Status and Overview of International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

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INPRO in short

- International forum to discuss development and deployment of innovative nuclear energy system (INS)
- 27 Members (+ 3 potential countries)
- IAEA provides secretariat function
- Cooperation from various experts across IAEA

International Role of INPRO

50th IAEA General Conference

"**INPRO** addresses issues faced by all countries that choose nuclear power"
(Director General Mr. Elbaradei)

2006 G8 summit statement

"we acknowledge the efforts made in the complementary frameworks of the **INPRO** project and the Generation IV International Forum."

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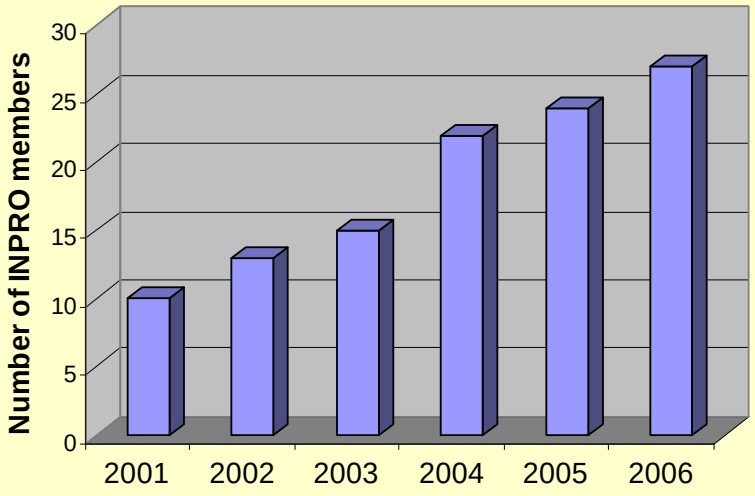
INPRO Members



27 Members Argentina, Armenia, Belarus, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Japan, Republic of Korea, Morocco, Pakistan, Russia, Slovakia, South Africa, Spain, Switzerland, The Netherlands, Turkey, Ukraine, USA and EC
(+ announcements from Algeria, Kazakhstan and Belgium)

INPRO Goals

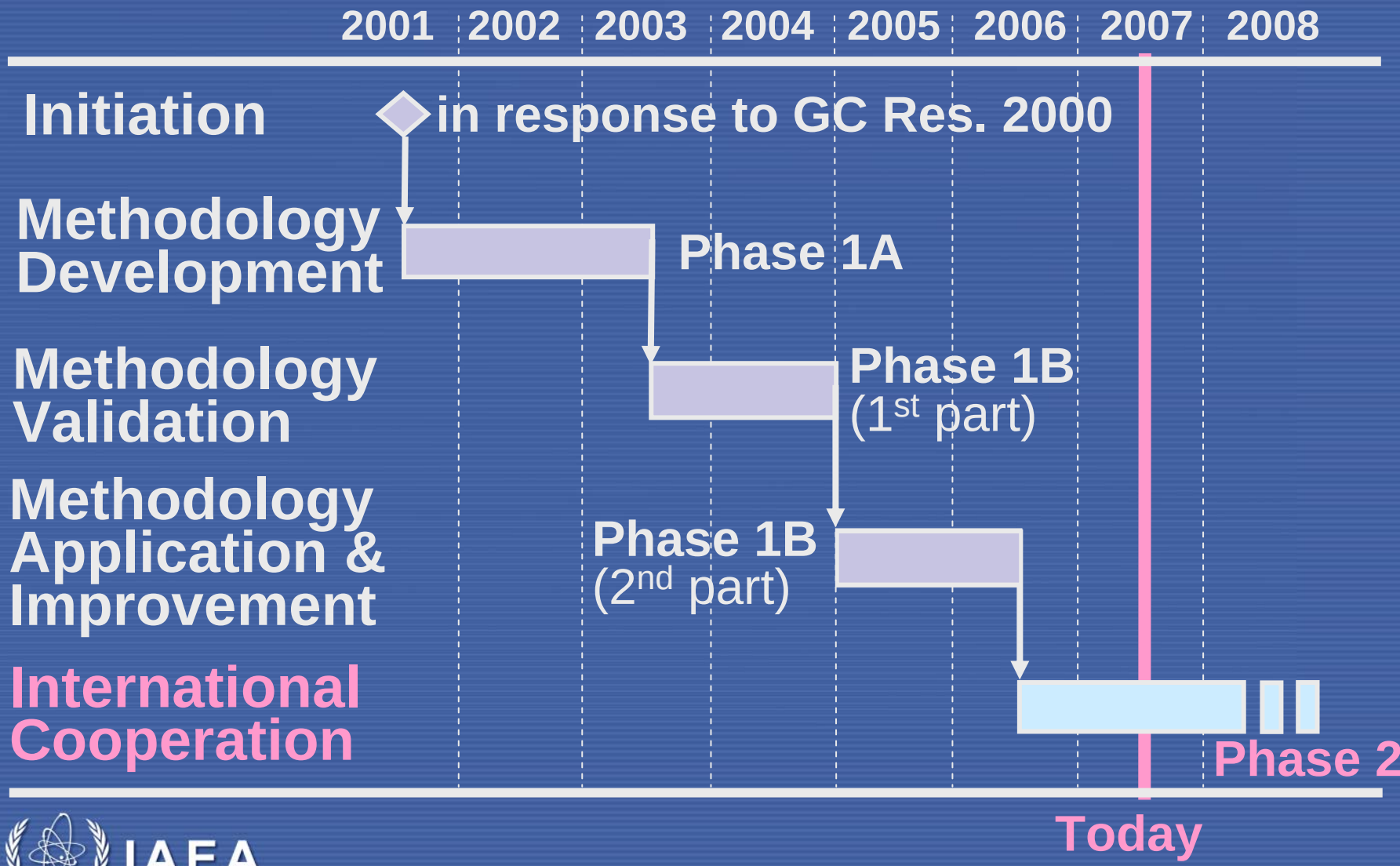
Goals

- To help ensure that nuclear energy is available to contribute in fulfilling energy needs in the 21st century in a **sustainable manner**;
- To bring together both **technology holders** and **technology users** to consider jointly the actions required to achieve desired innovations in nuclear reactors and fuel cycles

INPRO Time horizon

- From **today 50 years** into the future and beyond

INPRO Schedule



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Three directions of phase 2 activities

1. Development of Methodology

- **Improvement of INPRO methodology**
- **Assessment studies by INPRO Members**
- Establishment of global vision

2. Institutional/Infrastructure activities

- Identify innovative institutional options
- **Common User Criteria and Actions**

3. Collaborative Projects

- **Coordination of collaborative activities among INPRO Members**

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Development of INPRO methodology

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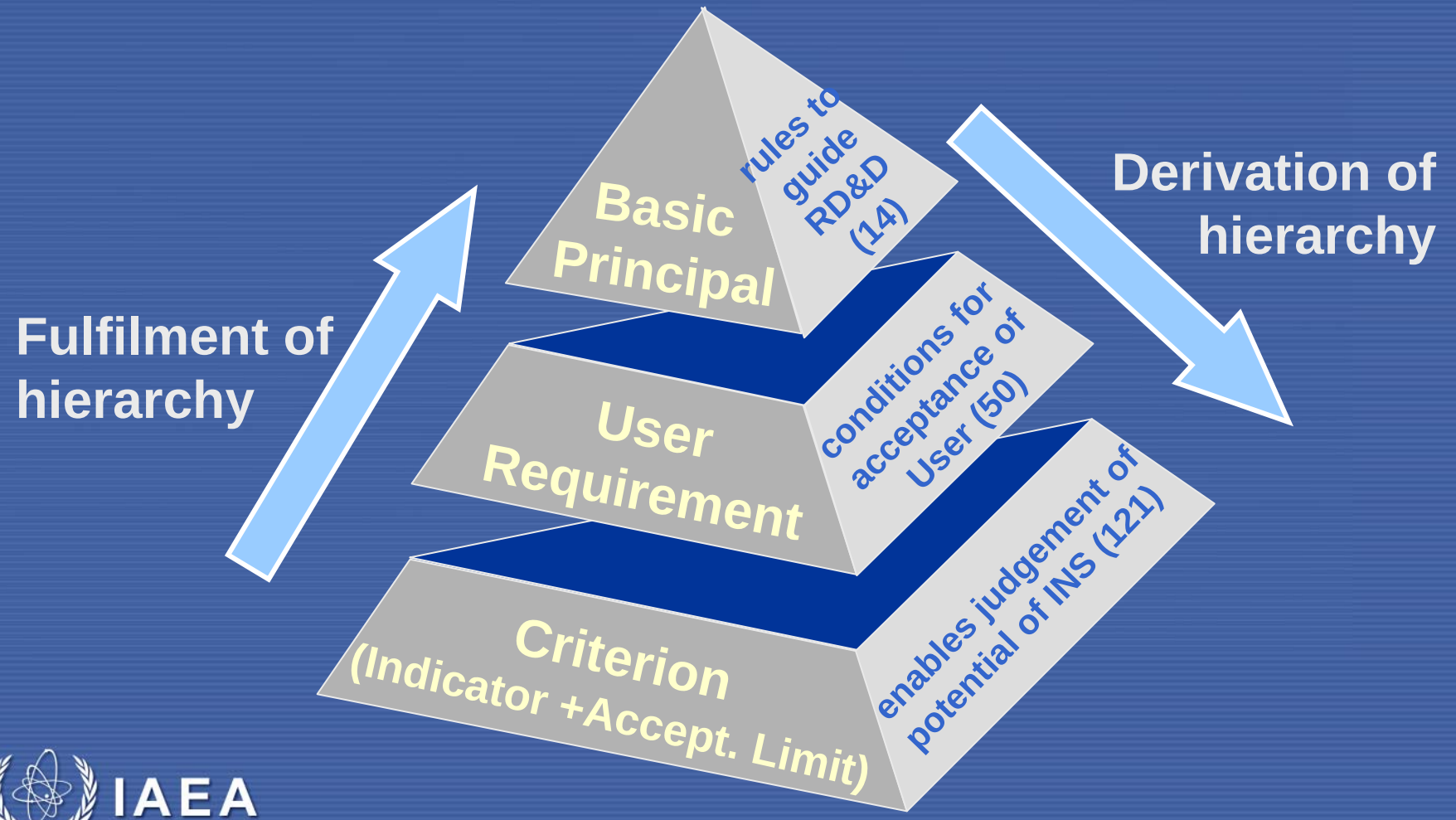
Objectives of INPRO assessments

- **Screening of INS** for their compatibility with the INPRO set of Basic Principles, User Requirements and Criteria to confirm its sustainability;
- **Comparison of different INS** or components thereof to find a preferred or optimum INS consistent with the needs of a given IAEA Member State;
- **Identification of R&D** needed to improve the performance of existing INS components and for the development of new components.

Structure of INPRO Methodology (1)

INPRO Hierarchy of demands on INS



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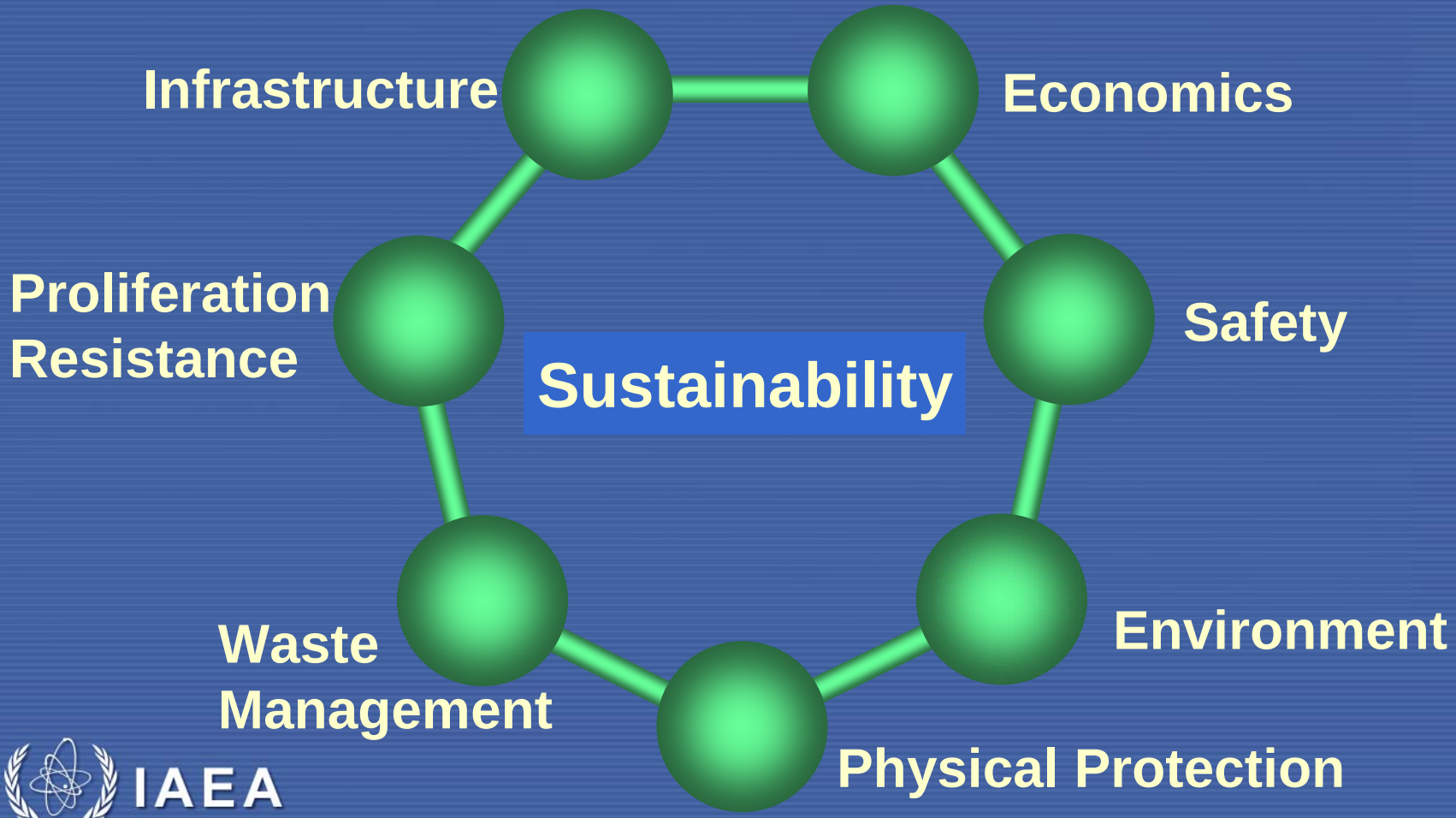
Structure of INPRO Methodology (2)

Holistic approach to assess INS in seven areas to assure its sustainability



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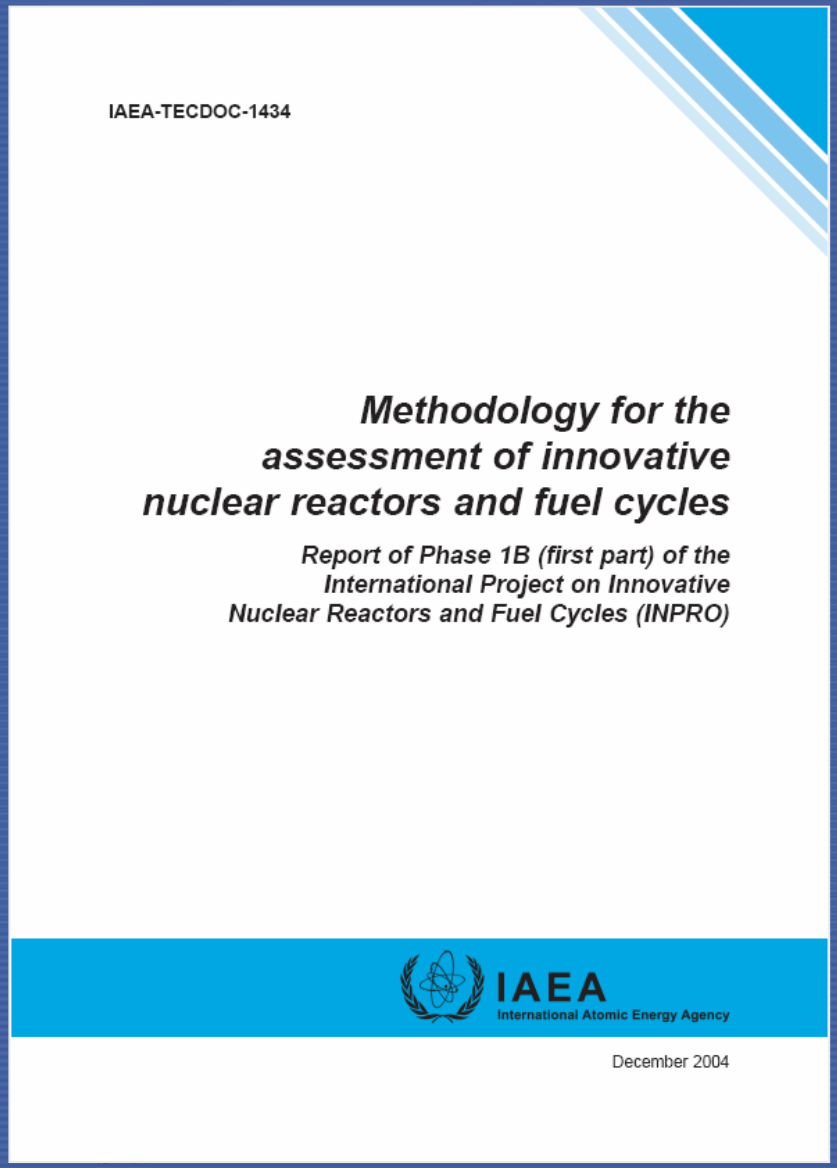
Structure of INPRO Methodology (3)

Area	Basic Principles	User Requirements	Criteria/ IN&AL
Economics	1	4	8
Safety	4	14	38
Environment	2	4	9
Waste manag.	4	7	18
Prolif. Resist.	1	5	7
Phys. Protect.	1	12	27
Infrastructure	1	4	14
Total	14	50	121

Deliverables



TECDOC-1434 describes basis of the methodology

Manual to guide how to make assessment will be published soon

9 volumes

1. Overview
2. Economics
3. Infrastructure
4. Waste Manag.
5. Prolif. Resistance
6. Physical Protection
7. Environment
8. Safety (NPP)
9. Safety (FC facilities)

Assessment Studies by INPRO members (1)

- Joint study to assess INS based on closed fuel cycle w/ fast reactors (Canada, China, France, India, Japan, Rep. of Korea, Russia and Ukraine);
- Transition phase between the current fleet towards the Gen IV fast neutrons systems (France);
- INS for countries with small electricity grid (Armenia);
- Assessment of additional nuclear generation capacity in the country from 2010 to 2025 for the evaluation of nuclear fuel cycle strategies (Argentina);
- Assessment of Hydrogen Generating INS in National Energy Mix (India);

Assessment Studies by INPRO members (2)

- Assessment of complete DUPIC Fuel Cycle in the area of Proliferation Resistance (Rep. of Korea);
- Two independent assessment studies on IRIS and FBNR (Brazil);
- Assessment of advanced high-temperature gas-cooled reactor (China) ;
- Assessment of national INS (Ukraine);

Collaborative Projects

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Collaborative Projects

International collaboration is key to perform R&D activities in a reliable and cost effective way:

- ✓ How to find real **R&D needs**?
- ✓ How to find right **partners**?
- ✓ How to find suitable **framework**?

⇨ INPRO can provide those. How?

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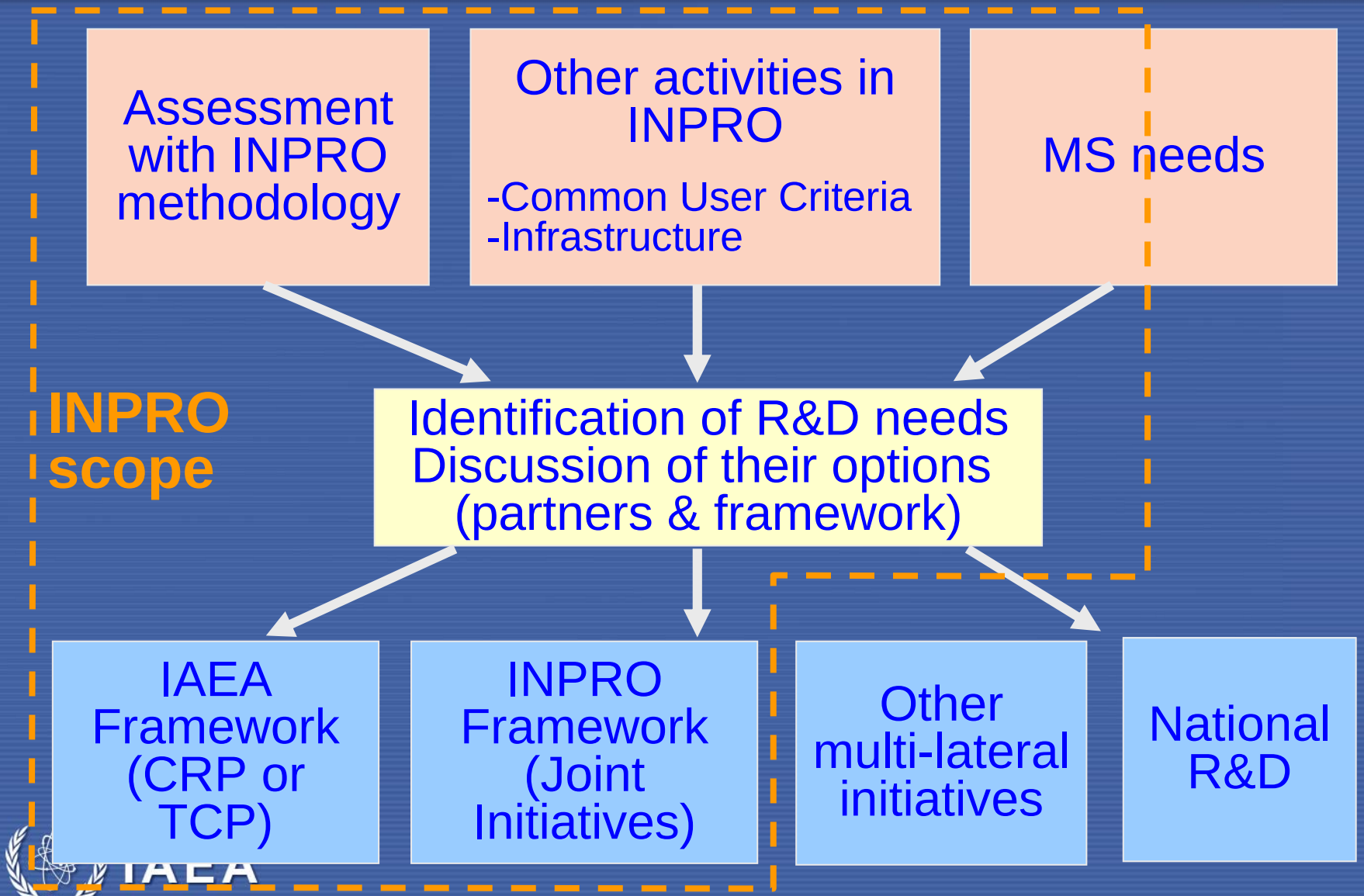
INPRO Collaboration Project Scheme



Proposals for Collaborative Projects

13 proposals from 8 countries (including EC) are under discussion for implementation

Scenario Studies

- Global architecture with thermal and fast reactors (GAINS)
- Scenarios in the period of raw materials insufficiency

Safety issues

- Passive Gaseous Provisions (PGAP)
- Safety for advanced HTRs and H_2 producing plants
- Safety operation for the small power grid

Proliferation Resistance (PR)

- Acquisition/diversion pathway analysis for PR

Proposals for Collaborative Projects

Technical solutions in Reactor technologies

- Technological challenges on advanced HTRs
- Advanced water cooled reactors
- Decay heat removal system for Liquid Metal Reactor

Environment & Waste Management

- Environmental impact benchmarking
- Spent nuclear fuel and radwaste in a small country

Alternative options

- Non-Stationary SMR
- Further Investigations of U-233/Th fuel cycle

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Common User Criteria and Actions

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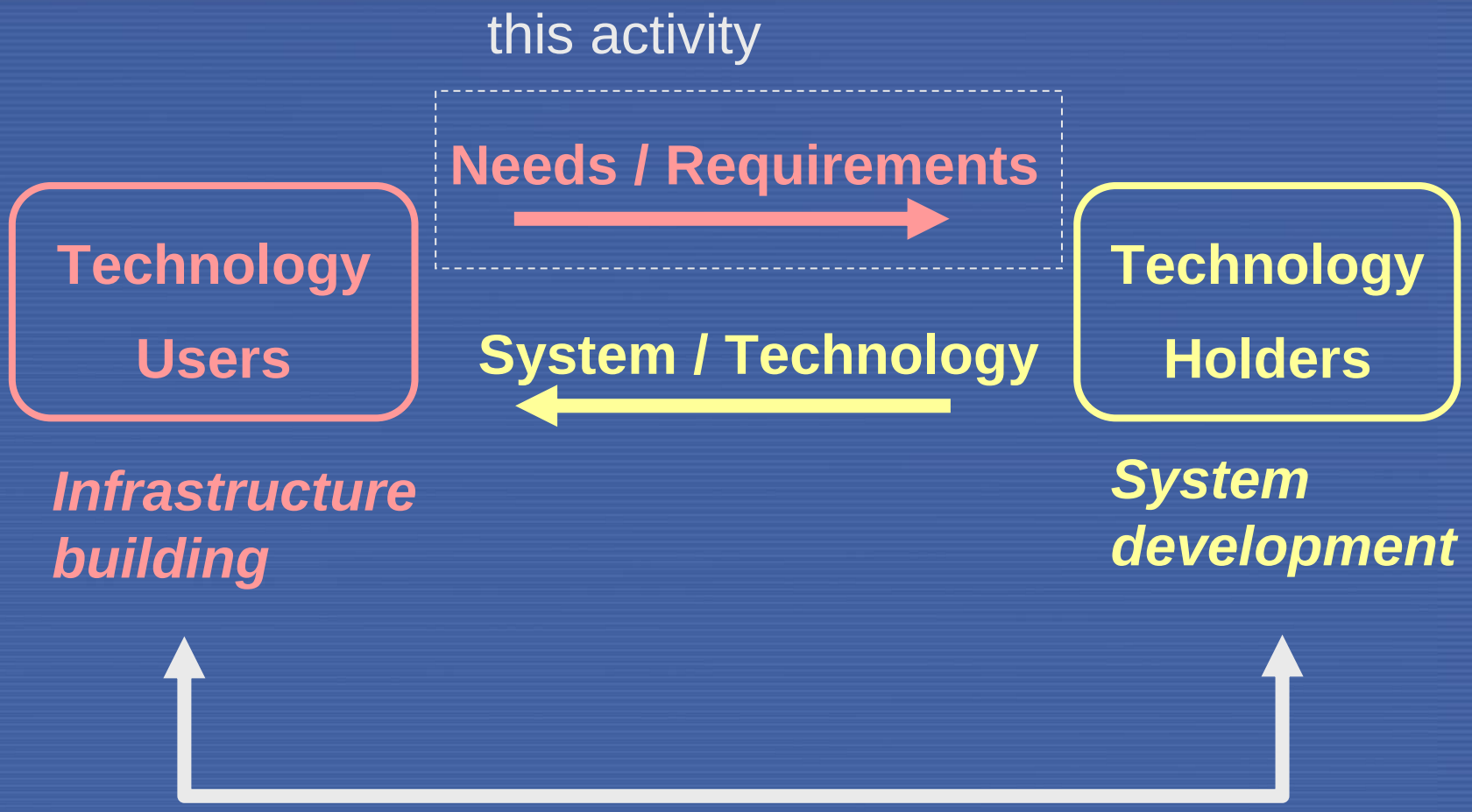
Relationship of Users and Holders



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Common User Criteria (CUC)

- To address sets of common characteristics needed and desired by potential users of new nuclear power plants in “developing countries” for next 50 years
  - General technical and economic characteristics of nuclear plant systems
  - Associated services and support
  - Nuclear fuel cycle options
- To be considered as a reference for technology holders on their technology development

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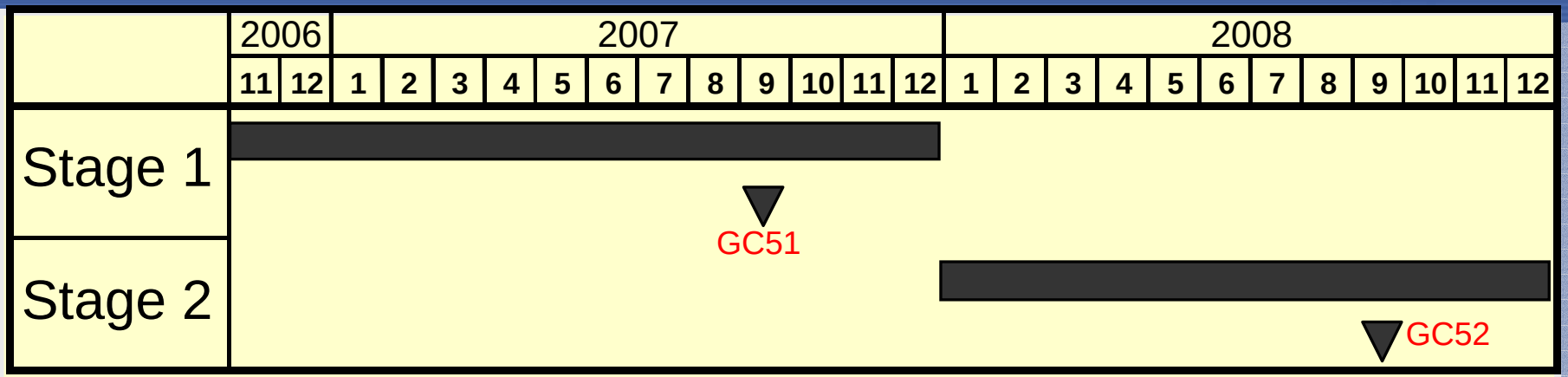
Overall Action Plan

- Stage 1 : Establish Common User Criteria
- Stage 2 : Consider necessary actions for the future by users and technology holders



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Basic approach of CUC development

"Detailed discussion" with 8 **representative countries** to produce draft CUC (May - August)

Workshop with all 55 **CUC countries** to get general agreement on CUC (Nov)

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Conclusion

- INPRO methodology has been developed for assessment of INS. Manual with 9 volumes will be published very soon.
- 13 Collaborative Project Proposals are waiting for implementation
- Common User Criteria (CUC) will be ready by the end of 2007 and actions to meet CUC will be discussed among users and developers in 2008

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Thank you for your attention

Http://www.IAEA.org/
Http://www.IAEA.org/INPRO

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INPRO Mission

- To provide a forum for discussion of experts and policy makers from industrialized and developing countries on all aspects of nuclear energy planning as well as on the development and deployment of innovative nuclear energy systems (INS) in the 21st century.
- To develop the methodology to analyze INS on a global, regional and national basis and establish it as an Agency's recommendation
- To facilitate coordinating and collaboration among member states for planning of INS development and deployment
- To pay particular attention to the needs of developing countries interested in INS.

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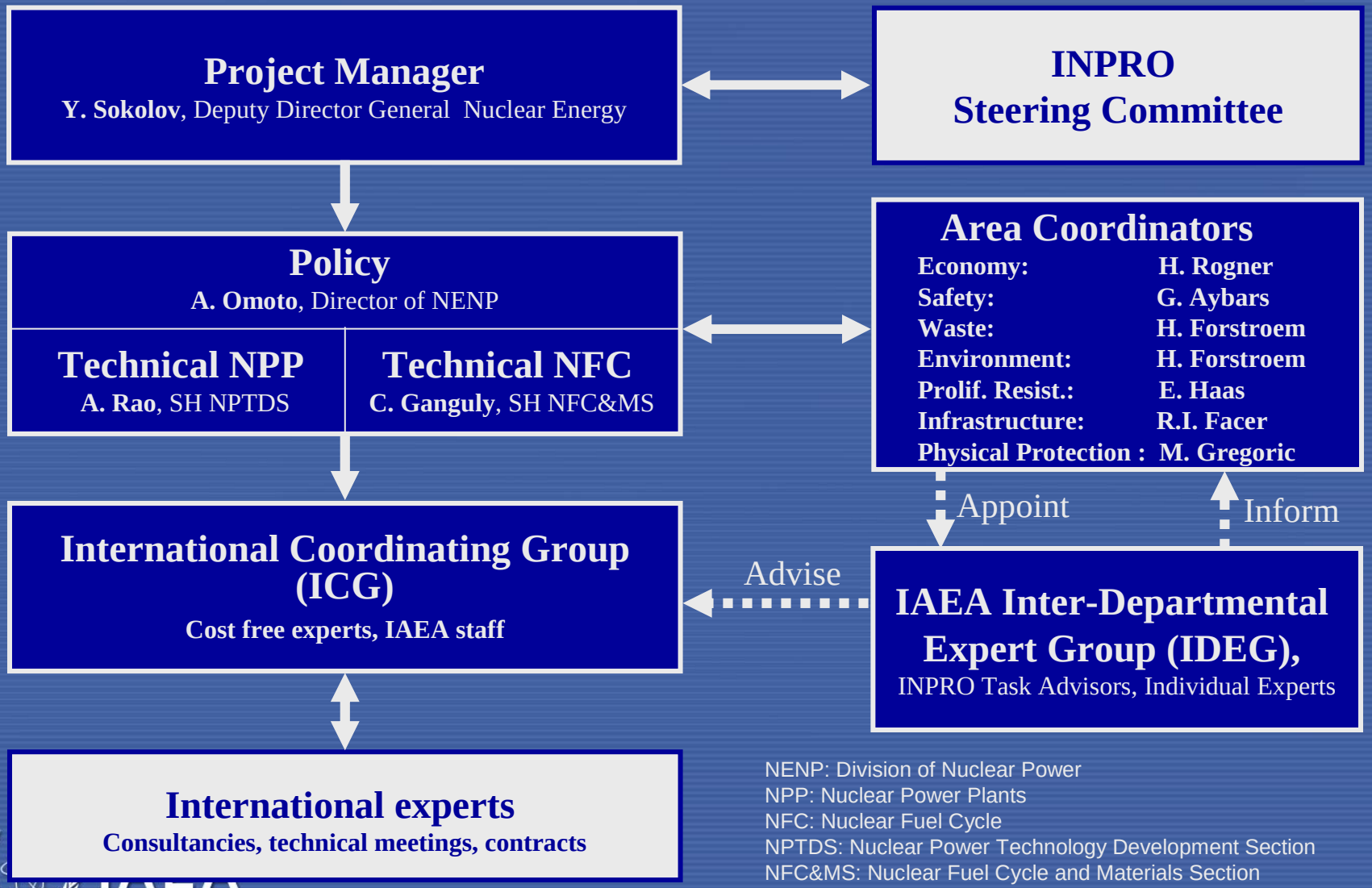
INPRO Organization



NENP: Division of Nuclear Power
NPP: Nuclear Power Plants
NFC: Nuclear Fuel Cycle
NPTDS: Nuclear Power Technology Development Section
NFC&MS: Nuclear Fuel Cycle and Materials Section
SH: Section Head

Countries addressed for CUC (CUC countries)

- IAEA Member States
- Gross National Income per capita ≤ $ 10,500/ year
- Expressed or potential interest for new nuclear or its expansion, but no on-going established long term nuclear construction project*

*: China and India are excluded

- **55 CUC countries identified**

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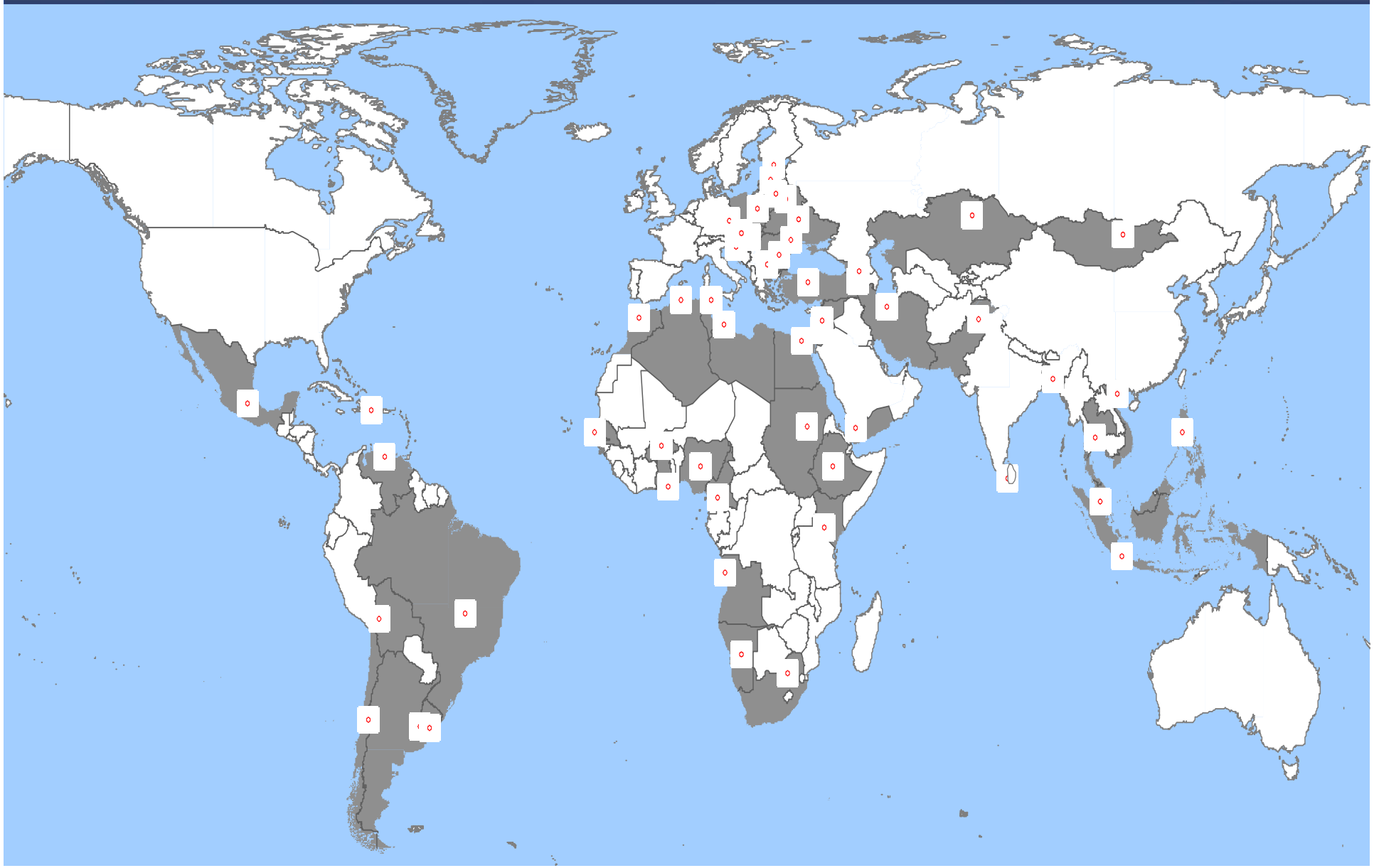
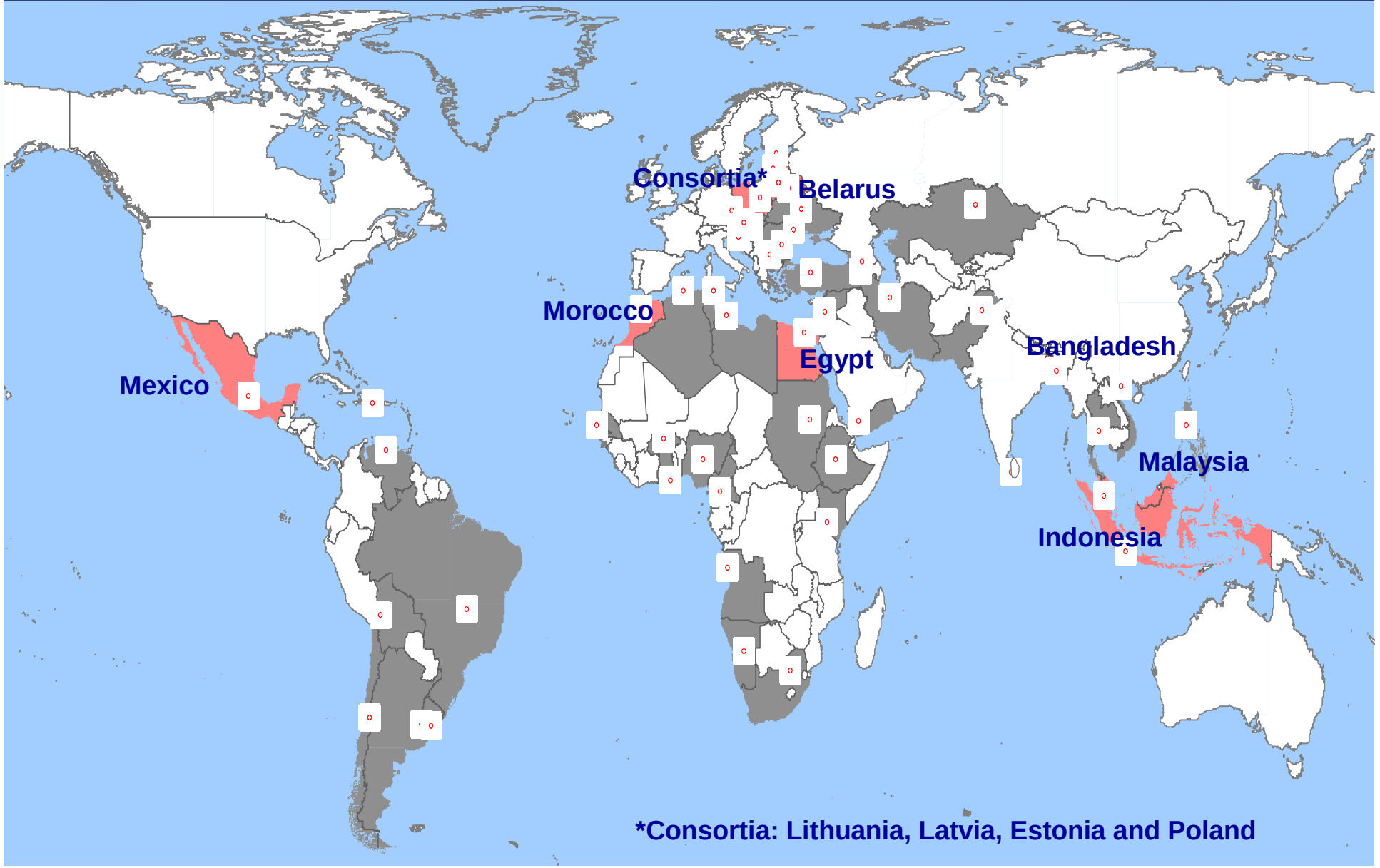
55 Countries addressed for CUC (CUC countries)



8 Representative Countries



Possible examples of CUC (1)

General technical and economic characteristics:

- Electrical capacity of NPP shall/must/should be more than 100MWe and less than 1000MWe.
- Power generation cost of NPP should/must be less than 150% of the cost of the most competitive power plant with the same level of capacity in the country.

Possible examples of CUC (2)

Associated services and supports:

- NPP project suppliers shall/must/should involve user country in the area of construction, manufacturing of regular equipments and O&M.
- NPP project suppliers shall/must/should provide services for removal or disposal of spent fuels

CUC Schedule

- Discussion with 8 rep. countries (May – Aug.)
- Draft CUC ready (Mid Aug.)
- Consultancy meeting with 8 rep. countries and technology holders (8 countries) to review draft CUC (First week of Sept.)
- Workshop with 55 CUC countries to get general agreement on CUC (Nov 27 – 29)
- Final CUC ready (End of 2007)