



International Atomic Energy Agency

Main Messages of INPRO

Paper: INPRO Status, Ongoing Activities and Outlook

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Introduction

- **INPRO** : International Project on **Innovative** Nuclear Reactors and Fuel Cycles.
- **Basis** of INPRO : **Resolution** at the IAEA General Conference in **2000/2001/2002/2003** in Vienna and at the United Nations General Assembly in 2001/2002/2003.

Text of IAEA General Conference Resolution
in September 2000:

IAEA GC 2000 has invited “all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology”

General objective of INPRO

To facilitate decision-making and implementing process for satisfying future energy needs in a sustainable manner through development and deployment of Innovative Nuclear Energy Systems (INS).

These systems will be competitive, safe and reliable, proliferation resistant and environmentally benign, will efficiently utilize resources and will be supported by adequate infrastructure. Having proved the fulfillment of these requirements the INS will be accepted by the society.

Goals of INPRO

- INPRO Goals (Terms of Reference):
 1. To help to ensure that nuclear energy is available to contribute in fulfilling energy needs in the 21st century in a sustainable manner.
 2. 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.
 3. To **create a process** that involves all relevant stakeholders that will have an impact on, draw from, and complement the activities **at the national and international level**.
- INPRO Time horizon is 50 years into the future.

Status of INPRO

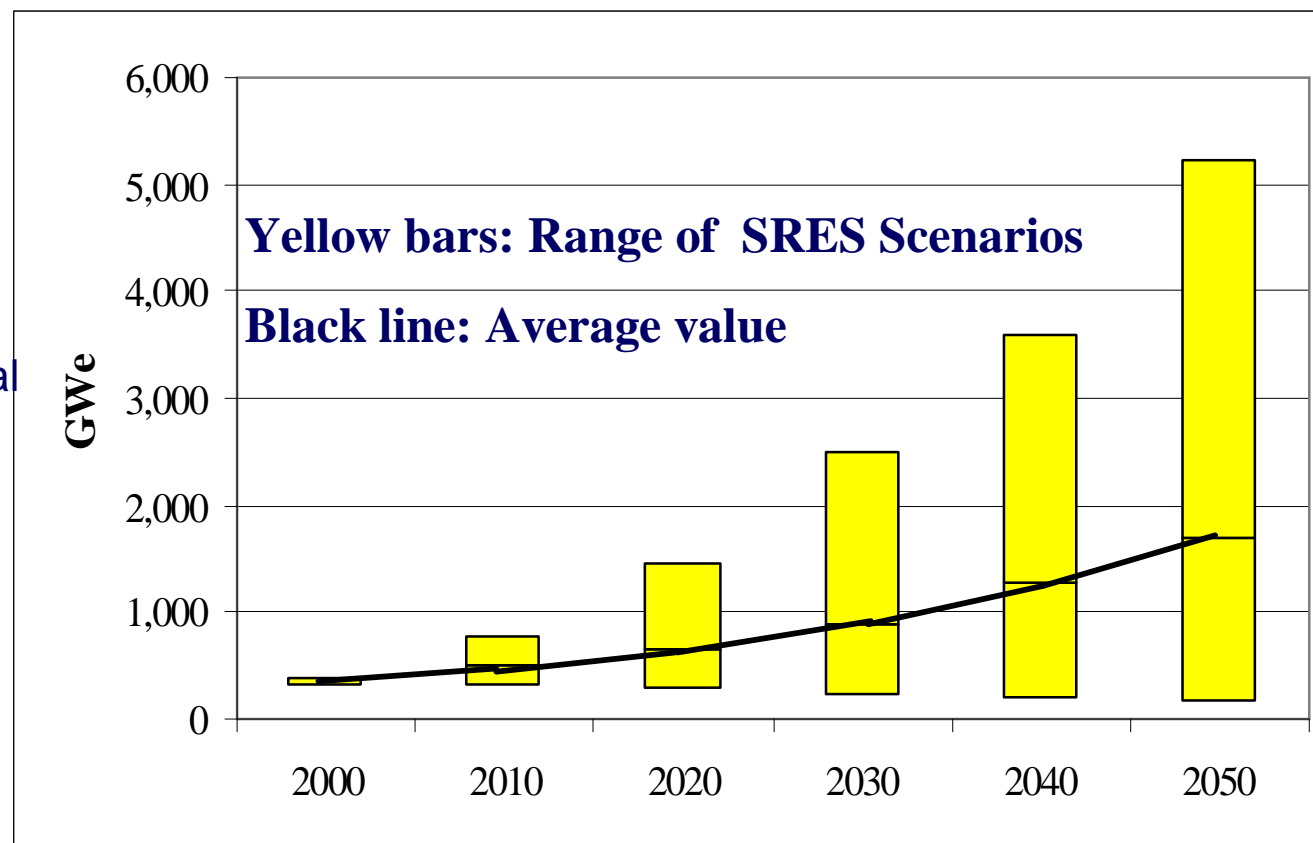
- **June 2003: End of INPRO Phase 1A**
 - Phase 1A: Definition of **Basic Principles, User Requirements and Criteria** for Innovative Nuclear Energy Systems in the Area of **Economics, Environment, Safety, Waste Management, Proliferation Resistance, Crosscutting Issues, and Outline of Methodology**
- **Documentation** of Results of INPRO Phase 1A in IAEA Report **TECDOC-1362**
- **July 2003: Start of Phase 1B (Validation of Methodology)**

Status of INPRO

- **19 Participants** in INPRO (April 2004):
 - Argentina, Brazil, Bulgaria, Canada, Czech Republic, China, France, Germany, India, Indonesia, Republic of Korea, Pakistan, Russian Federation, South Africa, Spain, Switzerland, The Netherlands, Turkey and the European Commission.
 - Number of participants is growing
- Several Observers in INPRO (e.g. Australia, Belgium, Chile, Croatia, Japan, UK, USA, OECD/NEA, etc.)

INPRO Main Messages in the Area Nuclear Power Prospects and Potentials

SRES = Special
Report on
Emission
Scenarios of the
Intergovernmental
Panel on Climate
Change (**IPCC**)

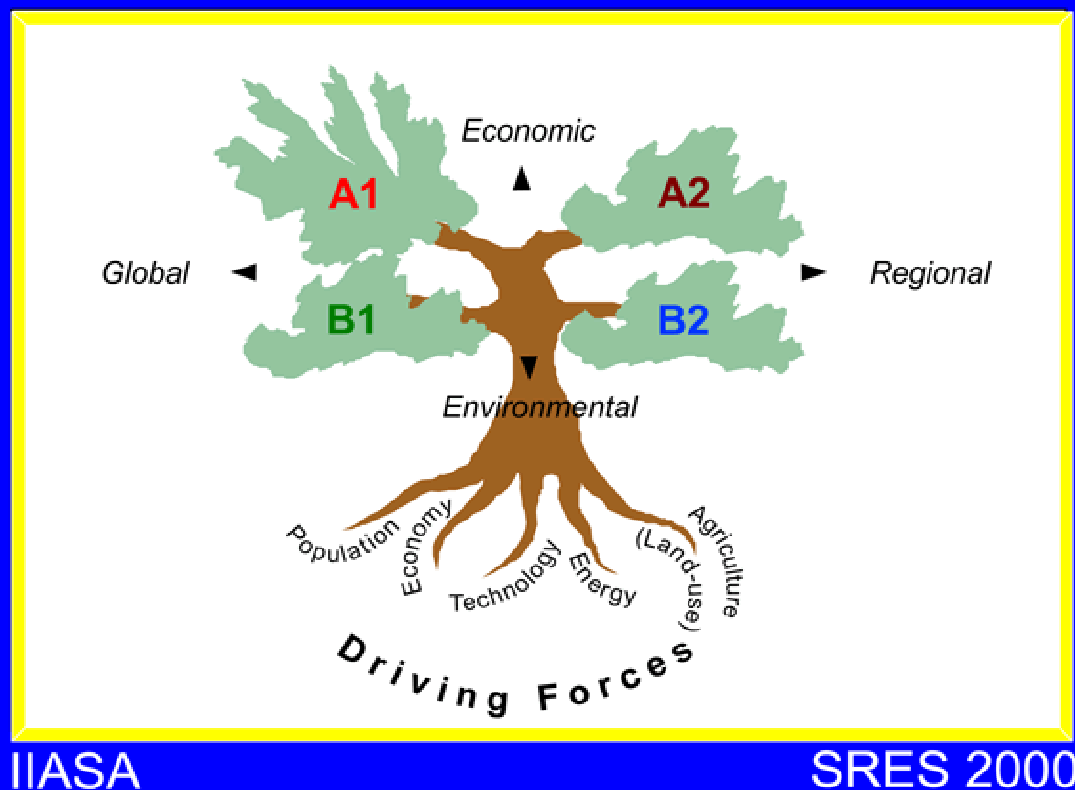


Predicted World Nuclear Electricity Production (GWe)

(Source : IPCC)

INPRO Main Messages in the Area Economics

SRES SCENARIOS



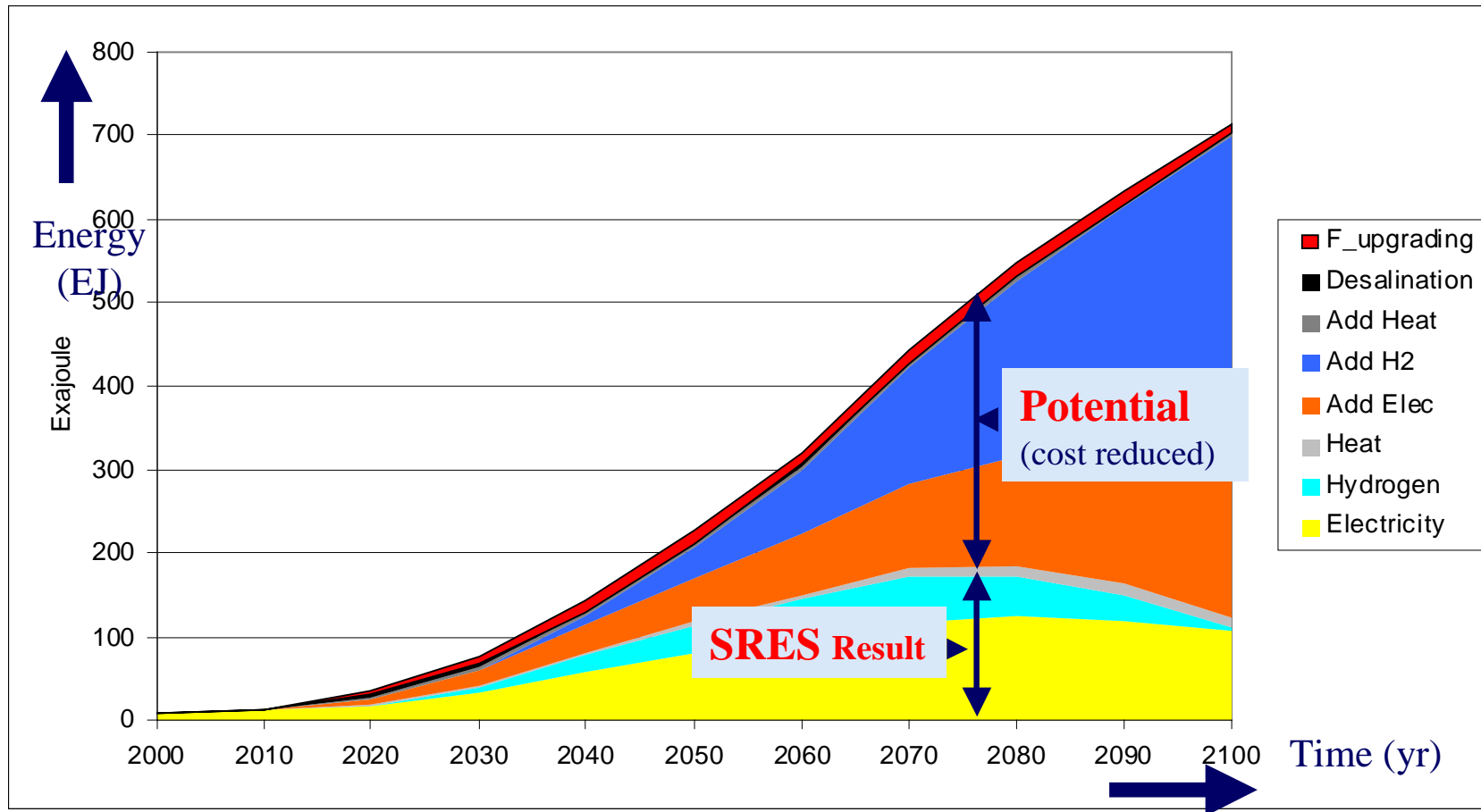
SRES = Special
Report on Emission
Scenarios of the
Intergovernmental
Panel on Climate
Change (**IPCC**)

IIASA =
International
Institute for Appplied
System Aalysis

➔ Selection of **4 Representative Scenarios** of the Future out of 40



Main Messages of INPRO in the Area Economics

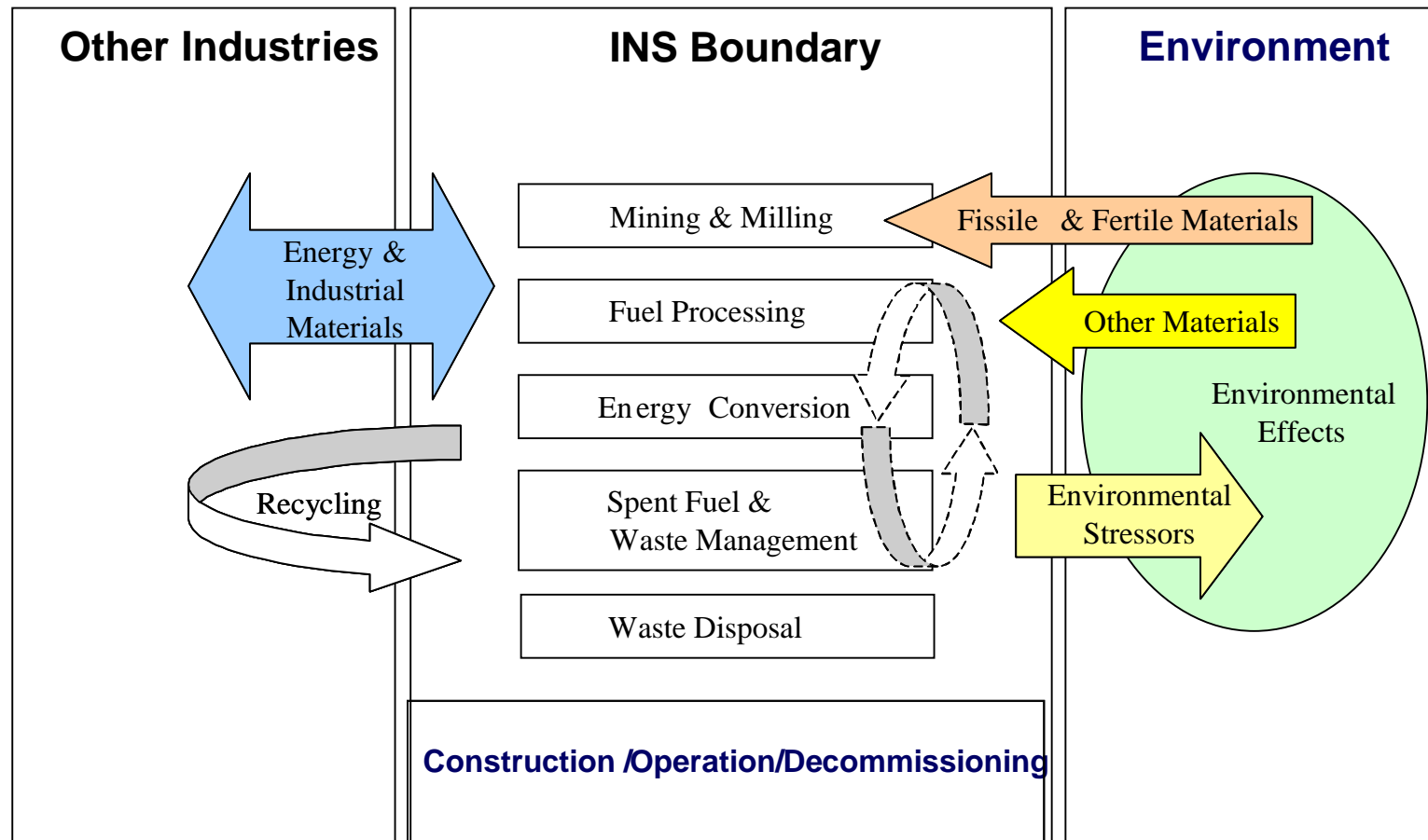


Potential Global Market for Nuclear Power (Electricity, Hydrogen, Heat and Desalination) for SRES Scenario A1T

Main Messages of INPRO in the Area Economics

- The **cost of energy** from an Innovative Nuclear Energy System (**INS**), taking all costs and credits into account, must be **competitive with** that of **alternative** energy sources
- INS must represent an **attractive investment** compared with other major investments
- Improved Learning rates (**cost reductions**) **needed** compared to SRES predictions

Main Messages of INPRO in the Area Sustainability / Environment



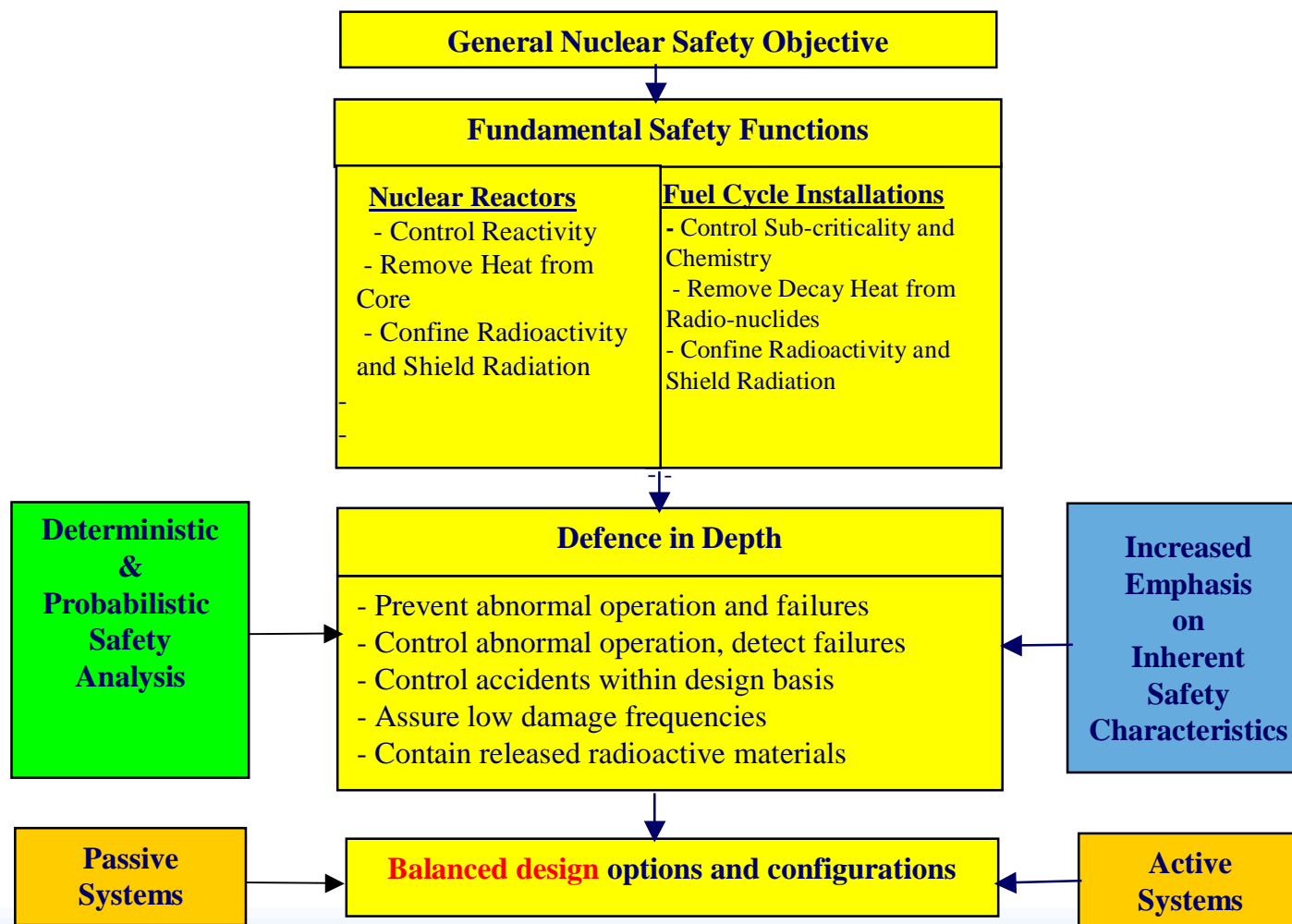
- **Holistic Approach for Environmental Assessment**

Main Messages of INPRO in the Area Environment

- Acceptability of Environmental Effects:
The **adverse environmental effects** of the INS must be **well within the performance envelope of current nuclear** energy systems.
- Fitness for Purpose :
The INS must be **capable of contributing to the energy needs in the future** making efficient use of non-renewable resources.

Main Messages of INPRO in the Area Safety of Nuclear Installations

Development of Basic Principles, User Requirements and Criteria in the Area of Safety



Main Messages of INPRO in the Area Safety of Nuclear Installations

- The Innovative Nuclear Reactors and Fuel Cycle Installations shall:
 - Be so safe that they **can be sited in locations similar to other industrial facilities** used for similar purpose.
 - No need for evacuation outside the plant.
 - Incorporate **enhanced defense in depth.**
 - Incorporate **increased emphasis on inherent safety and passive features.**
 - Include **holistic life-cycle analysis.**
 - Consider all components of INS (**cradle to grave**).

Main Messages of INPRO in the Area Waste Management

- Waste Management Installations shall (IAEA SS 111-F) **secure acceptable level of protection** for:
 - **Human health**
 - Avoid undue burdens on future generations
 - **Environment**
 - Including effects beyond national borders
- **Minimize waste generation**
- **Consider all interdependencies among all steps of waste generation**

Main Messages of INPRO in the Area Proliferation Resistance

- Definition of Proliferation Resistance (PR):
 - **Characteristics** of nuclear energy system that **impedes diversion** or **undeclared production** of nuclear material or **misuse** of technology.
- Achievement of PR by **balanced combination** of:
 - **Intrinsic** Features: Technical design (e.g., core with small reactivity margins).
 - **Extrinsic** Measures: Control and verification agreements (e.g., IAEA safeguards).
- **Need** for internationally accepted **assessment method**

Main Messages of INPRO in the Area Crosscutting Issues

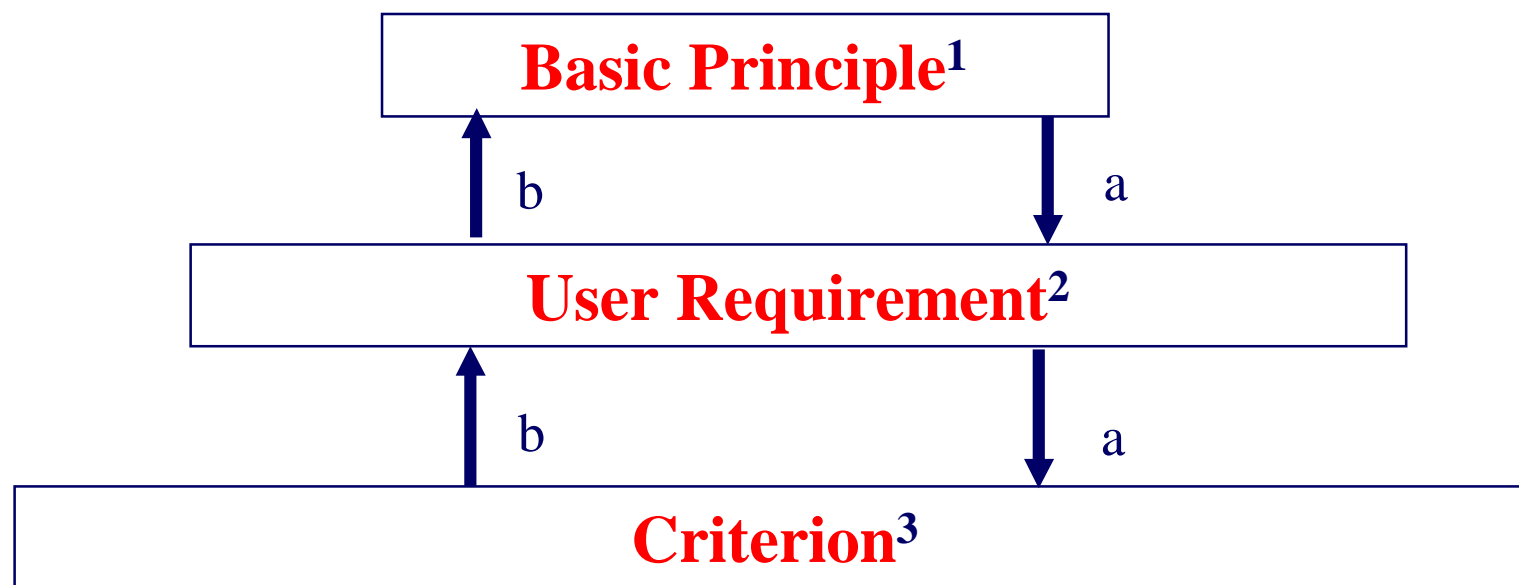
- **Need of Improvement of:**
 - Legal and Institutional **Infrastructure**
 - Economic and Industrial Infrastructure
 - Socio-Political Infrastructure
 - Human Resources and Knowledge
- **Improvement via e.g.:**
 - **International accepted** licensing
 - International multi-component system
 - Application of INPRO requirements
 - Enhanced international cooperation

Main Messages of INPRO in the Area Methodology for Assessment

- For all INPRO Areas Development of :
 - **Basic Principles**
 - **User Requirements**
 - **Criteria**
- Compiling of **Approaches** in INS relevant to different Areas
- Check of Compliance of Approaches by **Judgment of Potential** to fulfill Criteria.

Main Messages of INPRO in the Area Methodology for Assessment

INPRO Hierarchy of Demands on Innovative Nuclear Energy Systems (INS)



a = Derivation

b = Fulfilment

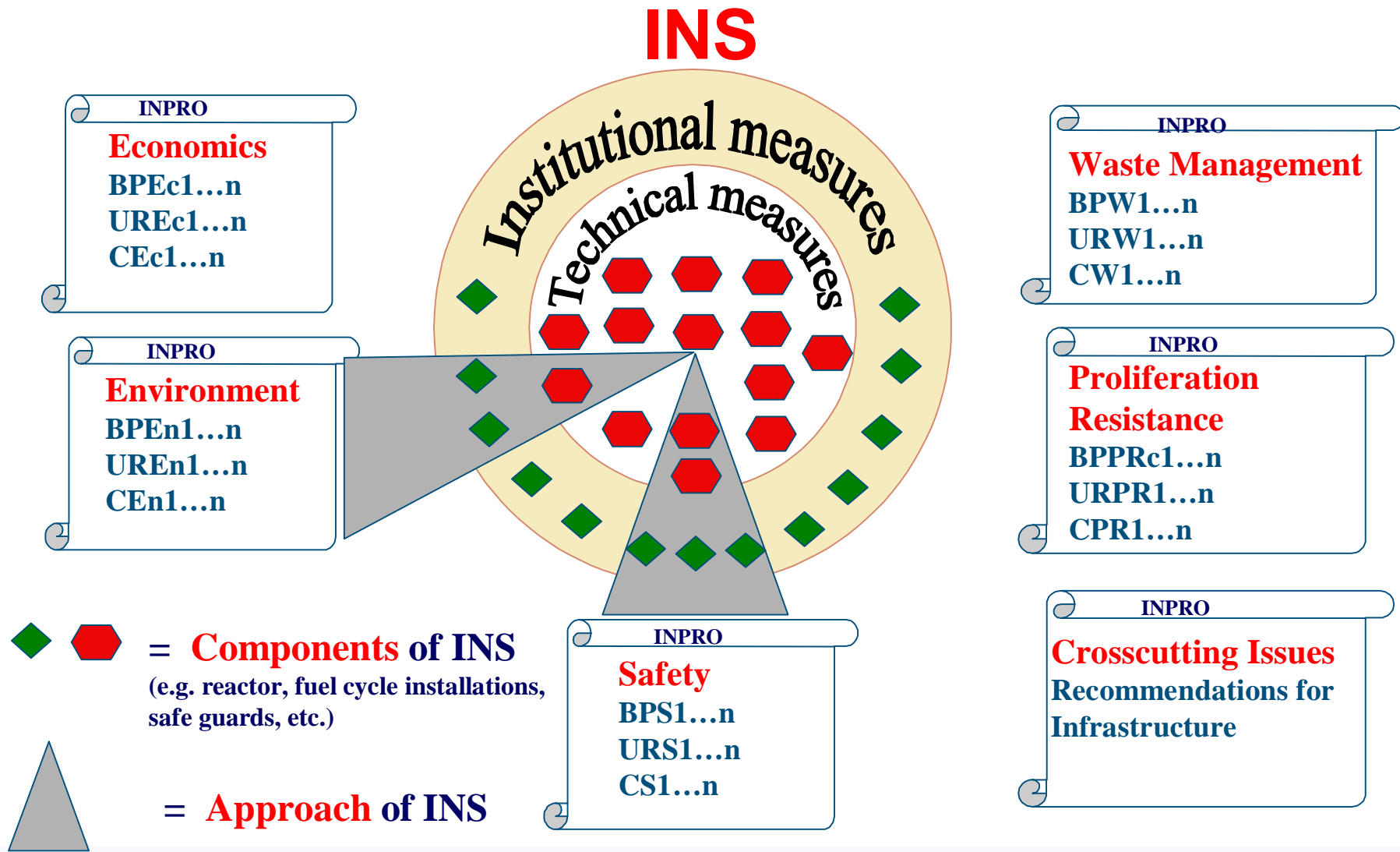
1 ~ Goal in GIF

2 ~ Criteria in GIF

3 ~ Metrics in GIF



Main Messages of INPRO in the Area Methodology for Assessment



Methodology for Assessment of INS

- **Developed and published in TECDOC 1362**
- **Validation ongoing by several case studies**
- **The outcome will be incorporated in a Manual for the application of the Methodology for Assessment of INS**

Ongoing activities

Phase 1B

- Feedback from
 - National Case Studies
 - Individual Case Studies
 - Different categories of userswill result in the validation of the INPRO methodology and, where necessary, an adjustment of BP, UR and Criteria
- Case Studies

Case studies are to be performed to gain experience with the INPRO methodology, and to assess :

 - ü whether the BP, UR and C are understandable, workable, consistent (avoid redundancy), comprehensive (additional needed ?) and independent of the system studied.
 - ü whether the INPRO methodology is useful for providing an overall assessment of the INS, comparing different INS, identifying regional specificities and identifying R&D needs.

Ongoing Activities in Phase IB

- INPRO Phase 1B started in July 2003:
Validation of INPRO Methodology via
 - National Case Studies performed by Member States:
 - Argentina with CAREM-X,
 - India with AHWR,
 - Korea with DUPIC,
 - Russia with BN family
 - China with PBR
 - Czech Republic with M S R
 - Results of all Case Studies are due June 2004
 - Consultancies with industry and regulators

Outlook: Phase II

Background

- All scenarios (e.g. SRES from IPCC) show a substantially increasing demand for energy (mostly electricity)
- Highest increase of energy demand in developing countries
- INS clearly needed to satisfy the increasing demand for energy
- INS must satisfy special needs of developing countries
- Many innovative nuclear reactors and associated fuel cycles are being developed in Member States

Outlook: Phase II

INPRO approach

- **INPRO uses a holistic view for INS assessment (cradle to grave)**
- **INPRO has created a tool (INPRO methodology) which is capable of defining an optimized INS based on local, regional or global boundary conditions**

Outlook: Phase II (INPRO Vision)

- **Further development of INPRO methodology and its establishment as an internationally acknowledged IAEA recommendation for the assessment of INS**
- **Assistance to INPRO Members in energy planning and analyzing the possible future role of nuclear energy in global, regional and national context.**
- **Identification of technologies (National preferences) and R&D needs, examination of the feasibility of commencing international projects on multilateral or international basis.**

Outlook: Phase II (INPRO Vision cont'd)

- **Coordination of R&D Projects carried out by INPRO members, on national, bilateral, or multilateral basis.**
- **Promotion of infrastructure development needed for deployment of INS**
- **Coordinate and assist INPRO Member States with activities to communicate information in order to support the public acceptance**
- INPRO will address the needs of both technology users and technology holders with especial emphasis on the needs of developing countries.
- INPRO will seek cooperation from other international initiatives like GIF.

INPRO-GIF Interactions

- Continuous **Participation of IAEA in GIF** policy and expert **groups**
- GIF participated in last INPRO Steering Committee
- Performance of **comparison of both assessment methodologies** in January 2004, based on GIF peer review of INPRO Methodology
- Co-operation between IAEA-INPRO and GIF in analysis of sustainability, globalisation and safety

CONCLUSIONS

- Ø INPRO has political, financial and technical support from Member States**
- Ø Phase IA on the establishment of Basic Principles, User Requirements and Criteria and the development of an Assessment Methodology has been finalised**
- Ø Phase IB addresses the validation of the INPRO methodology and the assessment of concepts and approaches**
- Ø INPRO is open to all interested Member States and International Organizations**