

**International Atomic Energy Agency**

# **Formulating National Needs for Nuclear Power**

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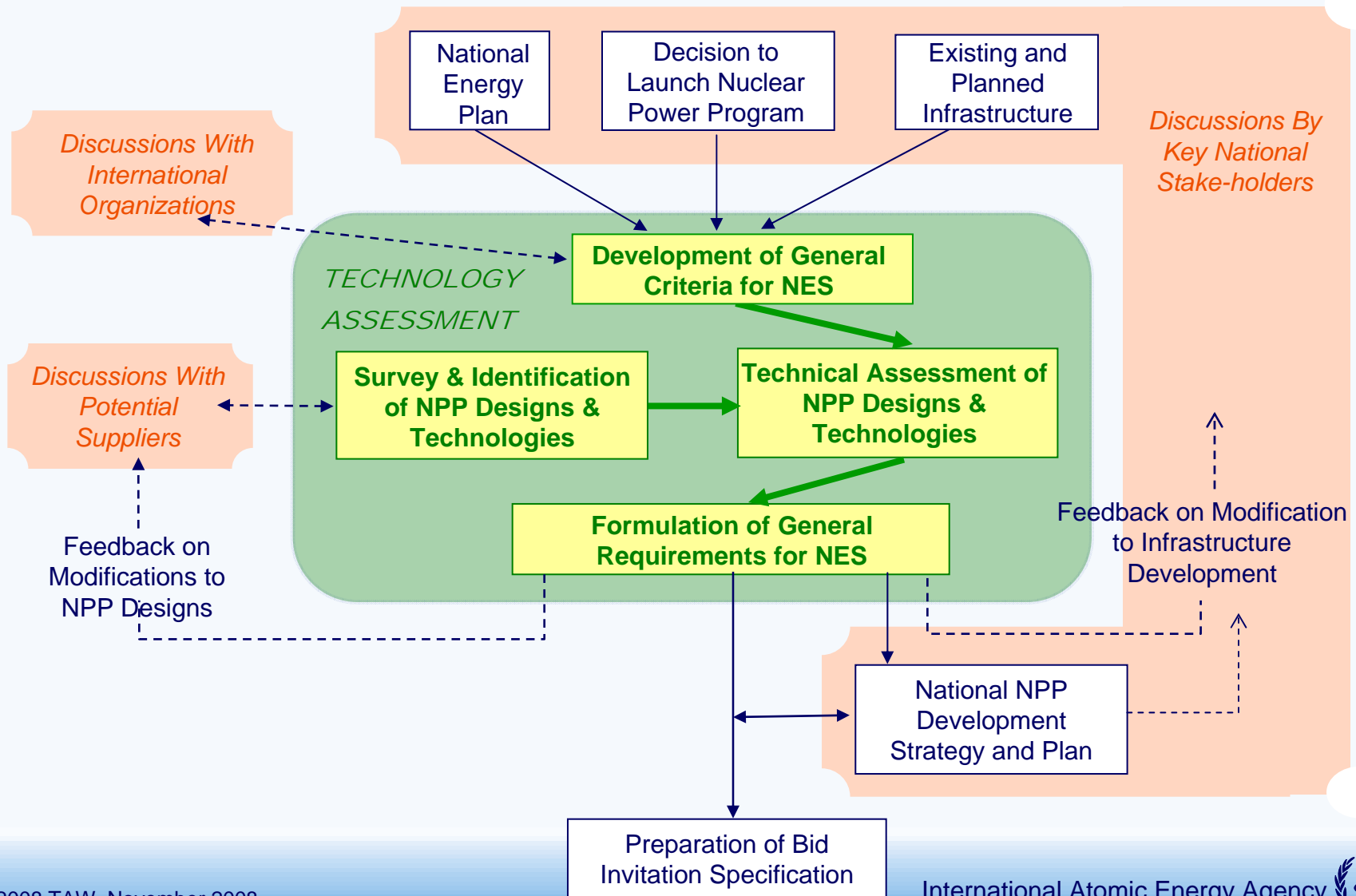
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# Outline

1. References for formulating national needs for nuclear power:
  - Developing countries common user considerations;
2. Nuclear power plant risk management:
  - Through long-term considerations:
    - Long-term energy policy and plan;
    - National capability building strategy
    - Fuel Cycle Strategy



# Scope of Technology Assessment



# General Criteria for NES

## Areas Covered:

- Sustainability of the nuclear power programme
- Demand for power generation capacity
- Electrical grid characteristics
- Site characteristics
- Environmental impact
- Nuclear safety, regulatory framework and licensability
- Radiation protection
- Nuclear fuel cycle policy
- Nuclear waste management .
- Safeguards
- Security, physical protection and emergency planning
- National participation , Industrial development and human resource development strategies
- Overall Economics of NES



# General Criteria for NES

## (continued)

### References:

- European Utility Requirement (EUR);
- Utility Requirement Document (URD);
- Common User Consideration (CUC):
  - A survey of needs and requirements of developing countries for deployment of new nuclear power plants in the next 50 years, in response to an IAEA General Conference resolution
  - Some specific requirements from the CUC to be discussed in this lecture (L.5).



# Components of CUC

1. Economics and Financing
2. Infrastructure and Implementation
3. Nuclear Safety
4. Environment, Resources and Waste Management
5. Proliferation Resistance
6. Physical Protection
7. Technical Requirements

# General Rationales For Requirements

- Majority of requirements are driven by similar concerns and general desires;
- Most important one is **minimization of risks** associated with nuclear power program:
  - Major investment;
  - Long-term commitment;
- Also important are:
  - Be treated **equally/access to same** technologies;
  - Continued improvement of **national capabilities**



# Rationale Type 1: Reliance on Established Experience

- Risks due to ‘inexperience’ in technology;
- Desires to have those with more experience (Supplier) to share more risk:
  - Turnkey contract in 1st project(s);
  - NPP product proven prior to introduction;
    - Proven design: systems, components, methodologies/ codes and licensing;
  - Assistance to establish experience timely.



## Rationale Type 2: Improvement of National Capability

- Desire to have **more confidence** in technology: through experience gained in **participation** + gradual **improvement in capabilities**:
  - Utilization of local infrastructure and skill-sets;
  - Involvement in project execution;
  - Training of essential staff for running the plants;
  - Information to help understand the technology;
  - Systematic transfer of technology & know-how;
  - Step-wise increase in national participation.



## Rationale Type 3 : Sustained Operation Over Lifetime

- Concern for possible interruption to NPP operation
  - perturbation in international market or politics **perceived** to be **beyond the control** of the user country;
- Desire to have technology supplier to share responsibility for sustainable operation:
  - Assurance of fuel supply;
  - Assurance of critical components and spare-parts;
  - Assurance of service and supply of technical know-how;
  - Maximization of self-reliance to a practical limit

## Rationale Type 4: Safety and Related Public Acceptance

- Requirements mainly associated with unfamiliarity with technology;
- Willingness to rely on **supplier's** and international **assurance** that the current technologies are safe
  - Design proven-ness is essential: no need to require 'safer' design;
  - Supplier has more experience and established practices and analysis approach/methodology
  - Have been licensed or licensable in country of origin;
  - Meet IAEA Nuclear Safety Standards & comply with national regulation.

## Rationale Type 5: Economics and Related Information

- Minimum electricity generation cost is generally not the main nor the only objective for introducing NPP:
  - But must be competitive with best alternative source of energy locally available;
  - General perspective that nuclear electricity is competitive;
- Concern is more related to availability and credibility of **relevant information** for:
  - Detailed comparison with other sources in energy/project planning;
  - Supporting decisions and selection of options;
- One important option is related to utilization of local facilities and human resources:
  - **Need relevant cost breakdown.**



## Rationale Type 6: Spent Fuel Management

- An important concern but no strong requirement for ultimate solution in the short-term:
  - Realization that it is not yet feasible;
- Most countries are willing to join the ‘expert’ countries to ‘wait and see’:
  - Effective intermediate spent fuel storage
- Some are more concerned with possibility of permanent storage in own country:
  - Spent fuel take-back option
- Some believe in the right to pursue closed fuel-cycle option in the future if/when necessary:
  - Flexible fuel in future



# Other Considerations

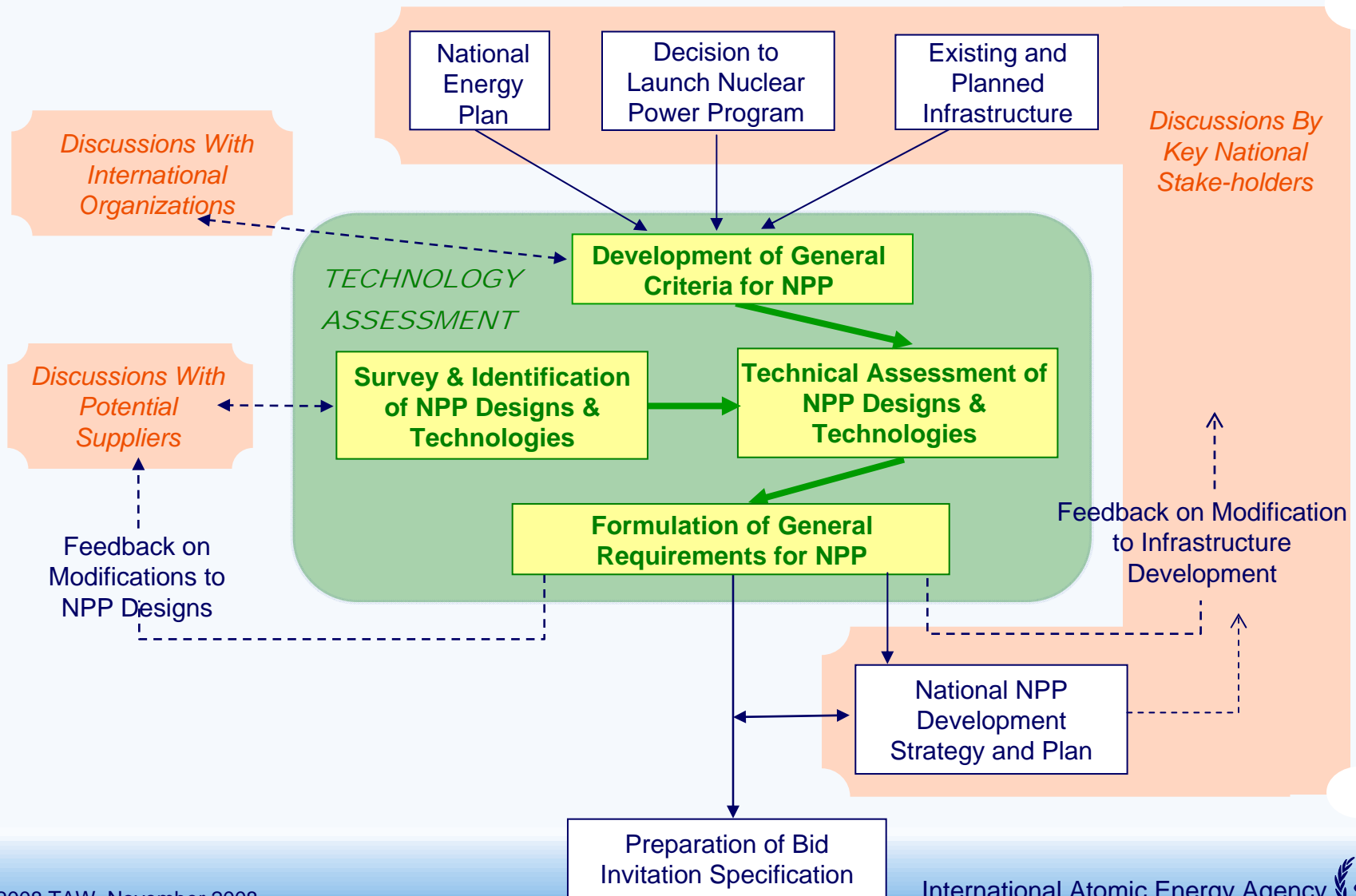
- Short/certain project duration;
- Support for financing;
- Good performance and ease of operation/maintenance;
- Maximum size within constraints of grid characteristics and national capability

# NP Program Risk Management

- NPP life-cycle is long-term: 80+ years
- Significant investment:
  - A few billions US\$ / NPP unit;
  - Physical infrastructure;
  - Others: human resource, regulatory, long-term national & international commitments;
- Principle of **risk management** through long-term considerations:
  - Long-term energy policy and plan;
  - National capability building strategy
  - Fuel cycle strategy
- Incorporate risk management options in General Criteria for NPP, and finally in General Requirements for NPP.



# Scope of Technology Assessment



# Long-Term Energy Policy and Plan

# National Policies That Affect NPP Development

- National economic development policy
    - Including goals and priority;
  - National policy on energy development
    - Energy demand forecast and supply plan;
  - National policy on international relations.
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- ❖ Long-term nature
  - ❖ Ideally resulting from national consensus and not subject to political changes in the country

# Forecast of Energy Demand

- Be realistic and objective (for long-term):
  - Demand quantity and timing;
  - Application types;
  - Characteristics such as centralized or distributed loads;
  - ❖ Pay attention to regions and sectors with higher-rate growth

# Understanding Energy Supply

- In-dept understanding of long-term availability and potential of domestic energy resources;
  - Optimum utilization for maximum national interest;
  - Appreciation of current and long-term energy technologies:
    - Advantages & disadvantages



# Objectives of Energy Policy

Examples:

- Improved energy independence;
- Utilization of indigenous energy resources;
- Preservation of indigenous energy resources;
- Economic optimization of energy and electricity supply;
- Stability of electric grid system;
- Security of electricity supply;
- Environmental protection;
- Privatization of electric utilities and opening of competition in electricity market;
- Demand side management



# Consistency and Longevity of Energy Policy

- Changes in policy likely to cause high penalties in money/resources, opportunities and confidence;
- If urgent and drastic change in energy supply system is required:
  - May need to develop both short-term and long-term plan
- Establish the longevity and stability of the energy policy:
  - Essential to get support from all major stake-holders;
  - Avoid possibility of being politicized;
  - Incorporation into multi and highest possible levels of regulation



# Long-term National Energy Supply Plan

- Based on prioritization of objectives and optimization of resources and supply options;
- Choice of centralized or distributed supplies based on:
  - Demand load size and characteristic;
  - Type of applications;
  - Supporting infrastructure including grids and other energy distribution systems;
  - Development trend of the above including any grid connection strategy

# Contribution of Nuclear Energy to National Energy Supply

- Role of and size of contribution of power supplied by NPP determine nature of nuclear power program;
- Typically more related to Energy Policy objectives than simple economical consideration;
- Highest capital cost, lowest & most stable fuel cost among all energy alternatives;
- Significant investment in infrastructure, and large/long-term mobilization of national effort



# Nuclear Power Development Plan

- Size of NPP units:
  - NPP based on current technologies is more economical with larger plant size;
  - Best used for centralized power plants supplying base-load;
- More demanding siting considerations;
- Natural to include additional objectives other than just safe, economical generation of power, such as:
  - Improve national technological and industrial development;
  - Long-term assurance of fuel supply;
  - Conservation of natural resources.



# NPP Timing Consideration

- ❖ Preparatory work for the first NPP takes 5 to 10 years assuming concerted effort under a consistent plan:
  - Human resource development;
  - Regulatory system;
  - Other hard and soft Infrastructure development;
  - Technology selection and contract negotiation;
- The following should be considered in sync:
  - Availability of NPP design options, and their proven-ness at the time of building the first NPP;
  - Condition of power system including grid at the time,
  - National participation strategy: Contract type,
  - NPP project duration (Engineering, procurement and construction = EPC);
  - Plant life



# National Capability Building Strategy

# Strategy on Self-reliance for Economic Development

- Capacity Building is part of a Self-reliance strategy;
- Every country has some degree of self-reliance on critical (or essential) sectors of economy
- Different degrees, considering:
  - population size in comparison with 'critical-mass' for market and production potential;
  - Current and potential economic growth;
  - Scarcity/availability of material and energy resources;
  - Relationship with neighboring countries and other countries potentially influencing economical development and national security
- Strategy on nuclear should have similar considerations plus role and relative size of nuclear contribution.



# Fuel Cycle Strategy

# Sustainability of Operation

- ❖ Fuel cost is relatively low (5 to 15% of Linearized Unit Energy Cost), but no fuel no operation
- Assurance of fuel supply, and supply of spare-parts and critical components replacement is essential to sustainable operation of NPP throughout its plant life
  - Some countries have faith in market mechanism
- Two major decisions in Fuel Cycle Strategy must be made:
  - Front end and back end;
  - Front end considerations include: enriched fuel or natural uranium fuel, its supplies, fuel fabrication, refuelling services.

# Summary

- Several references exist for formulating national needs for NPP, including EUR & URD;
- CUC is based on survey of developing countries' need;
- Most considerations are for minimizing risk associated with nuclear power program, equal access to the same technologies and continued improvement of national capabilities;
- Management of NPP risk requires long-term considerations:
  - Energy policy and plan (including nuclear);
  - National capability building strategy;
  - Fuel cycle strategy
- Consistency and longevity of energy policy supported by all stake-holders are essential.