

IAEA ACTIVITIES IN SUPPORT OF RISING EXPECTATION FOR THE ROLE OF NUCLEAR POWER IN DEVELOPING COUNTRIES

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IAEA

International Atomic Energy Agency

Rising expectation to the role of nuclear power

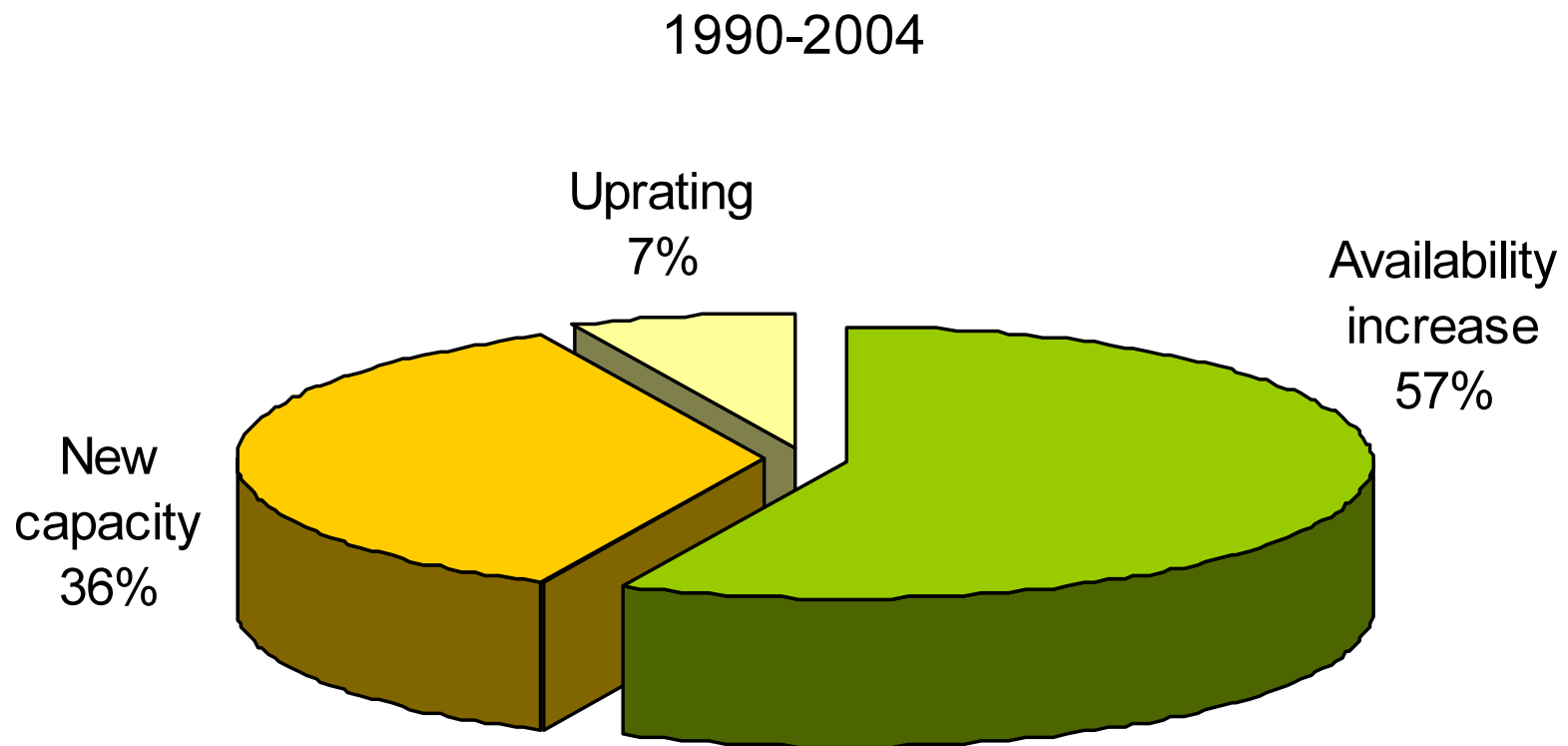
Agency's Support to Infrastructure building

On-going trend on Nuclear Power

- **Current worldwide nuclear generating capacity**
 - ✓ Commercial NPPs in Operation 442 (~ 370 Gwe)
 - ✓ Share of nuclear electricity 16%
- **Observed slowdown of capacity addition since late 80's**
 - ✓ Electricity market deregulation
 - ✓ Slow growth of electricity demand in advanced countries
 - ✓ Public Perception
 - ✓ Economic reforms in Russia and EE countries
- **Current expansion in Asia**
- **Nuclear electricity increased due to availability increase**
 - ✓ Best practice prevailing
 - ✓ Consolidation to those who perform best
 - ✓ Risk-informed regulation

From 1990 through 2004, global nuclear electricity production increased ~40%

Fig.1: Contributions to nuclear production growth



On-going trend on Nuclear Power

In addition to continuing new build in Asia

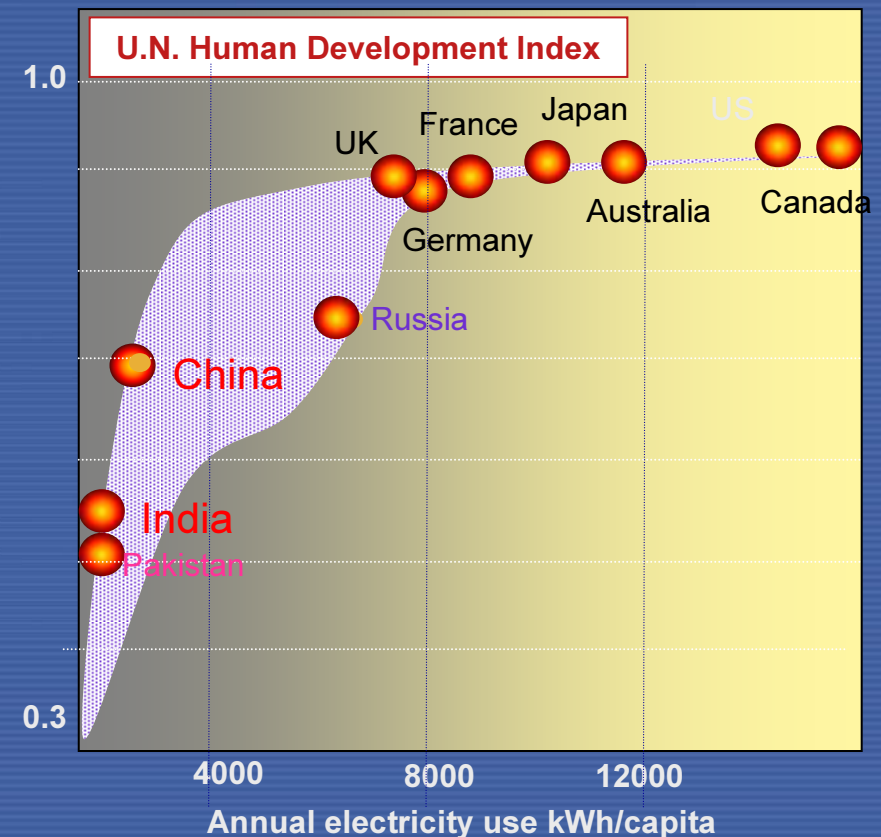
✓ Revisit to nuclear option for new build in some OECD countries

✓ Ambitious expansion plan in Asia/EE

✓ Growing interest from developing countries not operating any NPP yet

growth of;

- population
- per capita energy consumption



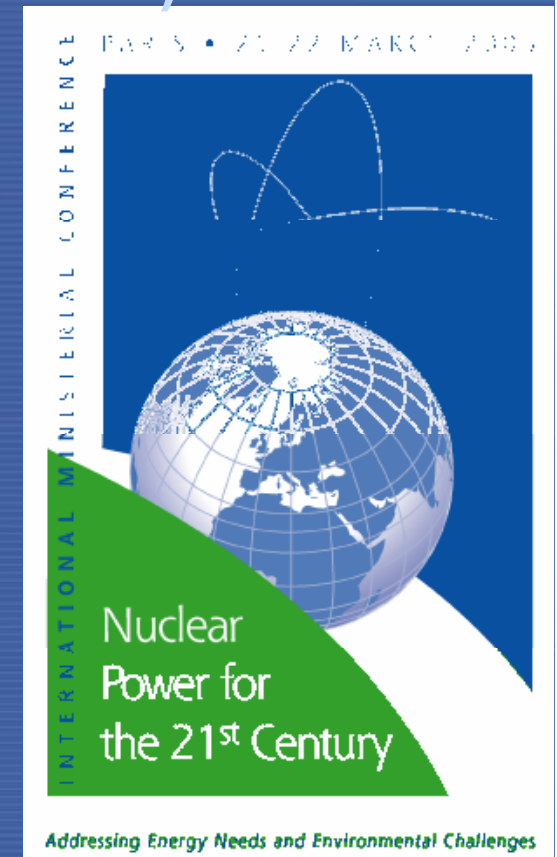
Rising expectation

□ Paris Ministerial Conference (21-22 March 2005)

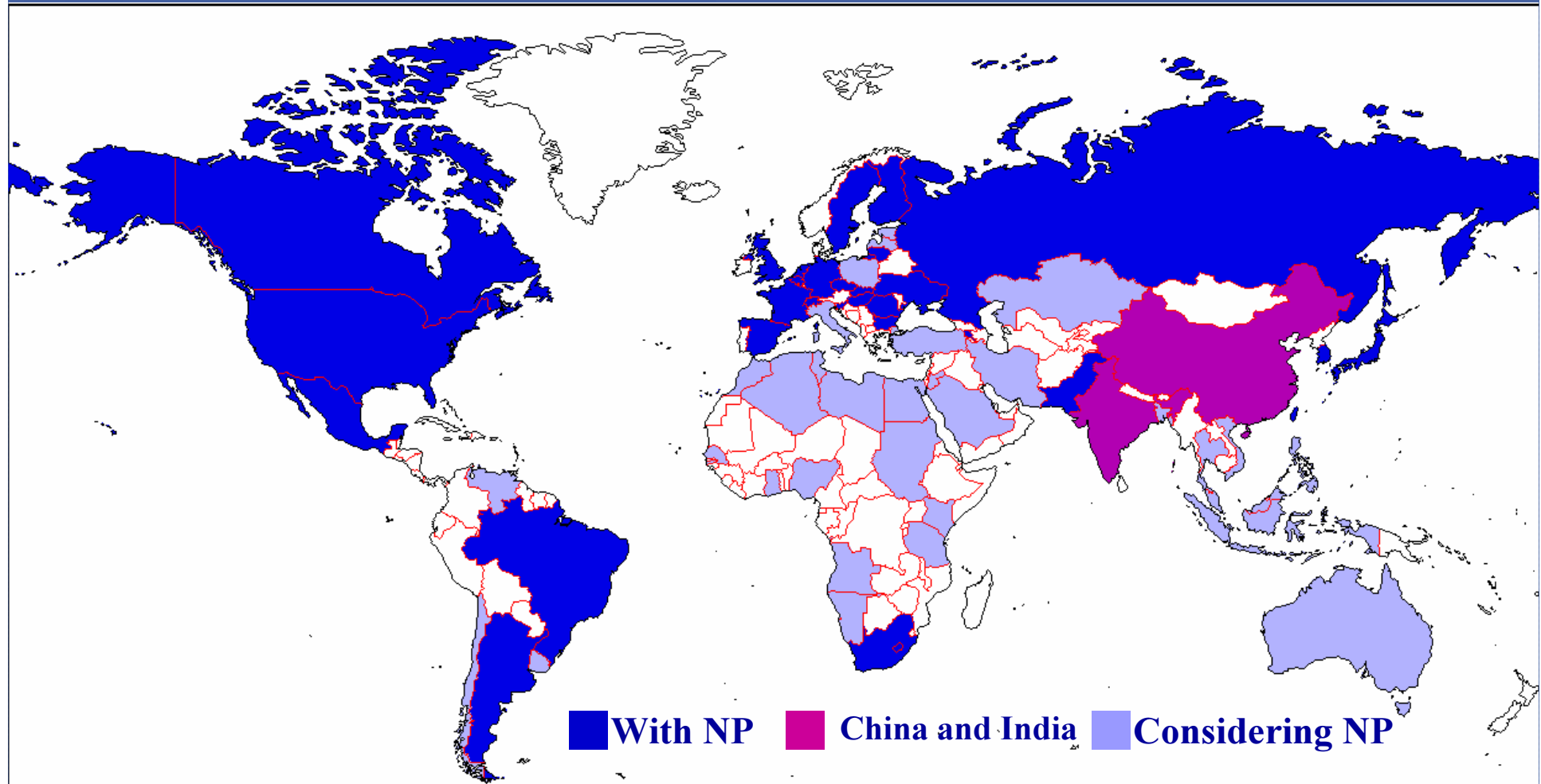
- 74 MSs, and 10 International Organisations
- Of 32 Ministers, or statements on behalf of Ministers
13 from MSs without Nuclear Power, of which;
✓8 Indicated positive move to nuclear power
Morocco, Indonesia, Iran, Poland, Turkey,
Bangladesh, Egypt, Vietnam

□ Other MSs that have expressed interest in Nuclear Power on various occasions

Chile, Malaysia, Thailand, Uruguay, Algeria, Tunisia, Tanzania, Nigeria, Sudan... 30 Plus countries listed

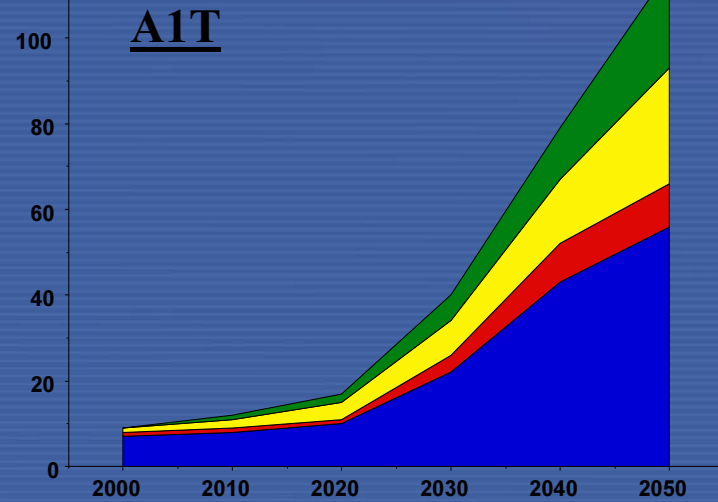


Increasing Nr. of countries considering nuclear power plant

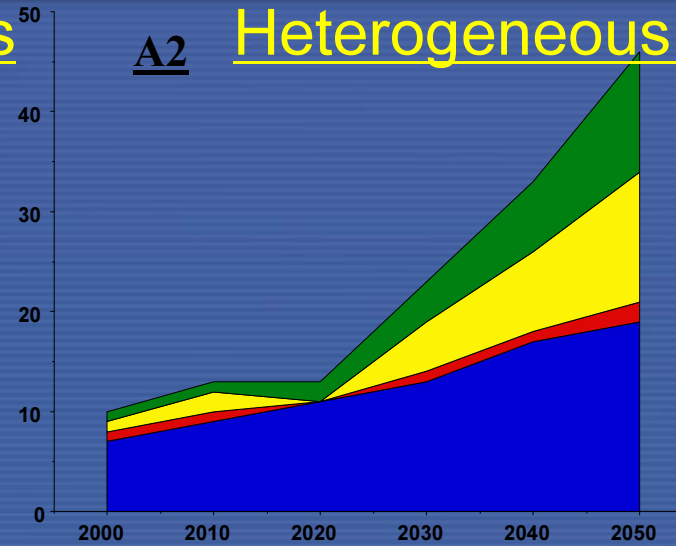


Nuclear Power in IPCC-SRES 4 storylines by 2050

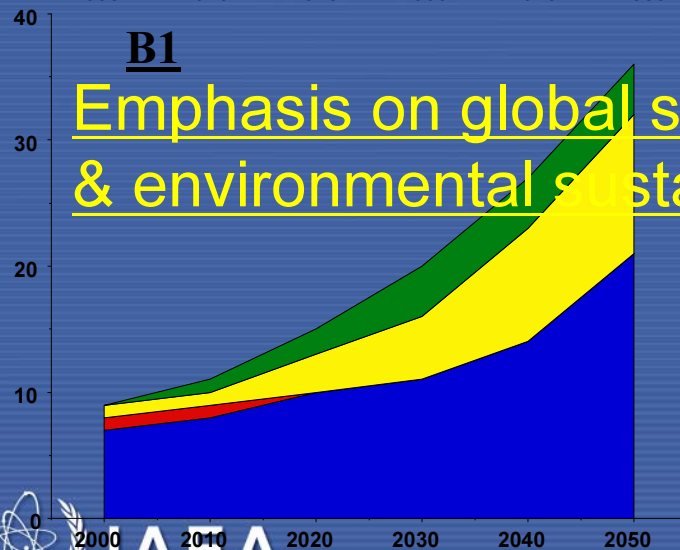
A1T Convergence among regions



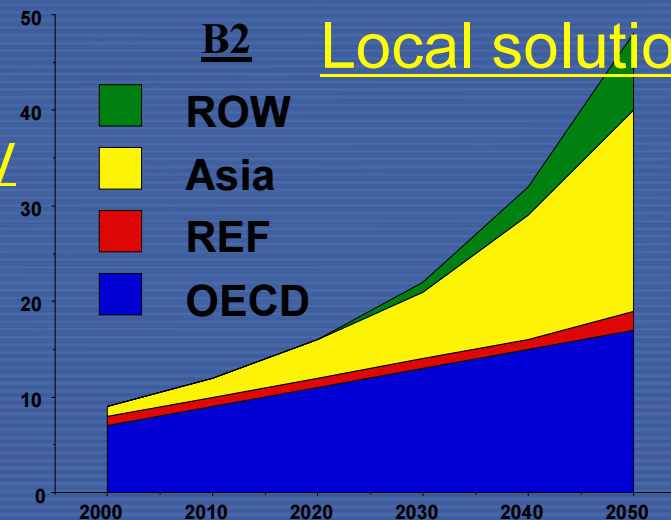
A2 Heterogeneous world



B1 Emphasis on global social & environmental sustainability



B2 Local solution

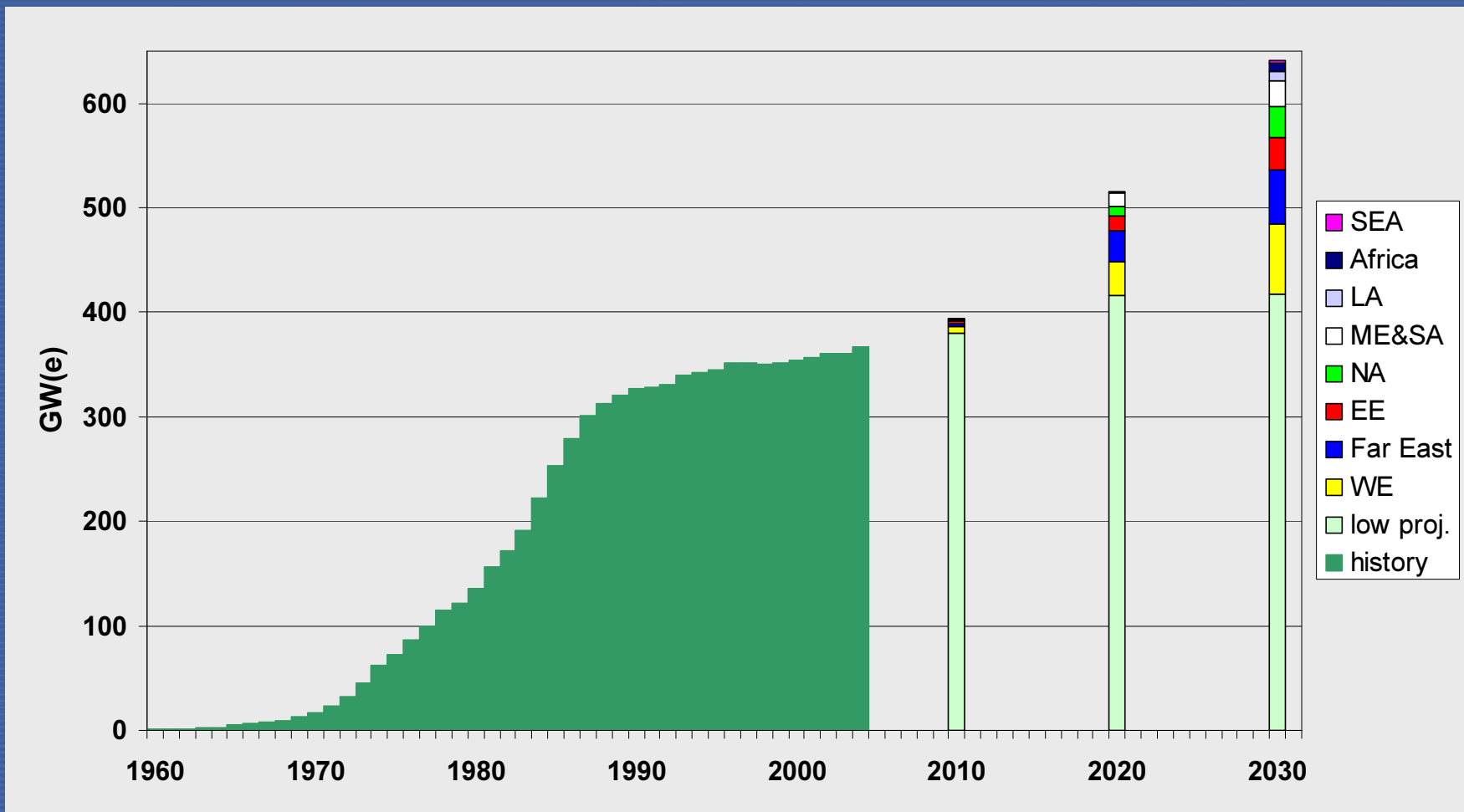


Ambitious near-term expansion plans

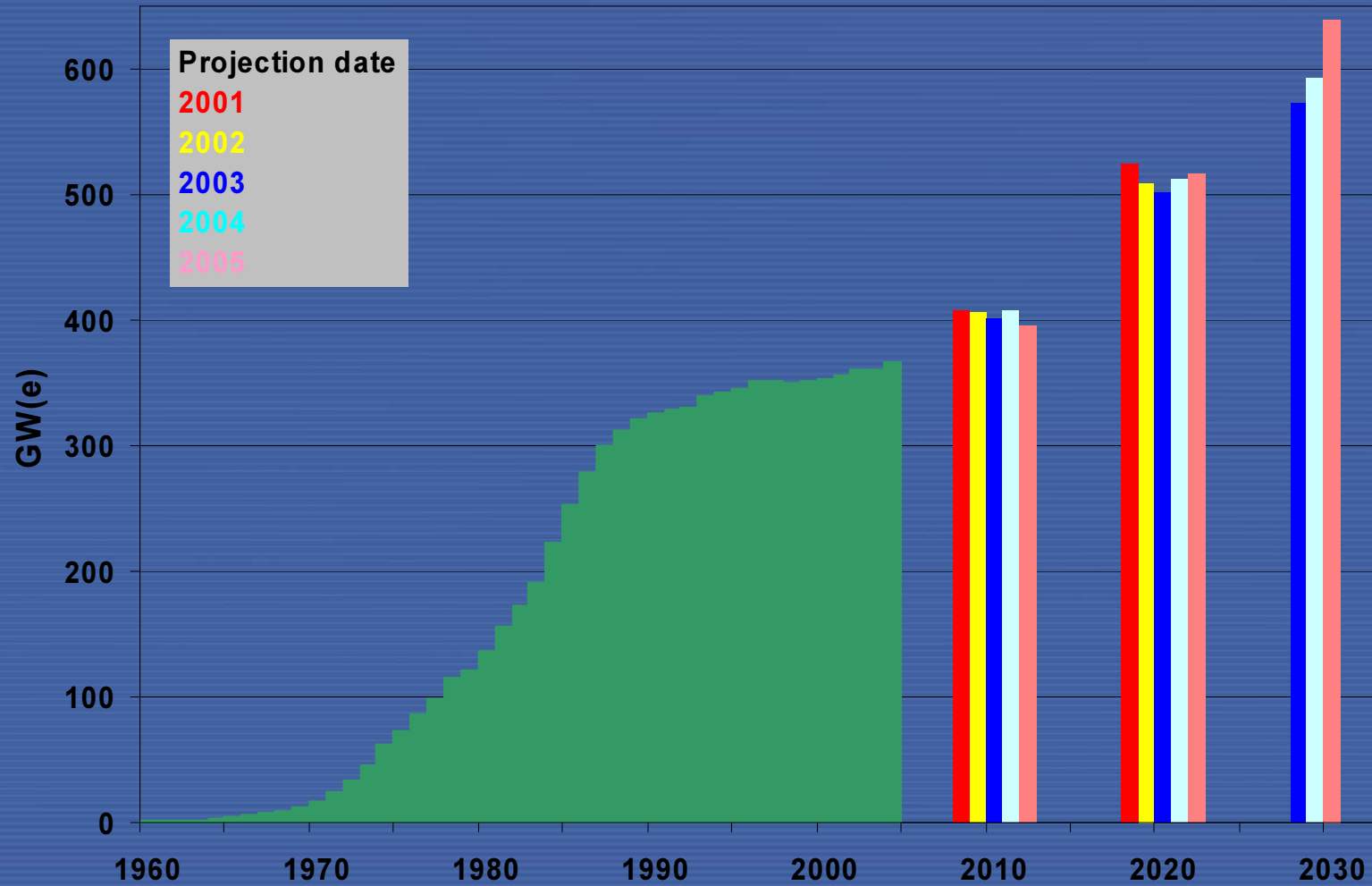
Declared near-term deployment plans (different in various sources)

	<u>CURRENT (% of total production)</u>	<u>NEAR-TERM EXPANSION PLAN</u>	
(Asia)			
China	6.6 GWe (2.03%) ...2x 1000 MWe plant/year	40 GWe (4%) by 2020	x 6
India	3.0 GWe (2.8%)	29.5 GWe (10%) by 2022	x 9
ROK	16.8 GWe (44.7%)	26.6 GWe by 2015	x 1.6
Pakistan	0.4 GWe (2.8%)	8.5 GWe by 2030	x 20
(Eastern Europe)			
Russia	21.7 GWe (15.8%)	40 GWe (25%) by 2020	x 2
Ukraine:	13.1 GWe (48.5%)	20-22 GWe by 2030	x 1.5

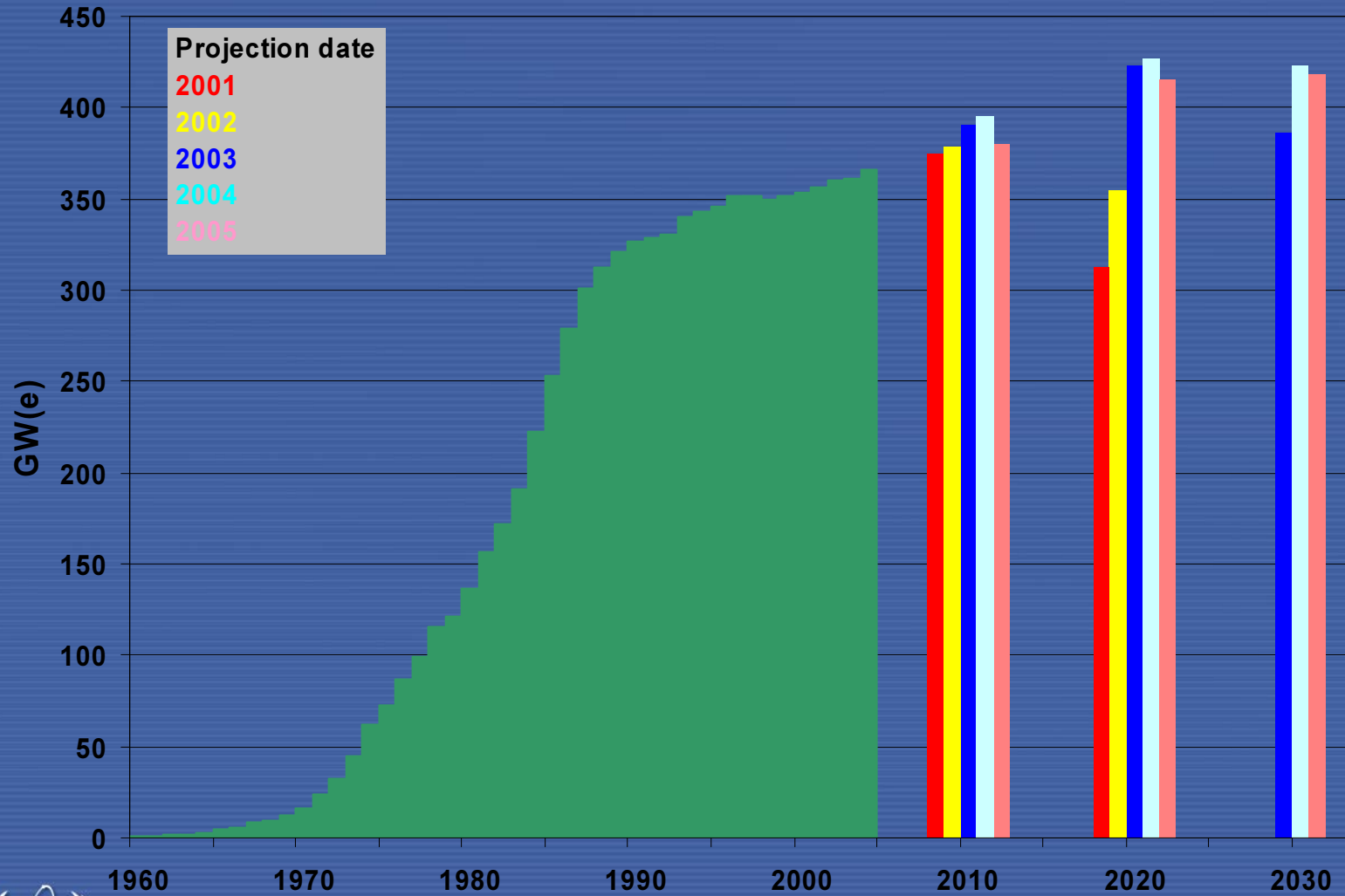
Rising expectations (IAEA high projection)



IAEA's high projections



IAEA's low projections



Background of rising expectation

- ❑ Confidence from operational trend
 - Stable and economically competitive in many places around the world
- ❑ Growing need for electricity supplies in developing countries
- ❑ Environmental concern (GHG emission, air pollution)
- ❑ Concern over energy supply security

Recognition of nuclear power as an important option in the nation's future energy portfolio

- environment
- energy security
- efficient use of resources
- potential for competitiveness

Nuclear Energy and Sustainable Development

□ Many attributes of nuclear energy have potential to contribute to improve indicators of sustainable development

* Achieving sustainable growth and global equity within and across countries as well as across generations

□ Potential to improve EISD of a nation by having NE in the energy portfolio

EISD (Energy Indicator for Sustainable Development)

- ✓ 29 indicators : Society (4), Economy (15), Environment (10)
- ✓ Usable to
 - Analyze: past trends and current situation
 - Diagnose: measure distance to target
 - Formulate strategy: explore options
- ✓ Published in 2005 through the concerted efforts by UN-related organs, IEA and others



EISD in “Society” dimension

Theme	Sub-theme	Energy Indicator	
Equity	Accessibility	SOC1	Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy
	Affordability	SOC2	Share of household income spent on fuel and electricity
	Disparities	SOC3	Household energy use for each income group and corresponding fuel mix
Health	Safety	SOC4	Accident fatalities per energy produced by fuel chain

EISD in “Economy” dimension

Theme	Sub-theme	Energy Indicator	
Use and production patterns	Overall Use	ECO1	Energy use per capita
	Overall Productivity	ECO2	Energy use per unit of GDP
	Supply efficiency	ECO3	Efficiency of energy conversion & distribution
	Production	ECO4	Reserves to production ratio
		ECO5	Resources to production ratio
	End-use productivity	ECO6	Industrial energy intensities
		ECO7	Agricultural energy intensities
		ECO8	Service / Commercial energy intensities
		ECO9	Household energy intensities
		ECO10	Transport energy intensities
	Fuel Mix	ECO11	Fuel Shares in energy and electricity
		ECO12	Renewable energy share in energy and electricity
	Prices	ECO13	End use energy Prices by fuel and by sector
Security	Imports	ECO14	Net energy import dependency
	Stocks	ECO15	Stocks of critical fuels per corresponding fuel consumption

EISD in “Environment” dimension

Theme	Sub-theme	Energy Indicator	
Atmosphere	Climate Change	ENV1	GHG emissions from energy production and use per capita and per GDP
	Air quality	ENV2	Ambient concentrations of air pollutants in urban areas
		ENV3	Air pollutant emissions from energy systems
Water	Water quality	ENV4	Contaminant discharges in liquid effluents from energy systems including oil discharges
Land	Soil quality	ENV5	Soil area where acidification exceeds critical load
	Forest	ENV6	Rate of deforestation attributed to energy use
	Solid Waste generation & management	ENV7	Ratio of solid waste generation per energy produced
		ENV8	Ratio of solid waste properly disposed to total generated solid waste
		ENV9	Ratio of solid radioactive waste per energy produced
ENV10		Ratio of solid radioactive waste awaiting disposal to total generated solid radioactive waste	

Rising expectation to the role of nuclear power
Agency's Support to Infrastructure building

MSs request

- ❑ Many developing countries approaching the IAEA with requests to assist them with the energy planning including nuclear option as well as implementation of their first NPP Project
 - Some through Technical Cooperation Programme
 - Others directly through various channels
- ❑ Support to Infrastructure building is the key to countries thinking of its first NPP

Three pillars of IAEA's activity

- 1) Science & Technology
- 2) Safety & Security
- 3) Verification

← TC
(Technical
Corporation)

NE (Nuclear Energy)
NA (Nuclear Application)

Highlights of TC activities

Mandate based on Statute Article II

The Agency shall seek to accelerate and enlarge the contribution of atomic energy for peace, health and prosperity throughout the world

Goal

“To increasingly promote tangible socio-economic impact by contributing directly in a cost-effective manner to the achievement of the major sustainable development priorities of each country.”

882 current operational TC projects

667 National

192 Regional

23 Interregional



Highlights of TC activities

- ❑ Value US \$ 76.1 million
- ❑ Human Resources:
 - ✓ 3,121 International Expert and Lecturer Assignments
 - ✓ 2,848 Meeting/Workshop Participant Assignments
 - ✓ 1,411 Fellows/Scientific Visitors
 - ✓ 2,107 Participants in 155 Training Courses
- ❑ TC funding
 - ✓ TCF (Technical Cooperation Fund)
 - ✓ Voluntary Contributions
 - ✓ National Participation Costs (NPCs)
 - ✓ Extrabudgetary
 - ✓ In-kind
- ❑ Recipients: All IAEA Member States



Highlights of NS activities

Establishing IAEA Safety Standards

* Issued upon approval of BoG

Fundamentals*

**objectives, concepts,
principles**

Requirements*

**requirements that
must be met (“shall”)**

Guides

**recommendations
 (“should”)**



Highlights of NS activities

Safety Review services

- Providing Review services whenever there is a request from the Member State <http://www-ns.iaea.org/reviews/>

OSART(Operation safety)

TranSAS(Radioactivity transport)

EPREV (Emergency

Preparedness Reviews)

ORPAS (Occupational Radiation Protection Appraisals)

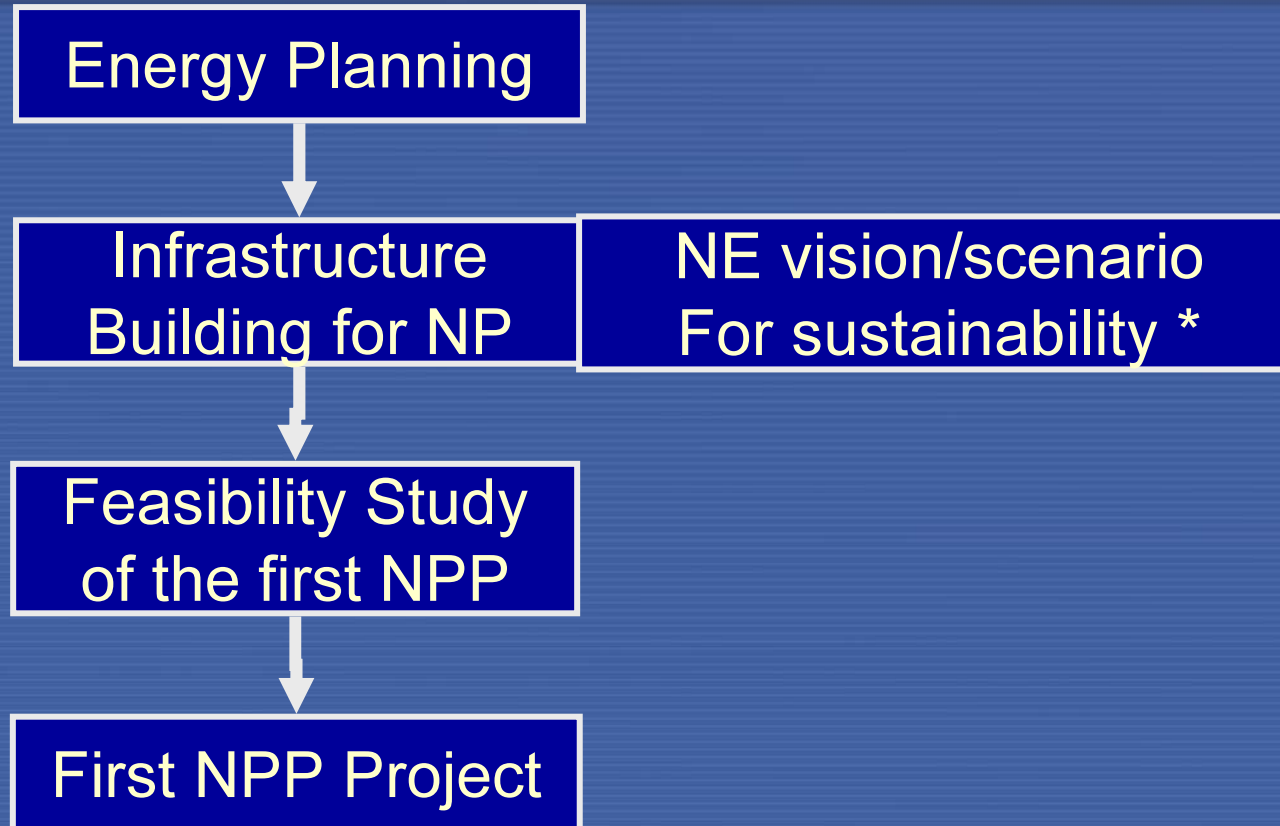
RaSIA (Radiation Safety Infrastructure Appraisal (RaSIA)

IPPAS (Physical Protection)

IAEA's role

- 1) To ensure **protection**: that, wherever nuclear energy is used to produce electricity , it is used:
 - Safely, Securely, and With minimal proliferation risk.
- 2) To ensure continued **technological innovation** – for greater efficiency in energy production, for improved economic viability, etc
- 3) To ensure that **the needs of developing countries are taken into account**:
 - That NE does not become an exclusive privilege of the few
 - That **technological innovation** focuses also on developing country needs
 - That **institutional innovation** focuses on ways to make nuclear energy more accessible to those countries that choose this option.

Possible steps



Methodologies / indicators for energy planner/decision-maker

- ❑ **EISD** (Energy Indicator for Sustainable Development)
 - ✓ to measure “distance to the target” in national energy plan
- ❑ Methodologies/Indicators for **comparative assessment**
 - ✓ of different energy technologies
 - ✓ considering
 - non-market value (environment/security)
 - whole energy chain (equipment production, fuel, transport)
- ❑ Methodologies/Indicators for assessment of different **nuclear energy systems and scenarios**
 - ✓ INPRO methodology

Tools for informed decision-making by MS for Capacity Building



- **M**odel for the **A**nalysis of **E**nergy **D**emand



- **W**ien **A**utomatic **S**ystem **P**lanning Package



- **E**nergy and **P**ower **E**valuation **P**rogramme



- **M**odel for **E**nergy **S**upply **S**ystem **A**lternatives and their **G**eneral **E**nvironmental impacts



- **F**inancial Analysis of Electric Sector Expansion **P**lans



- **S**implified Approach for Estimating **I**mpacts of Electricity Generation

Used in 102 countries

MESSAGE

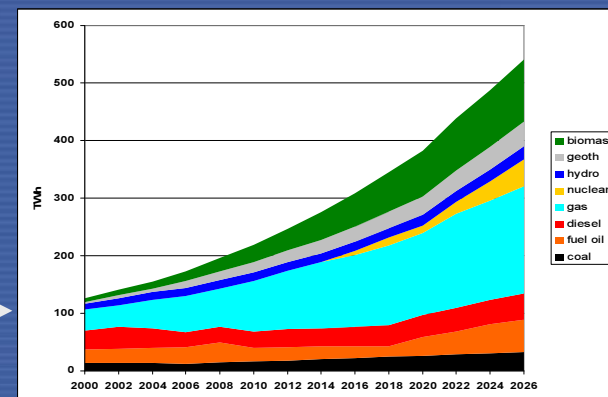
Model for Energy Supply System Alternatives and their General Environmental impacts

INPUT

- Energy system structure (including vintage of plant and equipment)
- Base year energy flows and prices
- Energy demand projections (MAED)
- Technology and resource options & their techno-economic performance profiles
- Technical and policy constraints



OUTPUT



- Primary and final energy mix
- Emissions and waste streams
- Health and environmental impacts (externalities)
- Resource use
- Land use
- Import dependence
- Investment requirements

Agency's approach in providing support for infrastructure building

- ❑ Recommend **comprehensive assessment of infrastructure preparedness** to avoid missing factors for effective implementation of NE plan to achieve the use of NE in safe, secure, technically sound manner
- ❑ Recommend the use of relevant **Agency's document**
- ❑ Recommend **regional approach** for efficiency
- ❑ Through **TCP** (if TC recipient country)
- ❑ Inter-departmental **coordinated response** to Member States

Agency's ongoing/planned activities

□ Guidance documents

- ✓ Released “Basic infrastructure for a nuclear power projects” (TECDOC 1513, June 2006)
- ✓ Preparing publication of new documents
 - Potential for sharing nuclear power infrastructure between countries (printing) (TECDOC 1522)
 - Planning for the first NPP (yet-to-be-published)
 - Milestone document (yet-to-be-drafted)
- ✓ Assessment of all previously developed Agency documentation & update : ongoing

Guideline documents to assist the first NPP Plan

Already published in the last 20+ years

Manpower Development for Nuclear Power: A Guidebook, Technical Reports Series No. 200 (1980).

- Introduction of Nuclear Power: A Guidebook, TRS No. 217 (1982)
- Interaction of Grid Characteristics with Design and Performance of Nuclear Power Plants: A Guidebook, Technical Reports Series No. 224 (1983)
- Promotion and Financing of Nuclear Power Programmes in Developing Countries, (1987)
- Developing Industrial Infrastructures to Support a Programme of Nuclear Power: Guidebook, TRS No. 281 (1988)
- Policy Planning for Nuclear Power: An Overview of the Main Issues and Requirements (1993)
- Choosing the Nuclear Power Option: Factors to be considered (1996)
- Economic Evaluation of Bids for NPPs, TRS No. 396, 1999
- Nuclear Power Programme Planning: An Integrated Approach TRS No. 1259 (2001)



Agency's ongoing/planned activities

- ❑ **TCP** (Technical Cooperation Project) for new build
 - ✓ Current : 6 TCP including coupling with desalination
 - ✓ 2007-8 : 12 countries plus regional projects
Algeria, Bulgaria, Indonesia, Jordan, Morocco, Nigeria, UAE, Egypt, Sudan, Mexico, Turkey, China
- ❑ Response to specific request, support to Uranium exploration
- ❑ **Workshops and Conferences**
 - ✓ “Issues for the Introduction of Nuclear Power” (Dec2006)
 - ✓ Other regional workshops planned for 2007
 - ✓ Participation to regional conferences on NE
 - Powering Africa (December 2006, South Africa)
 - NE conference in Algeria (January 2007)
 - ✓ 2nd Ministerial Conference on Nuclear Power in the 21st Century: Autumn 2008 in China
- ❑ **Institutional arrangements**
 - ✓ International cooperation in Fuel cycle, Licensing, Financing ...



4-6 December 2006 Workshop in Vienna

□ “Issues for the Introduction of Nuclear Power”

<http://www-pub.iaea.org/MTCD/Meetings/Meetings2006.asp>

□ By

- Representatives from Member States without a NPP, who have indicated their interest in using NPP for electricity generation or desalination.
- Representatives from Member States who are supplier countries or other countries with an interest in the future application of NE.
- Level of participation:
 - ✓ Senior representatives of responsible energy supply Ministries
 - ✓ Senior Executives of power companies
 - ✓ Senior Directors of Atomic Energy Commissions or equivalent
 - ✓ Heads of Regulatory Bodies (Nuclear, Environmental or Commercial)

Agency's ongoing/planned activities

Infrastructure/Institutional directions in INPRO phase 2

- ✓ The Milestones Document will represent the “Current international structure”
- ✓ INPRO : Necessary infrastructure and institutional arrangements to enable deployment of INS (Innovative Nuclear System), and long term targets,
 - INPRO methodology (completed), manual (to be released)
- ✓ DG speech at GC(50): “INPRO, Phase two will, inter alia, focus on innovative approaches to infrastructure and institutional development” for countries beginning nuclear power programmes, as well as on the development of collaborative projects

Agency's Inter-departmental coordination

The infrastructure to support the implementation of a nuclear power project has many components; including

- the *legal and regulatory framework* within which all of the necessary activities are carried out
- the *human and financial resources* necessary to provide confidence in the ability to implement required activities
- *physical facilities and equipment* associated with the delivery of the electricity,
- the *transport* of the material and supplies to the site, the site itself, etc.

Agency's Inter-departmental coordination

- ❑ These topics are addressed by different parts of the Agency and coordination among Agency activities is required.
- ❑ An inter-Departmental coordination group (NPSG)
 - ✓ To provide coordinated support to MSs
 - ✓ To share information in the Agency etc.
- ❑ The support process could involve;
 - a) providing **milestones** of infrastructure building
 - b) MS's **self-assessment** (and **review** by international experts) for assessment of the progress, prioritization, identification of areas for Agency's cooperation
 - c) Potential for linkage with **indicators** of infrastructure development

Milestones in the matrix form

By the **time** of:

- Formal Intention To Implement Nuclear Power Program
- Ready to issue Invitation To Bid
- Ready for Commercial Operation

Expected preparedness and competency in key **areas** of;

- Legal Framework/Regulatory Framework
- Managing Organization
- Training and Human Resources
- Sites & Supporting Facilities
- Financial arrangement
- Public understanding/Public involvement in decision-making
- Grid
- Fuel cycle
- Safeguards and security applications etc.

Issues/challenges

- Access to the international LWR technologies and Uranium market
 - ✓China
 - ✓India

- Resources
 - ✓Capital
 - ✓Human resources
 - ✓Available domestic uranium resources

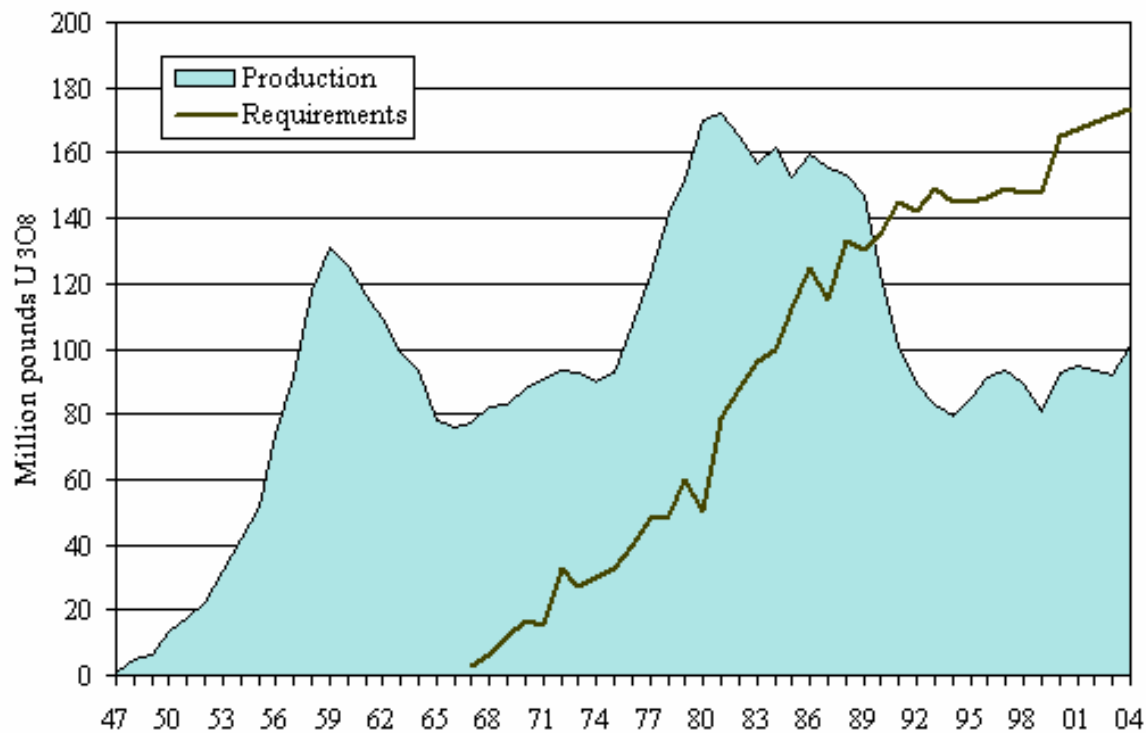
- Non-proliferation

- Localization of technologies

- Future technology development
 - FR and its fuel cycle, Th technology

Uranium

- ✓ In the short-term, the ambitious programmes in China/India would add fuel to the rise of Uranium price, because make up by inventory drawdown is becoming difficult
- ✓ After 2 decades of low price, U price nearly tripled in the last 3 years,



Already current demand
outpaces
supply since 1985

World Production versus
Requirements, 1947-2003
Source : [Jeff Combs](#) "Fueling the
Future: A New Paradigm Assuring
Uranium Supplies in an Abnormal
Market"

WNA annual symposium 2004

AESJ, 27Nov2006

Uranium resources [Uranium 2005]

□ “Uranium 2005” by OECD/NEA and IAEA

Total identified 4.7 Million Ton (<USD130/Kg U)

Total undiscovered (Prognosticated & speculative)

10 Million Ton (<USD130/Kg U)

□ Current consumption = 68,000 Ton/year for 360GWe

- R/P with comfortable margin
- Closed fuel cycle using FR further extends this margin

	<u>R/P (total conventional)</u>	<u>R/P (conventional & phosphate)</u>
LWR	270 years	675 years
Fast Reactor	8000 years	~20,000 years

□ Seawater 4500 Million Tons



SUMMARY

- ❑ **Globally growing interest to the role of nuclear power**
- ❑ **Growing interest from countries without NPP**
- ❑ **IAEA's role defined**
 - ✓ To ensure *protection* (safety, security, minimal proliferation risk)
 - ✓ To ensure continued *technological innovation*
 - ✓ To ensure that the needs of *developing countries* are taken into account
- ❑ **Support to developing country's infrastructure building through;**
 - ✓ Guidance documents
 - ✓ Workshops and Conferences
 - ✓ TCP (including comprehensive assessment of infrastructure preparedness)
 - ✓ Consideration of potential institutional arrangement for easiness of expansion of NE programme

Under inter-departmental coordination





...Thank you for your attention