

INPRO Dialog Forum DF-8
26-29 August 2014

Overview of the Revised INPRO Methodology

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IAEA

International Atomic Energy Agency

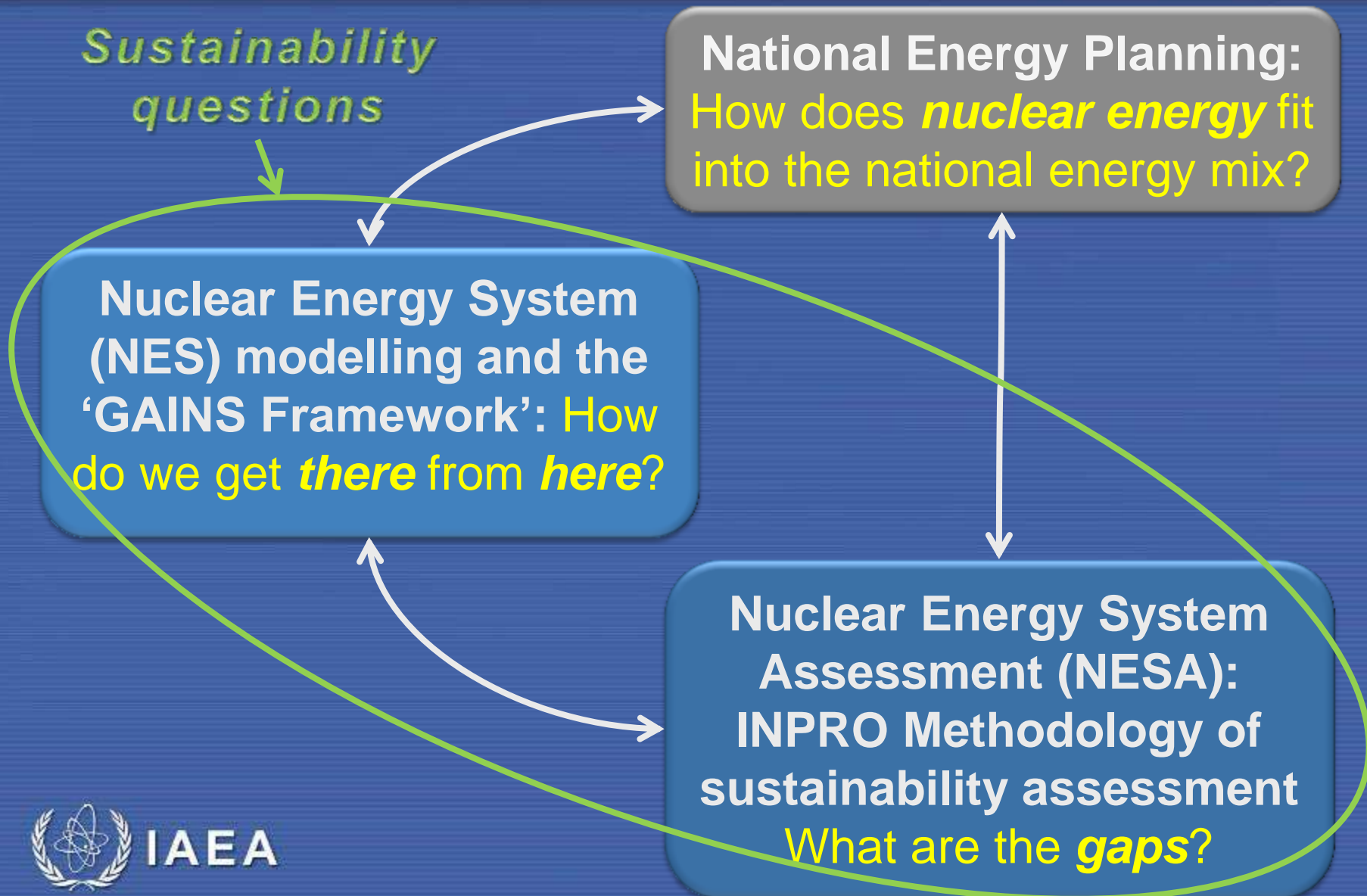
- Introduction – INPRO Methodology and strategic energy planning context
- INPRO Methodology: a metric of sustainability of nuclear energy system (NES)
- History and contents of the Methodology
- Experience with NESAs
- Track 1 Revision of INPRO Methodology
- Status of effort

Strategic Nuclear Energy Planning: Beginning with the End in Mind



- 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 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.***

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



Services and Training Offered for Energy and NES Strategic Planning Tools



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- PESS offers training on broad energy planning that can help define the role of nuclear energy in the national energy mix.
- In coordination with PESS, INPRO offers training on nuclear energy system (NES) strategic planning tools:
 - ✓ NES Assessment (NESA) using the INPRO Methodology helps develop a detailed technical perspective of actions needed to improve sustainability
 - NES Scenario Modelling and Key Indicator assessment helps develop a big picture view of NES strategy and outcomes
- *Some IAEA codes disseminated to MS for energy economics and NES strategic planning: MESSAGE, NFCSS, DESAE, NEST...*

Nuclear Energy Systems – 6 Key Sustainability Issues



To measure NES sustainability, metrics covering 6 key issues are assessed:

- Public and occupational **safety** – *i.e. radiation protection*
- **Environmental impact**
- High level and long-lived **radioactive waste disposal**
- National and international **security** – *proliferation in particular*
- **Affordability** and competitiveness
- **Resource depletion**

Of the above issues, only resource depletion was not listed in the discussion on nuclear sustainable development in the Brundtland Commission Report (1987)

IAEA-NE Sustainability Metrics – INPRO Methodology



- Originally derived from **UN Sustainable Development Concept** (Brundtland Commission, 1987)
- Sustainability measured in a given time frame – **within the present century**
- **Sustainability assessment – *not analysis***
- Types of INPRO sustainability criteria:
 - **Progress** toward improved metric within a technology lineage
 - **Comparative performance** on a metric with respect to technology used for similar purpose (e.g., coal, natural gas)
 - Forward-looking **target value** of a metric
 - **Proper scale** to fit the purpose
 - **Yes or no** answers on requirements and good practices

History of INPRO Methodology



- **2000:** International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) launched by IAEA General Conference resolution (GC(44)/RES/21);
- **2001 – 2006:** Development of the Methodology as a tool for Nuclear Energy System Assessment (NESA):
 - Contribution by 150 experts (29 countries);
 - Contribution by 50 IAEA staff: **NENP, NEFW, PESS, OLA, NS, NA, NSNS, SG**
 - Total effort for development: **~40 person years**
- **2004 – 2008:** Six national and one multinational NESA leading to several collaborative projects;
- **2008:** TECDOC 1575 rev. 1, vols. 1-9, published – **current version**
- **2010 – 2011:** NESA in Belarus;
- **2011 –** : NESA in Ukraine, Indonesia, Romania, Kazakhstan.

History...

7 key issues that influence sustainability of nuclear power:

Safety

Cost

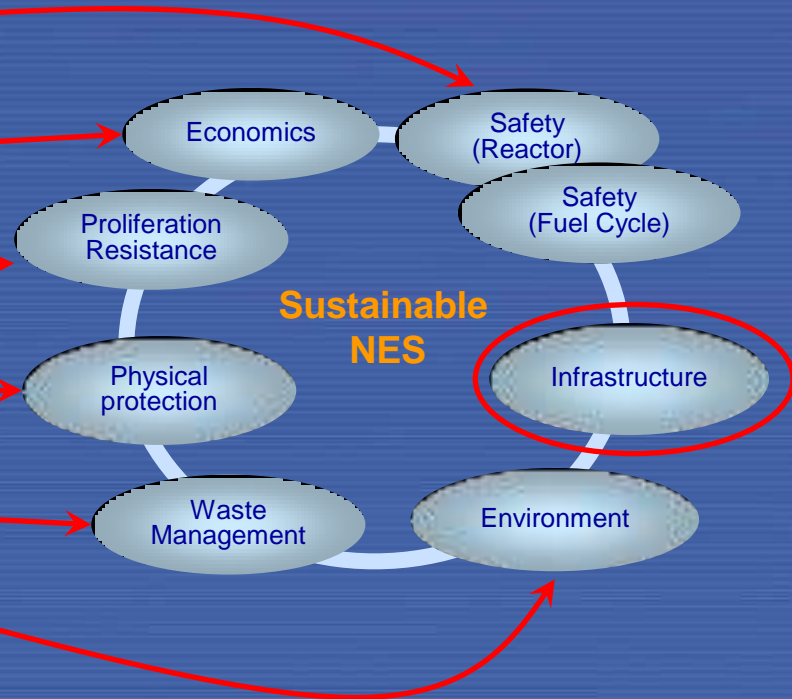
Proliferation

Security – including sabotage

Waste

Environment and Resources

Existing INPRO Methodology assessment manuals:



Architecture of INPRO Methodology



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Basic Principles: Goals for development of sustainable NES.



User Requirements: What should be done by designer, operator, industry and State to meet goal defined in Basic Principle.



Criteria: Assessor's tools to check whether a User Requirement has been met.

Generalized INPRO metrics



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Basic Principle level **NES sustainability** messages:

1. **Economics:** Nuclear energy products must be competitive within the energy portfolio available in the country.
2. **Waste Management:** Nuclear waste must be managed so that human health and environment are protected and undue burdens on future generations are avoided.
3. **Physical Protection:** Efficient graded PP regime protecting all materials, facilities and operations implemented for whole life cycle of NES.

Generalized INPRO metrics



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Basic Principle level **NES sustainability** metrics:

4. **Proliferation Resistance:** NES must remain unattractive to nuclear weapon program through implementation of technical features combined with effective and efficient institutional measures.
5. **Environment:** Impact of stressors from future NES must remain within performance envelope of current NES.
Resources must be available through end of 21st century.
6. **Safety:** New deployments of NES facilities should show demonstrable improvements in safety over existing facilities.

Generalized INPRO metrics



Basic Principle level **NES sustainability** metrics:

7. **Infrastructure:** Assure adequate infrastructure and efficiently create and maintain infrastructure.
 - Legal and institutional framework
 - Supporting industrial and economic infrastructure
 - Socio-political infrastructure (public acceptance, human resources)

Users and types of NESAs



- **Different types of users perform a NESAs:**
 - **Newcomers** – first time nuclear technology users
 - **Experienced users** of nuclear technology
 - **Occasionally developers/designers** of nuclear technology
- **Different levels of depth and scope in a NESAs:**
 - **NESAs as a learning tool:** Increase awareness of long-term nuclear sustainability issues (newcomers)
 - **Limited scope NESAs:** Selected areas of INPRO methodology and/or selected components of NES (needs driven)
 - **Full scope NESAs:** All areas and full depth of assessment, complete NES → development of sustainability strategy, long-term planning
- **NESAs** is member State “self assessment.”
- **Duration** of NESAs project: **~2 to 3 years**

Main Outcome of NESAs



- Sustainability metric of defined NES through identification of “gaps”* and development of **gap map**
- Follow up actions should be considered to close gaps over time
- Gaps are commonly found – **purpose is to find them and help develop a path to sustainable NES**

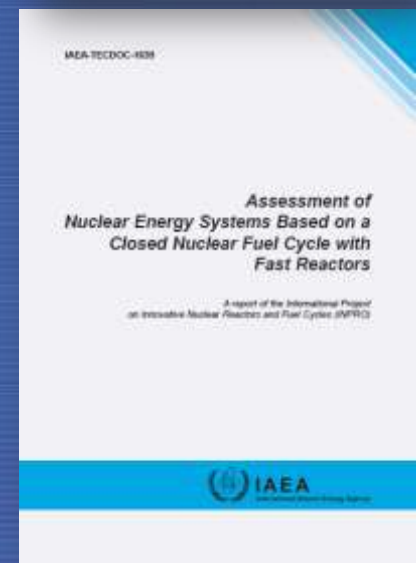
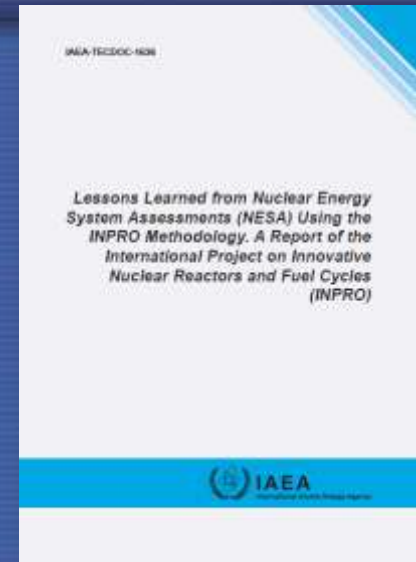
* Gap = INPRO Methodology Criterion not met

Experience with NESAs

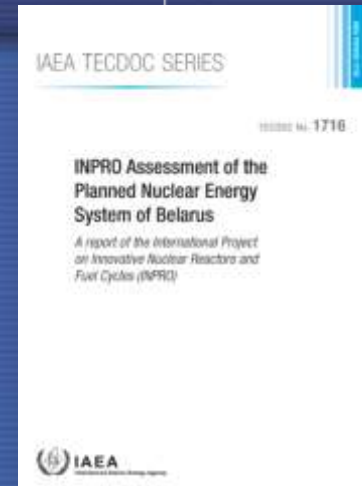


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- 6 national assessments:
 - Argentina, Brazil, India, Republic of Korea as **technology developer**;
 - Armenia, and Ukraine as **technology user**.
- Documented in IAEA report TECDOC-1636.
- 1 multinational assessment (“Joint Study”):
 - Canada, China, France, India, Japan, Republic of Korea, Russian Federation, and Ukraine;
 - Development of NES of sodium cooled fast reactor with closed NFC.
- Documented in IAEA report TECDOC-1639.



Experience with NESAs



- NESAs completed in **Belarus**:
 - Full scope assessment of all INPRO methodology areas;
 - Simplified NES consisting of power plant and SNF/waste management facilities;
 - Documented in TECDOC-1716.
- NESAs on-going in **Indonesia**:
 - Full scope assessment of two types of reactors and certain fuel cycle facilities;
 - To be completed in 2014.
- NESAs on-going in **Ukraine**:
 - Limited scope: economics, infrastructure, SNF/waste management;
 - To be completed in 2014.
- NESAs on-going in **Romania**:
 - Full scope assessment of two types of reactors and certain fuel cycle facilities;
 - To be completed in 2016.
- NESAs of **Kazakhstan** – *activities to resume in 2015*

Background of methodology revision



- INPRO has consistently called upon member State users to suggest improvements
- 216 proposals from INPRO methodology users collected since 2008 – covering all areas;
- Revision project initiated by INPRO Steering Committee (39 MS) in July 2012;
 - Special request to incorporate lessons learned from Fukushima Daiichi NPP accident;
- 16 Member States are actively participating in project.

Kick-off meeting for methodology update



- Held 21-23 November 2012
- Member State participants' recommendations:
 - Project will address 130 technical proposals for the update of manuals – limited scope revisions (**Track 1**) three recently published revised manuals discussed in Dialogue Forum 8.
 - 12 proposals to be covered in NESAs Support Package;
 - 52 proposals do not require actions to be taken;
 - 22 proposals to be considered under a later separate task (Track 2) – *SCM (June 2014) has directed to start as soon as resources are available.*

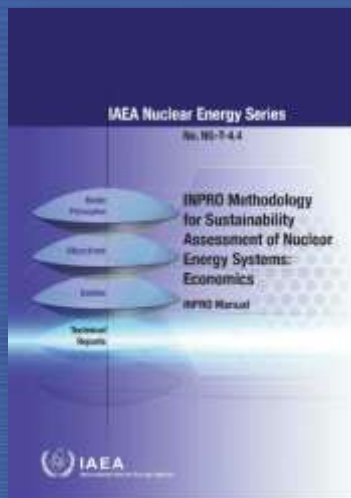
Current Status of Update – Topics of Dialogue Forum 8



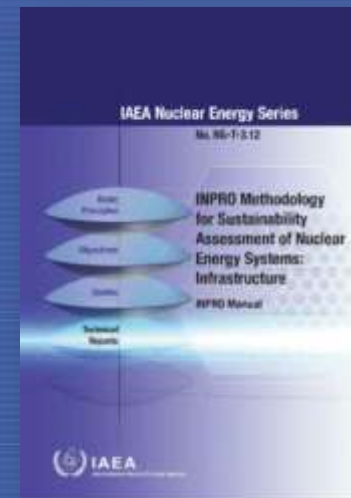
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- Two revised manuals have been published and are available on the IAEA website as of August 2014:

Economics manual (NG-T-4.4)



Infrastructure Manual (NG-T-3.12)



- One additional revised manual on “**Environmental Impact from Depletion of Resources**” (NG-T-3.13) is in press, but not yet available on the IAEA website.
- Other draft revised manuals are in different states of review and editing.

...Thank you for your attention



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