1. About WNA
2. Value of:
   • New construction
   • Early dismantlement
   • Operating revenues
3. The Supply Chain
4. Three challenges
   • Economics
   • Capability
   • Quality
1. About WNA

180 member companies

- Utilities
- Technology Vendors
- Original equipment manufacturers (OEMs)
- Professional services

Providing Public Information and News
Nuclear Fuel Market and Supply Chain
Enabling Industry Contacts and Cooperation
Representation in Key International Forums
International Technology Vendors

- AREVA
- Candu
- ROSATOM
- B&W
- GE
- HITACHI
- ICEPCO
- DOOSAN
- MITSUBISHI HEAVY INDUSTRIES, LTD.
- Westinghouse
- TOSHIBA
WNA Supply Chain Working Group

• Working Group was set up in 2010

• Tasks:
  • Maintain updated information on planned NPP construction;
  • Determine the market potential for key components;
  • Assemble a database of leading companies worldwide;
  • Identify possible “pinch points/bottlenecks” in supply;
  • Develop ways to improve product qualification practices;
  • Issue a periodic Market Report that consolidates supply chain information.

• Task Force for Vendor Oversight and Control of Suppliers (VOCS):
  Develop a framework for a common process of supplier approval, oversight and quality control that enhances industry efficiency and effectiveness in meeting regulatory requirements and promotes the public good through continual enhancement of the safety and security of nuclear installations.
Nuclear Supply Chain Market Report

Aims to provide the industry, energy suppliers, the investment community and policy-makers with:

• An up-to-date picture of planned and ongoing NPP construction;
• An analysis of the worldwide market for components;
• An analysis of supplier capacity;
• A review of trends in the market;
• A look at how the industry is addressing the challenges in the market;
• Recommendations for harmonization and standards.

Complements the WNA’s Nuclear Fuel Market Report
2. Value of Nuclear Construction to 2030

- 295 new NPPs are under construction or planned
- 50 in OECD countries
- 118 in China
- 42 in Former Soviet Union
- 21 in India

Total Value of Planned Build*
US$ 1,232 billion

Estimated Value of International Procurement
US$ 575 billion

- Reactors currently under construction in China, India, UAE, USA, etc. have an aggregate project value of approx. US$ 232 billion.

- International procurement is worth approx. US$ 26 billion a year.
- Nuclear investment is a small proportion of the US$ 14-17 trillion needed for clean power (Goldman Sachs estimate) to stabilize CO₂ emissions.
Market Size – New Build
Under Construction + Planned to 2030

North America
Under construction: 5
Planned: 7
Total Value: $90 bn

Latin America
Under construction: 2
Planned: 1
Total Value: $14 bn

Europe (EEA)
Under construction: 4
Planned: 20
Total Value: $190 bn

Former Soviet Union
Under construction: 11
Planned: 31
Total Value: $183 bn

East Asia
Under construction: 36
Planned: 125*
Total Value: $545 bn

West Asia
Under construction: 2
Planned: 16
Total Value: $92 bn

South Asia
Under construction: 7
Planned: 18
Total Value: $65 bn

Africa
Under construction: 0
Planned: 4
Total Value: $22 bn

Southeast Asia
Under construction: 0
Planned: 6
Total Value: $31 bn

$1.2 tr

* WNA Reference Case
The World Nuclear Supply Chain – An Overview
Greg Kaser

Market Size - Decommissioning
Planned to be under dismantlement by 2030

North America
Planned
Dismantlement: 4
Total Value: $ 5 bn

Europe (EEA)
Planned
Dismantlement: 60
Total Value: $ 52 bn

Former Soviet Union
Planned
Dismantlement: 1
Total Value: $ 1 bn

East Asia*
Planned
Dismantlement: 17
Total Value: $ 25 bn

South Asia
Planned
Dismantlement: 2
Total Value: $ 4 bn

West Asia
Planned
Dismantlement: 0
Total Value: $ 0 bn

Latin America
Planned
Dismantlement: 0
Total Value: $ 0 bn

Africa
Planned
Dismantlement: 0
Total Value: $ 0 bn

Southeast Asia
Planned
Dismantlement: 0
Total Value: $ 0 bn

$87 bn

* 75% in Japan
Revenues from Nuclear Energy

US$ Billion

Output & revenues from nuclear power plants, 2010-2030

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
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<tr>
<td>OECD</td>
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<tr>
<td>Output from NPPs (TWh)</td>
<td>2 192</td>
<td>2 092</td>
<td>2 228</td>
<td>2 262</td>
<td>2 357</td>
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<tr>
<td>Revenues (US$ billion)</td>
<td>284.4</td>
<td>274.6</td>
<td>290.0</td>
<td>297.0</td>
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<tr>
<td>Output from NPPs (TWh)</td>
<td>436</td>
<td>737</td>
<td>1 005</td>
<td>1 440</td>
<td>1 936</td>
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<tr>
<td>Revenues (US$ billion)</td>
<td>41.2</td>
<td>56.7</td>
<td>82.4</td>
<td>121.4</td>
<td>164.7</td>
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<tr>
<td>World</td>
<td></td>
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<tr>
<td>Output from NPPs (TWh)</td>
<td>2 628</td>
<td>2 829</td>
<td>3 233</td>
<td>3 702</td>
<td>4 293</td>
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<tr>
<td>Revenues (US$ billion)</td>
<td>325.6</td>
<td>331.3</td>
<td>372.4</td>
<td>418.4</td>
<td>481.8</td>
</tr>
</tbody>
</table>

Source: WNA estimates based on Reference case.

• WNA anticipate revenues from nuclear power plants to grow at approx. 2% a year in real terms.
• Capital expenditure at US$ 26 billion a year is 6-8% of annual nuclear revenues or <1% of all annual electricity sales worldwide.
• In general, nuclear investment appears feasible, but ...
3. The Nuclear Supply Chain

All tiers need to qualified to high standards
Components: What is needed

• Typical amounts for a Generation III Nuclear Power Plant:
  • Basemat concrete (6 000 m³)
  • Steel (61 000 t)
  • Forgings (4 000 t)
  • Pumps (~ 200)
  • Valves (5 000+)
  • Piping (~210 km)
  • Cabling (2 000 km+)
  • Welding seams (50 000+)

• Exceptional quality required from ‘nuclear-grade’ components (higher than normal ‘industrial or commercial grade’):
  • Safety-related items – performance testing required
  • Safety-significant items – reasonable assurance of performance required

• Engineering: civil, mechanical, electrical, software
4. Three Industry Challenges

How can nuclear power stay competitive?

• Ensuring that the economics of nuclear power are competitive with other generating sources:
  • Economic challenges

• Developing reliable international supply chains:
  • Capability challenges
  • Quality challenges

• Challenges are inter-related
First-of-a-Kind Premium

The extra cost of a First-of-a-kind (FOAK) plant arises from the following factors:

- **Poor economies of scale**; with multiple orders manufacturers can offer bulk discounts;
- **Additional construction costs** reflecting the ‘learning curve’;
- A risk premium, reflecting the contingency element built into component and plant prices;
- A **profit element** that takes account that there may not be any follow-up orders.

The FOAK premium may account for 10-40 % of the price of the first plant built.

Conclusion: Build a **series of standard plants** that can take advantage of **global supply capacity**.
Addressing the Capability Challenge

Develop the supply base:
• Clarify requirements to create joint understanding, e.g.
  • on safety culture,
  • on quality management, and
  • through the product realization process;
• Facilitate knowledge transfer;
• Build upon the existing capabilities of the workforce.
Addressing the Quality Challenge: Examples from other industries

“Industries where safety and quality are shared goals” (PRI)

- NADCAP – formerly the National Aerospace & Defence Contractors Accreditation Program
- SAE AS-9100 standard for aerospace
- TPG – Transportation & Power Generation Accreditation Program (with GE Transportation)
Addressing the quality challenges: Nuclear Industry Initiatives

- Nuclear Quality Standard Association (NQSA) – established in 2011 by AREVA and Bureau Veritas
  - NSQ-100

- Nuclear Procurement Issues Committee (NUPIC) – established 1989 by US operators
Potential Solutions

Strengthen product realization/ conformity assessment processes along the supply chain:

- **Quality assurance** (QA): focus on an organization’s quality management system (QMS), e.g.
  - IAEA GSR Part 2 (revision of GS-R-3: 2006) requirements on leadership & management for safety – “safety culture”
  - ASME NQA-1: 2008 (links to US Federal Code 10 CFR 50 Appendix B)
- **Quality control** (QC): focus on the product or process of production.
  - Industry consensus on “critical manufacturing processes” (aka “special processes”)
  - Oversight (surveillance) of critical manufacturing processes
  - Advanced product quality planning
  - Reducing non-conformances
  - Learning from each other

VOCS Discussions since January 2013
Next Steps

• Deepen our understanding of the gaps in product realization
• Collaboration with NQSA (Nuclear Quality Standard Association) on developing the NSQ-100 quality management standard
• Pilot audits with suppliers to develop a common consistent audit checklist and guidance linked to NSQ-100
• Scoping out an industry-managed of supplier oversight & quality control:
  • ‘Global NUPIC’?
  • ‘Nuclear NADCAP’?

N.B. The Task Force does not expect ASME NQA-1 standard to be superseded where this is the relevant standard
The World Nuclear Supply Chain – An Overview
Greg Kaser
11 March 2014

Thank you:
Greg KASER
WNA London
kaser@world-nuclear.org
www.world-nuclear.org