The Nuclear Revival: a global industry perspective

Adrian Collings
World Nuclear Association

Workshop on NPP Technology Assessments

IAEA Headquarters Vienna

17-20 November 2008

World Nuclear Association

WNA: Aims and Activities

- **World Nuclear Association**

  - Over 170 members in 40 countries
    (60 members in 16 countries in 2001)

  - Members account for 95% of all front-end fuel cycle production and over 90% of world nuclear generation

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WNA: Aims and Activities

WNA Major Activities (1)

- **Bringing the industry together**
  - Conferences & Symposia
- **Strengthening the industry**
  - Working Groups
- **Developing & advocating industry views & positions**
  - Representation in key international forums

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WNA: Aims and Activities

WNA Major Activities (2)

- **Publishing high-quality materials**
  - Position Statements and other Reports
- **Providing a reliable information source**
  - World Nuclear News (WNN)
  - Web site
- **Strengthening the industry's educational foundations**
  - World Nuclear University

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WNA: Bringing the industry together

Conferences & Symposia

34th Annual WNA Symposium

9-11 September 2009, London

(www.wna-symposium.org)

6th World Nuclear Fuel Cycle 2009

21-24 April 2009, Sydney, Australia

(www.wnfc.info)

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WNA: Strengthening the industry (1)

Working Groups

- **Nuclear Fuel Cycle Plenary Session**
- **Transport of Radioactive materials**
- **Radioactive Waste and Decommissioning**
- **Climate Change and Sustainable Development**
- **Industry Economics**
- ****Cooperation in Reactor Design Evaluation and Licensing ("CORDEL")**
- ****Uranium Stewardship**
- ****'Event Communications'**
- ****Security of the International Fuel Cycle**
- ****Radiological Protection**
- ****Global Strategies**
- ****Capacity Optimisation**

**new since 2001

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WNA: Strengthening the industry (2)

- **Nuclear Fuel Cycle Plenary Session**
  - *Functions as forum for presentations on nuclear fuel and trade issues. Also receives reports from full array of WNA WGs and from sub-groups, including the biennial WNA Market Report.*

- **Global Strategies Group**
  - *Provides "brainstorming" function, advising WNA Board on new initiatives, with particular reference to the requirements of the 'nuclear renaissance'*

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WNA: Strengthening the industry (3)

- **Industry Economics**
  - *Focusing currently on the financing of new NPPs and projections of the full potential role of nuclear power in the 21st century global energy mix*

- **Radiological Protection**
  - *Promotes improvements in the international RP system by advocating scientifically sound policy positions of practical importance for nuclear industry operations; fully engaged in discussions with ICRP on policy revisions and with IAEA on revision of IAEA safety standards*

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WNA: Strengthening the industry (4)

- **Sustainable Development & Climate Change**
  - *Engages with international policy-making bodies (UNFCC; IPCC; CSD) to advance industry positions on SD and CC, both directly and through industry partnerships (ICC; WBCSD)*

- **Waste Management & Decommissioning**
  - *Developments – and presents to IAEA, OECD/NEA and other international bodies – industry views aimed at proposing the adoption by national governments of policies to support the safe management and disposition of of nuclear materials and facilities.*

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WNA: Strengthening the industry (5)

- **Event Communications**
  - *Engaged with the IAEA and WANO to ensure that the International Nuclear Event Scale (INES) is minimally susceptible to misinterpretation. Also developing guidance to help nuclear operators in accurate public communication.*

- **Security of the International Fuel Cycle**
  - *Established to make a constructive industry contribution to the evolving policy debate on the security of the international fuel cycle, and specifically to the IAEA report on "Multilateral Approaches to the Nuclear Fuel Cycle"*

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WNA: Strengthening the industry (6)

- **Transport**
  - *Serves as a forum and coordinator for cooperative action on commercial issues relating to the transport of radioactive materials.*

- **Uranium Stewardship WG**
  - *Is shaping an industry programme to standardize best practice in all phases of the nuclear fuel cycle and to build public trust by credible demonstration of excellent environmental performance.*

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WNA: Strengthening the industry (7)

- **"CORDEL"**
  - *Is working with the OECD's Nuclear Energy Agency, national regulators and the IAEA's Nuclear Safety Standards Committee to examine ways to achieve international harmonization in reactor design licensing requirements.*

- **Capacity Optimisation**
  - *Is surveying all aspects of nuclear power plant management to identify means by which nuclear operators worldwide can increase their collective efficiency by 10 percent in 10 years. If successful, the 10/10 project offers enormous gains both economically and environmentally.*

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WNA – Advocating industry views (1)

Climate Change and Sustainable Development WG

- guidance to WNA Secretariat in coordinating industry representation at UN forums and negotiations on climate change and sustainable development

"CORDEL" WG

- working with the OECD/NEA ("MDEP"), national regulators and IAEA NSSC to examine ways of achieving greater international harmonisation in reactor design licensing requirements

Security of the International Fuel Cycle WG

-coordinates industry responses to IAEA and supplier state initiatives aimed at providing fuel supply assurances while limiting the proliferation of sensitive nuclear technologies

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WNA – Advocating industry views (2)

Radiological Protection WG

-has become the main industry interface with the ICRP and the IAEA's Radiation Safety Committee, in particular preventing an unnecessary ratcheting up of ICRP standards

Event Communication WG

-is working with the IAEA to ensure that the International Nuclear Event Scale (INES), as applied, is susceptible to minimal misinterpretation.

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WNA – Advocating industry views (3)

Waste Management and Decommissioning WG

- develops and presents to the IAEA, OECD/NEA and other international bodies industry views aimed at the promoting the adoption by national governments of policies to support the safe management and disposition of nuclear materials and facilities

Transport

-working in close conjunction with and providing industry input to IAEA Steering Committee on 'Delay and Denial of Shipments'

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WNA – Publishing high-quality materials (1)

WNA publications

- WNA Market Report
- Position Statements
- Other Reports (Industry Economics; Security of the International Fuel Cycle)
- Nuclear English
- Nuclear Energy in the 21st Century

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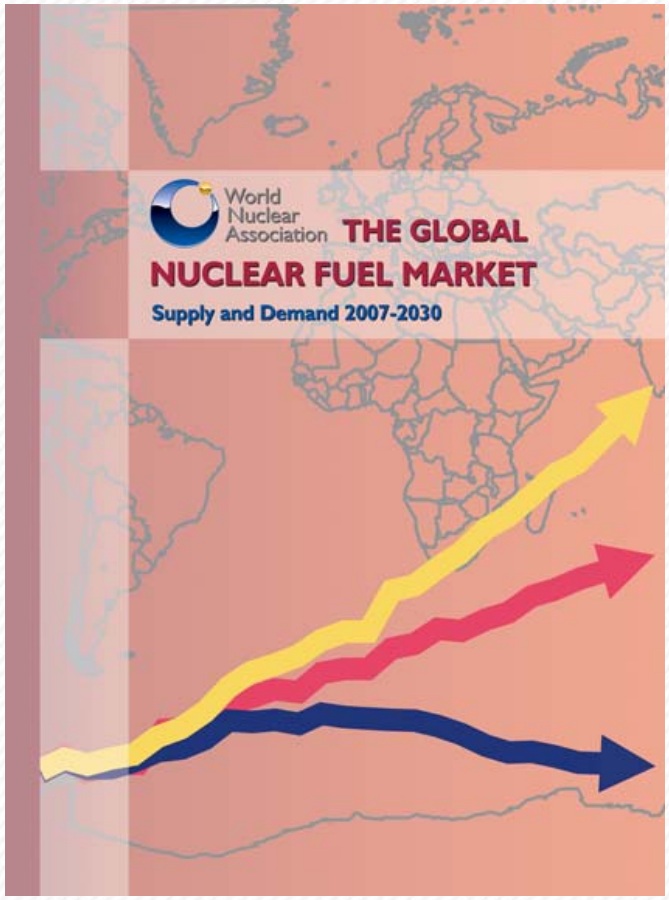
WNA – Publishing high-quality materials (2)

Global Nuclear Fuel Market Report



An industry resource prepared biennially

Supply & Demand

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WNA – Publishing high-quality materials (3)

WNA Position Statements

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WNA –Publishing high-quality materials (4)

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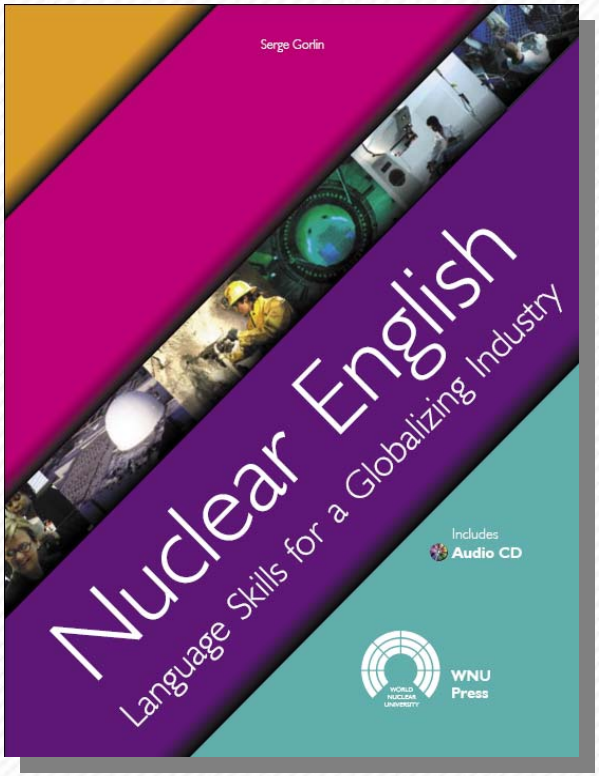
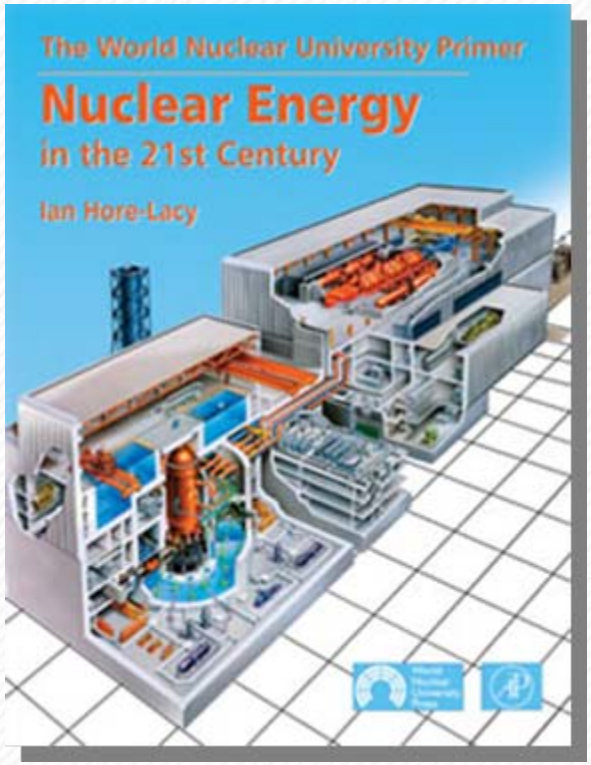
WNA – Publishing high-quality materials (4)





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WNA: Providing a reliable information source (1)

WNA Information Services

- WNA Website
  - Leading information source on the global nuclear industry
  - 100+ 'Information Papers' receive over 2 million hits a year

    (*www.world-nuclear.org*)

- 'World Nuclear News' (WNN)
  - Established January 2007
  - Over 13000 e-mail subscribers……and growing

    (*www.world-nuclear-news.org*)

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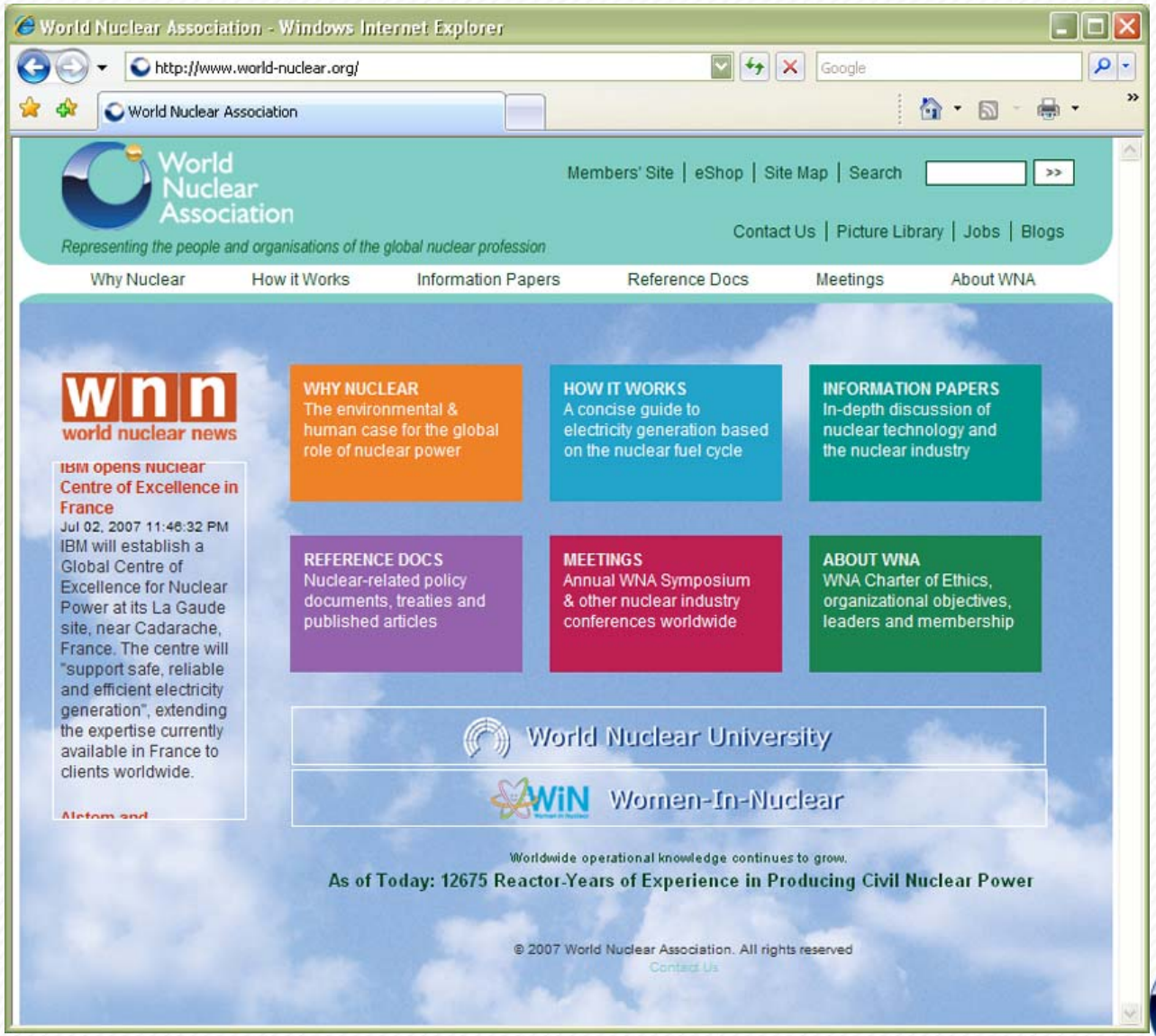
WNA: Providing a reliable information source (2)



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Daily Distribution: 13,000

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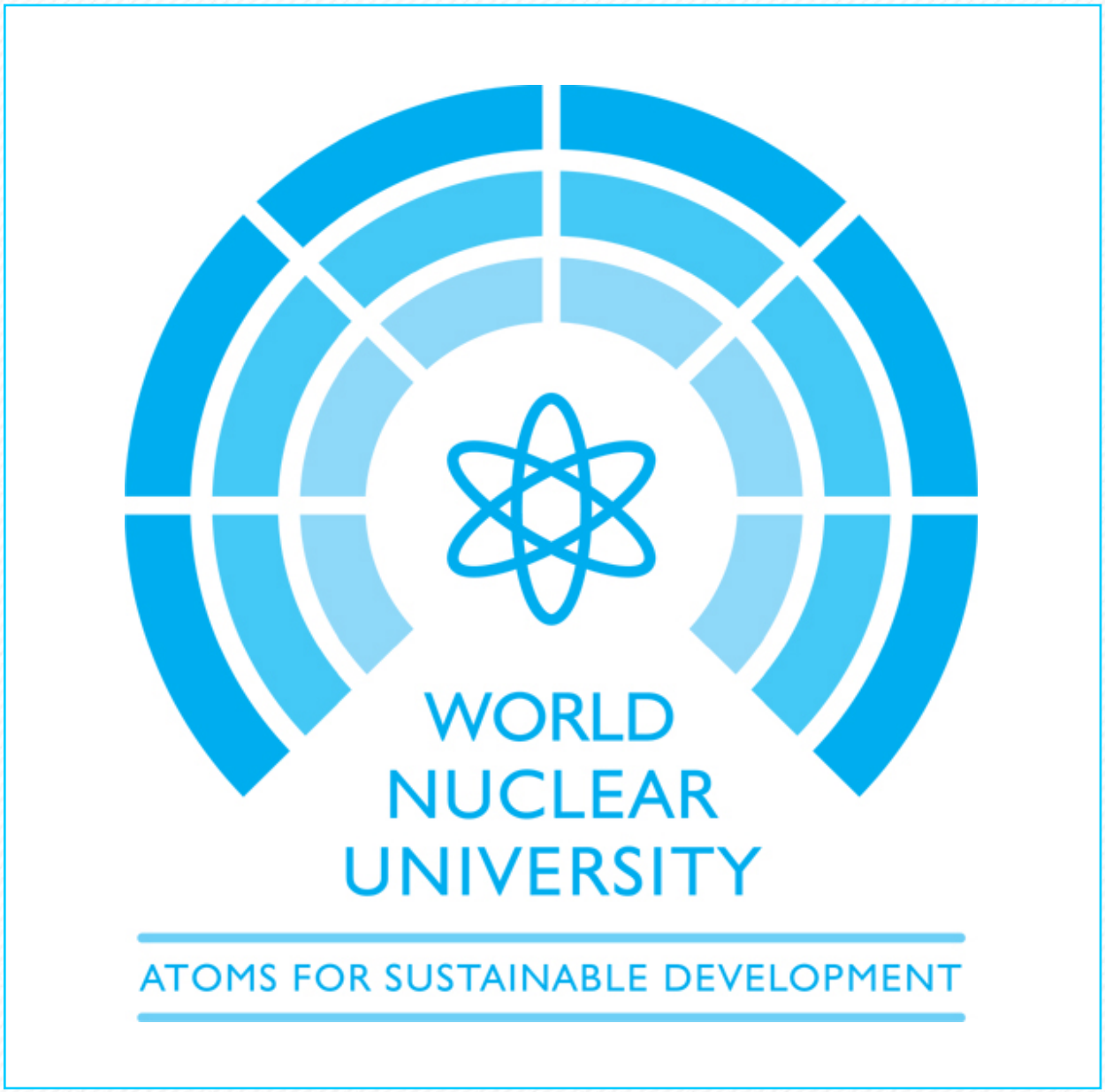

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WNU: A Global Partnership

Founding Supporters:

WNA, IAEA, NEA, WANO

Worldwide Partners:

- Major companies
- Institutions of nuclear learning

Mission:

- Build nuclear leadership
- Strengthen nuclear education

WORLD NUCLEAR UNIVERSITY

ATOMS FOR SUSTAINABLE DEVELOPMENT

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WORLD NUCLEAR UNIVERSITY

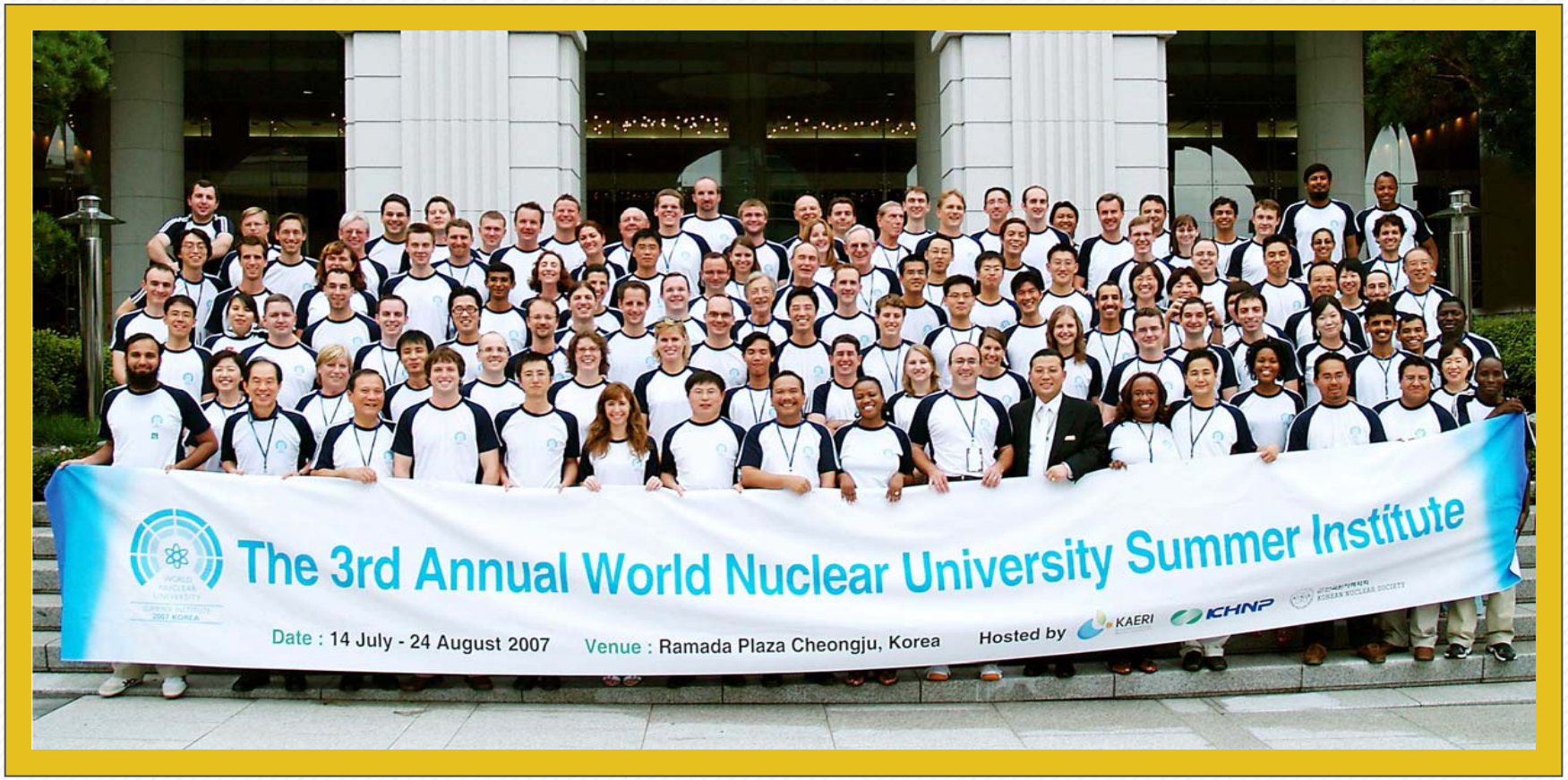
WNU Summer Institute

2005: Idaho, USA

WNU Summer Institute

2006: Sweden & France

WNU Summer Institute



2007: South Korea

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WNU Summer Institute

2008: Ottawa

WNU Summer Institute 2009

WNU One-Week Course

- Designed for industry, government and academia
- An overview of global nuclear regimes (law, safety, non-proliferation) and the global nuclear industry

2007:	China
2008:	Brazil
	Argentina
	South Africa
	Korea
	China
	Turkey

WNA: *Summary (1)*

The WNA's scope of action includes:

(1) Representing the industry vis-a-vis the IAEA, the NEA, the ICRP, and at UN meetings on climate and sustainable development

(2) Supporting a wide range of Working Groups that bring together experts from all over the world

(3) Running the world's most-used information resource on the global nuclear industry: the WNA website

(4) Providing a global nuclear news service (WNN)

(5) Acting as the principal support base for the World Nuclear University partnership (WNN)

(6) Hosting the industry's major global forum for top industry decision-makers, the WNA Symposium, every fall.

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WNA: *Summary (2)*

"For countries planning to cross the threshold to nuclear power, the IAEA will be a valuable, indeed indispensable, advisor in pointing the way. Once a country comes close to building a nuclear power plant, it will, in addition, find advantage in becoming a part of the WNA, whose members are responsible for construction, fuelling, operation and maintenance of the vast majority of the world's nuclear reactors and meet regularly to exchange information and develop best practices."

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The Nuclear Revival: Constraints?

- Sustainability of uranium supplies
- Trained manpower and skills shortages
- Heavy engineering plant availability

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Sustainability of uranium supplies (1)

Benefits of uranium as a fuel

- Virtually emissions-free
- Small volumes of uranium:
  - produce huge amounts of electricity
  - are easily stockpiled, providing major buffer against energy insecurity
  - represent only a small proportion of electricity generation costs, ensuring relative price stability
  - produce a correspondingly small amount of solid waste, which can be safely contained and managed without environmental harm.
- Uranium resources are geographically well spread

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Sustainability of uranium supplies (2)

Uranium: current and future supply

- Current annual requirements: ~67,000 tonnes of uranium
- Present known economic resources (exploitable at <$80 per kg/u) are ~3.5 million tonnes (~50 years' supply)

  (NB ~2.1 million tonnes the years ago)
- Current estimates of all expected uranium supplies (including those not yet economic or accurately quantified) are ~14,000 tonnes (~200 years' supply)

NOTE: Uranium is not scarce in a geological sense: its average abundance in the earth's crust is 2.7 parts-per-million (ppm), which is comparable with, e.g. tin, tungsten and molybdenum.

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Sustainability of uranium supplies (3)

‘Resource expanding factors’

- **Gains in knowledge of the minerals in the Earth and in the technologies used to discover them.**
- **Gains in technology related to mining and processing techniques used to discover mineral deposits**

  (e.g. the development of *in situ* leaching (ISL) techniques now permits low-cost mining of resources previously viewed as economically non-viable)
- **Fluctuations in the economics of minerals**

  (i.e. what will be economic over time in the light of price changes and technological developments)

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Sustainability of uranium supplies (4)

Alternative uranium fuel supplies

- **"Secondary supplies"**

  i.e. from military and civilian stockpiles: since 1985 primary uranium production has filled no more than ~60% of annual requirements of commercially usable fissile material

- **Additional sources of nuclear fuel**
  - **Reprocessing**
  - **Increased enrichment**
  - **Thorium (four times as abundant as uranium)**
  - **Enhanced reactor efficiency (NB GENIV/INPRO)**
  - **Breeder reactors**

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Sustainability of uranium supplies (5)

Conclusions

- **The uranium resource is sustainable, with adequate known resources being continuously replenished at least as fast as they are being used**
- **Depletion of today's known uranium resources will be more than counterbalanced by discoveries from new discoveries, technical progress and possible substitution**
- **The technological step to fast neutron reactors offers an option unique among mineral resources, offering a special kind of insurance against any future uranium resource**

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Trained manpower and skill shortages (1)

Three major problems:

- Retaining existing skills and competences (especially in countries which have not yet decided to replace existing, ageing facilities)
- Developing and retaining skills and competencies in areas such as decommissioning and radwaste management
- Supporting a revival of nuclear power in countries with an ageing workforce and declining programme

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Trained manpower and skill shortages (2)

Why the shortages?

- Fewer young people choosing to study technical subjects, especially in Europe
- Electricity market liberalisation caused utilities to downsize workforces and research facilities
- Decreases in government funding for nuclear research

NB These are NOT purely ‘nuclear’ problems

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Trained manpower and skill shortages (3)

Initiatives across the world

- France: EdF and Areva will source a combined total of 15,500 in 2008; EdF will put 5,000 recruits through an apprentice scheme to replace retiring staff over the next five years
- Russia: The Russian government has established a new National Nuclear Research University and a new National Nuclear Technological University
- USA: Industry has wide-ranging programmes with government and educational institutions to address workforce needs; enrolments in undergraduate nuclear programmes have grown from 470 (1998-99) to 1,933 (2006-07), and graduate enrolments from 220 to 1,153 over the same period

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Trained manpower and skill shortages (4)

Initiatives across the world

- **South Korea: The International Nuclear Safety School has been launched to promote nuclear safety learning and cooperation on a regional and global basis**
- **Vietnam: Hanoi University of Technology has developed a nuclear power plant technology course with the aim of providing skills training for the first nuclear power plant in Vietnam**
- **South Africa: Nuclear Energy Corporation of South Africa (NECSA) has signed an agreement with Areva to ensure that nuclear engineering skills development is extended.**
- **United Kingdom: The government has establishes a National Skills Academy to develop a standardized and coordinated approach to education, training and skills in the nuclear sector**

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Trained manpower and skill shortages (5)

Conclusions

- **Governments, industry and universities in many countries are cooperating to ensure that future supply of technical specialists. But this is only that start of a long and difficult road**
- **Is there scope for more, and better known, international cooperation in this area (IAEA, WNU)?**
- **Need to distinguish between (academic) training and (practical) experience: you can teach the principles of how to operate a nuclear reactor, but you cannot 'teach' 20 years' experience of actually doing it**

NB Nuclear shortages and training are part of a much wider problem covering many other engineering and scientific disciplines

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Heavy engineering plant availability (1)

“Only one company, in Japan, produces ultra-large forgings that are mainly used for reactor pressure vessels, and the company has a three- year backlog. This could inhibit the expansion of nuclear power in the United States and around the world absent new foundries.”

(Nuclear Energy Institute, April 2007)

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Heavy engineering plant availability (2)

Reasons for concern (heavy forgings):

- **Some saw Japan Steel Works as controlling the fate of the global nuclear revival with its 14,000 tonne hydraulic forging presses**
- **JSW's current capacity is reported to be only four reactor vessels per year (but this is set to double)**

BUT

- **237 reactors may be built by 2030 (10+ per year on average), compared with 78 since 1986 (less that four per year)**
- **Do the major reactor vendors see this as a major constraint?**

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Heavy engineering plant availability (3)

Can/will the market respond?

- South Korea: Doosan Heavy Industries is currently investing in a 14,000 tonne forging press
- China: China First Heavy Industries has invested in a 15,000 tonne forging press
- France: Areva is investing in plant in Le Creusot to increase production capacity of forged nuclear components, enabling EPR reactor vessels to be manufactured there
- United Kingdom: Sheffield Forgemasters is currently looking at options for installing a 15,000 tonne press, able to manufacture all heavy components for EPR and AP1000 reactors

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Heavy engineering plant availability (4)

Can/will the market respond?

- Czech Republic: In 2007 the Vitkovice Group reported that it would upgrade heavy nuclear forgings in two years
- Russia: OMZ-Izhora is doubling production of large forgings to be able to manufacture 3-4 pressure vessels per year. This will involve increasing the capacity of its hydraulic press to 15,000 tonnes
- India: Larsen & Toubro is planning capacity for ultra-large forgings and Bharat Heavy Electricals plans to invest $7.5 billion building plants to supply components for reactors up to 1,600MWe

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Heavy engineering plant availability (5)

Conclusions

- **The market can and will respond**

BUT

- **New investment in major forges and similar plant is dependent on actual orders rather than uncommitted plans or vague proposals**
- **The supply challenge is not only to the heavy forgings for RPVs, generators and steam turbines, but extends to other engineered components**
- **As with other generating technologies, supply constraints plus escalating steel and energy prices flow on to plant costs**
- **SUPPLIERS OF NUCLEAR EQUIPMENT MUST BE QUALIFIED AND QUALITY CONTROLLED (ASME N-stamp)**

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Thank you for you attention

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