Q \) is the annual thermal energy output, GWth/a
- \( Pe \) is the net electric capacity, GWe
- \( CF \) is the capacity factor
- \( \eta_{th} \) is the thermal efficiency, GWe/GWth
- \( B_d \) is the average discharged burnup, GWd/tHM

Though the expression is capable of obtaining the mass of SF from all reactor types. Only PWRs are taken into consideration in our study.
Calculation of discharged SF(2)

- All symbols modified according to PWR
  - $P_e$: by deduction of the capacity of HWR, HTR and FR

<table>
<thead>
<tr>
<th>Year</th>
<th>low case /GWe</th>
<th>high case /GWe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>10.07</td>
<td>10.07</td>
</tr>
<tr>
<td>2020</td>
<td>47.4</td>
<td>56.6</td>
</tr>
<tr>
<td>2025</td>
<td>62.1</td>
<td>84.6</td>
</tr>
<tr>
<td>2030</td>
<td>76.7</td>
<td>112.6</td>
</tr>
<tr>
<td>2035</td>
<td>93.4</td>
<td>142.6</td>
</tr>
</tbody>
</table>
Calculation of discharged SF(3)

- All symbols modified according to PWR
  - Bd: given as 33GWd/tHM and 50GWd/tHM respectively for calculation earlier and no earlier than 2004
  - $\eta_{th}$: given as 0.33 for PWR
  - CF: given as 0.85

Capacity factors of NPP in China

<table>
<thead>
<tr>
<th>Unit</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daya Bay 1</td>
<td>86.7%</td>
<td>88.0%</td>
<td>89.7%</td>
<td>89.6%</td>
</tr>
<tr>
<td>Daya Bay 2</td>
<td>88.0%</td>
<td>90.9%</td>
<td>82.0%</td>
<td>84.5%</td>
</tr>
<tr>
<td>Ling’ao Phase I-1</td>
<td>- -</td>
<td>- -</td>
<td>92.0%</td>
<td>76.8%</td>
</tr>
<tr>
<td>Ling’ao Phase I-2</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>85%</td>
</tr>
<tr>
<td>Qinshan Phase I</td>
<td>76.8%</td>
<td>93.9%</td>
<td>67.8%</td>
<td>- -</td>
</tr>
<tr>
<td>Qinshan Phase II-1</td>
<td>- -</td>
<td>- -</td>
<td>74.9%</td>
<td>81.2%</td>
</tr>
</tbody>
</table>

Capacity factors of Daya Bay NPP (1&2)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Daya Bay 1</td>
<td>87.8%</td>
<td>100%</td>
<td>80.3%</td>
<td>91.2%</td>
<td>99.8%</td>
<td>91.2%</td>
<td>89.1%</td>
<td>100%</td>
<td>99.9%</td>
</tr>
</tbody>
</table>
Calculation of discharged SF(4)

Annual discharged SF

<table>
<thead>
<tr>
<th>Year</th>
<th>High Case (tHM)</th>
<th>Low Case (tHM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>238</td>
<td>238</td>
</tr>
<tr>
<td>2020</td>
<td>1064</td>
<td>891</td>
</tr>
<tr>
<td>2025</td>
<td>1591</td>
<td>1167</td>
</tr>
<tr>
<td>2030</td>
<td>2117</td>
<td>1443</td>
</tr>
<tr>
<td>2035</td>
<td>2681</td>
<td>1756</td>
</tr>
</tbody>
</table>
Calculation of discharged SF(5)

Accumulated discharged SF

<table>
<thead>
<tr>
<th>Year</th>
<th>High case /tHM</th>
<th>Low case /tHM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>1767</td>
<td>1767</td>
</tr>
<tr>
<td>2020</td>
<td>8281</td>
<td>7732</td>
</tr>
<tr>
<td>2025</td>
<td>15257</td>
<td>13091</td>
</tr>
<tr>
<td>2030</td>
<td>24865</td>
<td>19829</td>
</tr>
<tr>
<td>2035</td>
<td>37144</td>
<td>27983</td>
</tr>
</tbody>
</table>
Experience of transportation

- **Cask:** NAC-STC for SF transportation
- Ministry of Environmental Protection first licensed the metal cask for SF transport in 2003

- 26 (17*17) PWR assemblies in each cask
- Mass of U: 464 Kg/assembly
- Enrichment: 1.7<(wt% $^{235}$U)<3.3
- Burnup: < 40 GWd/tU

Source: www.mep.gov.cn/gkml/hbb/haq/201003/t20100329_187512.htm
Experience of transportation

• First transportation of SF from commercial reactor:
  In 2003, from Daya Bay to Lanzhou
  About 3720 km, through 7 provinces

  Road transportation, route\textsuperscript{a}: 大亚湾核电站省道 深圳 高速 广州 高速 长沙 高速 武汉 高速 信阳 高速 漯河 高速 郑州高速 洛阳高速 秦东镇 ( 省界 ) 高速 西安 高速 咸阳 G312 兰州 G312 武威 G312 404厂

• In 2006-2010, 56 (cask⋅time) transportations with total journey of more than 210,000 (cask ⋅ km)\textsuperscript{b}
  Including SF from research reactors
  Totally >300 tHM of commercial SF (about \(\frac{1}{2}\) of loading) delivered from Daya Bay to Lanzhou
  Meaning that most SF discharged before 2001 have been transported.

\textsuperscript{a} : www.mep.gov.cn
\textsuperscript{b} : www.cnnc.com.cn/publish/portal0/tab618/info51136.htm
Experience of interim storage

At Reactor (AR) storage:

Reactors in construction or planned supported with SF storage capacity over 20 yr.

<table>
<thead>
<tr>
<th>NPP name</th>
<th>Storage method</th>
<th>AR storage capacity/yr</th>
<th>Estimated year of filled up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daya Bay 1&amp;2</td>
<td>Wet storage</td>
<td>10</td>
<td>2003 and 2004</td>
</tr>
<tr>
<td>Qinshan Phase I</td>
<td>Dense-pack wet size expansion</td>
<td>35</td>
<td>2025</td>
</tr>
<tr>
<td>Qinshan Phase II 1&amp;2</td>
<td>Dense-pack wet</td>
<td>20</td>
<td>2022 and 2024</td>
</tr>
<tr>
<td>Ling’ao Phase I 1&amp;2</td>
<td>Dense-pack wet</td>
<td>20</td>
<td>2022</td>
</tr>
<tr>
<td>Qinshan Phase III 1&amp;2</td>
<td>wet and dry storage</td>
<td>40</td>
<td>2042 and 2043</td>
</tr>
<tr>
<td>Tianwan Phase I 1&amp;2</td>
<td>Dense-pack wet</td>
<td>20</td>
<td>2026 and 2027</td>
</tr>
</tbody>
</table>

Source: Yun Zhao, China’s spent nuclear fuel management: current practices and future trend, 2011
Experience of interim storage

Away From Reactor (AFR) storage:

- A centralised wet SF storage facility built at Lanzhou Nuclear Fuel Complex

  25 km northeast of Lanzhou
  Total AFR storage capacity 550 tHM
  Including 500 tHM for commercial reactors and 50 tHM for research reactors

- According to estimation that >300 tHM SF were transported from Daya Bay NPP, the available capacity is < 200 tHM

- Reportedly, storage capacity to be increased by 550tHM

- Possible to build a 3,000-ton SF pool as part of its commercial reprocessing plant (Deng, 2010)a.

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a: Yun Zhao, China’s spent nuclear fuel management: current practices and future trend, 2011
Experience of interim storage

SF storage pool attached to the pilot reprocessing plant

Borated stainless steel frame for SF high-density storage.
Experience of reprocessing

A pilot reprocessing facility

– At Lanzhou Nuclear Fuel Complex
– Throughput: 50 tHM/a
– In Dec. 2010, hot test of power reactor SF reprocessing conducted successfully
– Considered to be extended to 80 tHM/a\(^a\), or 100 tHM/a\(^b\)

\(^a\): www.9abc.net/index.php/archives/13993
\(^b\): Hui Zhang, On China’s Commercial Reprocessing Policy
Plans of reprocessing

A large-scale commercial reprocessing plant

– Throughput: 800-1000 tHM/a
– In Nov. 2007, an agreement signed with AREVA to set up a 800tHM/a reprocessing plant.
– However, only one small step of a long march
– Schedule: Construction completed no earlier than 2020, and in commission after 2025
Part 3: scenario analysis of SF mgmt.

1. Nuclear energy in China
2. Experience and plans of SF management
3. **Scenario analysis of SF management**
   
   **scenario: model and assumption**
   
   **results of discussion**

4. Conclusion
**Scenario assumptions**

**Reference Scenario:**

Pilot reprocessing plant:

- average 40tHM/a from 2012, without extension
- No more reprocessing plants in operation before 2035
Scenario assumptions

Scenario A: less-reprocessing-case

Pilot reprocessing plant:
40tHM/a from 2012, expanded to 80 tHM/a in 2026

Large-scale commercial plant:
in operation with full capacity from 2030
Scenario assumptions

Scenario B: more-reprocessing-case

Pilot reprocessing plant:

50tHM/a from 2012, expanded to 80 tHM/a in 2021

Large-scale commercial plant:

in operation with full capacity from 2026
Scenario calculation

constitute of SF
- with ORIGEN2 calculation
- all SF stored for 10 a for decay before reprocessing
- without regard to nuclide decay after reprocessing

Mass composition of element in SF

<table>
<thead>
<tr>
<th></th>
<th>Uranium g/tSF</th>
<th>U-235 g/tSF</th>
<th>Pu g/tSF</th>
<th>MA g/tSF</th>
<th>FPs* g/tSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 GWd/tU</td>
<td>9.56E5</td>
<td>7.97E3</td>
<td>8.68E3</td>
<td>1.03E3</td>
<td>2.82E4</td>
</tr>
<tr>
<td>50 GWd/tU</td>
<td>9.34E5</td>
<td>6.68E3</td>
<td>1.23E4</td>
<td>1.88E3</td>
<td>4.26E4</td>
</tr>
</tbody>
</table>

*: involatile FPs during reprocessing
## Result: accumulated SF

### accumulated SF (/tHM)

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2020</th>
<th>2025</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nuclear high case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: more-rep.</td>
<td>1955</td>
<td>7831</td>
<td>14407</td>
<td>27494</td>
</tr>
<tr>
<td>B: less-rep.</td>
<td>1965</td>
<td>7921</td>
<td>14657</td>
<td>31744</td>
</tr>
<tr>
<td><strong>Nuclear low case</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: more-rep.</td>
<td>1955</td>
<td>7282</td>
<td>12241</td>
<td>18333</td>
</tr>
<tr>
<td>B: less-rep.</td>
<td>1965</td>
<td>7372</td>
<td>12491</td>
<td>22583</td>
</tr>
<tr>
<td><strong>Reference Scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low nuclear growth with least repro.</td>
<td>1965</td>
<td>7372</td>
<td>12510</td>
<td>27022</td>
</tr>
</tbody>
</table>
Discussion: stored and reprocessed SF

According to present assumption

- very limited reduction of stored SF in 2025 (<4.3%)
- the amount of stored SF increase steadily in full time scale

In term of SF reduction, the large-scale plant is highly effecient.

- remarkable reduction by 2035 (maximum 22.8%) due to large scale plant
Discussion: impact on transportation

Today’s transportation capacity
- Capacity: maximum 135 tHM per year
- much greater than repro. capacity of pilot plant

Without large-scale reprocessing plant....
- current transportation able to provide SF for pilot plant.

However....
- AR storage pools in Qinshan Phase I & II and Ling’ao NPP nearly full in 2022-2025
- Impact of “March 11 accident” to reduce highly dense storage of SF in AR pools
Result: separated Pu

Scale of reprocessing: only factor to determine the amount of separated Pu

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2020</th>
<th>2025</th>
<th>2035</th>
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</thead>
<tbody>
<tr>
<td>A: more-rep.</td>
<td>0.43</td>
<td>3.91</td>
<td>7.38</td>
<td>602.7</td>
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<tr>
<td>B: less-rep.</td>
<td>0.35</td>
<td>3.12</td>
<td>5.21</td>
<td>176.2</td>
</tr>
</tbody>
</table>

more reprocessing -> less reprocessing
Discussion: separated Pu

Simplified situation

- typically, \(~4\) t Pu is required for first loading of a FR with 1GWe capacity.
- \(~2.8\) t Pu per year for reloading

Construction of FR stagnated due to the delay of first \(4\) t Pu supply

No significant impact on the operation of the first FR

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</table>
Discussion: impact on repository

Volume reduction by SF reprocessing

- without reprocessing: 2m³ / tHM SF to repository
- after reprocessing, waste to repository: 0.5m³ / tHM SF

But, more repository spaces needed for vitrified waste than directly disposed SF

- higher density of ⁹⁰Sr and ¹³⁷Cs
- thermal output increased

From literature, reprocessing helps to expand the benefit of repository

Patrice Bernard, 2006
Discussion: impact on repository

Yucca Mountain Repository
- capacity: 70,000 tHM SF
- as reference repository

Stock of SF in 2035
- ~55,000 tHM without reprocessing
- >32,000 tHM with maximum reprocessing
- reprocessing seems to have little impact on the requirement for first repository in this time scale
- no urgent requirement for geological repository until 2050
Part 4: conclusion

1. Nuclear energy in China
2. Experience and plans of SF management
3. Scenario analysis of SF management

4. Conclusion
China is a unique country with....

large population and responsibility
rapid grow economic strength and
environmental crisis

Nuclear is an inevitable choice to solve
the hunger for secured energy supply
China is a nuclear country with....

small installed nuclear capacity
huge potential and ambitious plan
limited experience in SF management
unclear or undetermined roadmap

Nuclear strategy needs to be discussed openly
Thank you

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