Dialogue Forum 11

UN Concept of Sustainable Development and Sustainability of Nuclear Energy Systems

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Strategic Nuclear Energy Planning: Beginning with the End in Mind

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- Top-level national policy decisions, supporting nuclear power program, are *often focussed on nearer term progress and goals*
- A single modern NPP represents *nearly a century of commitment* from initial decision to full decommissioning
- Disposition of spent fuel and waste is institutionally complex and *commitments can span much more than a century*
- Near-term deployment of a first NPP implies *a long-term context* that typically involves further deployments: *strategic nuclear energy planning can help rationalise overall program direction.*

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Nuclear Energy System (NES) Strategic Planning: 3 linked Parts

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Sustainability questions

National Energy Planning: How does ***nuclear energy*** fit into the national energy mix?

Nuclear Energy System (NES) modelling and the 'GAINS Framework': How do we get ***there*** from ***here***?

Nuclear Energy System Assessment (NESA): INPRO Methodology of sustainability assessment What are the ***gaps***?

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Services and Training Offered for Energy Planning

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- Among other services, PESS offers training on broad energy planning that can help define the role of nuclear energy in the national energy mix.
- PESS will cover the contents of this service in the next presentation.

Services and Training Offered for NES Sustainability/Strategic Planning Tools

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- INPRO offers training on nuclear energy system (NES) strategic planning tools:
  - NES Assessment (NESA) using the INPRO Methodology helps develop a more detailed technical perspective of actions needed to improve sustainability – a "gap" assessment
  - NES Scenario Modelling and Key Indicator evaluation and analysis helps develop a big picture view of NES strategy and outcomes

IAEA-NE Sustainability Concept
INPRO Methodology

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Derived from UN sustainable development concept (Brundtland Commission, 1987*):

> "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Definition implies a three-part test of any approach to sustainability and sustainable energy development:

1. current development should be fit to the purpose of current needs,
2. current RD&D programmes should maintain trends that lead to technological and institutional developments that serve as a platform to meet future needs, and
3. the approach to meeting current needs should not compromise the ability to meet future needs.

* See: http://www.un-documents.net/ocf-02.htm#I

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Brundtland Report – Seven Key Sustainability Issues

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Seven key issues were discussed in the Brundtland Report on sustainability of nuclear energy systems (in this order):

- *Proliferation risks* (2nd largest discussion on this issue)
- Economics
- *Human health and environment risks*
- *Nuclear accident risks* (largest discussion on this issue)
- *radioactive waste disposal*
- Sufficiency of national and international institutions
- Public acceptability

Among energy technologies, the set of unique nuclear energy sustainability issues are radiation protection, radioactive waste disposal and nonproliferation.

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See: http://www.un-documents.net/ocf-07.htm#III

INPRO Interpretation of Brundtland Commission – Nuclear Sustainability

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To measure NES sustainability, the 7 key issues are interpreted by INPRO Methodology as 6 areas and an additional 7th area was added by INPRO:

- *Proliferation resistance*
- Economics
- *Environmental stressors*
- *Nuclear safety (reactor and fuel cycle)*
- *radioactive waste disposal*
- Infrastructure (institutions – covers nuclear security)
- Resource depletion – added by INPRO

INPRO Methodology interprets public acceptability to be a representative proxy measure in several of the areas above. Large physical infrastructure is often sensitive to public acceptance to maintain legitimacy

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INPRO Interpretation of Brundtland Commission – **Examples**

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INPRO Methodology interpretation of Brundtland sustainability:

- Economics, NES should be:
  - Competitive on cost with comparable sources of energy
  - Affordable and financeable
  - An acceptable investment risk
- Interpretation:
  - Competitive with comparable sources* measures fitness to current need
  - Affordability and acceptable investment risk, implies that it does not impose an unacceptable burden on the current economy, minimizing "overhangs" that could compromise making future investments

* Competitive cost presumes captured externalities (emissions, etc.) and comparable sources are dispatchable (thermal plants and hydro)

INPRO Interpretation of Brundtland Commission – Examples

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INPRO Methodology interpretation of Brundtland sustainability:

- Safety of reactor:
  - Safety issues that have large deleterious impacts on public acceptability should be practically eliminated by design (e.g., core melt, LER requiring evacuations and lengthy dislocation of public)
  - Lower lifecycle risk* to the public than other comparable sources of energy (e.g., dispatchable power supplies)
  - Superior safety performance compared to a reference plant design
  - Continuous improvement in safety by design affected through R&D programme

* Lifecycle risk to the public should include all known sources: emissions related (including climate change), occupational and other hazards, etc.

INPRO Interpretation of Brundtland Commission – Examples

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INPRO Methodology interpretation of Brundtland sustainability:

- Interpretation:
  - Ultimate public acceptability is a proxy measurement of meeting current needs – practical elimination (by design) of severe accidents, particularly those that require lengthy dislocations of the public, are essential to maintain public acceptance
  - Lower lifecycle risk than comparable energy sources – implies that nuclear power more benign to meet current needs than available alternatives
  - Demonstration of progress in deployed technology builds public confidence that current and immediate future needs can be met
  - Safety by design R&D programme sends a public message that safety will continue to be a central design issue, building confidence that future needs will be met

Nuclear Energy System Scenario Analysis – Paths to a Sustainable Future

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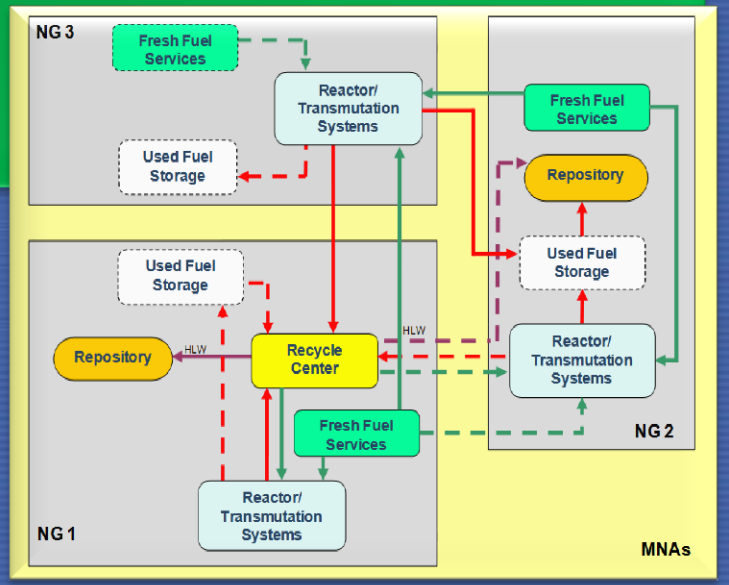
Today

- Reactors
  - water cooled – modest thermal efficiency
  - Large units
- Fuel resource
  - Natural/enriched U – limited natural resource
  - Limited U/Pu mono recycle – MOX
- Most SNF is stored and accumulating
- HL waste and direct SNF disposal
  - National repository development programmes
- Most trade in reactor and front end services

The Future?

- Reactors
  - Water, gas, metal and salt cooled, double the range of thermal efficiencies
  - Large and small modular units
- Fuel resource
  - Diverse and indefinite supply
  - U, U/Pu, Th/U-233
- SNF inventory in equilibrium with reactor fleet capacity
- HL waste and limited direct SNF disposal
  - National and regional repositories in operation
  - MA incinerated and disposed
- Trade distributed more uniformly across sectors improves economics

Developing system analysis and assessment tools to evaluate cooperative strategic paths to a sustainable future…



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…Thank you for your attention

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