Global Trends in Nuclear Power and Fuel Cycle and IAEA Activities

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Global trends in nuclear power and fuel cycle

IAEA’s role and activities

Summary
1. Current worldwide nuclear generating capacity
   - Commercial NPPs in Operation: 435 (367.8 GWe)
   - Share of electricity: 16%

2. Slowdown of capacity addition since late 80’s
   - Electricity market deregulation
   - Slow growth of electricity demand in advanced countries
   - Public Perception
   - Economic reforms in Russia and Eastern Europe

3. Current expansion mainly in Asia

Global Trends in Nuclear Power & Fuel Cycle - Installed generating capacity -
Global Trends in Nuclear Power & Fuel Cycle - Operation -

4. Nuclear electricity increase by 40% (1990-2005)

Contributions to nuclear production growth

- Uprating: 7%
- Capacity: 36%
- Availability: 57%

Capacity factor improvement by:
- Best practice prevailing
- Consolidation to those who perform best
- Risk-informed regulation

IAEA
5. Long-term operation and power uprating

- Long term operation through continuous monitoring, replacement and regulatory review

Age distribution (327/435 over or equal to 20 years)
Transition scenario from current fleet of LWR to Gen-IV
- Case of France : CEA proposal -

Global Trends in Nuclear Power & Fuel Cycle -
- To the future -
Global Trends in Nuclear Power & Fuel Cycle
- To the future -

7. New initiatives proposed
✓ MNA (M. ElBaradei)
✓ Global Nuclear Energy Partnership (GNEP) (USA)
✓ President Putin’s initiative to develop a Global Nuclear Power Infrastructure (GNPI) (Russia)

8. Rising expectations for the role of nuclear power

IAEA
Increasing Nr. of countries considering introduction of nuclear power

Population of the countries Considering NP=1 Billion

IAEA

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Global trends in nuclear power and fuel cycle

IAEA’s role and activities

Summary
IAEA’s role

1) To ensure protection: that, wherever nuclear energy is used to produce energy, it is used:
   • Safely, Securely, and
   • With minimal proliferation risk.

2) To ensure continued technological innovation to improve its attributes in safety, security, economics, proliferation-resistance, environment and waste

3) To ensure that the needs of developing countries are taken into account:
Activities by the Department of Nuclear Energy

Mission
1) Support to existing Nuclear Power for excellence & to new countries for infrastructure development
2) Catalyse innovation for sustainable development
3) Build national capability

Activities
- Develop methodology
- Information sharing
- Coordinated research
- Technology transfer
- Review services
1. Knowledge Management

- Issues Member States face:
  - Sustaining existing knowledge for the continued safe operation of existing nuclear installations
  - Human resources development in new countries
  - Preservation of knowledge before it degrades or is lost

- IAEA activities in:
  - Methodology and guidance
  - Educational networks
  - Knowledge preservation
2. Uranium resources

After 2 decades of very low U price, price tripled in the last 2 years; make up by inventory drawdown is very uncertain

• Support to new Uranium exploration activities
• Support training for Uranium exploration & other activities
• Sharing information through meetings & databases
  “Red book” with OECD/NEA

Inventory drawdown since 1990
Uranium resources (“red book”)

- “Uranium 2005” by OECD/NEA and IAEA
  - Total identified: 4.7 Million Ton (<USD130/Kg U)
  - Total undiscovered (Prognosticated & speculative): 10 Million Ton (<USD130/Kg U)

- Current consumption
  - = 68,000 Ton/year for 360GWe
    - Resource/Consumption with margin
    - Closed fuel cycle using FR further extends this margin

R/P (total conventional)
- LWR: 270 years
- Fast Reactor: 8000 - 16000 years

R/P (conventional & phosphate)
- 675 years
- 20,000~40,000 years

Source: Uranium 2005
NTR2007
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3. Support for building infrastructure

- Infrastructure is a key to successful introduction/expansion of nuclear power, including legal and regulatory framework, human resources, and industrial background.

- Guidance for the introduction of nuclear power and for development of infrastructure:
  - Numerous guidance documents
  - Filling in gaps & updating guidelines
  - Milestones document & its implementation (self-assessment and review by international experts)
  - Encouraging regional approach for efficiency

- Institutional issues (Assurance of supply, Financing, Licensing)
4. Energy Indicator for Sustainable Development (EISD)

Many attributes of nuclear energy have potential to contribute to improve indicators of sustainable development

* “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, Brundtland, Our Common Future, 1987

Potential to improve EISD of a nation by having NE in the energy portfolio

29 EISD indicators:

- Society (4), Economy (15), Environment (10)

- Usable to
  - Analyze past trends and current situation
  - Measure distance to target
  - Formulate strategy

IAEA
5. Stimulating innovation

- DG statement at 50th GC, 2006

“Technological and institutional innovation is a key factor in ensuring the long-term sustainability of nuclear power”
Three directions of current INPRO activities

1. Methodology improvement
Methodologies/Indicators
- assessment of different systems and scenarios
- screening of reactor and fuel cycle system

2. Institutional/Infrastructure

3. Collaborative Project

IAEA
Summary
Summary

1. Rising expectations for the role of nuclear power after 20 years of stagnation

2. The mission of NE, as one of the Agency’s three pillars:
   - Support Member States’ safe, reliable operation in a technically sound manner & infrastructure building for introduction/expansion of Nuclear Power
   - Catalyze innovation, and
   - Support Member States’ capacity building and knowledge management
IAEA’s role

Statute article II: Objectives

- The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.
Uranium mining and milling

- Agency’s support
  - Identification of uranium deposits
  - Training for exploration activities
  - Best practices in mining and milling
  - Environmental effects of mining and milling
  - Closing of mining and milling facilities
  - Environmental restoration of old mines

- Past experiences of MSs support
  - China, Pakistan, Argentina - Exploration and prospecting techniques
  - Egypt – Uranium resources development
  - Romania – Restructuring of the uranium mining industry
## EISD in “Society” dimension

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<tr>
<td>Use and production patterns</td>
<td>Overall Use</td>
<td>ECO1 Energy use per capita</td>
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<td>Overall Productivity</td>
<td>ECO2 Energy use per unit of GDP</td>
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<td>Supply efficiency</td>
<td>ECO3 Efficiency of energy conversion &amp; distribution</td>
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<td>Production</td>
<td>ECO4 Reserves to production ratio</td>
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<td>ECO5 Resources to production ratio</td>
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<td>End-use productivity</td>
<td>ECO6 Industrial energy intensities</td>
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<td>ECO12 Renewable energy share in energy and electricity</td>
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<td>Prices</td>
<td>ECO13 End use energy Prices by fuel and by sector</td>
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<td>Security</td>
<td>Imports</td>
<td>ECO14 Net energy import dependency</td>
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<td>Stocks</td>
<td>ECO15 Stocks of critical fuels per corresponding fuel consumption</td>
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The impact of the emission trading on the electricity generation cost (Prof. Voß, Univ. of Stuttgart)

[Source] Burgherr & Hirschberg, 2004
CO2 emission rates from electricity generation

CCS: Carbon Capture & Storage