Nuclear new build around the globe

Serge Gorlin
Director for Trade and Transport
WNA links with South Africa
World Nuclear Association

200 Members

- Transport, legal, financial, insurance & brokerage companies
- Virtually all uranium mining, conversion, enrichment & fuel fabrication
- Operators generating some 90% of world nuclear power
- Almost all reactor vendors
- Major nuclear engineering, construction & waste management companies
Representation of industry in key international forums

- International Atomic Energy Agency (IAEA)
- Nuclear Energy Agency of the OECD (NEA)
- UN Framework Convention on Climate Change (UNFCCC)
- International Commission on Radiological Protection (ICRP)
Enabling industry contacts and cooperation

• Annual Symposium each September in London

• Joint WNA-NEI World Nuclear Fuel Cycle conference. Rotates between Europe, Asia, and the US.

• WNA Working Groups meet as vehicles for industry cooperation
• Continuing the tradition of the Uranium Institute, WNA remains the expert forum on developments in nuclear fuel and trade

• Biennial market report is an authoritative projection of the global fuel market
In an era of new build, WNA will devote attention to supporting members in building complex international supply chains. Activities envisaged include:

- Determine market potential for key components
- Develop database of leading companies
- Identify ‘pinch points’ in supply
Public Information & News

- 200 Information Papers updated regularly
- A ‘hit’ every 5 seconds round the clock
- Used equally by public and industry
• Free electronic news service
• Timely and concise daily reporting
• Daily distribution: 20,000
Nuclear generating capacity scenarios

• Country-level judgements

• Existing reactors - consideration of operating lives (technical, licensing and policy issues) - also power up-rates

• New reactors - a) under construction

  b) already within planning & licensing

  c) proposed without firm commitment
Nuclear Generating Capacity GWe (2009 WNA Market Report)
Reference Case Capacity
Net GWe

- USA: 101 (today), 122 (2030)
- Canada: 13 (today), 15 (2030)
- Latin America: 4 (today), 10 (2030)
- China: 69 (today), 118 (2030)
- Russia: 22 (today), 46 (2030)
- Europe: 135 (today), 130 (2030)
- E Europe: 13 (today), 20 (2030)
- Other: 45 (today), 6 (2030)

Map showing net GWe capacity by region for today and 2030.
Reasons for renewed interest in nuclear

- Contribution to a country’s energy security of supply
- Improved nuclear economics
- Environmental advantages - particularly low carbon characteristic
- Good safety record since Chernobyl
Energy Security

• Growth in world energy demand. According to WEO 2010:
  - 1.2% annual year increase in primary energy demand 2008-2035
  - 2.2% annual increase in world electricity demand 2008-2035
    • 80% of this is in non-OECD countries
    • China projected to add generating capacity equivalent to current installed capacity of US in next 15 years

• Import dependency

• Widespread and plentiful uranium resources
Improved operating performance of nuclear
US Electricity Production Costs 1995-2008

in 2008 cents per kilowatt-hour

Production Costs = Operations & Maintenance + Fuel. Production costs do not include indirect costs or capital.

Source: Ventyx Velocity Suite, via NEI
World Primary Energy 2030

World Energy Outlook 2009: reference case vs 450 case
Effects of Fukushima

- Accidents at TMI and Chernobyl were followed by weak nuclear growth. Will history repeat itself?
Effects of Fukushima

• In the 1980s
  - Cheap and plentiful fossil fuels
  - BRICS not yet emerged
  - Poor performance of nuclear
  - High construction costs for nuclear (due to overruns)
  - High interest rates
  - Climate change not on the agenda
  - Improvement in urban pollution

• Even under these conditions, France Japan, S. Korea & India press ahead with nuclear programmes
NPP Operating and Under Construction in India

- Rajasthan: 1085 MWe
- Narora: 404 MWe
- Kakrapar: 404 + 1300 MWe
- Tarapur: 1280 MWe
- Kalpakkam: 470 MWe
- Madras: 404 MWe
- Kaiga: 808 MWe
- Kudankulam: 1900 MWe
Nuclear Energy Parks proposed

• Kudankulam, Tamil Nadu, 9200 MWe, VVER
• Jaitapur, Maharashtra, 9600 MWe, EPR
• Mithi Virdi, Gujarat, 6 units, US (AP1000?)
• Kovvada, Andhra Pradesh, 6 ESBWR?
• Haripur, W Bengal, 4-6 VVER-1200
• Kumharia, Haryana, 2800 MWe, 4 PHWR
• Bargi, Madhya Pradesh, 1400 MWe, 2 PHWR
• Markandi, Orissa, 6000 MWe, PWR
Nuclear Industry in Korea – NPP Status

### Operation

<table>
<thead>
<tr>
<th>Type</th>
<th>In Operation</th>
<th>Under Construction</th>
<th>Planning (~2030)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPR1000</td>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>APR1400</td>
<td>0</td>
<td>4</td>
<td>10 ~ 11</td>
</tr>
<tr>
<td>W 14X14</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>W 16X16</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>W 17X17</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>CANDU</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>8</strong></td>
<td><strong>10 ~ 11</strong></td>
</tr>
</tbody>
</table>

### Under Construction

<table>
<thead>
<tr>
<th>Construction (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPR1000 Type</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>
Other countries

- **USA**
  - NRC has inspected all 104 reactors since Fukushima and concluded that all would be safe even in the event of power losses or extensive site damage following extreme events. Short-term prospects for nuclear not good prior to Fukushima, due to price of shale gas, lack of premium on carbon, and anticipated construction costs (2 units under construction)

- **Russia**
  - Will not veer from path of nuclear power expansion, releasing more of oil and gas for export. (10 units under construction)

- **UK**
  - UK Plants safe (according to interim report or regulator). Government has made legally-binding commitment to carbon reduction up to mid-2020s, and sees nuclear as part of the mix. (4 units planned, 1st online from 2018)
Other key countries (negative)

• Germany
  - Coalition government, having ordered a 3-month shutdown of 7 units built 1980 or earlier, has now called for nuclear phase-out by 2022

• Switzerland
  - Cabinet will not allow replacement of 3 units, despite February referendum supporting such a policy. Not yet approved by Parliament

• Japan
  - PM Kan made clear at the G8 meeting in Deauville that Japan will not abandon nuclear, but government will review energy strategy whereby nuclear to provide 41% of electricity by 2017 and 50% by 2030
World Nuclear Generating Capacity - 2011 vs 2009 (provisional - April 2011)
Nuclear Supply Chain Opportunities

- A globalizing market
- Not just new build, but refurbishments and uprates
- High quality expectations, especially for nuclear-grade items.
- Possible life-time for components of 60 years - unparalleled in other industries
- (Heavy) national regulation
- Pinch points in certain areas (notably large forgings)
- Opportunities in Africa?
- WNA Supply Chain Working Group
Major AP1000 Suppliers

- BAE Systems
- Rolls Royce
- Doosan Babcock
- Sandvik SG Tubes
- Sheffield Forgemasters
- RCP Casings Forgings
- KSB - Reactor Coolant Pumps
- ENSA - Steam Gen Reactor Vessel
- Mangiarotti Containment Vessel Reactor Vessel Piping
- Other Nuclear Industrial Centers
  - Czech Republic
  - France
  - Brazil
  - India (post 123)
  - Canada
  - Russia
Demand is not just from new build!

- Replacement parts
  - Steam generators
  - Reactor vessel head
  - Other large components
- Turbine upgrades
- Other refurbishment
What is needed?

• Typical amount per Gen III plant
  - Pumps (~ 200)
  - Valves (5000+)
  - Piping (~210 km)
  - Cabling (2000 km+)

• Split between nuclear-grade and non-nuclear
• Number of qualified suppliers down
An example PWR Schedule

- **V.C Summer (USA) AP1000 schedule**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Delivered</th>
<th>Purchase order</th>
<th>Reserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Vessel</td>
<td>2.5 years</td>
<td>8 years</td>
<td>9+ years</td>
</tr>
<tr>
<td>Steam generators</td>
<td>2.5 years</td>
<td>7.5 years</td>
<td></td>
</tr>
<tr>
<td>Coolant pumps</td>
<td>3.5/2.25 years</td>
<td>7.5 years</td>
<td></td>
</tr>
<tr>
<td>CA20</td>
<td>5 years</td>
<td>7 years</td>
<td></td>
</tr>
<tr>
<td>Turbines</td>
<td>2.5 years</td>
<td>6.5 years</td>
<td></td>
</tr>
</tbody>
</table>
New build in Africa?

- According to a Sept 2010 IAEA report: *International Status and Prospects of Nuclear Power*, there are 21 countries in Africa that are “expressing interest in, considering, or actively planning for nuclear power”.
- Includes: Egypt, Nigeria, Kenya, Algeria and Morocco
- Implementation of economic objectives of the African Union in terms of a free trade area would put RSA in excellent position to exploit that market.
In an era of new build, WNA will devote attention to supporting members in building complex international supply chains. Activities envisaged include:

- Determine market potential for key components
- Develop database of leading companies
- Identify ‘pinch points’ in supply
The case for licensing unification
Cooperation in Reactor Design Evaluation and Licensing (CORDEL)

• Founded in January 2007

• Main aim: promoting international standardization

• Membership:
  – all major vendors
  – utilities interested in new build
  – service companies
  – observers from int’l organisations

**International standardization** means that each vendor’s design can be built by a vendor, and ordered by a utility, in any country without obligatory adaptation to specific national regulations
See www.world-nuclear.org ➔ Publications

2008

Benefits Gained through International Harmonization of Nuclear Safety Standards for Reactor Designs

WNA Discussion Paper

2010

International Standardization of Nuclear Reactor Designs

A Proposal by the World Nuclear Association’s Working Group on Cooperation in Reactor Design Evaluation and Licensing (CONDEL Group)

WNA Report
Standardization as a benefit for safety

- Fleets of standardized designs offer a broad basis for construction and operation experience feedback
- Design improvements could be implemented across the fleet

Standardized advanced plants will bring additional safety layers in all stages: design, construction, operation and decommissioning
Benefits for the industry and regulators

Standardization will

• reduce strains on resources
• reduce investment risks, time and cost in licensing and construction
• foster joint supplier oversight
• enable project neutral manufacturing of components for standardized designs
• improve transparency of regulatory practices
• gain public confidence
• facilitate establishment of nuclear power programmes in emerging countries in the safest and most efficient manner
Harmonization of regulatory regimes

Harmonization of regulation - important for standardization!

- National licensing processes
- Safety requirements
- Applicable standards and codes
CORDEL Roadmap

“Internationalisation” of DESIGN APPROVAL process

- Phase 1. Sharing design reviews and assessments
- Phase 2. Validating and accepting design approvals of other countries
- Phase 3. Issuing international design certification
Phase 1:
Share design assessments/reviews

Regulator A

design review

design approval by regulator A

share

elements of design review, i.e. calculations, modelling of event sequences, etc.

Regulator B

design review

design approval by regulator B
Phase 2: Validate & accept design approvals of other countries

Not “automatic” but through a “validation”.
Examples: transport casks for waste, aviation industry’s Type Certification
Phase 2: Validation and acceptance of design approvals (2)


[Government is empowered to issue] a provision that licences relating to technical requirements and specifications for reactor designs which have been licenced in the past 10 years by the competent authorities in member states of OECD-NEA, or in states linked to Italy by bilateral agreements ... in the nuclear sector, will be considered to be valid in Italy after approval by the Nuclear Safety Agency.
Phase 3: International Design Certification

Team of Regulators: A, B, C
(or, later, International Organisation)

Joint design review

multinational design Approval / Certification

Country A
Country B
Country C
Phase 3: International Design Certification

- Multinational Design Certification/Approval - issued by a team of all concerned regulators or by an international organisation

- Multinational certification is owned by the vendor and is valid for entire design life

- Operator is “intelligent customer”, but vendor is responsible for the detailed design knowledge

- Network of vendors, operators and regulators is required to address post-certification design changes and to maintain the lifetime validity of Multinational Design Certification
CORDEL - commitment from industry

13 April 2010, 12 Leading Nuclear Companies’ CEOs published a letter of support for CORDEL:

- John Ritch, DG, WNA
- Anne Lauvergeon, CEO, Areva
- Hugh MacDiarmid, CEO, AECL
- Henri Proglio, CEO, EDF
- Wulf H Berntotat, CEO, E.On
- Christopher Crane, President & CNO, Exelon
- Jack Fuller, CEO, GE-Hitachi
- Masaharu Hanyu, President, Hitachi-GE
- Akira Sawa, Director, Nuclear Systems, Mitsubishi Heavy Industries
- Ichiro Takekuro, CNO, Tokyo Electric Power Co
- Yashuharu Igarashi, CEO, Power Systems Toshiba
- Aris Candris, CEO, Westinghouse

Recipients:
- Yukiya Amano, DG, IAEA
- André-Claude Lacoste, Chairman, Multinational Design Evaluation Program (MDEP)
- Luis Echávarri, DG, OECD-NEA
- Andrej Stritar, Chairman, ENSREG

cc: Laurent Stricker, Chairman, WANO
CORDEL Action Plan 2010-2011

- Interaction with MDEP & other regulatory initiatives, e.g. in the EU
- IAEA safety standards: continuous participation in revision
- Design Change Management Task Force (TF): develop institutional mechanisms in the industry to enable compliance with standardization throughout standard fleet’s lifetime
- Standards and codes TF: cooperation with SDOs of various countries in convergence of industry codes
- Probabilistic safety goals TF: promotion of harmonization of industry’s methodologies and values
- Licensing and permitting TF: industry interests in better efficiency; also in support of emerging markets (jointly with NLC)
- SMRs TF: encouraging commercial development
Licensing and Permitting Task Force

• A joint initiative with the Nuclear Law and Contracting WG

• Objectives:
  – to provide a unified industry position in the dialogue on new licensing arrangements;
  – to establish new structural arrangements for licensing and permitting of NPPs with requirements for safety and efficiency of new build, particularly in emerging markets.
  – to enhance communication with all stakeholders - regulators, IAEA, OECD-NEA
Licensing and Permitting Survey

• **Membership Survey will seek to identify**
  – The current licensing and permitting processes and nuclear laws in various countries, successful practices and areas for improvement.
  – In order to propose to emerging countries the process fitting best their needs.

• **Two main areas:**
  – Nuclear safety related **Licensing Process**
  – Integration of licensing process with other **Permits**

• **Findings to be published in mid 2012**
Conclusions

• The drivers for nuclear are still strong
• There are opportunities for suppliers to penetrate domestic and international markets
• Harmonization of reactor design requirements is good for safety and economics: however a lot of work still needs to be done
• Industry needs to cooperate on areas of common interest, and maintain a strong safety and economic performance.