Setting up nuclear programme and international support to newcomers

Akira Omoto, Director
Division of Nuclear Power
a.omoto@iaea.org

IAEA
International Atomic Energy Agency

OUTLINE

Introduction

IAEA's support to newcomers' nuclear infrastructure building

International coordinated support

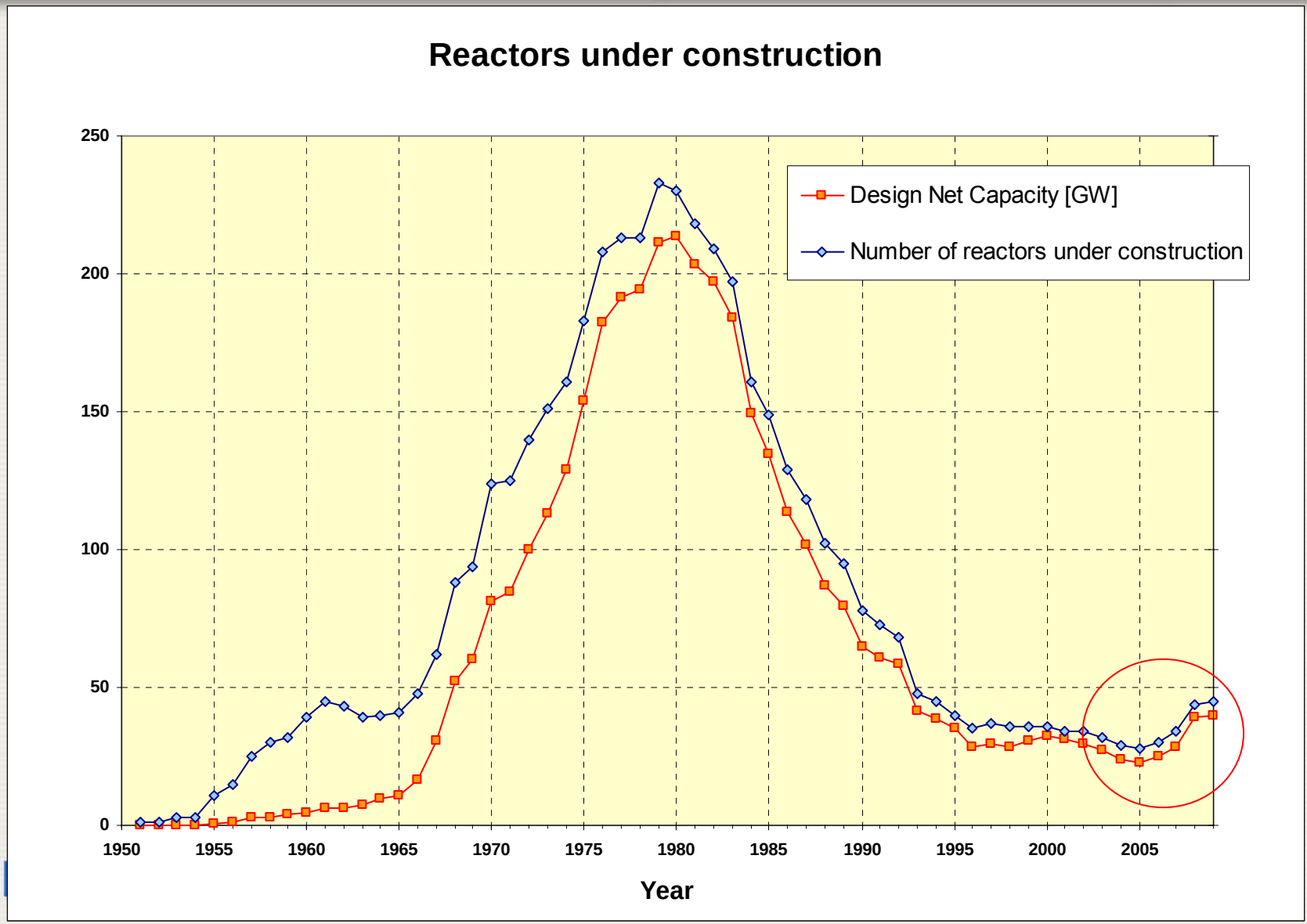
Other relevant IAEA support activities

Summary

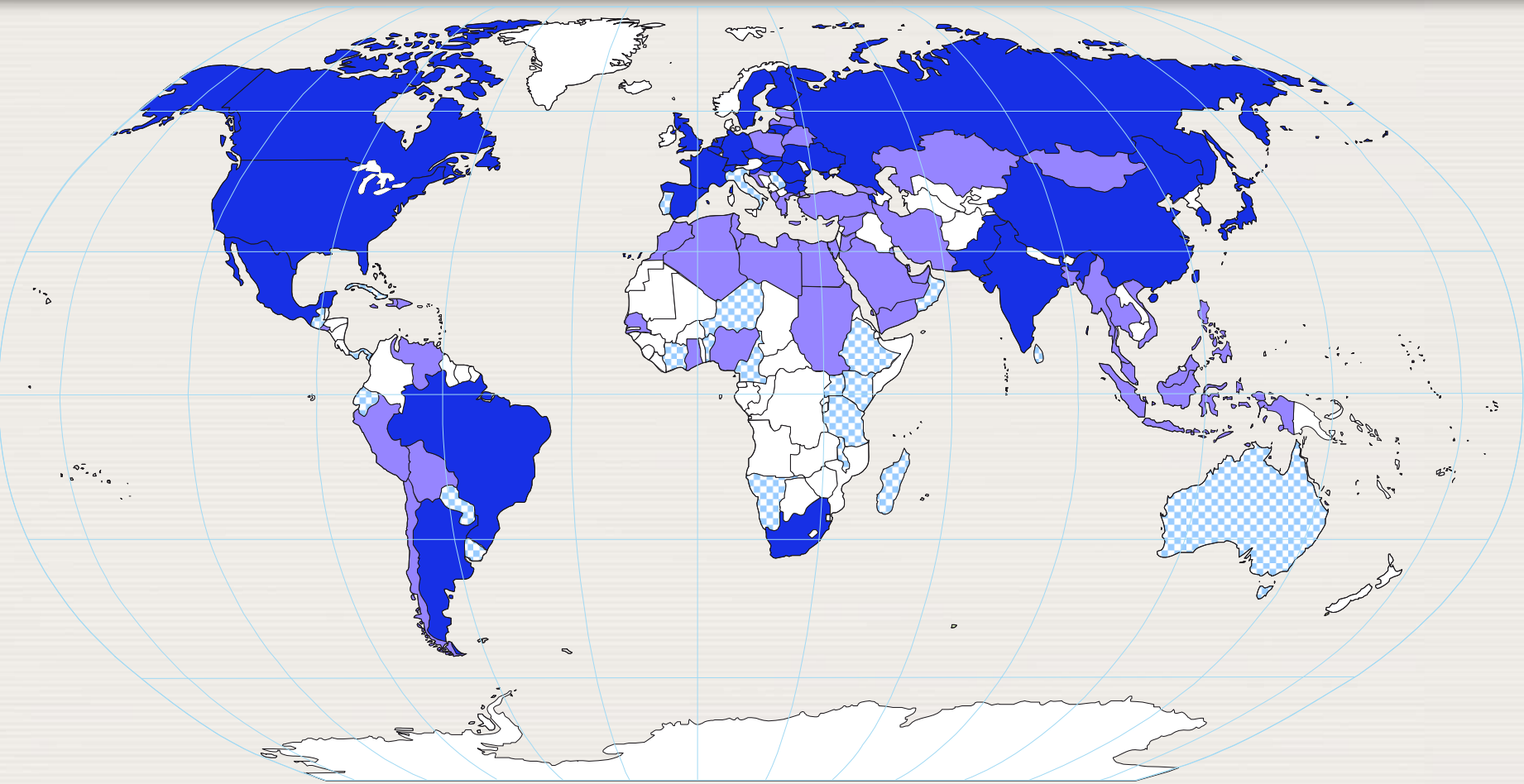
Increasing Nr. of countries considering introduction or expanded use of Nuclear Power (NP)

- Rising expectation to the role of NP to meet growing energy demand
  - Considering as an option, given concern over energy supply security, fossil price volatility, and environment
- Ambitious expansion programme: China, India, Russia, USA…
- More than 60 Member States have expressed through different channels to the IAEA their interest in the introduction of NP
- **2008 IAEA Projection (RDS-1) by 2030**
  - 748 GWe in operation in Hi-projection from 372 GWe
  - 473 GWe in operation in Lo-projection
  - Most of the growth in existing NP countries

Slight increase of new build



Increasing Nr. of countries considering introduction/expansion of nuclear power



Operating (30) **Considering (43)** **Countries having expressed interest (25)**

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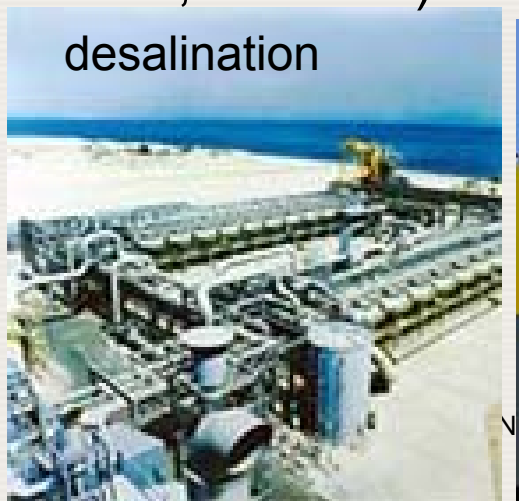
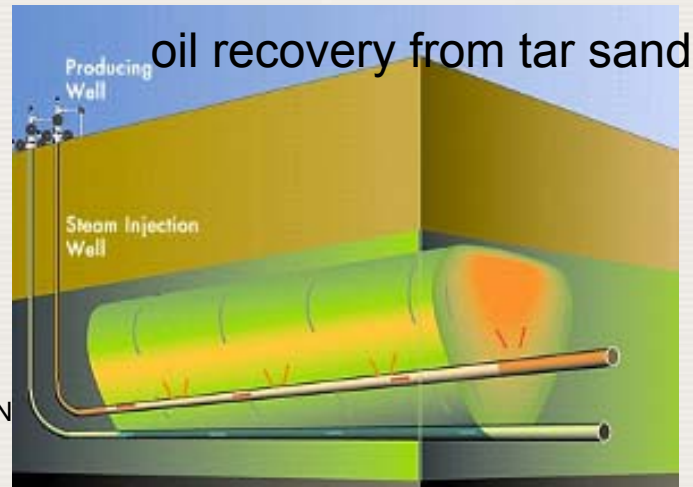
Further expectations to broader applications of nuclear power

- Global demand for portable water increase: **desalination**
- Most of the world's energy consumption is for **heat and transportation**. NE has potential to penetrate into these sectors currently served by fossil fuels (price volatility and finite supply)
- Technology development is ongoing so that nuclear energy can help **chemical energy production**
  - Recovery of oil from tar sand (Canada)
  - Sweetening of oil by adding hydrogen
  - Coal Liquefaction (S. Africa, Australia)

desalination



oil recovery from tar sand



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Challenges of expansion/introduction

(IAEA status and prospect report on nuclear power)

1. **Safety and reliability**
2. **Economic competitiveness and financing**
3. **Public acceptance**
4. **Uranium resources**
5. **Fuel and waste management**
6. **Human and industrial resources**
7. **Proliferation risk and security**
8. **Infrastructures, especially in new countries**

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IAEA support to newcomers' infrastructure building

1. **Through Technical Cooperation projects tailored for specific national and regional needs to build own capacity**
   - *For the country's capacity building*
   - *2009-11: Triple increase (13+2 → 38+6)*

2. **Intended for balanced development of nuclear infrastructure**

   Milestone approach, associated evaluation guide and review mission
   - *Progressive development of infrastructure*
   - *Holistic approach*
   - *Use of experiences and LL from NP countries*

3. **Establishing guidelines and dissemination of information through national/regional/international workshops**

Topical area of IAEA's support

Cover a wide variety of topics by mobilizing international experts

- Review of Feasibility Study
- *Review of draft Nuclear law*
- *Regulatory framework and organization*
- *Site survey, site evaluation*
- *Human resources development plan*
- Bid tendering and evaluation
- Consideration in selection of reactor design
- Owner/Operator's competence building
- Regulator's competence building
- Infrastructure status review

In providing assistance, IAEA emphasizes

- **Energy Planning** before considering nuclear programme
- **International framework for safety and safeguard**
- **Sound infrastructure** for safe, reliable and efficient use of NP under holistic approach
- **Safety culture and Ownership/responsibility of Owner/Operator**
- **Self-assessment** of infrastructure status
- **Regional approach** for efficiency
- **Important role by the Government**
- Use of **IAEA guidance documents & services**

Phases and Milestones

Declaration of interest in nuclear as an option

ENERGY PLANNING

Phase 1: 1-3 years

Development of knowledge of commitment/obligation & Assessment

viability of NP, national capability, what needs to be done

Milestone 1 Formal Intention To Implement Nuclear Power Program

Phase 2: 3-7 years

Start implementation of INFRASTRUCTURE BUILDING PLAN

Milestone 2 Invitation To Bids Issued

Phase 3: 4-6 years

First Project Contract Signed

CONSTRUCTION of the FIRST NPP

Milestone 3 Ready for Criticality and Operational Testing

Many IAEA documents to be studied or used as guide Published in the last 20+ years

- Publications to assist in the development of the necessary legal/regulatory framework for a NP programme;
  - Safety standards and INSAG documents
  - Nuclear Security Series
  - Handbook on Nuclear Law etc

- International instruments for MSs to consider adopting prior to beginning a nuclear power programme
  - INFCIRC/153 (Corr.), -INFCIRC/540 (Corr.), Additional protocol
  - Various Conventions etc

- Technical guidance related to
  - Interaction of Grid Characteristics with NPP, TRS No. 224 (1983)
  - Economic Evaluation of Bids for NPPs, TRS No. 396 (1999)

- Reports : downloadable from
  http://www-pub.iaea.org/MTCD/publications/seriesMain.asp

Guidance documents published recently with focus on Newcomers

- " Basic Infrastructure for a Nuclear Power Project", TECDOC-1513, June 2006
- "Potential for Sharing Nuclear Power Infrastructure between Countries", TECDOC-1522 October 2006
- "Managing the First Nuclear Power Plant Project", TECDOC-1555, May 2007
- "Consideration to launch a nuclear power programme" , Brochure, March 2007
- "Milestones in the Development of a National Infrastructure for Nuclear Power, NE series guide NG-G-3.1, September 2007
- INSAG-22 on Safety Infrastructure, 2008
- Infrastructure status evaluation guide, 2008

Milestones in the development of infrastructure

Clarifies:

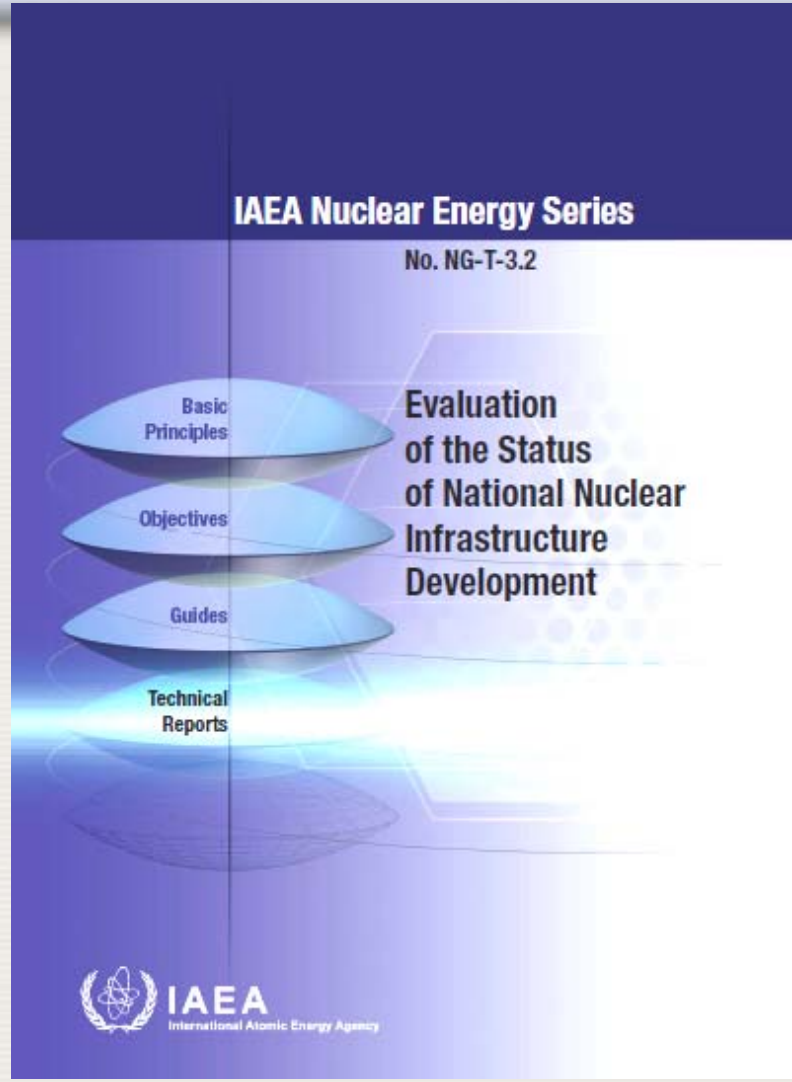
- **19 major issues to consider in infrastructure building**
- **Conditions to achieve the milestone for each issues**

National Position	Legal Framework
Regulatory Framework	Radiation Protection
Financing	Human Resource Development
Safeguards	Security and Physical Protection
Emergency Planning	Nuclear Fuel Cycle
Nuclear Waste	Environmental Protection
Nuclear Safety	Sites & Supporting Facilities
Stakeholder Involvement	Electrical Grid
Management	Industrial Involvement
Procurement	

(Nuclear Energy Series NG-G-3.1)

Infrastructure status evaluation (published in Nov. 2008)

- Methodology for continuous self-assessment against milestone
- Clarify “Basis for evaluation”
- For phase I & II
- Not intended to duplicate/replace with already available services



Integrated Nuclear Infrastructure Review (INIR) mission

The IAEA ‘s involvement could add values

a) objective view

b) clarifying areas of further assistance

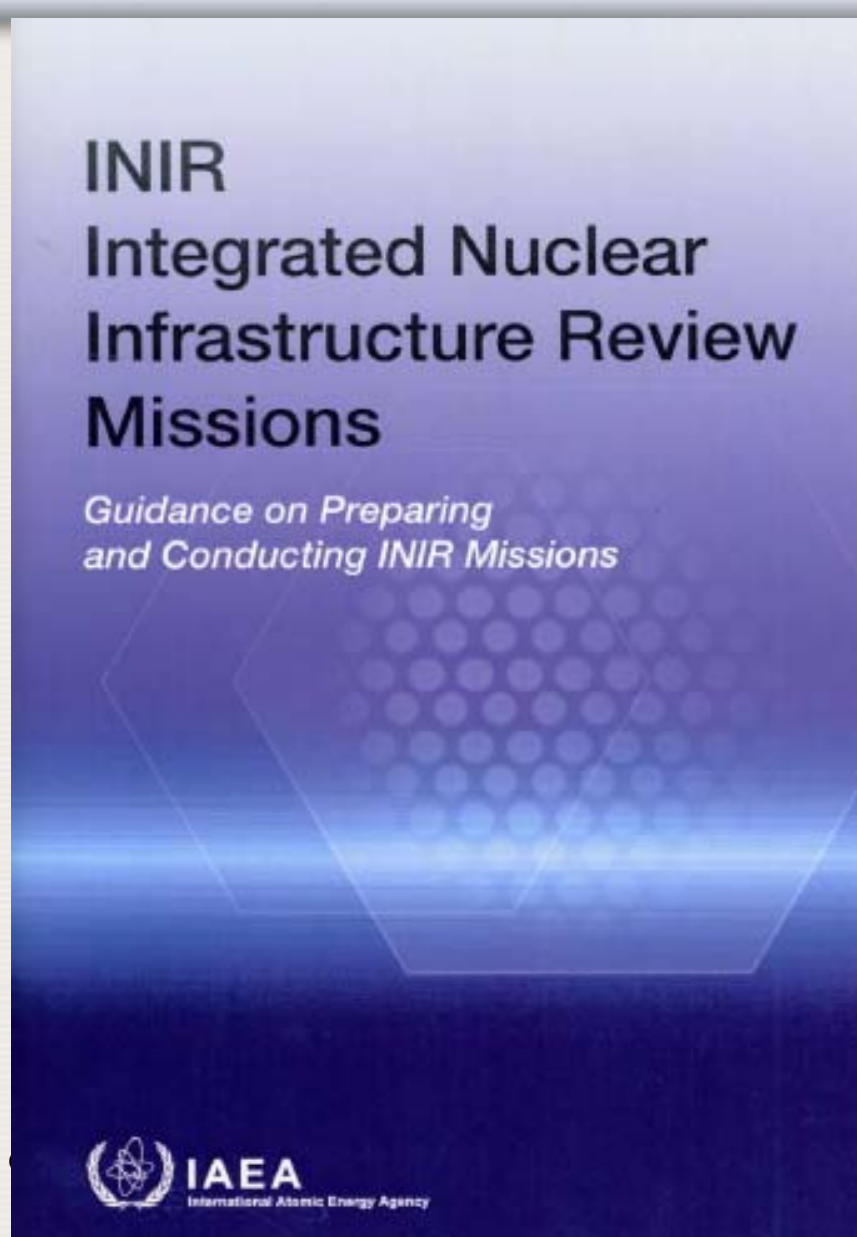
c) confidence building

Nature of the mission

- ***Upon request by the Member State***
- Holistic peer review
- Multidisciplinary international experts led by IAEA staff

Outcome from INIR mission

- Evaluation of status
- Suggestions for action plan



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Guidance documents – in the pipeline

Soon-to be published

- Improving Prospects for Financing NPP Projects
- Responsibilities and competences of the nuclear implementing organizations (NEPIO) to initiate a nuclear program
- Responsibilities and capabilities of the Owner/Operator
- Workforce Planning for new Nuclear Power programmes

In preparation

- Update of grid-interface guidance, as a part of Siting Document (& dedicated annex in *NTR2009)*
- Invitation and Evaluation of BIDS for NPPS
- Alternative Approaches for Contracting and Ownership
- Legal and institutional issue of non-stationary reactor
- Stakeholder involvement in the life cycle of nuclear facilities
- Managing site activities for NPPs

NEPIO
(Nuclear Energy Programme Implementing Organization)

- **NE Series document "Responsibilities and Competencies of NEPIO"** (**NG-T-3.6**) describes its responsibility, function, structure, necessary competence

- **NEPIO is**
  - Leading organization to achieving Milestones 1 and 2
  - Deals with NP programme but not NP project
  - Transitory organization to regulatory body and the owner/operator
  - Funded by the Government
  - Staffed by various ministries (Energy, Industry, Environment, Finance, Foreign Affairs) and representatives from industry/utility

- **NEPIO's Function**
  - Phase 1: Study and make policy and strategy recommendations for the government with respect to each of the 19 infrastructure issues
  - Phase 2: Assume an oversight roll to assure that the overall infrastructure development is properly planned and an executed

Issues in providing assistance

1) Need strong and long-standing national commitment

- Clear statement of commitment
- Creation of NEPIO
- Clarify who is responsible to what element of NE programme

2) Timing of support

- NPSG's Guiding Principle addresses this issue

3) Building culture for safety, ownership and transparency

- "Nuclear-worthiness" form Suppliers view

4) Agency's resources

5) INIR / Coordination : implementation

6) Responding to MSs needs: HR development, Financing etc

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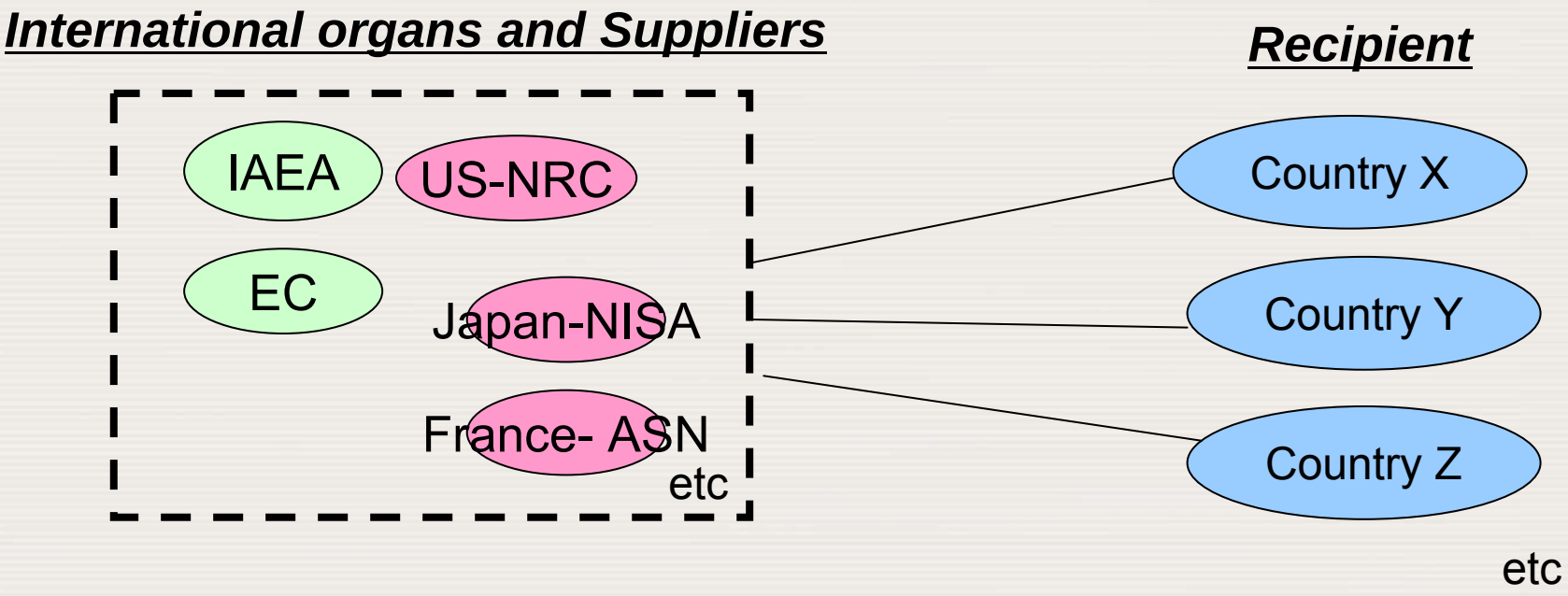
Enabling coordinated assistance to address the gaps

- **Various international initiative and suppliers** are willing to support
  - GNEP, EC, WANO, Bilateral arrangement, Suppliers, Consultants
- **Agency's support has limitation**
  - (for instance) technology specific support by Suppliers
- **Coordination may be necessary**, with the following objectives
  - To address the identified gap by the internationally concerted efforts
  - Effective use of international resources, Avoid overlap
  - Help international confidence building on the country's NP programme
- **Who will take action**
  - To be initiated by the proposal of specific newcomer
  - Under clear recognition of benefits
- **Modality and framework**: prepared
- **Key**: 1) Willingness/Needs by recipient, 2) sharing information

Modality

TYPE A: Issue specific global WG

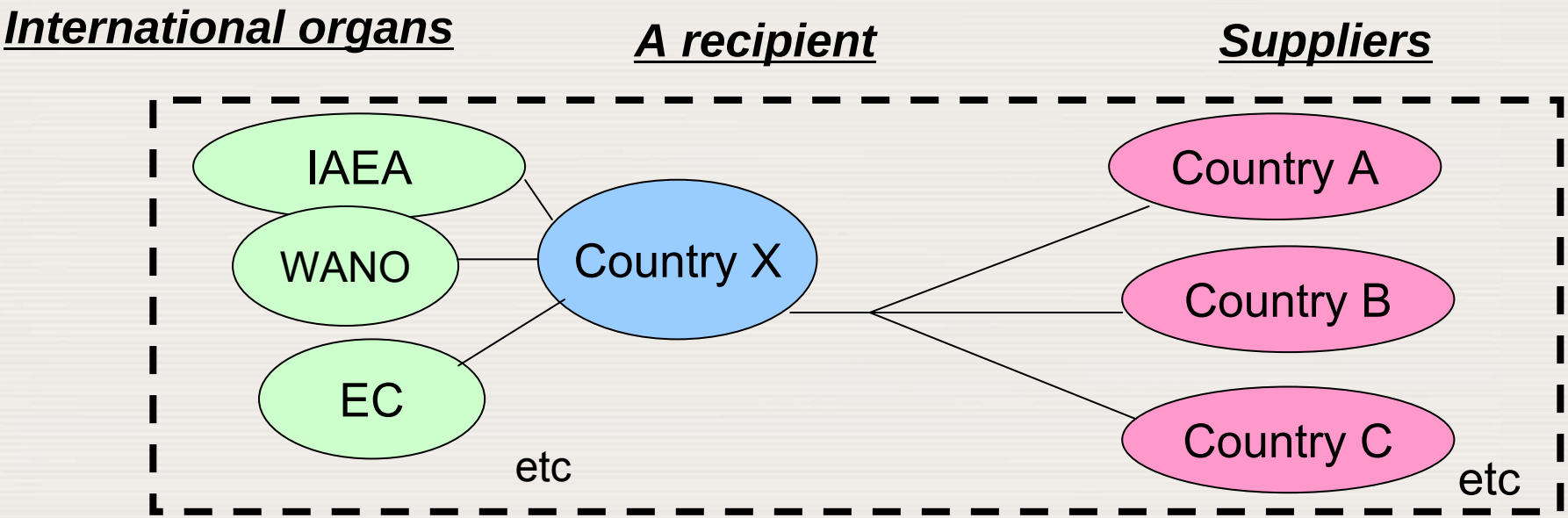
- **Safety and safeguard**



Modality

TYPE B: A group approach centred around a specific recipient country

- **By the initiative of a recipient country**



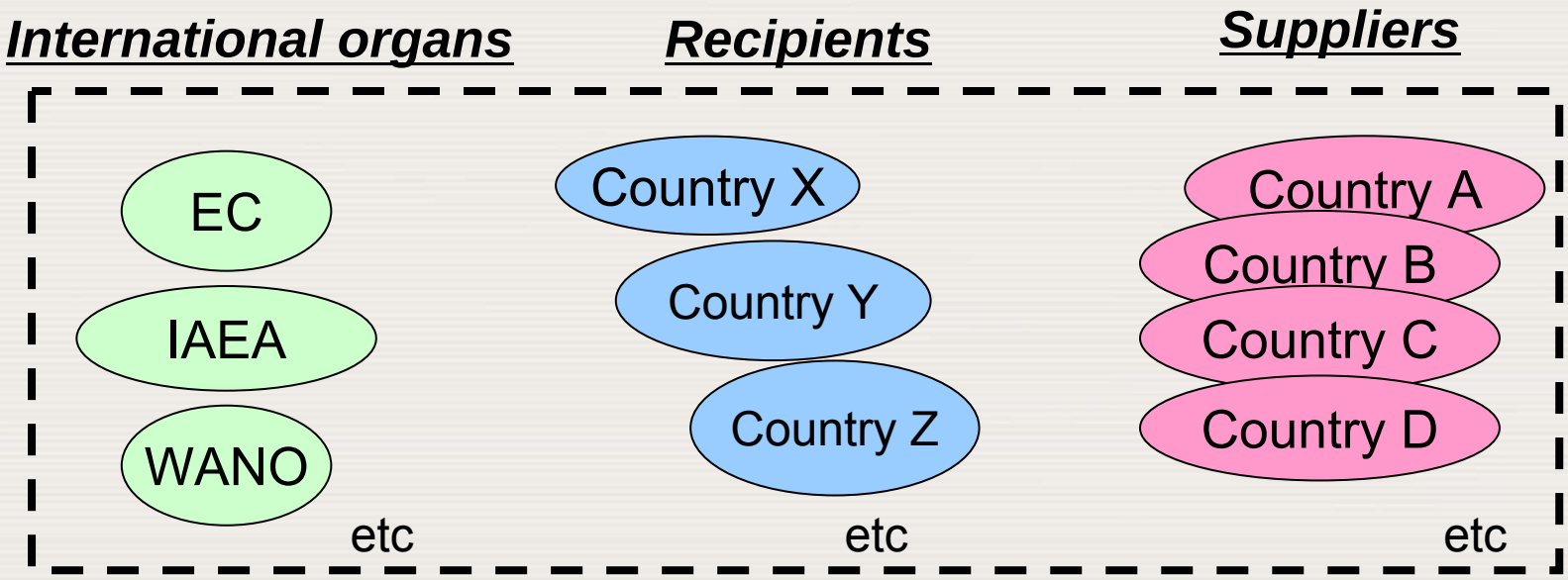
Modality

TYPE C: Global/regional forum

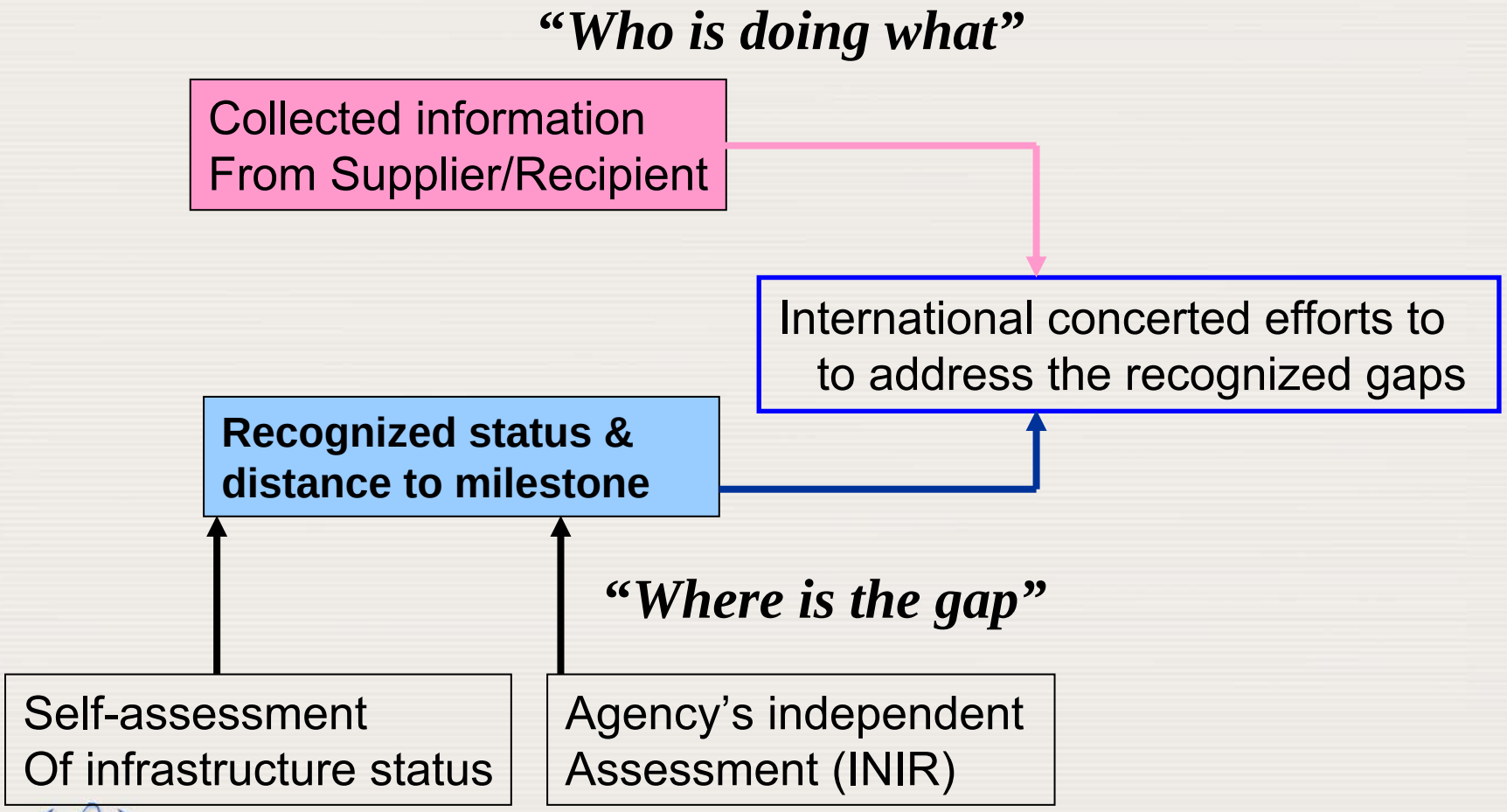
- ***National/regional/international confidence building***

  a) Supplier expressed expectation to newcomer to be eligible for "nuclear-worthiness" (Dec 2008 WS)

  b) Need transparency by showing achievement to Milestone



Basis: shared information



Addressing HR challenges

- *Use of networks (ANENT, ENEN etc) for regional cooperation*
- *E-learning*
  (Ex) Audio-visual training modules on CD-ROM
  ENTRAC database at http://entrac.iaea.org
- *Preservation and sharing knowledge and disseminating good practices in HR area using ENTRAC (http://entrac.iaea.org)*
- *Corporate Policy on capacity building and Education and Training established by the interdepartmental Education & Training Support Group (ETSG)*
- *Regional training centre: Being considered by TC & ETSG*
- *Evaluation of HR development plan (TECDOC-1586: Planning and Execution of KM Assist Mission for Nuclear Organization)*

Estimated manpower requirements at the peak during NPP project construction and commissioning

Activity \ Manpower classification		High-grade Professionals	Professionals	Technicians	Craftsmen	Total
1. Pre-Project activities		1	27	2		30
2. Project Management	NEPIO	8	47	10		65
	Main-contractor	8	22	5		35
3. Project engineering		25	185	160		370
4. Procurement		8	12	10		30
5. Quality assurance / Quality control		8	32	60		100
6. Manufacturing of equipment & components		90	210	600	2100	3000
7. Plant construction		10	80	340	2270	2700
8. Plant commissioning		10	40	50	100	200
9. Operation & maintenance		25	25	140	30	220
10. Nuclear fuel cycle (fuel fabrication)		5	35	70	30	140
11. Nuclear Licensing & Regulation		45	5			50
Total		243	720	1447	4530	6940

Networking for Nuclear Knowledge Management

ANENT (Asian Network for Education in Nuclear Technology)

- Since 2004
- Networking regional educational institutions
- Fostering cooperation: harmonize curricula, prepare teaching material, enable Distance Long
- 28 member institutions from 12 countries, and 5 collaborating organizations.

http://www.anent-iaea.org

Australia China India Indonesia Korea Malaysia

Mongolia Pakistan The Philippines Sri Lanka Thailand Vietnam

ARCCNM ASNM ENEN WNU MEPhI

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Summary

Other IAEA supports to capacity building

Energy Planning

- Tools provided from the IAEA used for national EP in more than 100 countries
- Enables assessment of the role of NP in the power generation portfolio

INPRO

- Provides assessment methodology for future nuclear energy vision/scenario to assure NE's contribution to sustainable growth
- Development of Common User Considerations

EISD

Society, Economy, Environment

Usable to

- Analyze trends and current
- Measure distance to target
- Formulate strategy

MAED

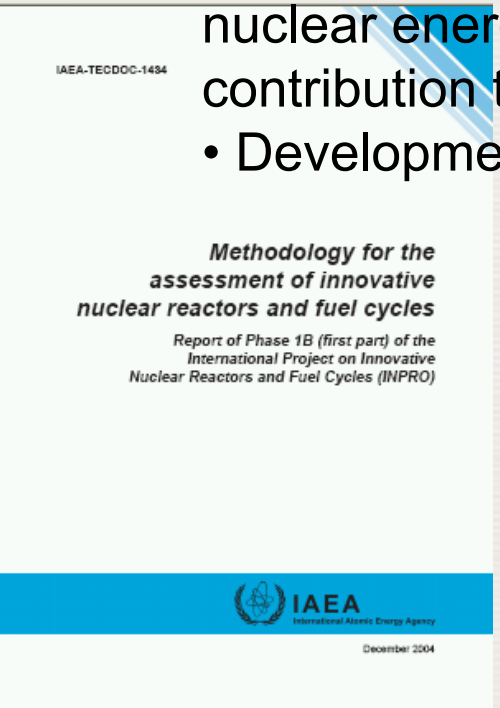
WASP

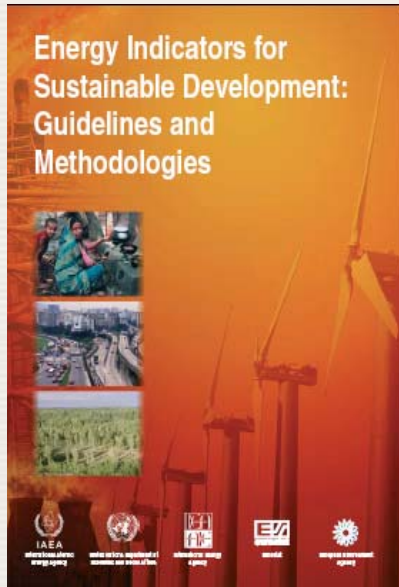
ENPEP

MESSAGE

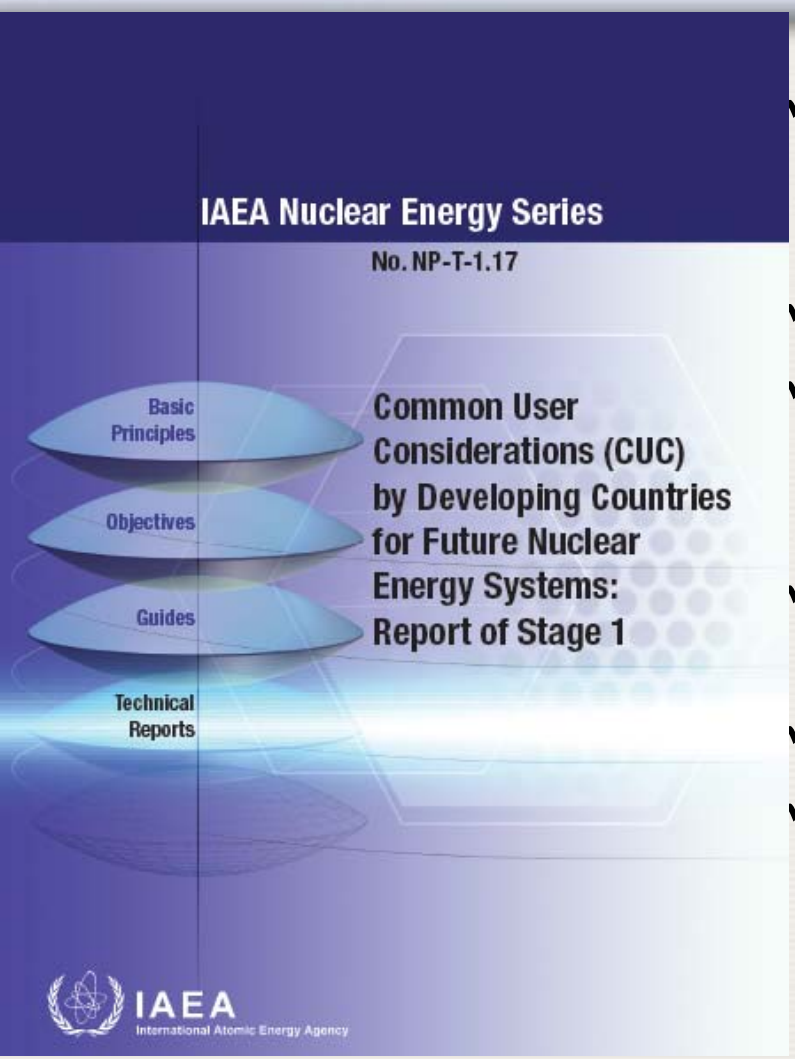
FINPLAN

SIMPACTS





Common User Considerations (CUC)
- Developed under the framework of INPRO -



- ✓ Competitiveness with alternative supported by comprehensive and reliable cost information
- ✓ Suppliers role in financing
- ✓ Supplier's role in establishing international mechanism for AOS of FC services, spare part pool
- ✓ Proven by operation, standardized and licensed in the country of origin
- ✓ Plant size distributed
- ✓ Technology transfer, transfer of database of operational experiences of similar plants, local participation (some targets), support to (soft) infrastructure building
- ✓ . . . .

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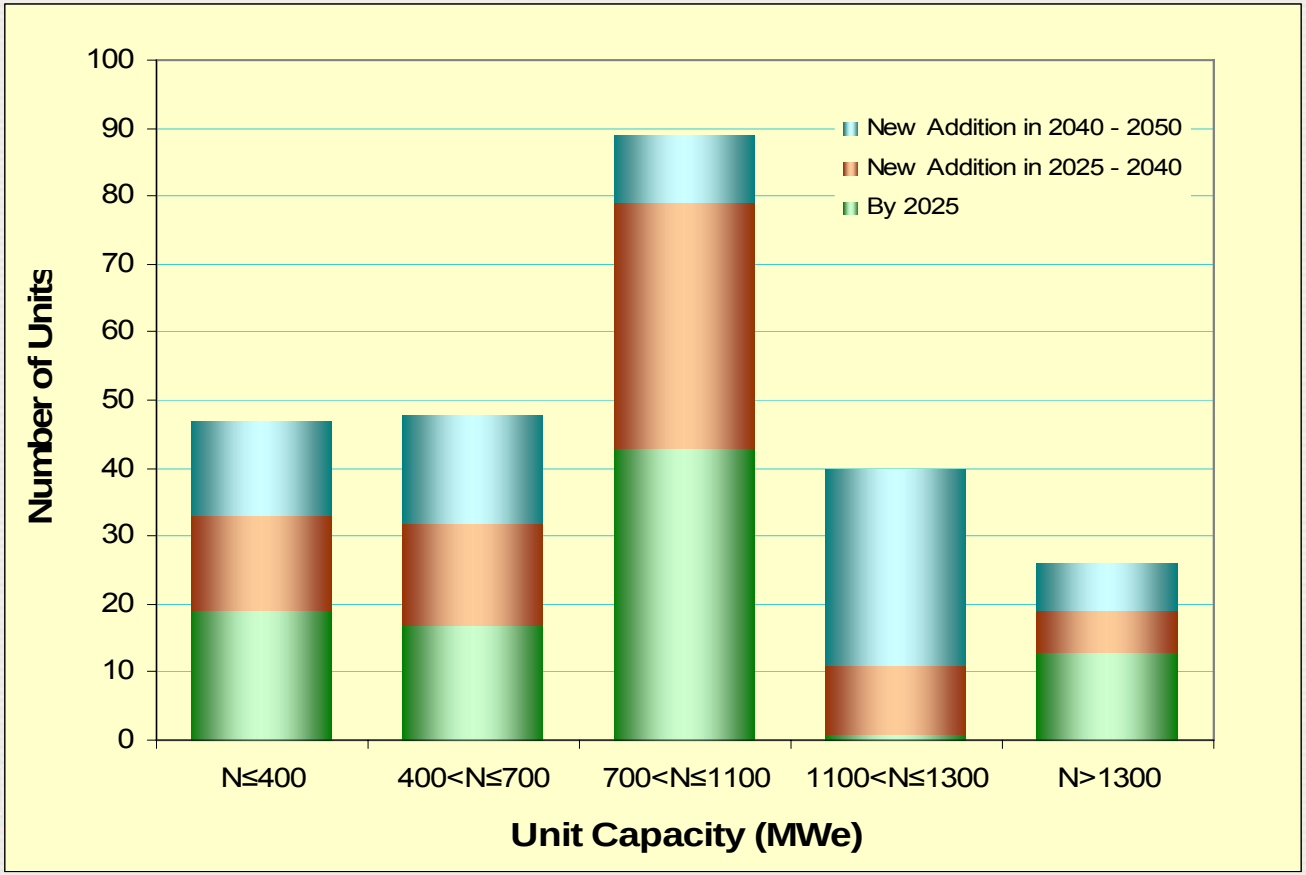
CUC: Unit size expectation and constraints

- Expectation by 31 experts in prospective user countries :
  62% of new NPPs>700MWe up to 2050
- Assuming a rule of thumb (10% of grid, no interconnection with neighbors), among 54 prospective user countries, 20 countries to less than 300MWe, 12 countries to less than700Mwe (larger than 300MWe) as of today



SMR (Small and Medium-sized Reactor)

- **IAEA Definition**

  Small sized reactor: up to 300 MWe
  Medium sized reactor: 300-700 MWe

- **IAEA observation**

1. History of pursuit of economics of scale
2. Continued deployment of SMR
   - Under operation in India
     1x500 MWe PHWR, 12x220 MWe PHWRs, 2x160 MWe BWRs
   - Under construction in India
     1x500 MWe PHWR, 4x220 MWe PHWRs, 1x500 MWe FBR
3. Current interest in Member States;
   - Developing countries: ***For use in a small grid***
   - Existing nuclear power countries : ***For local solution***
     (power source at isolated area, multi-purpose energy source)
     (minimize investment on transmission line)
   - Deregulated and unbundled electricity business environment : ***For incremental investment to avoid financial risk***

SMR - challenges

- Development of regulatory standards for innovative designs
  - Claim for no-containment, no EPZ due to “inherent safety”
- Economic competitiveness by innovation/learning

  Economic advantages of SMRs derived from
  - Multiple modules (common to all SMRs)
  - Passive safety : saving capital, O&M
  - Simplicity
- Technology
  - Without onsite refueling for small reactor by use of very long life core
  - Reliability of passive safety system
- Institutional
  - non-stationary reactor
  - fuel lease back

SMR-related activities

- Focused on;
- Collecting information in State-of-the art report
- Small reactor without onsite refuelling
- Economic competitiveness
- Legal, security and safety aspects of barge- mounted reactor

- CRP 2004-2008-2011: Common technologies and issues for small and medium sized reactors (SMRs)
- CRP “Small Reactors without On-site Refuelling (2004-2008)
- CRP on reliability of passive safety systems
- CP on “legal, institutional and technical issues of development and deployment of non-stationary movable SM NPP in developing countries” under INPRO framework

A bit more on INPRO: INPRO is….

- A forum by technology holders and technology users to consider jointly the actions required to achieve desired innovations in nuclear reactors and fuel cycles
- Operated since 2001 mostly by Extra-budgetary contribution
- Steered by a Steering Committee of participating members, while IAEA's inter-departmental team serves for secretary function
- Divided into two phase so far

  Phase I (2001-2006) : Methodology development

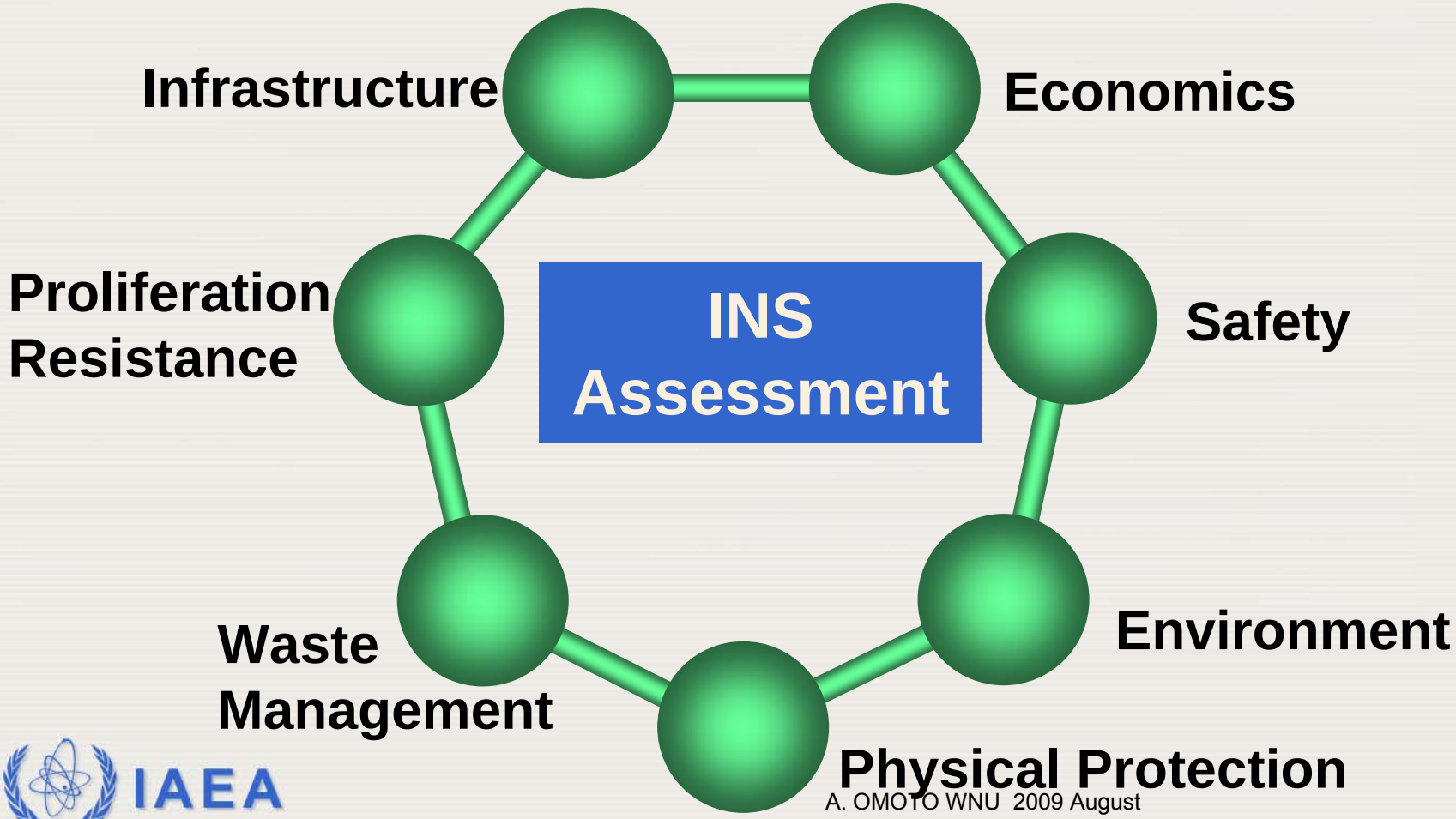
  Phase II (2006-) : Started Vision/Scenario study,

  Collaborative Projects etc

30 INPRO Members

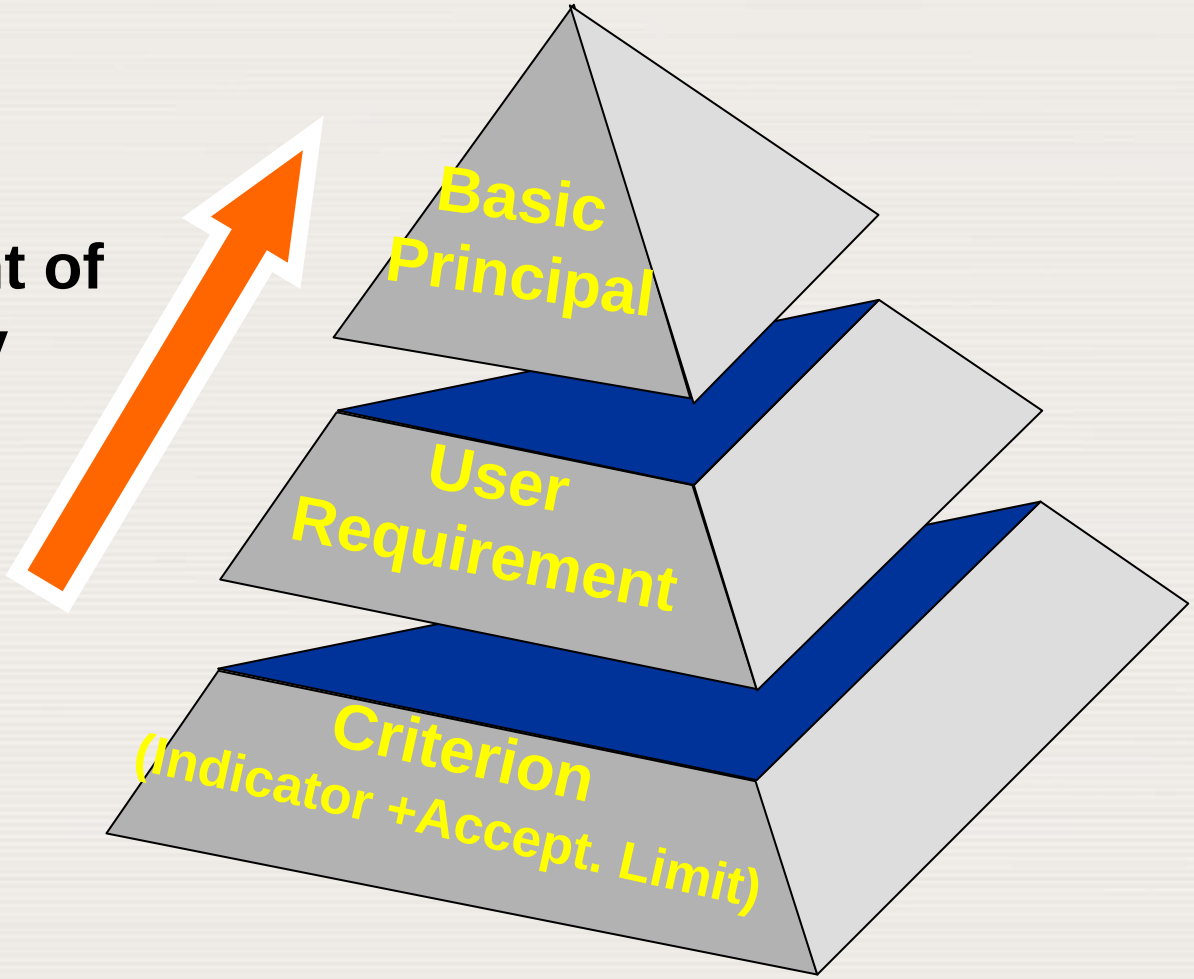
Assessment Methodology

Based on expectation to technology innovation in seven areas to assure the benefit of NE use for sustainable development



Hierarchy of demands on innovative designs In INPRO methodology

Fulfilment of hierarchy



2010-11 Action Plan : streamlined

A Methodology and its use in Assessments

- PRADA

B Global Vision/Scenario

- GAINS
- ThFC
- FINETE
- RMI

C Addressing issues in Nuclear Technology

- PGAP
- COOL
- AWR
- HTR-H2

D Innovation in Institutional Arrangements

Differences between GIF and INPRO

- GIF: R&D activities by technology holders
- INPRO's unique value
  - ✓ Forum by technology holders & users
  - ✓ Address issues other than development
  - ✓ Viewpoint from users
  - ✓ Pay attention to the needs of developing countries
- Relationship between the two: drafted by both side and posted in the public domain regarding mission, organization, funding and complementarity

Assurance of supply of fuel services: why?

- **Assurance of services in the nuclear fuel cycle …**
  - ***Could facilitate increased use*** **of NE for peaceful purposes**
  - ***Could reduce the incentive*** **to sensitive parts of the fuel cycle**

- **States need to have confidence for fuel services in a predictable, stable and cost effective manner over the long term … and also to have back-up mechanisms to protect against political disruptions**

Assurance of supply of fuel services : Multilateral approaches / studies

Multilateral approaches – nothing new

- Russian supply and take-back of fuel for Russian type reactors
- Supply and take-back of US or Russian origin research reactor fuel
- Joint financing of UP-3 and THORP reprocessing facilities

Multilateral studies – nothing new

- 1977 Regional Nuclear Fuel Cycle Centres
- 1980 INFCE International Nuclear Fuel Cycle Evaluation
- 1982 International Plutonium Storage

What is new? - Changing nuclear environment

- Rising expectation to the role of nuclear power, including new countries considering embarking on nuclear power programme
- Understanding that open fuel cycle is not viable in the long run (sustainability)
- Renewed concern over proliferation risk

Assurance of supply of fuel services : MNA Expert Group: five suggested approaches

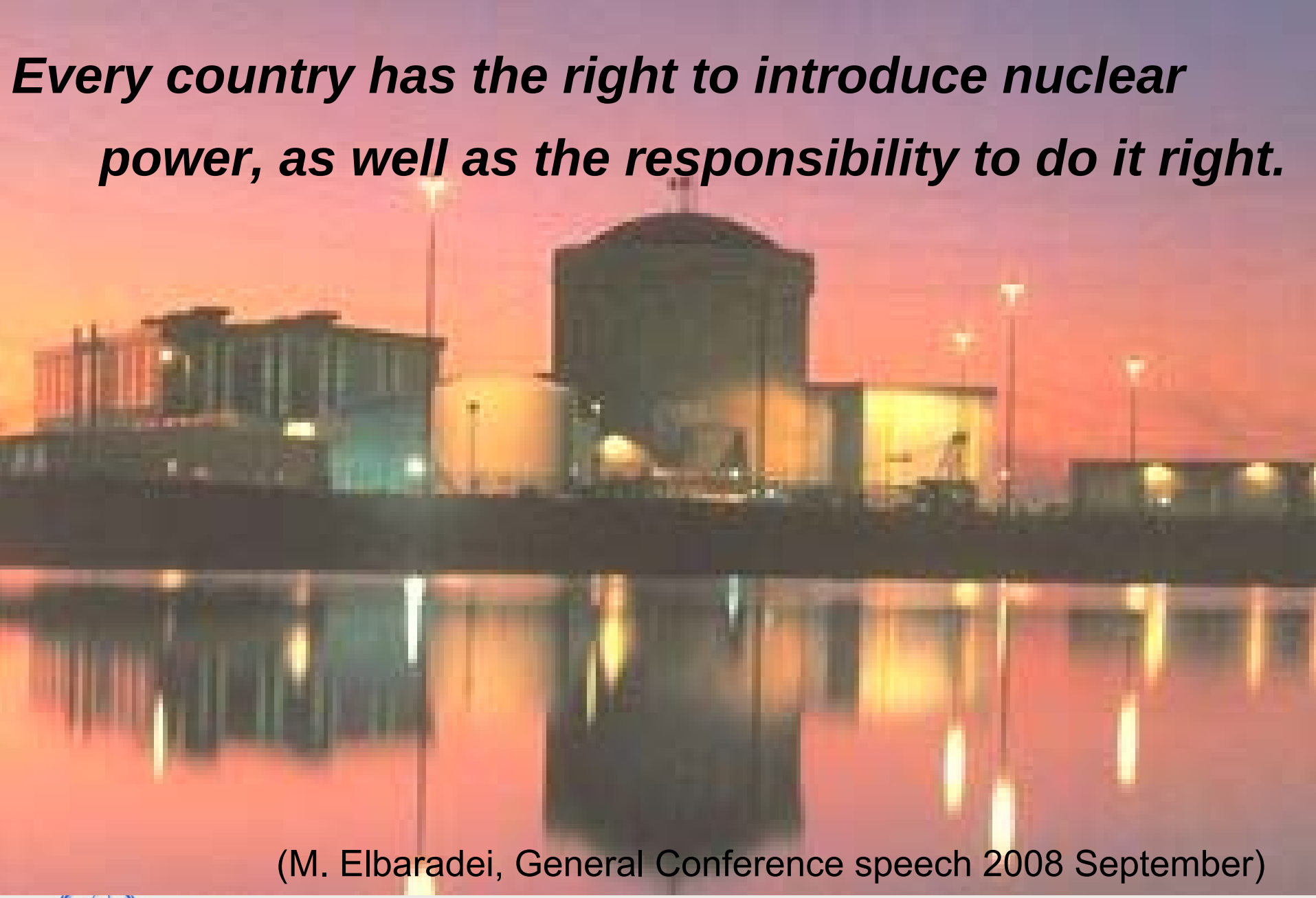
- Reinforcement of existing commercial market mechanisms: long-term contracts with government backing, fuel leasing and fuel take-back offers, commercial offers to store and dispose of spent fuel, commercial fuel banks,
- Development of international supply with the IAEA as guarantor of service supplies,
- Voluntary conversion of existing facilities to MNAs as confidence-building measures,
- Creation multinational, and in particular regional, MNAs for new facilities based on joint ownership,
- In further expansion of nuclear energy the development of a nuclear fuel cycle with stronger multilateral arrangements and broader cooperation, involving the IAEA and the international community.

In summary

- Developed more guidance documents with focus on newcomers since 2006 under concerted efforts with other departments
- Introduced "phased and holistic approach" in the development of national infrastructure building

- Current focus

1. Successful implementation of TCP 2009-11 **with limited resources in RB recognizing the issues in providing assistance**
2. Additional technical guidance documents in the pipeline
3. Continuous infrastructure evaluation against milestone by newcomers
   - To identify gaps and needed assistance
   - By "self assessment" and "INIR"
4. Then, how to address the identified gaps by internationally concerted effort
   - Will necessitate "soft coordination" among stakeholders


Every country has the right to introduce nuclear power, as well as the responsibility to do it right.
(M. Elbaradei, General Conference speech 2008 September)

…Thank you for your attention

Financing to NPP projects

Special features of nuclear power projects as are perceived by the financial community;

- Need long term government commitment and public support
- Technologically complex and uncertain
- Capital intensive and long timescale return on investment
- Carry uncertainties:
  - ✓ Management of radioactive wastes
  - ✓ Potential for low probability high consequence accidents
  - ✓ Stability in safety regulation
- International implications
  - ✓ Non-proliferation
  - ✓ Liabilities
  - ✓ Industry and supply chains
- Requires extensive technical and human resources

Overview and guidance documents by the IAEA

NE Series document

- ***"Financing of New Nuclear Power Plants" (2008 Sept)***
- ***"Improving the Prospects of Financing Nuclear Power Projects"*** *(2009)*

Audience

✓Primarily targeted at the nations introducing nuclear power for the first time
✓Especially decision-makers, government, prospective owner/operator

Objective

✓Recognise the political, technology and commercial factors which would impact on finance
✓Develop understanding of the risks that may influence financing
✓Suggest strategies and actions for developing successful financing

key risk factors influencing financing and potential mitigation measures

Political and legal

- ✓political stability and continued support to NP
- ✓National legislation establishing necessary legal & regulatory framework
- ✓Signatory to Vienna convention on liability
- ✓Public support (Recognition as clean energy technology)
- ✓Responsibility and funding scheme of waste management
- ✓Allowing real credit for environmental benefit

Further

- ✓Providing 'backstop' financial guarantees, especially for the first few units
- ✓Especially in deregulated markets, introducing a mechanism to safeguard longer return on investment periods (Some countries are considering long term 'power purchase agreements')
- ✓Financial support for early licensing work to facilitate vendors demonstrating satisfaction of sovereign safety and licensing

key risk factors influencing financing and potential mitigation measures

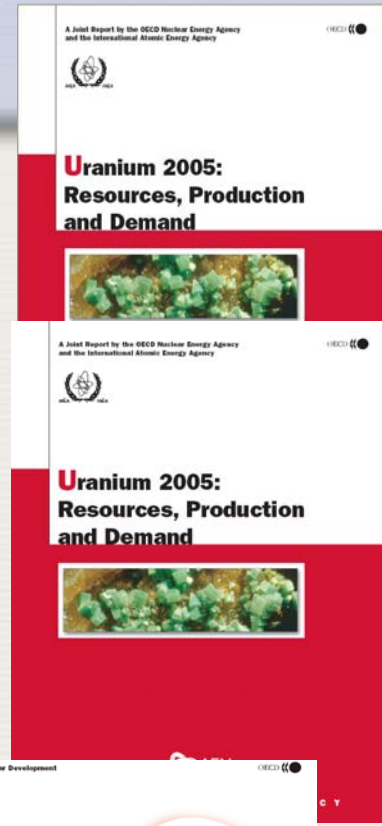
Technical

- ✓Use of proven design and avoid FOAK
- ✓Regulatory stability
- ✓Local supply chain to support reliable/stable procurement for maintenance
- ✓Confirming site suitability, good site preparation work, and obtaining necessary clearance and consents

Financial

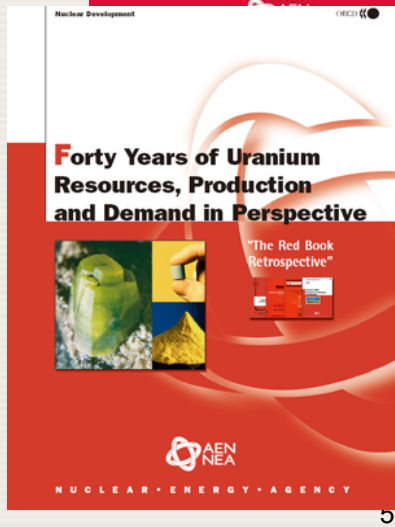
- ✓Define such waste & decommissioning strategy
- ✓Establish revenue plan
- ✓Government support/participation in the project
- ✓Consider financing is an activity integral with the complete project cycle and is an essential input to the formulation of project strategy

Uranium resources



- **"Uranium 2007" by OECD/NEA and IAEA**
  Total identified 5.5 Million Ton (<USD130/Kg U)
  Total undiscovered
  (Prognosticated & speculative)
  10.5 Million Ton (<USD130/Kg U)

- **With current consumption (0.07 M Ton/year) for 439 reactors, 16 Million Ton** U
  could support open cycle for 228 years
- **If 1000 reactors by 2050, 16 Million Ton** U
  could support open cycle for 140 years
- **Closed fuel cycle using Fast Reactor**
  extend to 20, 000~40,000 years



IAEA

TECDOC 1522 "Sharing nuclear power infrastructure" (2006 October)

Potential exists for;

- **Grid system**
- **Human resources development**
  - **by establishing regional training centre**
  - **by utilizing under-utilized RR**
- **Localization of industrial capacity**
- **Maintenance and In-service inspection**
- **Models for national legal framework**
- **Research and development**
- **Waste management and disposal etc**