World Nuclear Vision and Role of IAEA

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International Atomic Energy Agency

Contents

I. Now in the World (1)

Late September 2010, Downtown Seoul, Korea

I. Now in the World (2)

- 1.6 billion people without electricity
- 2.4 billion people use traditional biomass fuels for cooking and heating
- natural disasters throughout the world – climate change
- rapid growing economy in developing countries
- need massive advanced clear energy sources
  - fossil fuels limited
  - Low carbon energy sources: solar, wind, hydro, biomass, nuclear

II. Nuclear Energy (1)

- over 50 years of development and utilization
- massive supply possible
- low carbon technology
- multiple applications
- can play major role in sustainable development
- concerns on safety, security, and safeguards
- issues on waste management

II. Nuclear Energy (2)

- **nuclear power**
  - electricity
  - desalination of sea water, hydrogen production
- **medical applications**
  - cancer therapy, nuclear medicine, X-rays, CT, etc.
- **agricultural applications**
- **industrial applications**
  - high temperature process heat applications, NDT…..

III. Nuclear Power

1. Current Status of Nuclear Power
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4. Nuclear Power Projections
5. Global Nuclear Initiatives
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    2) Reduction of Vendors
    3) Human Resources
    4) Energy Resources & Waste Management
    5) New Nuclear Power Programmes

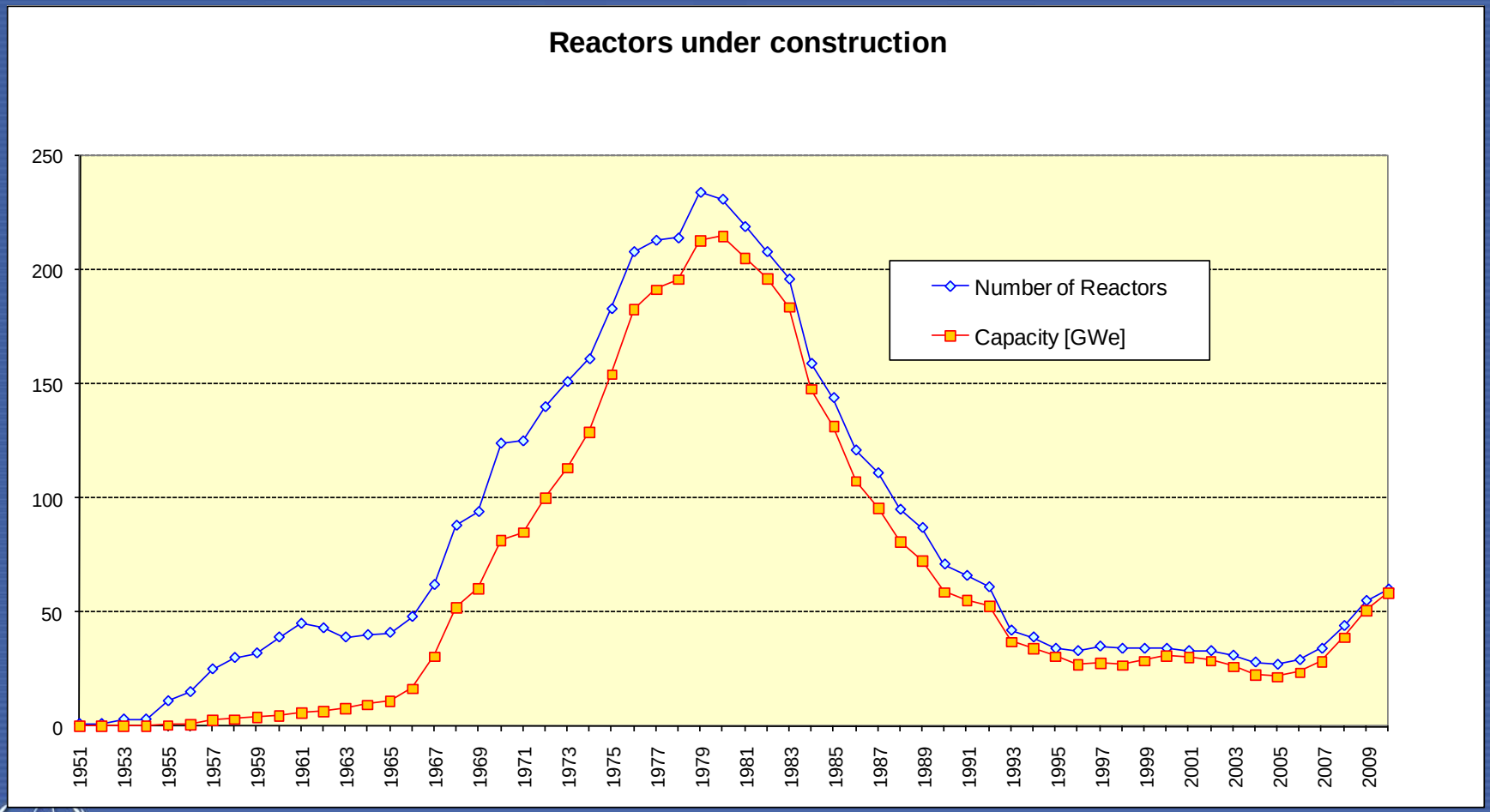
III.1 Current Status of Nuclear Power

- NPPs operating : 441 (375 GWe) in 29 countries
- NPPs under construction : 61(as of Oct. 2010) in 15 countries

Region	# NPPs operating	# NPPs Under construction
Africa	2	0
America - Latin	6	2
America - Nothern	122 (104 in USA)	1
Asia – Far East	94 (54 in Japan)	33 (24 in China)
Asia – Middle East/South	21	6
Europe – Central/Eastern	67 (32 in Russia)	17 (11 in Russia)
Europe - Western	129 (58 in France)	2

III.2 Global Trends (1)

NPP Construction



III.2 Global Trends (2)

Existing fleet

- slight decrease of average capacity factor
- increased trend of life extension and power uprating
- a few countries expanding NP programme (China, Russia, Korea, India), more countries considering
- more digitized I&C system
- integrated management system including HR management

III.2 Global Trends (3)

Newcomers

- number of “interested countriess” up to 31 from 16 (2008)
- number of countries actively preparing nuclear infrastructure up to 10
- newcomers’ plans becoming more concrete and defined
- more technical and detailed requests for support
- use of consultant services
- widespread use of IAEA’s “Milestones” in bilateral and commercial activities
- donor countries increase cost free experts, extrabudgetary contributions to support newcomer countries

III.2 Global Trends (4)

Technology development

- focused on economics and addressing technical issues
- many SMRs designs available, but many new ones being developed for niche markets-economic challenges
- increased interest in fast reactors with closed fuel cycle
- goal of HTGR development shifting to process heat applications
- water scarcity may push towards more interest in nuclear desalination
- more demands for innovative systems

III.3 Main Drivers for Growth of Nuclear Power

- Climate change
- Sustainable development
- Security of energy supply
- Fossil fuel costs and volatility
- Improved performance & safety record of operating Nuclear Power Plants
- Non-electric applications: desalination, H_2 production, use of process heat

III.4 Nuclear Power Projections (1)

* Current World NP Capacity: **375 GWe (Oct. 2010)**
** IAEA Reference Data Series No. 2, 2010 Edition

	2030	2050
High (GWe)	803	1,415
Low (GWe)	546	590

Target on Nuclear Power by 2050 in Technology Roadmap by OECD/NEA and IEA: 1,200GWe (baseline scenario : 610GWe)

III.4 Nuclear Power Projections (2)

- **Newcomer countries**

Description	2008	2010
Not planning to introduce nuclear power plants, but interested in considering the issues associated with a nuclear power programme	16	31
Considering a nuclear programme to meet identified energy needs with a strong indication of intention to proceed	14	14
Active preparation for a possible nuclear power programme with no final decision	7	7
Decided to introduce nuclear power and started preparing the appropriate infrastructure	4	10
Invitation to bid to supply a nuclear power plant prepared	1	
New nuclear power plant ordered		2
New nuclear power plant under construction	1	1
Total	51	65

III.4 Nuclear Power Projections (3)

- Expect 10 ~ 25 new countries to bring their 1st NPPs on line by 2030

  Iran, Turkey, UAE, Vietnam, Belarus, Jordan, Egypt, Malaysia, Quwait, Saudi Arabia, Thailand, Morocco ……..

- 230 ~ 480 new NPPs to be on line by 2030 (over 100 operating NPPs to be closed)

- Expecting over 25% of global electricity by nuclear in 2050s (currently nuclear provides 14% global electricity)

III.4 Nuclear Power Projections (4)

- **Will not require major technological breakthroughs**
  - **short/mid term obstacles : political, industrial, financial related**
  - **continuous development is important to be competitive**

- **Proven and mature Water Cooled Reactors will play important role during the remainder of 21st Century while innovative reactors to be deployed in the 2nd part of the century.**

III.5 Global Nuclear Initiatives (1)

- GIF (Generation IV International Forum)
- INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles)
- IFNEC (International Framework for Nuclear Energy Cooperation; GNEP)
- SNE-TP (The Sustainable Nuclear Energy Technology Platform)
- ESNII (European Sustainable Nuclear Industrial Initiative)

III.5 Global Nuclear Initiatives (2)

Goals of Generation IV Nuclear Energy Systems

- **Sustainability**
  - provides sustainable clean energy
  - minimize & manage waste to protect public and environment
- **Economics**
  - life cycle cost advantage over other energy sources
  - comparable financial risk to other energy projects
- **Safety and Reliability**
  - safer and more reliable than previous generations
  - very low probability of reactor core damage
- **Proliferation Resistance and Physical Protection**
  - increased assurance of non-proliferation
  - increased physical protection against terrorism

III.5 Global Nuclear Initiatives (3)

Generation IV Nuclear Reactors

- Supercritical Water cooled Reactor (SCWR)
- Sodium Cooled Fast Reactor (SFR)
- Very High Temperature (Gas Cooled) Reactor (VHTR)
- Lead Cooled Fast Reactor (LFR)
- Gas Cooled Fast Reactor (GFR)
- Molten Salt Reactor (MSR)

III.6 Challenges

1) National Policy
2) Financing
3) Supply chain : multinational, manufacturing capacity
4) Human resources
5) Energy resources and radioactive waste management
6) New nuclear power programmes
7) Harmonizing licensing for new technologies
8) Safeguards and security

1) National Policy

- Long term strategy on energy policy including fuel cycle and waste management
- Legal and regulatory framework
- Role of Government
- International cooperations

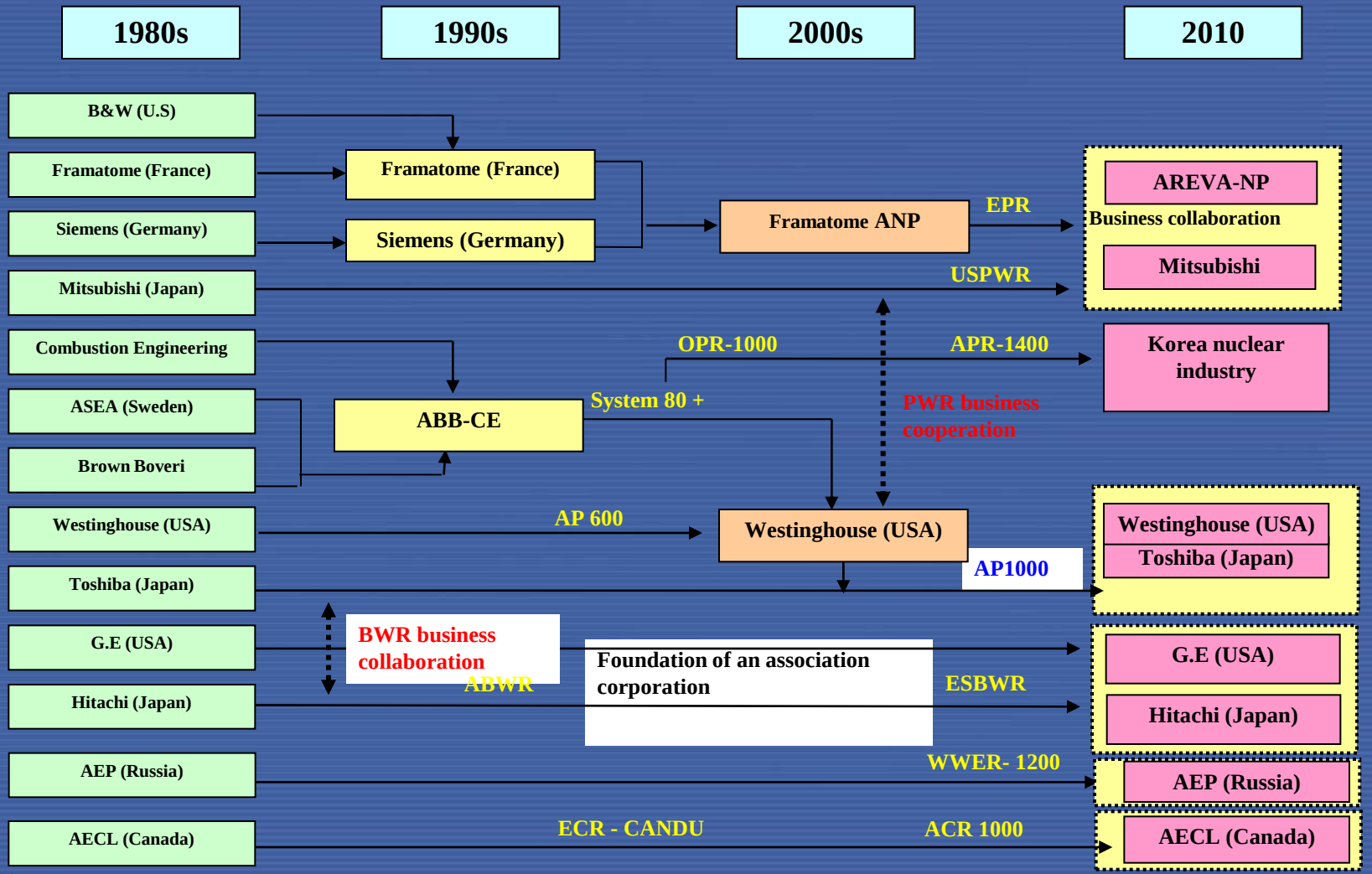
2) Financing

- Long and large investments needed
- Private sector investors hesitant
- May need loan guarantees by Government
- Need encouragement from international organizations such as IAEA, OECD/NEA, WANO to international lending institutions, e.g. World Bank, ADB
- Need to reduce investment risk by reducing uncertainties associated with construction and licensing

3) Supply Chain

- **Experience from Olkiluoto 3**
  - **500 suppliers from multi-nations**
- **Safety culture during construction phase**
- **Division of Responsibilities among contractors/workers**
- **Heavy forging capacity for RPVs, SGs, and other engineered components**
  - **France, Japan, Korea, Russia, China (domestic)**
- **Current capacity: ~12 NPPs/yr (source: WNA)**
- **Capacity expansion: need to be expanded in short term**

Reduction of Vendors



4) Human Resources

- **Two main challenges**
  - **replacing experienced, aged workforce**
  - **new recruits to support life extensions of existing fleet and new constructions**
- **No quantitative data at regional/global level**
- **Tens of thousands of technicians to be trained for future demands**
- **IAEA and other partners (NEA, NEI ..) launching a global survey in 2010 to understand magnitude**

Human Resources Solutions

- **International cooperation**
- **National focus on nuclear education/training**
  - **France, UK, Korea established "nuclear training academies" at Governmental level**
  - **Needs to be expanded**
- **Globalized workforce : e.g. UAE**
- **Recruit from other industries**

5) Energy Resources & Waste Management (1)

- **Effective management of existing resources**
  - **U Requirements**
    - **59 MtU/yr for 373 GWe in 2008**
    - **~ 160 MtU/yr for 1,000 GWe in 2050 (mid-growth)**
  - **Identified resources**
    - **5,400 MtU (< USD 130/kgU), 6,300 MtU (< USD 260/kgU)**
    - **~ 100 years for existing NPPs**
- **Find and develop new U mines**
  - **~ 840 MtU identified in 2 years (2007 – 2009)**
- **Develop new resource materials (e.g. Th)**

5) Energy Resources & Waste Management (2)

- **Spent Nuclear Fuel (SNF) management**
  - Interim storage
  - Good safety record
  - Accumulates 10 Mt HM/yr (needs to be stored > 100 yrs)
  - Reprocessing
- **Reuse of SNF with proliferation resistance**
  - Use of Mixed Oxide fuel in LWRs (30% SNF has been reprocessed)
    - partial benefit in waste management
    - interim solution
  - Use of spent LWR fuel in HWRs (e.g. DUPIC)
  - Closed fuel cycle: Fast reactors

5) Energy Resources & Waste Management (3)

- **Effective management of radioactive wastes**
  - **Low and intermediate level waste management**
    - **many good practices exist**
    - **no major global challenges forseen**
  - **High level waste disposal**
    - **not a new issue: systematic R&D over 30 years**
    - **major societal challenge**
    - **disposal sites in Finland and Sweden accepted local community**

6) New Nuclear Programmes

- **Newcomer countries: 65**
  - 34 Countries considering nuclear power
  - 31 Countries expressed interest in nuclear power
- **Building nuclear infrastructures**
  - international cooperations, policy/strategy, financing, project mgt, siting, laws, licensing, Human Resources, etc.
- **Rapid expansion of nuclear power (e.g. China)**
  - Supply chain (heavy forging), work force, licensing, safety/security

7) Harmonizing Licensing for New Technologies

- **New technologies under development for enhanced economics, safety/reliability, sustainability, proliferation resistance**
  - Sodium cooled fast reactors with closed fuel cycle
  - High temperature gas cooled reactors with H2 production
- **Harmonized safety standards and licensing requirements to be developed**
  - Not to halt deployment of new technologies
  - Multinational Design Evaluation Program (MDEP) (example)

    - Enhanced international cooperation within regulatory framework
    - Multilateral convergence on codes, standards, and safety goals
    - Facilitation of licensing for new reactors

IV. Role of International Atomic Energy Agency

1. General
2. Key Roles
3. Organization
4. Supporting Activities for Newcomer Countries

IV. 1 General (1)

- Established in 1957 as the world´s "Atoms for Peace" organization
- World´s center of cooperation in the nuclear field
- Objective by Statute: The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.

IV. 1 General (2)

" I should stress that it is the sovereign decision of each individual country whether or not to add nuclear power to its energy mix."

" Developing Countries have the same right as Developed Countries to use nuclear technology for peaceful purposes, and the same responsibility to do so safely and securely. Needless to say, all countries have an equal responsibility to work to prevent the proliferation of nuclear weapons. "

Yukiya Amano

IAEA Director General

IV. 2 Key Roles (1)

- **To search for balance between ensuring the non-proliferation of nuclear weapons and promoting the peaceful uses of nuclear energy**

- **To foster the efficient and safe use of nuclear power by supporting existing and new nuclear programmes around the world, catalyzing innovation and building indigenous capability in energy planning, analysis, and nuclear information and knowledge.**
  - **Main focus is on supporting newcomer countries**

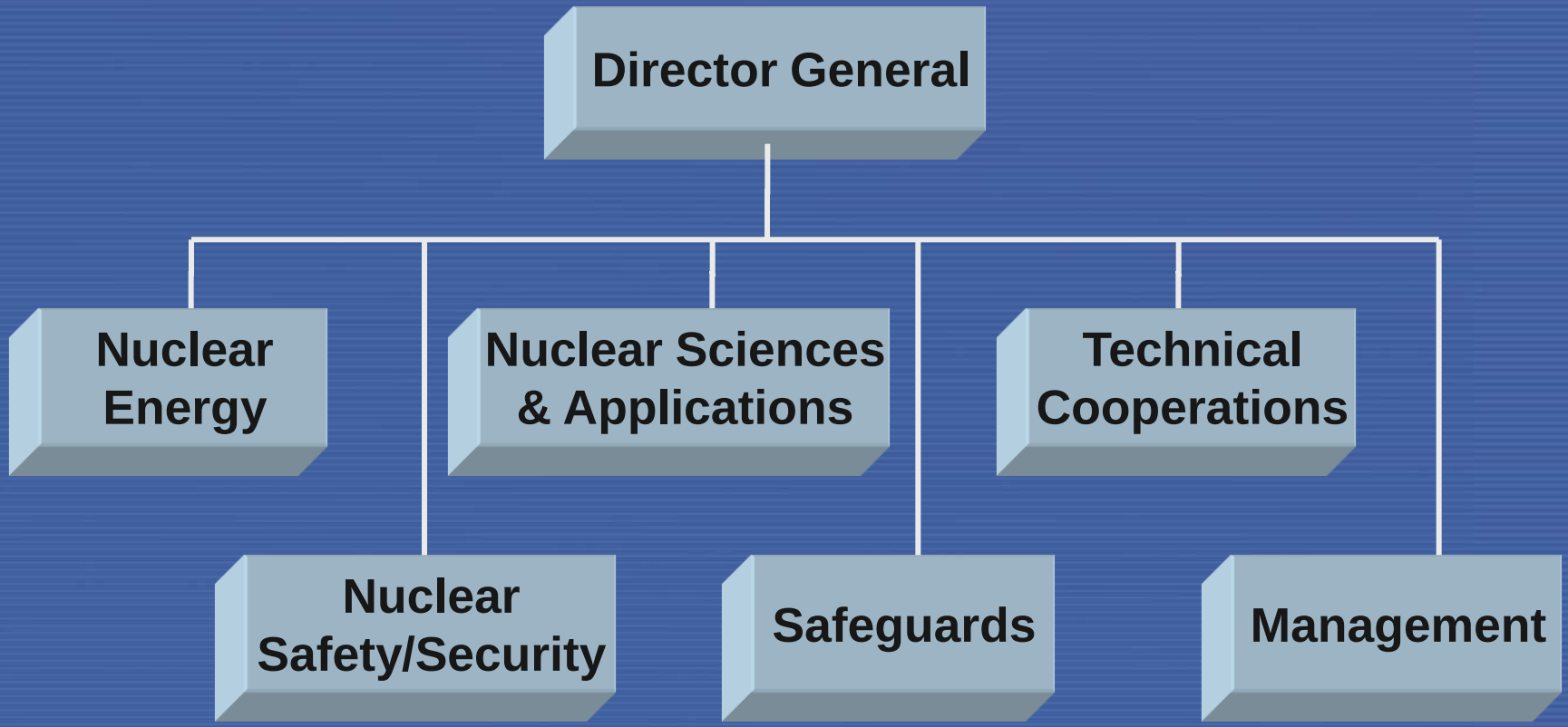
- **To formulate and implement Agency's program for the protection of people and the environment from radiation exposure, while responding to the safety & security related needs of its Member States.**

IV. 2 Key Roles (2)

- To provide solutions to Member States solve agricultural productivity and food security, improvement of human health, increased availability of water resources, assessment and management of the marine and terrestrial environments and industrial applications using radioisotopes and radiation technology Water, Energy, Health, Agriculture and Biodiversity use of nuclear and isotope techniques responding to the safety & security related needs of its Member States.

- To provide credible assurance to the international community that nuclear material and other specified items are not diverted from peaceful nuclear uses.

IV.3 Organization - IAEA



Department of Nuclear Energy

- **Division of Nuclear Power**
  - Support for operating NPPs and expansion of NPPs
  - Support newcomers' introduction of nuclear power programs
  - Technology development for advanced/innovative nuclear systems
  - Support for non-electric applications of nuclear power
- **Division of Fuel Cycle and Waste Technology**
  - Uranium production cycle, advanced fuels and fuel cycles
  - Management of spent fuel
  - Waste disposal, decommissioning, and environmental remediation
  - Research Reactor operations, utilizations, and maintenance

Department of Nuclear Safety and Security (1)

- **Division of Nuclear Installation Safety**
  - Development of safety standards
  - Enhancement of safety for installations and operations of nuclear facilities
  - Strengthening regulatory infrastructure
- **Division of Radiation, Transport and Waste Safety**
  - Ensure waste and environmental safety
  - Radiation safety and monitoring services
  - Regulatory infrastructure and transport safety

Department of Nuclear Safety and Security (2)

- **Office of Nuclear Security**
  - Contribute to global efforts to achieve effective security
  - Assist adherence to and implementation of nuclear security related international legal instruments
  - Strengthen the international cooperation and coordination of assistance enabling the safe, secure and peaceful uses of nuclear energy and of such applications with radioactive substances

Department of Nuclear Sciences and Applications (1)

➢ Division of Physical and Chemical Sciences

- Utilization of particle accelerators and research reactors, applications of instrumentation, and controlled nuclear fusion reserrch
- Radiation technology, radiopharmaceuticals, industrial and environmental applications
- Sustainable water resources management
- Development and dissemination of atomic and nuclear data for applications

➢ Division of Human Health

- Nuclear medicine
- Applied radiation biology and radio therapy (PACT)
- Nutritional and health-related environmental studies

Department of Nuclear Sciences and Applications (2)

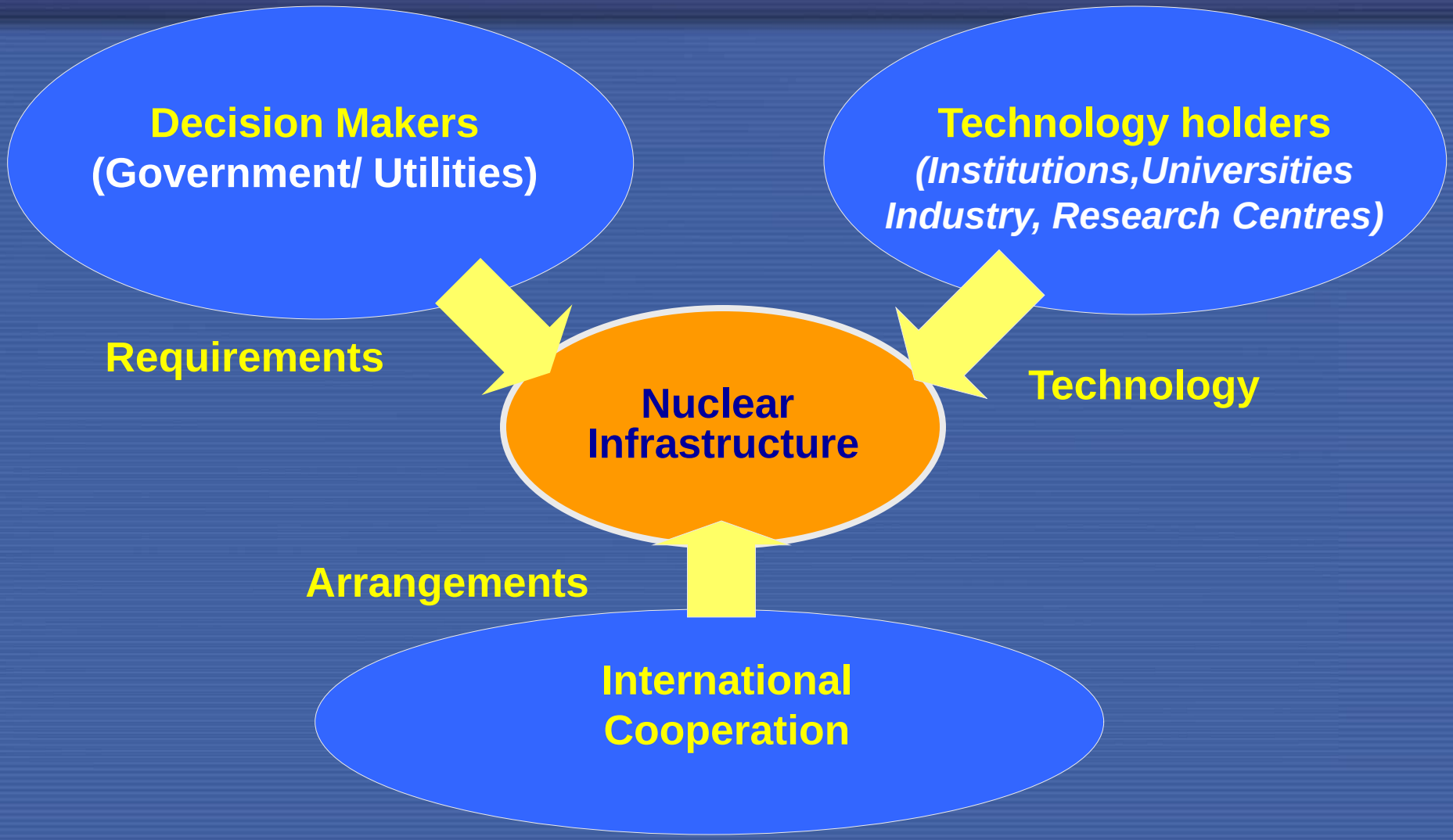
- **Division of Nuclear Techniques in Food and Agriculture (joint with FAO)**
  - Developing better soil and water management technologies and practices using isotopic, nuclear and related techniques
  - Improve animal production and health
  - Enhance food security by sustainable crop production
  - Food and environmental protection, insect control
- **IAEA Environmental Laboratories**
  - Radiometrics lab., radioecology lab., marine environmental lab., terrestrial environmental lab.

IV.4 Supporting Activities for Newcomer Countries (1)

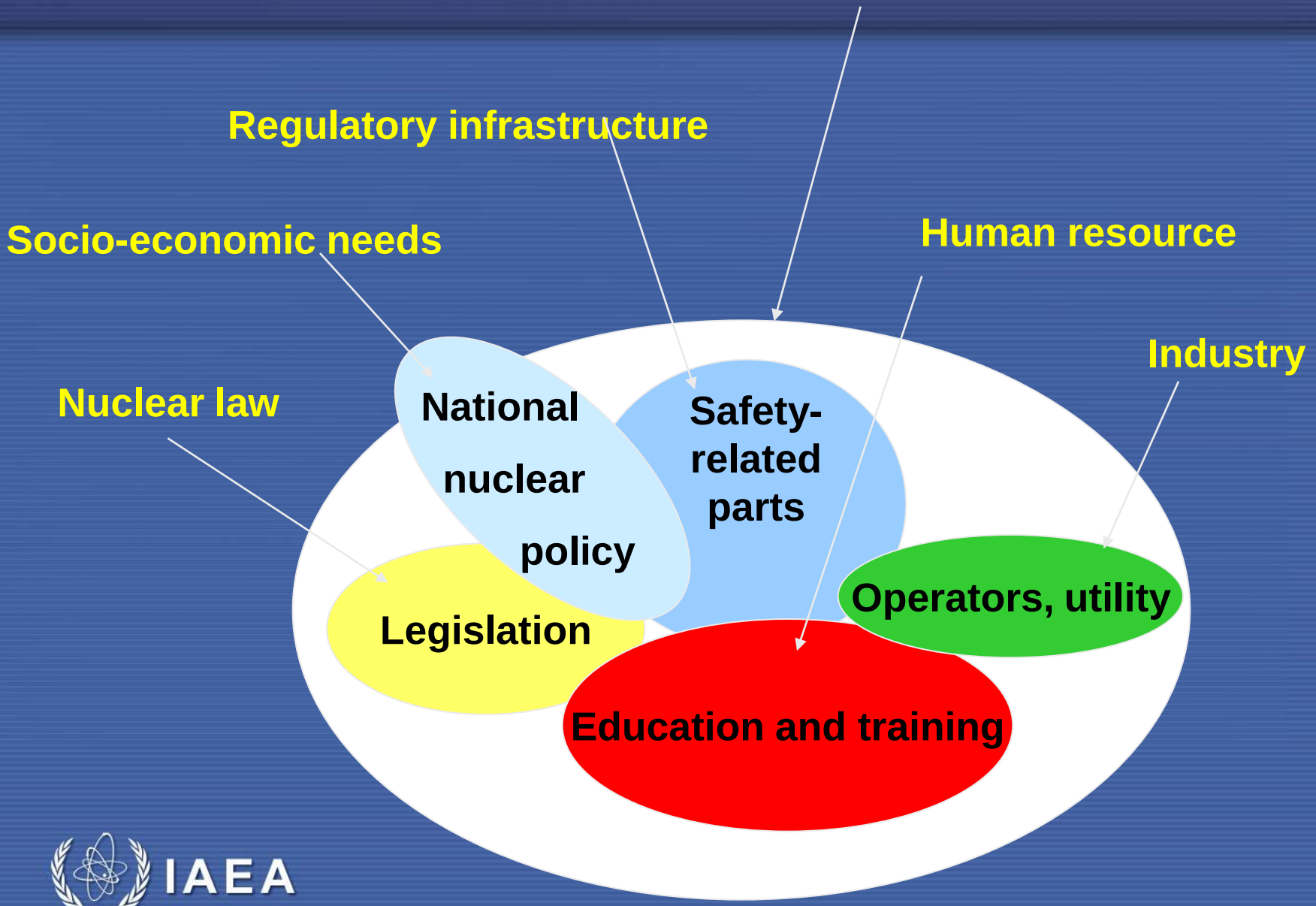
New Nuclear Power Programmes

- **Important to build nuclear power infrastructure to introduce NPPs in the country**
- **Important to be an intelligent newcomer**
  - **IAEA supports in all aspects: workshops, training, mentoring, etc.**
  - **strengthening capacity of newcomres**
  - **Newcomers "partnering with experienced NPP country"**
    e.g. bilateral agreements in education/training

Nuclear Power Infrastructure



Nuclear Power Infrastructure



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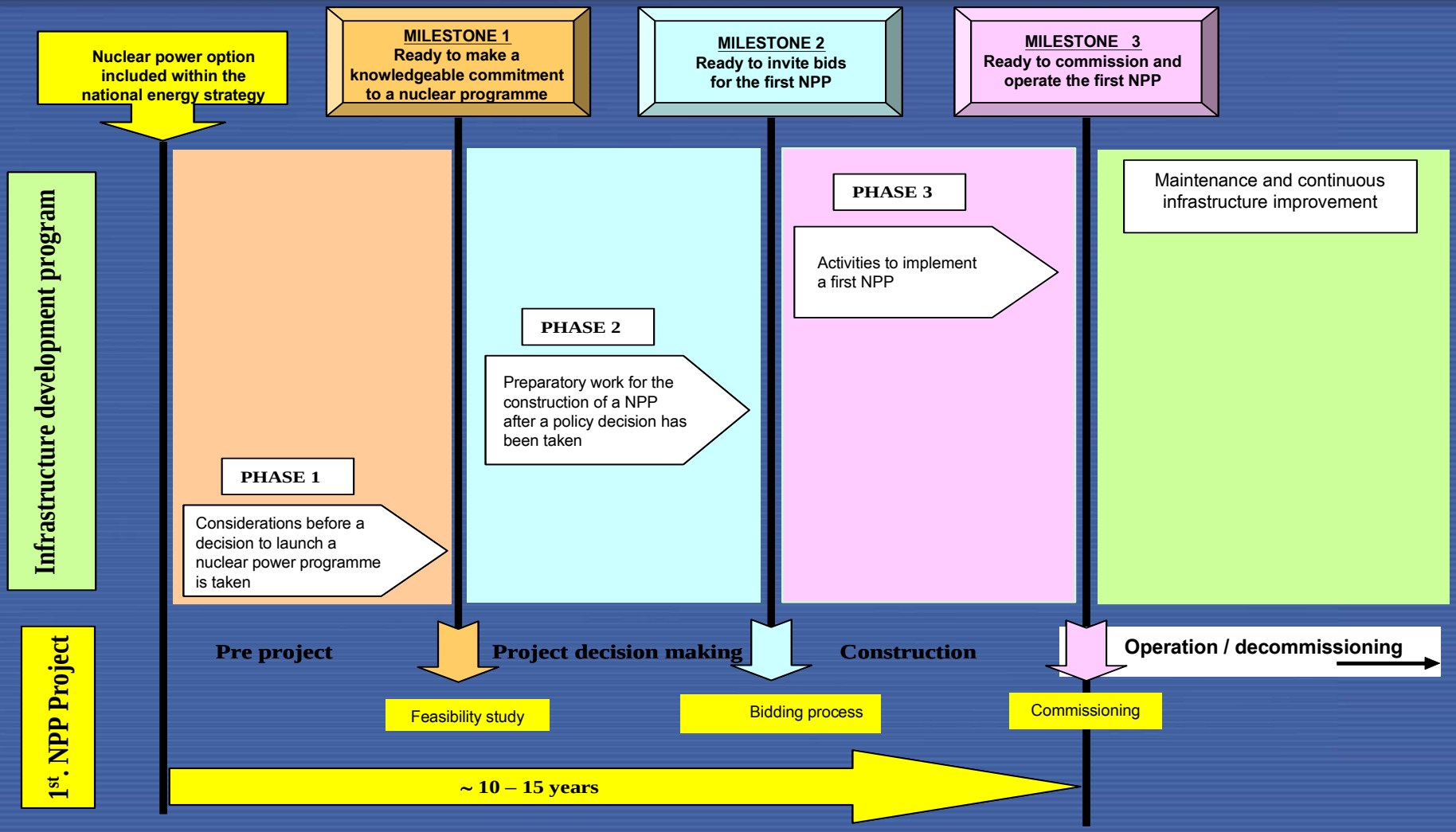
Nuclear Power Infrastructure 19 Issues

1. National Position
2. Nuclear Safety
3. Management
4. Funding and financing
5. Legislative framework
6. Safeguards
7. Regulatory Framework
8. Radiation Protection
9. Electric grid
10. Human resources development
11. Stakeholder Involvement
12. Site and supporting facilities
13. Environmental protection
14. Emergency planning
15. Security and physical protection
16. Nuclear fuel cycle
17. Radioactive waste
18. Industrial involvement
19. Procurement

Milestones Approach



Lessons from Experiences & Mistakes

Considerations before decision to launch → **Prep work for construction** → **Construction** → **Operation** → **Decommissioning**

Comprehensive approach!

Integrated Nuclear Infrastructure Review Mission (1)

Purpose of INIR Mission is to find out

- **Where the country stands?**
- **What are the major gaps?**
- **What are the national actions planned to fill in this gaps?**
- **What are the potential Areas for further Assistance?**
  - **From IAEA→ reflected on Integrated Work Package**
  - **From other international initiative/bilateral/consultant**

Integrated Nuclear Infrastructure Review Mission (2)

- **The IAEA ‘s involvement could add values**
  - objective view
  - clarifying areas of further assistance
  - confidence building
- **Nature of INIR mission**
  - holistic peer review
  - upon request by the Member State
  - multidisciplinary international experts led by IAEA staff
  - not an inspection/audit or IAEA stamp of approval
- **Outcome from INIR mission**
  - evaluation of status for each infrastructure issue
  - suggestions for action plan
- **Timing of INIR mission**
  - could be of value at Phase 1/E (or phase 2/B) and phase 2/E
- **Complementary relationship with other missions (such as IRRS)**

Integrated Nuclear Infrastructure Review Mission (3)

INIR Missions

- **Completed**
  - Jordan: Aug. 2009
  - Indonesia: Nov. 2009
  - Vietnam: Dec. 2009
- **Planned**
  - Thailand: Dec. 2010
  - UAE: Jan. 2011
- **Considering**
  - Poland, Malaysia, Egypt, Suadi Arabia, Quwait, Morocco…..

V. Summary

- Increase of global demands in energy
- Important to develop clean energy sources for sustainable development – climate change & issues on fossil fuels
- Nuclear is a viable option to meet the global demands
  - ✓ Number of challenges
  - ✓ Possible solutions
    - preparation in early stage
    - international cooperations through IAEA, NEA, etc.
    - Human resource development
    - continuous technology development……..
- IAEA plays an important role in promoting NP programs while maintaining balance on safety, security, and non-proliferation

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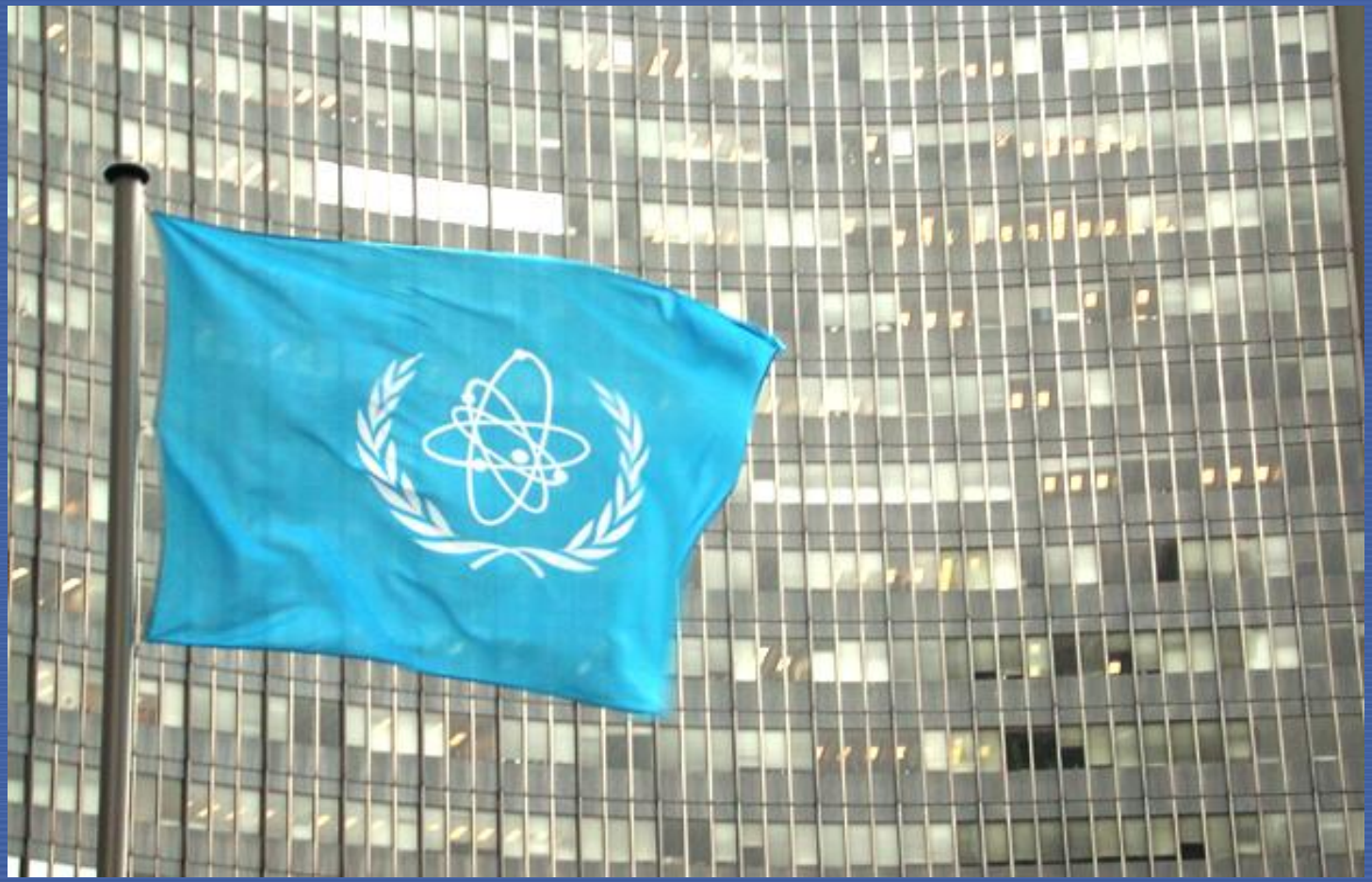
Thank you for your attention!!!



…atoms for peace.