

**International Atomic Energy Agency**

**National Participation, Technology  
Transfer and Human Resource  
Development**

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Nuclear Power Plant Technology Assessment  
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# Outline

- Self Reliance Strategy
- National Participation
- Technology Transfer
- Human Resource Development
- Optimization of Competing Criteria/ Requirements and Conflicting Program Objectives



# Self-reliance for Economic Development

- 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



# Degree of Self-Reliance in Nuclear

- Self-reliance strategy for nuclear technology should have similar considerations plus role and relative size of nuclear contribution;
- Important part of risk management;
- Mainly achieved through **national capability building** and self-supply of critical components/parts/fuel;
- **Immediate implementation of high-degree of self-reliance approach in NPP development starting with the first plant contradicts risk management principle;**
- Gradual increase in national capability via:
  - National participation in projects;
  - Technology Transfer;
  - Human resource development



# Minimum National Capability Requirement

- Regulatory function
- Electrical system and utility organizations;
- Basic engineering, manufacturing of basic parts and supplies, construction;
- Operation and maintenance;
- Education and training coordination;



# National Participation

1. Utilization of available local skills:
  - Define groups of local skill-sets and how they can be utilized:
    - Civil construction companies/crews: experienced in other large projects
    - Mechanical and electrical installation companies/crews : experienced in conventional plants;
    - Universities/research laboratories;
  - Long-term planning considering number of projects in the horizon



# National Participation Plan

<i>Areas of Participation</i>	<i>1<sup>st</sup> Project</i>	<i>2<sup>nd</sup> Project</i>	<i>3<sup>rd</sup> Project</i>
Design - reactor			
Design – major equipment			
Overall plant system engineering design			
Overall site design and preparation			
R&D to support design			
Procurement and bidding process			
Civil engineering			
Construction			
Project management			
Manufacturing of major, critical components & equipment (nuclear grade)			
Manufacturing of small but critical components & equipment (nuclear grade)			
Manufacturing of regular components & equipment (non nuclear grade)			



# National Participation Plan (continued)

<i>Areas of Participation</i>	<i>1<sup>st</sup> Project</i>	<i>2<sup>nd</sup> Project</i>	<i>3<sup>rd</sup> Project</i>
Licensing of NPP			
Safety analysis			
Radiation protection			
Operation and regular maintenance			
Major maintenance & plant life extension			
Supply of fuel			
Refuelling			
R&D to support operation			
Nuclear-grade QA			
Spent fuel storage and final nuclear waster disposal.			

# National Participation

(continued)

## 2. Utilization of local supplies

- Define groups of local supplies and how they can be utilized:
  - Supply of civil work material eg. cement and local construction method;
  - Manufactures: tubes, duct work, piping, non-nuclear components;

# National Participation

## (continued)

### 3. Utilization of local infrastructure

- Negotiate with suppliers groups regarding utilization and changes to local infrastructure:
  - Highway/roadway, bridge and railway;
  - Seaway/river & harbor;
  - Crain;
- Balance between changes and improvements to local infrastructure;
  - Schedule, cost and future investment;
- Balance between accommodating local infrastructure and engineering changes (cost);
  - Traditional (un-conventional) ways of transportation/construction,
  - Modularization and existing transportation;
  - Localized cost model – review of assumptions against local condition;



# Technology Transfer

- Part of risk-management strategy:
- Short-term: let the more experienced suppliers share bigger portion of risk;
  - Design proven-ness and licensable in country of origin;
- Long-term: risk minimized by comprehending technology;
  - Technology Transfer
- Reflected in contract type: BOO → Turnkey → Split package with several suppliers ...

# Technology Transfer (continued)

## *Examples of Technology Transfer:*

- Licence of system design and component manufacturing;
- Specification and design drawings;
- Training and the provision of documentation, design basis, computer codes for analyses, and other forms of know-how so technology users can:
  - Understand the design including capability in performing safety analyses and procurement
  - Effectively manage plant operations, maintenance, refuelling, spent fuel, waste management and decommissioning;
  - Manufacture key components, spare parts and fuel
  - Perform basic R&D to support the above
- Know-how – on the job training



# Human Resource Development

- Develop a long-term HR Development program prior to negotiate a Training package, considering:
  - Skill-sets required and scope of training;
  - Timing for skill-sets required and timing for training;
  - Who will provide the training?
- Scope of training required was discussed in a workshop on analyzing CUC.

# Training Required – Licensing

- Training on safety analyses – licensee perspective:
  - Overall safety analysis approach;
  - System thermalhydraulics code;
  - Core physics code;
  - Containment safety code;
  - Fuel safety code;
  - Probability safety analysis approach;
- Training on development of license application:
  - Preparation of PSAR and FSAR;
  - Licensing procedure;
- Training on assessment and approval of license application:
  - Compatibility/comparison of different but relevant licensing approaches

# Training Required– Construction & Procurement

- Training on quality assurance management;
- Training on procurement of nuclear-grade components and supply
- Training on manufacturing inspection:
  - Special equipment and components;
- Training on large construction project control and management;
- Training on modern civil construction techniques;
- Training on special installation techniques

# Training Required – Operation

- Provision of full scope training simulator and related facility:
  - Qualification/verification of simulator;
  - Simulator/training facility staff;
- Training of operators and operating-supervisors:
  - Training package for first crew & subsequent crews;
  - On the job training in existing plant;
  - Licensing of operators;
- Training of other plant operation staff:
  - Support for refueling;
  - Special equipments and systems such as fueling machine

# Training Required – Maintenance

- Training on integrated plant maintenance:
  - Provision of plant configuration management programme;
  - Access to plant operation/maintenance information of other similar plants
- Training program for maintenance personnel:
  - Mechanical;
  - Electrical;
  - Electronics and I&C;
  - Computers;
  - Chemical;
  - Radiation workers
- Training of basic research/testing procedure/skill to support maintenance.

# Optimization

- The Optimization is determination of the degree required of utilization of local infrastructure, local capabilities and national participation, and of design changes required to minimize impact on local infrastructure, while meeting the requirements of lower cost and shorter construction schedule;
- In general, optimization is frequently required in planning of nuclear power program with multiple objectives and in the assessment of nuclear power technologies.



# Example of Multiple Objectives

## *Primary Objective:*

- Economical and safe generation of power from NPP with minimum interruption to operation.

## *Additional Objectives:*

- Achievement of energy independence;
- Preservation of indigenous energy resources
- Reduction of CO<sup>2</sup> emission;
- Improvement of national technological/industrial development;
- Improvement of manufacturing capability;
- Spin-off of technological-based industrial sectors;
- Creation of jobs near the site

# General Approach of Optimization

- Consistency, methodological, no ad-hoc decision
- Objective Weight Factor (OWF):
  - Appropriate weight factor assigned to each objectives based on **prescribed strategic priorities**;
  - Criteria for overall success of nuclear power programme: maximum level of **total achievement** of all objectives, **weighted** with OWF
- Prioritization of criteria and requirements:
  - Impact of each criteria/requirements on individual objectives is quantified
  - **Priorities** of criteria and requirements and can then be **set based on** quantity of their **impact on overall success**
- Comparison of design feature and options:
  - Use a base-case and perturbation technique



# Strategic Priorities For OWF

- Example:

<i>Objectives</i>	Economic generation of electricity	Preservation of national oil resource	Improvement of national science/ engineering capability
<i>OWF</i>	<b>50%</b>	<b>40%</b>	<b>10%</b>

- Depends on countries' condition and aspiration, normally reflected in the national policies:
  - National economic development policy;
  - National policy on energy development and environment protection;
  - National policy on international relations;
- Should be **endorsed** a-priori by **all stake-holders** of nuclear power programme;
- INPRO Methodology can be used as a reference guide for reaching consensus and for sustainability consideration



# Multi-criteria Decision Making (MCDM)

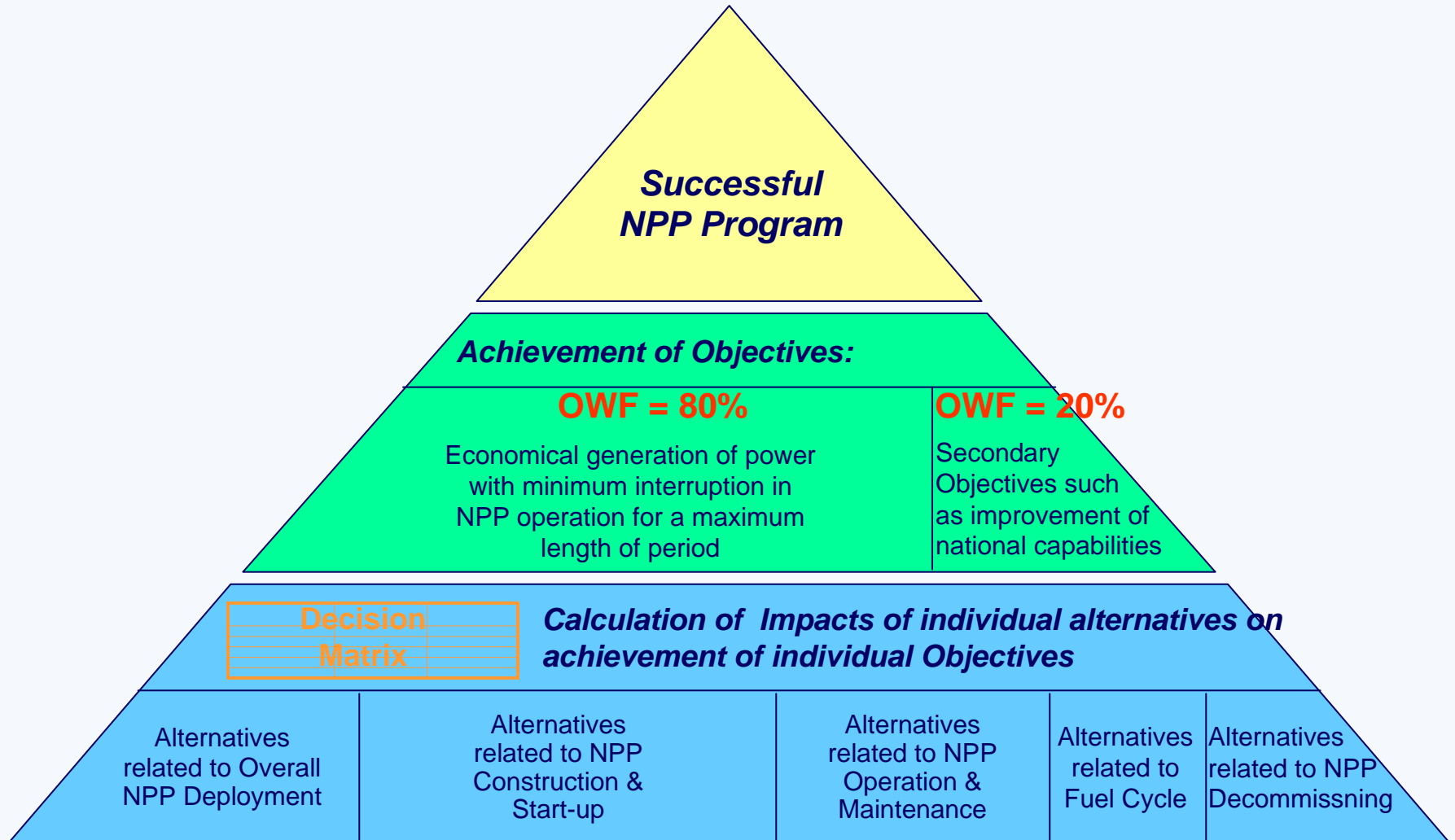
- Method of reaching decision on choice among *alternatives (criteria/requirements or options)* in uncertainty environment, based on a number of, possibly conflicting *objectives*;
- Use of Decision Matrix:

	<i>Objective #1</i>	<i>Objective #2</i>	<i>Objective #3</i>
<i>Alternative A</i>	28.7	1000.3	1.96
<i>Alternative B</i>	27.3	554.0	9.87
<i>Alternative C</i>	19.6	612.5	8.77
<i>Alternative D</i>	30.1	390.6	3.50

- Calculate measured or predicted *impact* of an *alternative* on each *objectives* - deterministic or probabilistic

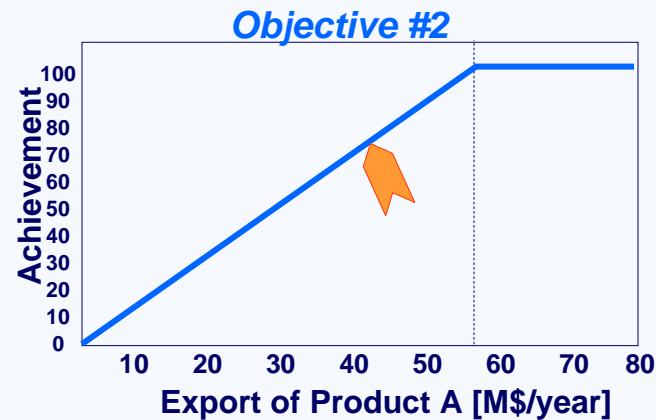
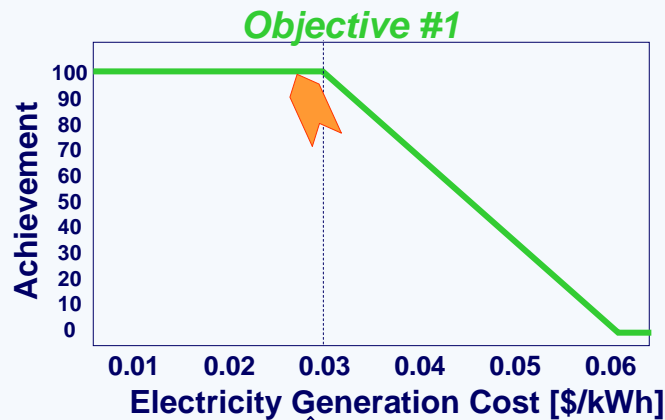


# Illustration of Approach



# Quantification of Impacts

- Use indicators: no need to use the same basis for quantifying different objectives:



**Overall Achievement:**

$$80 + 15 = 95$$

$$100 \times 80\% = 80$$

**Objective #1**

$$75 \times 20\% = 15$$

**Objective #2**



# Examples of Indicators

- Economical generation of electricity:  
Levelized Unit Energy Cost (LUEC);
- Achievement of energy independence:  
Annual total import of energy (\$/year);
- Establishment of a new technology sector:  
contribution from the sector to Technology  
Achievement Index (TAI)

# Summary

- Self reliance strategy is mainly carried out through a well-planned national capability building process;
- National participation is best done gradually and extensive discussions/negotiation with suppliers;
- Technology transfer and human resource development are best focusing on essential parts of national capability building plan;
- Optimization is frequently required in dealing with conflicting Criteria/ Requirements and in the planning of nuclear power program with multiple objectives;
- Methodological technique exists for this optimization: consistent, systematic, and based on prescribed strategic priorities.

