

International Atomic Energy Agency

Perspectives of Site Selection and Electric Grid Characteristics

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How does it all fit together?

- Site selection and grid assessment are not part of Technology Assessment:
 - Preliminary studies done before or in parallel with early part of Technology Assessment
 - Iterative process
 - It is a good idea to have a clear picture of the entire process!
 - Begin with the end in mind.

Site Selection Process And Interaction With Others

Technology Assessment

Site Considerations:

Infrastructure
Safety/Environment
(Socio-Political)

Grid Characteristics
Considerations

Optimization

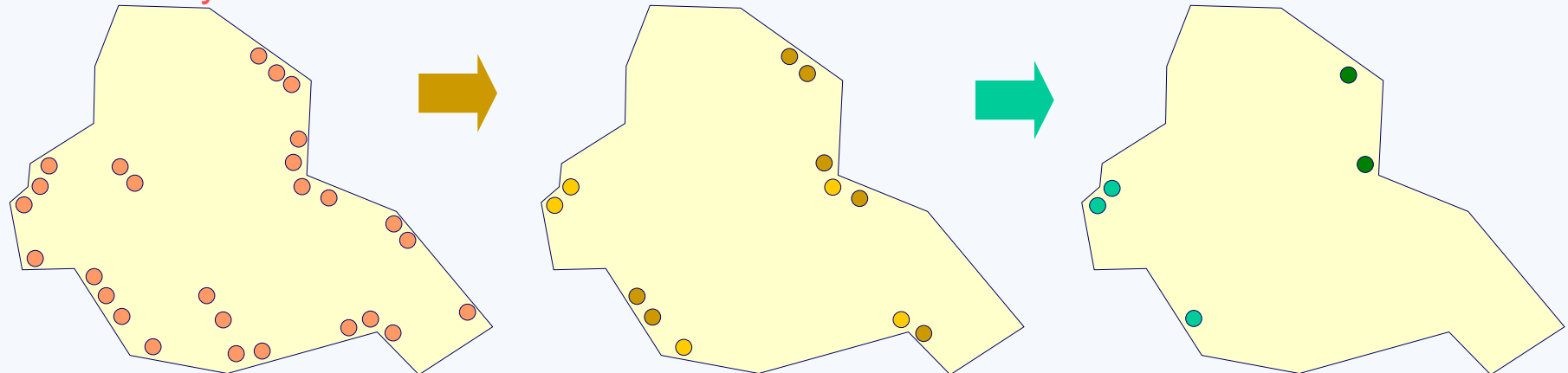
Feedback from
Technology Assessment

Socio-Political
Considerations

Site Survey

Site Evaluation

Site Selection



● Preferred Sites
● Backup Sites

● 1st NPPs Sites
● Future NPP Sites



Site Selection Process And Interaction With Others

Technology Assessment

Requirements:

*Unit Size
Timing*

Special Site Requirements

Localization

Site Considerations:

Infrastructure

Safety/Environment

(Socio-Political)

Grid Characteristic
Considerations

Optimization

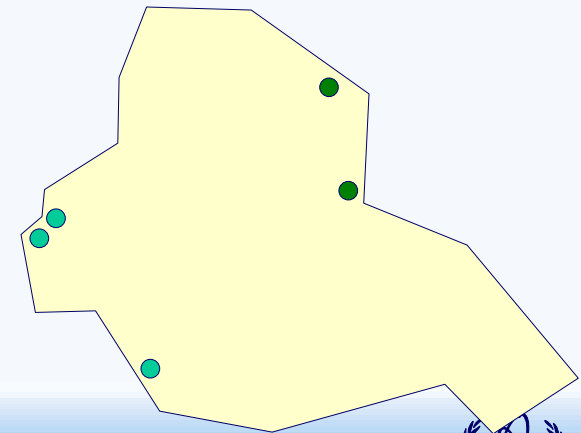
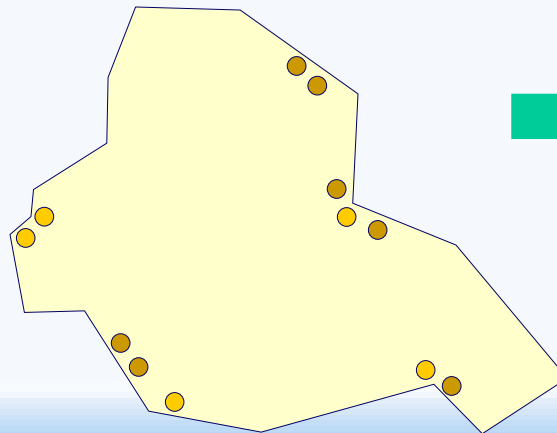
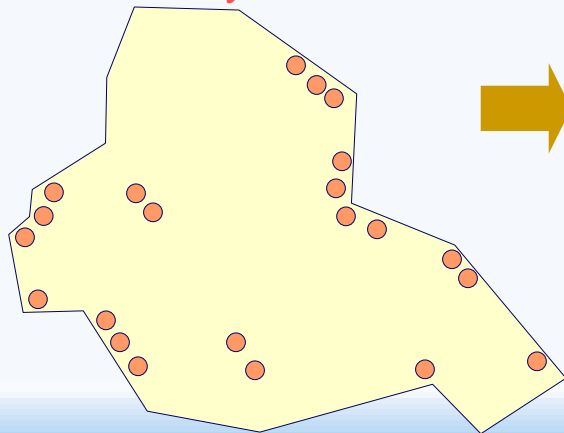
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Infrastructure Considerations

Select sites that minimize:

- Cost of **transmitting electricity** from the site to applications;
- Cost of **transportation**: road, harbour, etc;
- Cost of **land and site preparation** including excavation;
- Cost of facilities to **transfer heat to** ultimate **heat sink**;
- Cost of **new residential facilities** for plant employees and supporting personnel
 - Housing, hospital, schools, etc.
- Cost for **emergency** planning
 - Off-site centre, evacuation load, monitoring facility



Infrastructure Considerations

(continued)

Also minimize:

- Cost of **protection against** natural and man-made **hazard**:
 - earthquake, tornado, flood, aeroplane crash, toxic material release from nearby transportation;
- Cost to enhance **on-site power sources**
 - Depending on the vulnerability of transmission network;
- Cost for **environmental enhancement, preservation and protection**



Socio-Political Considerations

Consider:

- **Cost of labour** and benefit of **job creation** in local and neighbouring communities;
- Cost and benefit of potentially **creating new communities** and related **economic activities**;
- Impact (and cost) of **protecting site** for future use, and cost of **changing decisions** due to various social-political reasons (opposition, lawsuit, referendum, etc);
- Cost of **compensation** to local community and organizations (fishery, landscape, tourism, etc);
- Cost of **information sharing and education** with local stakeholders



Safety and Environment Consideration

- ❖ *More demanding requirements than for conventional plants*

Objectives:

- Avoid **severe phenomena** (natural events): against which plant **protection** through design is **impracticable/non-economical**
- **Reduce probability of less severe phenomena**: against which plant protection is achievable at reasonable additional cost;
- **Consequence** of potential NPP accidents would be **within acceptable limits**.



Safety and Environment Consideration

(Continued)

Require specific information:

- Geology;
- Seismology;
- Hydrology;
- Meteorology

Consider:

- **Effect** of natural & man-made site-related phenomena **on the plant safety:**
 - Earthquake, surface faulting, flooding, water waves;
 - Aircraft crashes, chemical explosion, moving fluids/clouds of explosive, flammable, corrosive, toxic or radioactive material
- **Impact** of plant accidents **on the site:**
 - Population distribution, dispersion in air and water



Site Selection Process

- Further study of initially selected candidate sites:
 - Confirmation of site feasibility from safety, economic, technical and business perspectives, completed with detailed reports providing evidence for the confirmations;
 - Selection of candidate sites with priority, backed up with safety assessment report and more detailed inspection, measurement and testing;
 - General study on engineering technical design based on a standard plant design;
 - Site envelope used for standard design may include unnecessary margins!!
 - Are there some specially constraining areas?
 - Detailed study of impact of plant on and interaction with transmission line and electrical network;
 - Develop an environmental impact study and report;

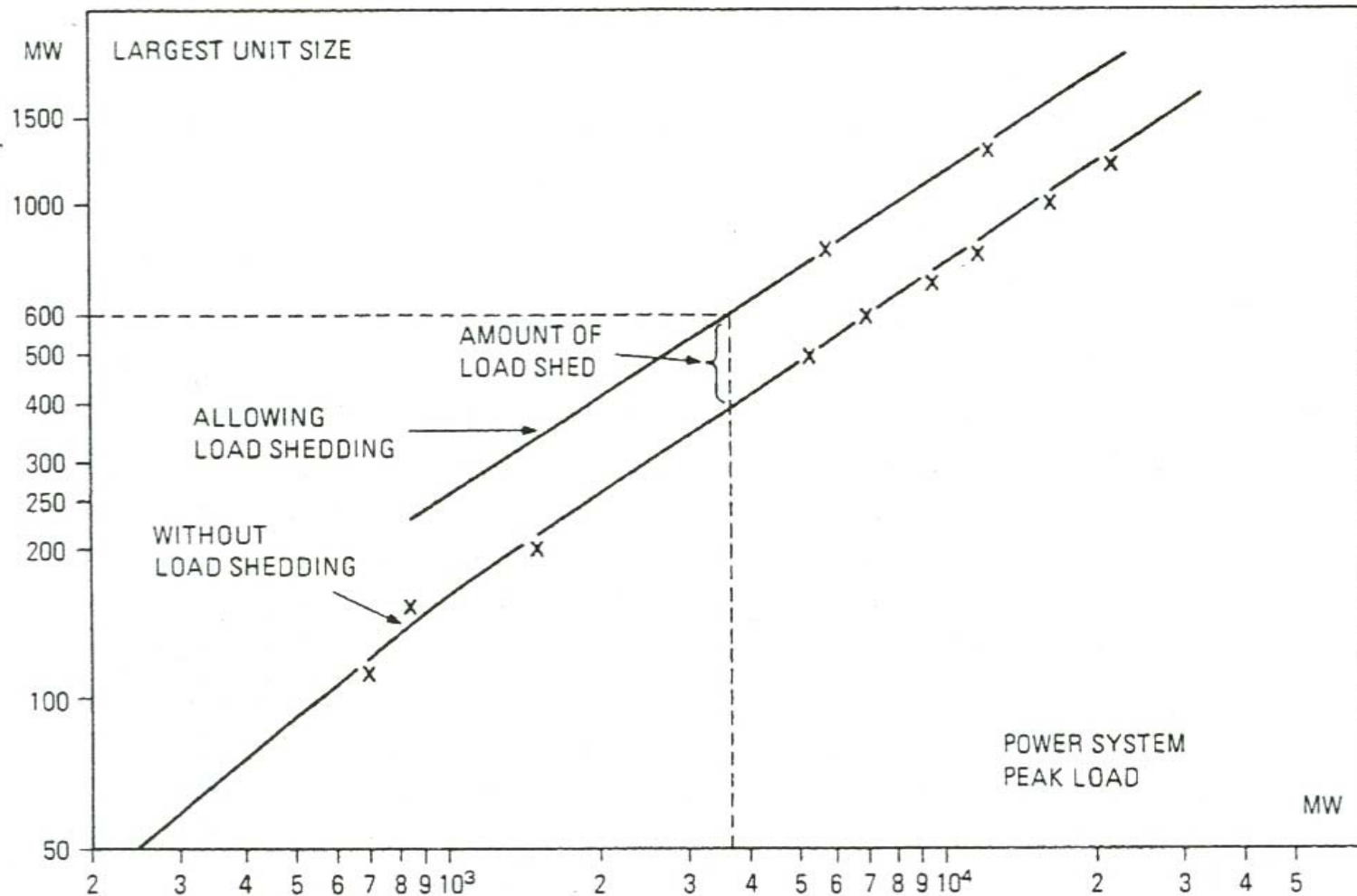


Grid Characteristic Considerations

- Analysis of overall power system network configuration:
 - Steady state load flows, transmission line requirements, voltage levels, system stability, etc
 - Capacity expansion from current to end-of-life of all major plants planned
 - Key to selection of preferred sites
- Analysis of **power system transient stability**:
 - All possible major disturbance: large plants trip;
 - Provide limit on size of the additional plants: Typically maximum unit size is about 10 % of grid size (peak load)
- **NPP unit size optimization**:
 - unit energy cost vs. penalties associated with larger size (generation reserve capacity and upgrading of transmission network)



Largest Admissible Unit Size



CUC Case Study

Determination of Site Characteristics with an impact on Plant Design

Steps in the Determination of Site Characteristics with an impact on Plant Design

1 - Identification of parameters to be considered

- **1. General Site Parameters**
 - Thermal Capacity
 - Local Grid Size and stability
 - Available Acreage
 - Maximum Height & Depth
 - Soil Characteristics
 - Access Routes
- **2. Meteorological and Atmospheric Parameters**
 - Atmospheric Pressure
 - Ambient Temperature
 - Ambient Humidity
 - Atmospheric Dispersion Patterns
- **3. Cooling Requirements**
 - Source
 - Cooling Intake Temperature
 - Cooling Flow Rate
 - Discharge Temperature
 - Chemistry
 - Drought Conditions
 - Auxiliary water requirements



Steps in the Determination of Site Characteristics with an impact on Plant Design

1 – Identification of parameters to be considered (cont)

➤ 4. External Events

- Rain
- Snow and Ice
- Lighting & Electrical Storm
- Wind
- Large Storms: Hurricane, Cyclone, Typhoon, Tornado
- Seismic Events
- Volcanic Events
- Flood
- Aircraft Crash



Steps in the Determination of Site Characteristics with an impact on Plant Design

4. External Events (cont.)

- **Other Man-Induced Events**
 - External Explosion
 - Forest Fire
 - Release of Hazardous Fluids
 - Release of Toxic Gases
- **Natural Events**
 - Fish
 - Coastal Erosion
 - Insects
 - Rodents
 - Sand Storms
 - Water Pollution
- **Other**
 - Avalanche
 - Collapse of a dam upstream the site
 - Landslide
 - Volcano

Steps in the Determination of Site Characteristics with an impact on Plant Design

2 – Influence of these parameters on

- Design of NPP systems (e.g. cooling tower)
- Design of buildings
- Design of components
- Layout of the site
- Materials selection
- Construction techniques

Steps in the Determination of Site Characteristics with an impact on Plant Design

3 – Cost Sensitivity of each parameter on cost

- Order of magnitude / qualitative assessment / rule of thumb
- Based on previous experience

4 – Assessment of number of sites enveloped by the generic **CUC List of Site Parameters** (CUC LSP)

5 – Approach for definition of “typical” generic CUC LSP

- Global
- Regional
- Climatic (e.g. tropical generic site, polar ...)



Resulting Requirements & Specifications

- Type of heat sink; **Infrastructure**
- Maximum size and weight of equipment or system modules;
- On-site power sources;
- Use of local infrastructure and human resource; **Socio-Political**
- Localization of plant support and service;
- Specific site requirements related to safety and environment protection; **Safety & Environment**

Resulting Requirements & Specifications

- Timing for connection to grid (project implementation);
- Maximum unit size;
- Preferred mode of operation: base load or load follow
- Plant manoeuvrability and compatibility to grid:
 - Load-following and load-change capability;
 - Ability to come back to house load and sustain house load operation;
 - Ability to withstand turbine trip without reactor tripping;
 - Time to return to full power after trip;
 - Power set-back and run-back capability;
 - Permissible voltage and frequency band

Grid Characteristics



Summary

- Factors related to the site and grid that affect Technology Assessment have been considered:
 - Infrastructure considerations;
 - Safety and environmental considerations;
 - Socio-political conditions;
 - Grid characteristic consideration;
- Resulting in several requirements/specifications:
 - Unit size, timing, localization, specific site-related conditions, grid-related conditions;
- Feedback from Technology Assessment can help selection of preferred sites.