The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific
and Cultural Organization

International Atomic
Energy Agency

SMR.1769-13

SCHOOL OF NUCLEAR KNOWLEDGE MANAGEMENT

18-22 September 2006

The Need for Nuclear Knowledge

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The need for Nuclear Knowledge

The need for Nuclear Knowledge

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IAEA
International Atomic Energy Agency

Outline

- Status of Nuclear Energy Development
- The Global Energy Imbalance
- The Role of Nuclear Energy
- The three legs of the chair and the need for Nuclear Knowledge
- Concerns
- Activities
- Hopes

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Status of Nuclear Power

- More than 11 000 reactor years of experience
- More than 440 power reactors in operation (installed capacity > 370 GWe)
- Average plant load factor: >80%
- Contributions to global electricity: ~16% in 2004
- Low electricity cost, good safety records
- In 2004/5, new capacity 7529 MWe connected to the grid.
  - South Korea: Ulchin 5 & 6 (2x960 MWe)
  - China: Qinshan 3 (610 MWe)
  - Japan: Hamaoka 5 (1380 MWe)
  - Ukraine: Khmelnitsky 2 & Rovno (2x950 MWe)
  - Russian Federation: Kalinin 3 (950 MWe)
  - Canada: Bruce 3 (769 MWe) restarted
- Shift in national energy strategies

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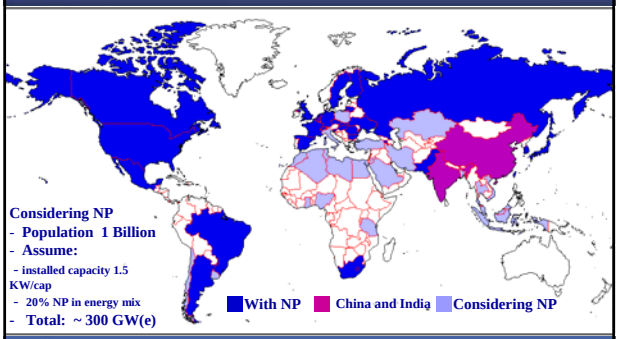
The Nuclear Power Map



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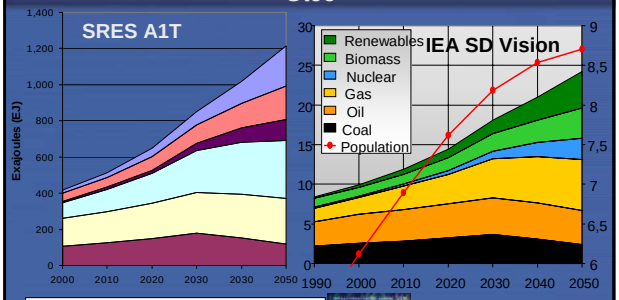
Sustainable Development Vision Scenario

Gtoe



Source IEA : Energy to 2050 - Scenarios for a Sustainable Future

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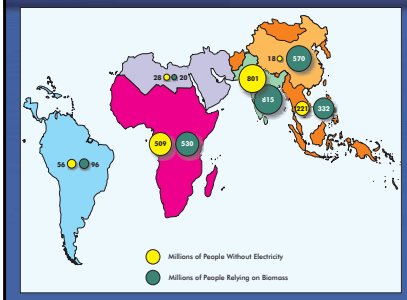
Map of Global Energy Poverty



1.6 billion people have no access to electricity, 80% of them in South Asia and sub-Saharan Africa

By 2030 (IAE):

GDP annual growth 3.2 %,

Electricity use 2,5 %,

New 4800 GW(e),

Investment 10 T$,

Expressed interest in NP

Paris (2005):

Bangladesh, Egypt, Iran, Indonesia, Morocco, Poland, Turkey, Vietnam

GC,Vienna (Sept. 2005)

Algeria, Ghana, Nigeria, Malaysia, Tunisia, Tanzania, Thailand, Uruguay, Chile,

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Growing expectations in NP: developed and developing countries.

Developed countries:

- Modest increase in use/capita
- Non-power application: transport(H_2)
- Market and deregulation (investment return, renewable, waste)
- Public acceptance, climate change factors

Developing countries:

- Multiple increase in use /capita, living standards
- Industrial development
- Non-power application: water, heat
- Infrastructure

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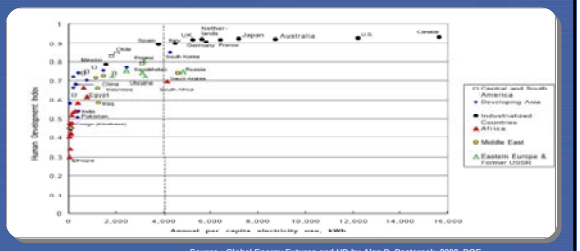
World Energy Demand : *More Energy, Better Life*

UN's HDI (Human Development Index) and Electricity Use



Source : Global Energy Futures and HD by Alan D. Pasternak, 2000. DOE.

- HDI based on three indicators : life time, educational level, GDP
  - Above 5000kWh, no country has an HDI below 0.9.
  - Below 4000kWh, no country above 0.9.

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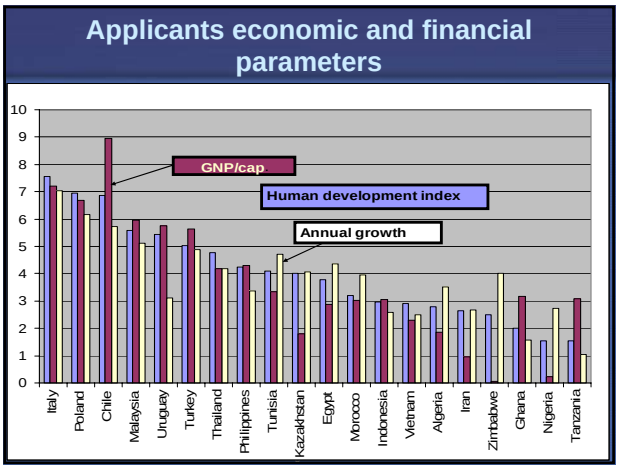

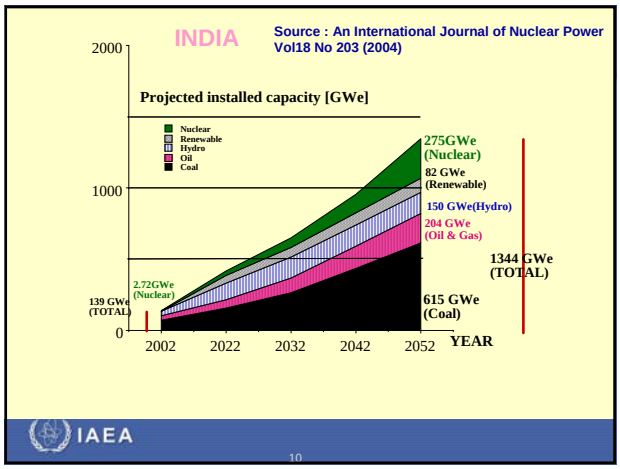

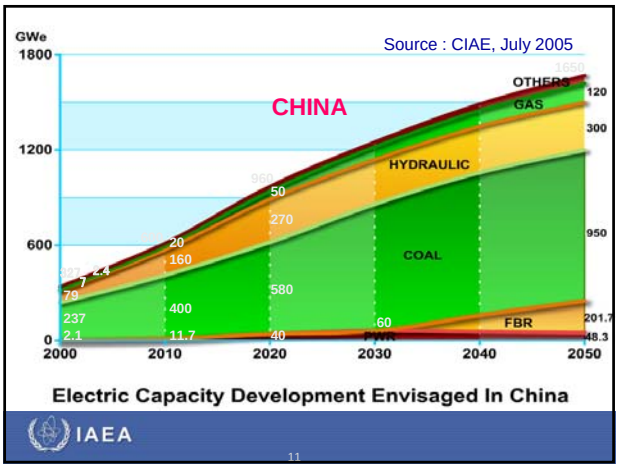

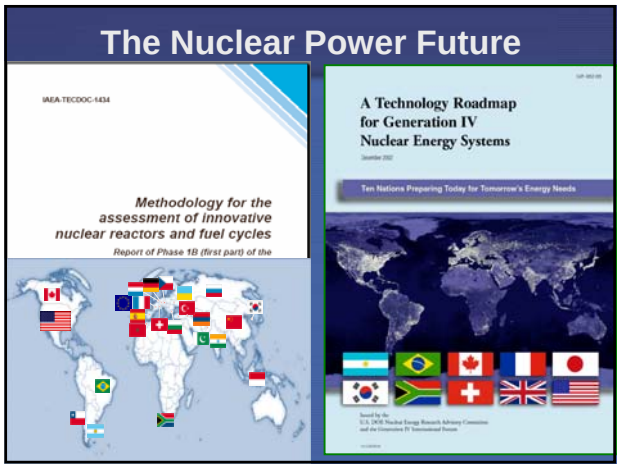

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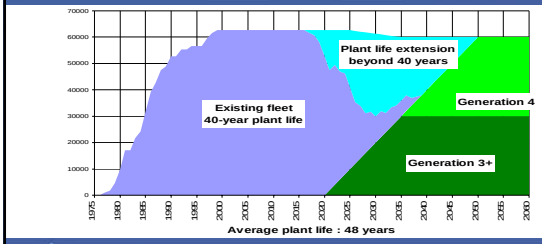
Nuclear Power Technology Forecast

- Live extension of present PWRs
- Replaced by EPR by 2020 and Gen IV fast reactors by 2035-2040.
- A transition phase between present reactors and 4th generation systems.



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Source : EDF, ENC 2002

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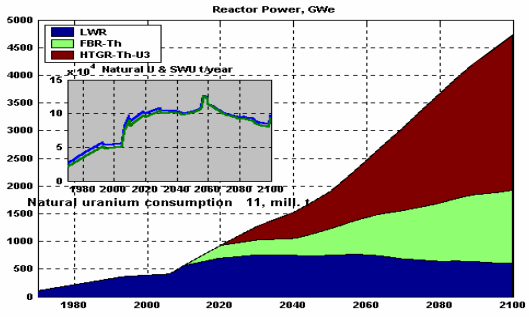
Nuclear Power Resource Forecast



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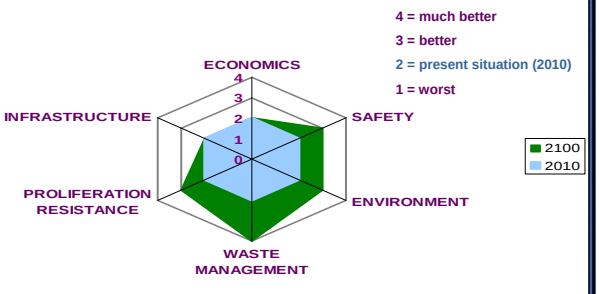
The Nuclear Power Challenges



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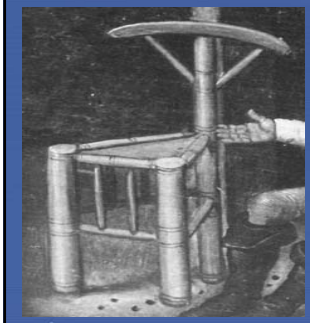
The 3 legs of the chair..



- Public interest
- Responsible use of nuclear technology
- Sustainable nuclear knowledge and expertise

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Concerns

- Aging of personnel, retirement
- Loss of knowledge,
- Degradation in technology skills and know-how
- Degradation in Safety of current installation
- Dilution or loss of innovation potential

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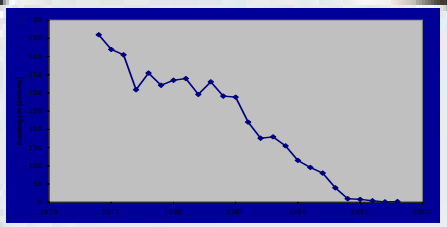
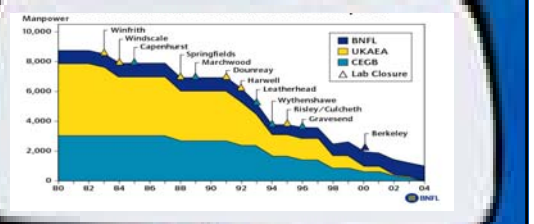
A look in the rear view mirror……
Decline in UK Public Fission R&D Funding

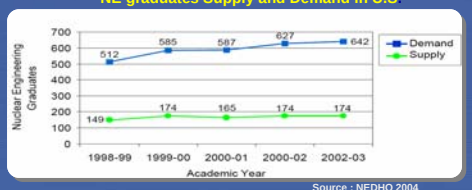


A look in the rear view mirror……
Decline in UK R&D Manpower in Industry



HRD : *Deficiency of NE Graduates*

NE graduates Supply and Demand in U.S



Source : NEDHO 2004

- Demand prediction – Survey result of 52 percent of 176 U.S. companies
- Supply prediction - Survey result of 28 U.S. universities
- ¼ Supply/Demand (S/D) deficiency in U.S.
  - It looks like the Janus Face

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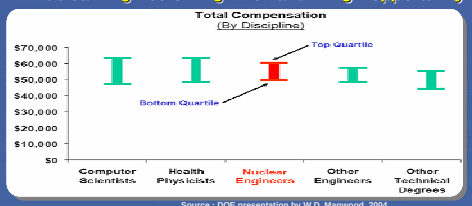
HRD : *The Janus Face of S/D Deficiency*

Nuclear Engineers : High Demand = High Opportunity



Source : DOE presentation by W.D. Magwood, 2004

- Despite of more job opportunity with high salary, the supply is continuously decreased due to the closing or merging of NE departments in universities.
- To enhance employment of the student, it is needed to encourage universities and graduate school

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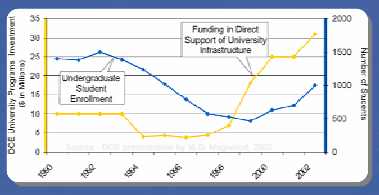
HRD : *Long-term Investment*

Trends in Enrollments vs. DOE University Program Investment



- A unique solution of S/D deficiency is dependant on the long-term investment to NE
- How ? When ? Where ? Amount ?
  - *The Yoyo Syndrome and Long Winter in four season Model by B.J. Chung*

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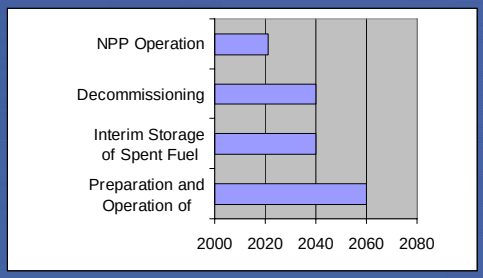
Needed Expertise in Germany



Source: Fritz, FZK, 2002.

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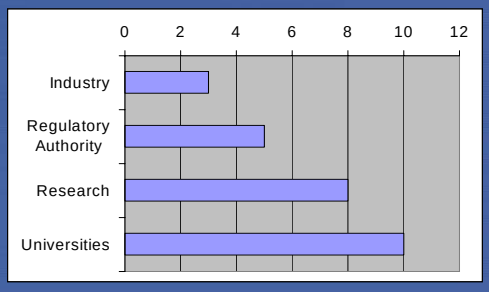
Time to built expertise



Source: Fritz, FZK, 2002/Griffiths, NEA News, 2002.

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HRD : *Highlight Issues*

- Nuclear Energy Faces Significant Human Resources Issues
  - Ageing of the 1st generation experts
  - Massive retirement within next years
  - Decreasing student supply and reducing nuclear program
  - Deficiency of human resource to replace the current workforce

Source : IYNC 2004 presentation by B.J. Chung
& OECD NEA, 2001 Nuclear Education & Training : Cause for Concern

Employment Crisis vs. **High Job Opportunities**

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How urgent is Nuclear KM?

- Unless action is taken now, invaluable assets in critical nuclear knowledge and capacity will soon be lost.
- The need to sustain the present level of deployment of nuclear technology (energy and non-energy alike) requires urgent action throughout the nuclear community and beyond.

IAEA Meeting of Senior Officials , June 2002

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The Role of the IAEA

IAEA has an obligation to lead activities towards preservation and enhancement of nuclear knowledge by complementing, and as appropriate supplementing, activities by governments, industry, academia and international organizations.

- The Agency, in particular, should use its potential in assisting Member States to ensure the preservation of viable nuclear education and training which is a necessary prerequisite for succession planning.

IAEA Meeting of Senior Officials , June 2002

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The need for Nuclear Knowledge

IAEA Objectives

- To increase awareness in Member States,
- To provide methodology and guidance,
- To support nuclear education and training,
- To implement special projects, provide services and support to nuclear knowledge management initiatives.

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Activities

A substantial area of Agency activity involves assisting Member States:

-capacity building,
-human resources development,
-support to educational programmes,
-hands on training,
-knowledge transfer,

in ways best suited to their desired uses of nuclear technology.

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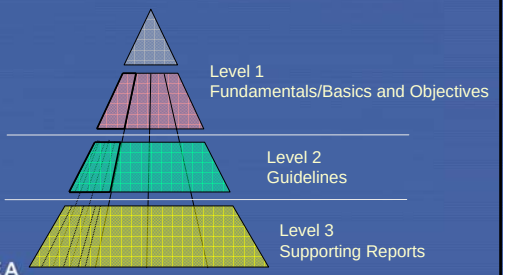
IAEA Nuclear Energy Knowledge Base

A new system of Agency Technical Support Documents

NUCLEAR ENERGY SERRIES / NES



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Agency's Nuclear Safety Knowledge

- **Embedded in the IAEA Safety Standards**

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The need for Nuclear Knowledge

Current activities of the KM Programme

- Developing Policy and Guidance for Nuclear Knowledge Management
  Knowledge Management in Nuclear Power Plants, Knowledge Loss Risk Management methodology,etc
- Networking Nuclear Education
  WNU, ANENT,ENEN,UNENE,IUSS, etc.
- Pilot Projects in critical areas -
  Fast Reactor KP initiative, GCR,Chernobyl Knowledge Preservation, others.

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Asian Network for Education in Nuclear Technology (ANENT)

- ANENT (URL: www.anent-iaea.org)

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What is ANENT?

- The ANENT was launched in February 2004.
- The ANENT has 28 member institutions from 12 countries, and 4 collaborating organizations.

Australia, China, India, Indonesia, Korea, Malaysia
Mongolia, Pakistan, The Philippines, Sri Lanka, Thailand, Vietnam
ARCCNM, ASNM, ENEN, WNU

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Progress of the ANENT

- **ANENT Web-portal is developed.**
  (URL: www.anent-iaea.org)
  - A database provides data on curricula from ANENT member institutions;
  - "Activities" support each ANENT group activities;
  - A cyber platform supports various types of web-based learning;
  - The other functions facilitate information exchange.

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A joint initiative of IAEA, ICTP and WNU

Trieste Summer School for Nuclear Knowledge Management

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The World Nuclear University

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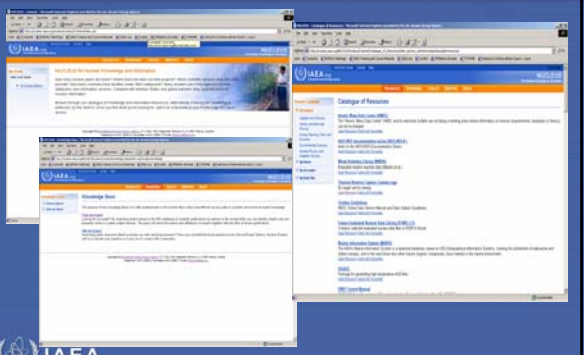
The new Agency "Nucleus" portal



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Future plans

- Continue to maintain the nuclear knowledge base,
- Complete the nuclear knowledge management methodologies, tools and practices and make them widely available.
- Initiate knowledge preservation projects in important areas,
- Provide support to educational networks,
- Cooperate with Industry (WANO, WNA) on assessing and managing "knowledge loss risks".

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