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Elements of the “Quality of Electric Power Infrastructure”

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Introduction

An understanding of the importance of considering the quality when procuring electric power infrastructure has been cultivated through yesterday's discussion

To further promote the argument, all of us need to have a common understanding of the "Quality of Electric Power Infrastructure"

- **In order to do so, it may be effective to break down the elements of the "Quality of Electric Power Infrastructure" and analyze each of the elements**
- **However, the aggregate of the elements has to explain the "Quality of Electric Power Infrastructure" in a mutually exclusive and collectively exhaustive (MECE) manner**

Elements of the "Quality of Electric Power Infrastructure"

Based on yesterday's discussion, we have broken down the "Quality of Electric Power Infrastructure" into six elements from the aspect of performance, externality and cost

Aspect	Element	Definition
Performance	①Initial Performance	The ability for an electric power infrastructure to start operation as scheduled
	②Availability	The ability for an electric power infrastructure to operate as planned
	③Resilience	The ability for an electric power infrastructure to stop operation immediately when a problem arises and promptly resume operation
Externality	④Environmental Consideration	The ability to prevent or suppress environment related damages caused by electric power infrastructure / symbiosis with local communities
	⑤Safety	The ability to prevent or suppress non-environmental damages caused by electric power infrastructure
Cost	⑥Life Cycle Cost	The sum of the cost throughout the life cycle from construction to decommissioning of electric power infrastructure

Elements of the "Quality of Electric Power Infrastructure"

The aggregate of the six elements explains the "Quality of Electric Power Infrastructure" in a mutually exclusive and collectively exhaustive (MECE) manner

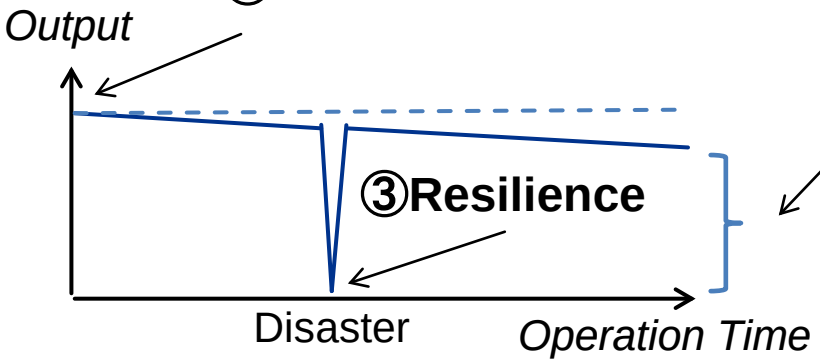
Cost

⑥Life Cycle Cost

Performance

①Initial Performance

②Availability



Electric Power Infrastructure (Generation/ Transmission and Distribution)

Externality

Environmental Destruction⇒**④Environmental Consideration**

Industrial Accident ⇒**⑤Safety**

Framework of Analyzing Each of the Elements

1. What is “Quality of Electric Power Infrastructure”?

- The “Quality of Electric Power Infrastructure” can be classified into six elements(① Initial Performance, ②Availability, ③Resilience, ④Environmental Consideration, ⑤ Safety and ⑥Life Cycle Cost)

2. How to accurately measure/evaluate “Quality of Electric Power Infrastructure”?

- A measurement/evaluation standard is required to determine the quality of electric power infrastructure

3. How to ensure the “Quality of Electric Power Infrastructure”?

- As it is impossible to accurately measure the quality of electric power infrastructure using measurement/evaluation standards before procurement, it is important to ensure quality in some other way (Pre-Qualification(P/Q) / Tendering stage)
- It is important to ensure that the electric power infrastructure sustains the measurement/evaluation standards even after the contract (Construction/O&M stage)

①Initial Performance

1. What is “Initial Performance”?

- The ability for an electric power infrastructure to start operation as scheduled
  - ✓ It is important for an electric power infrastructure to meet the required performance standards
  - ✓ The definition of initial performance may include the accuracy of delivery date (operation commencement date)

①Initial Performance

2. How to accurately measure/evaluate “Initial Performance”?

- Generation Facilities: Power Output, Generation Efficiency
- Transmission Facilities: Transmission Capacity, Transmission Loss Rate

①Initial Performance

3. How to ensure “Initial Performance”?

- P/Q and Tendering Stage
  - ✓ Explicitly state penalties for not meeting Performance Standards (Output, Generation Capacity etc.) or the delivery date in the specification
  - ✓ Request the bidders to submit past experiences (met the delivery date, situation of commissioning, operation rate etc.) in third party countries and confirm the operation status by physically visiting existing facilities

- Construction and O&M Stage
  - ✓ Confirm at the site of the field test / witnessed test (in which a third party institution is involved)
  - ✓ Request for prior approval by the ordering party when changing full-time engineer

①Initial Performance

【Ex：Performance regulation of thermal generation in Japan】

- The generation efficiency of a thermal generation plant is expressed as “thermal efficiency”(Electric Output ÷ Heat Input)
- In principal, the construction plan of a generation facility must meet this thermal efficiency standard for an electric company etc. to newly establish/renew a thermal power generation plant

Capacity【MW】	Methods of Power Generation【Burnup etc.】	Fuel		Gross Thermal Efficiency【%:HHV (%:LHV)】	Net Thermal Efficiency【%:HHV (%:LHV)】
		Type	Specification		
Coal-fired Power					
700	Pulverized Coal-fired Power【Ultra Super Critical/Super Critical】	Coal	Mainly high melting point of bituminous coal is used (ash melting temperature is over 1400℃)	42.5 （44.5）	40 （42）
600	Pulverized Coal-fired Power 【Ultra Super Critical】	Coal	Mainly high melting point of bituminous coal is used（ash melting temperature is over 1400℃）	42 （44）	39 （41）

Source: Ministry of Economy, Trade and Industry, Ministry of the Environment (Japan) ,”Commercialization and development status of latest generation technology (Reference Materials for Best Available Technology) ” (2014)

②Availability

1. What is “Availability”?

- The ability for an electric power infrastructure to operate as planned
  - ✓ Availability of an electric power infrastructure is a broad concept consisting of Ⅰ. Performance Retention, Ⅱ. Durability and Ⅲ. Security, and is expressed as the operation rate etc.
    - Ⅰ. Performance retention is the ability to prevent decline of performance over passage of time
    - Ⅱ. Durability is the ability to resist against physical exterior impacts
    - Ⅲ. Security is the ability to prevent decline of performance due to a disaster, hacking, terrorism etc.

②Availability

2. How to accurately measure/evaluate “Availability”?

- Generation Facilities: Continuous Operating Time, Operating Rate, Design Strength, Predicted Value of Power Generation Efficiency after the Warranty Period
- Transmission Facilities: Working Load

②Availability

3. How to ensure “Availability”?

- P/Q and Tendering Stage
  - ✓ Confirm the bidders’ past defective construction history
  - ✓ Confirm the “certificate of quality” of the products to be used
  - ✓ Confirm the appropriateness of the maintenance plan, disaster prevention plan etc. indicated in the technical proposal
- Construction and O&M Stage
  - ✓ Request submission of the prototype of the manual and make sure the facility manager education program is carried out
  - ✓ Thorough entrance and exit management to the facility
  - ✓ Optimize maintenance and management by gathering data in relation to power generation

②Availability

【Ex：Availability regulation of power plants in New Delhi, India】

- In general, an availability of above 85% is required for all thermal/hydro electric power plants in the city. An incentive is paid for availability in excess of 85% and a penalty is imposed on a power plant with availability less than 85%
- There are exceptions under certain circumstances
  - ✓ Lignite fired generating stations using the Circulatory Fluidized Bed Combustion (CFBC) technology and generating stations based on coal rejects
    1. First three years from COD: 75%
    2. For next year after completion of three years of COD: 80%
  - ✓ Storage and pondage type plants with head variation between Full Reservoir Level (FRL) and Minimum Draw Down Level (MDDL) of up to 8%, where plant availability is not affected by silt : 90%

③Resilience

1. What is “Resilience”?

- The ability for an electric power infrastructure to stop operation immediately when a problem arises and promptly resume operation
  - ✓ Preparation of various measures to mitigate the risk of suppliers/operators not being able to fulfill social responsibility is important

③Resilience

2. How to accurately measure/evaluate “Resilience”?

- The performance of the emergency stop function of the power plant (time to halt operation, damage to the plant）
- Existence of early recovery system (stock of spare parts, training of operator etc.) of electric power infrastructure
- Existence of BCP

3. How to ensure “Resilience”?

- P/Q and Tendering Stage
  - ✓ Confirm if there is an indication on the emergency stop function of the power plant in the technical proposal
  - ✓ Confirm the appropriateness of BCP etc. indicated in the technical proposal

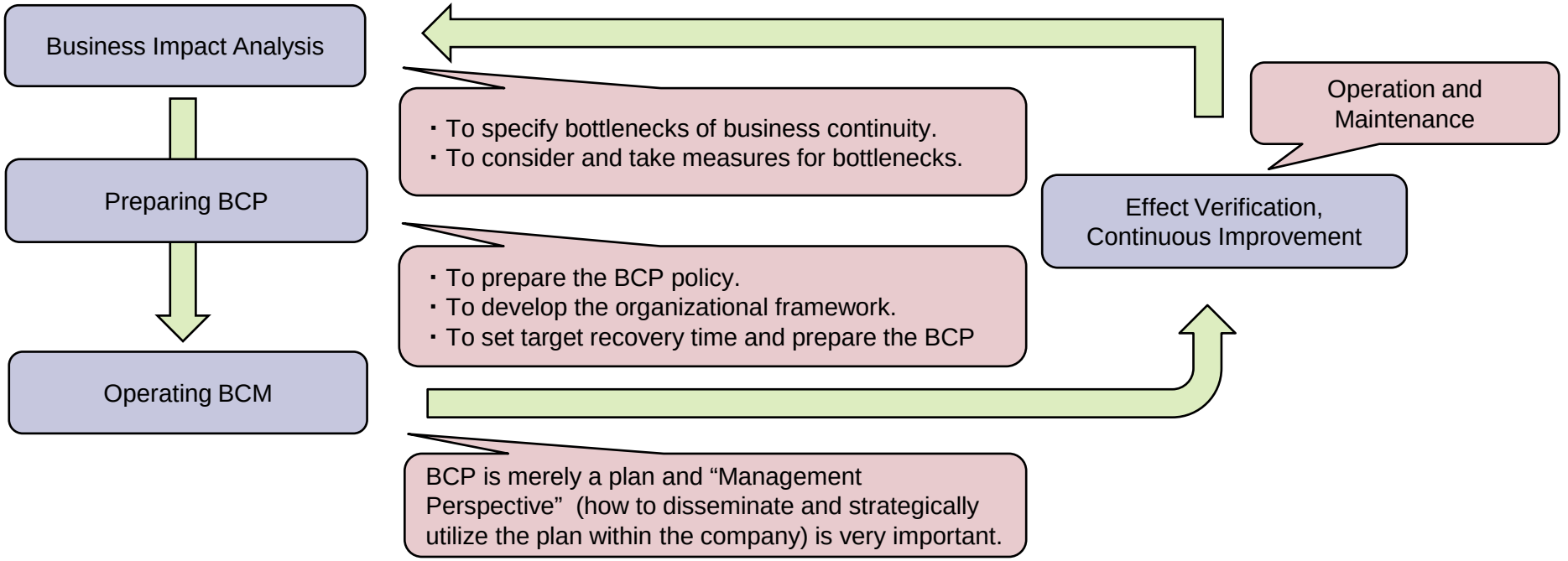
- Construction and O&M Stage
  - ✓ Make sure the facility manager education program (education in relation to BCM) is carried out
  - ✓ Establish a system to collect relevant data for early detection of problems

③Resilience

【Ex：Japanese Government's Guideline for Development of BCP】

- Guidelines containing the overview, necessity, effectiveness, method of implementation/development of BCP have been released by the Ministry of Economy, Trade and Industry (Japan)

＜Conceptual Diagram of BCP＞



Source: Ministry of Economy, Trade and Industry (Japan), "Guidelines for Development of Business Continuity Plan" (2005)

④Environmental Consideration

1. What is “Environmental Consideration”?

- The ability to prevent or suppress environment related damages caused by electric power infrastructure
- Symbiosis with local communities

  - ✓ Electric power infrastructure, due to its feature, has significant impact on the environment
  - ✓ Environment consideration is also important from a financing perspective, and compliance with IFC performance standards may be required for obtaining finance from international development and financial institutions

④Environmental Consideration

2. How to accurately measure/evaluate “Environmental Consideration”?

- P/Q（Appropriateness of environmental consideration indicated in the technical proposal）
- SOx, NOx, CO2 discharge rate

3. How to ensure “Environmental Consideration”?

- P/Q and Tendering Stage
  - ✓ Make EHS（Environment, Health and Safety）consideration a requirement
  - ✓ Confirm the appropriateness of the environmental preservation plan, compliance policy etc. indicated in the technical proposal

- Construction and O&M Stage
  - ✓ Obligate green procurement
  - ✓ Make sure the facility manager education program is carried out
  - ✓ Specify penalties will be imposed for violation in the agreement

④Environmental Consideration

【Ex: IFC's Performance Standards】

Performance Standard 1	Assessment and Management of Environmental and Social Risks and Impacts	To identify and evaluate environmental and social risks and impacts of the project.
Performance Standard 2	Labor and Working Conditions	To establish, maintain, and improve the worker-management relationship.
Performance Standard 3	Resource Efficiency and Pollution Prevention	To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.
Performance Standard 4	Community Health, Safety, and Security	To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances.
Performance Standard 5	Land Acquisition and Involuntary Resettlement	To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	To protect and conserve biodiversity.
Performance Standard 7	Indigenous Peoples	To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of indigenous peoples.
Performance Standard 8	Cultural Heritage	To protect cultural heritage from the adverse impacts of project activities and support its preservation.

Source: International Finance Corporation, "Performance Standards on Environmental and Social Sustainability " (2012)

1. What is “Safety”?

- The ability to prevent or suppress non-environmental damages caused by electric power infrastructure
  - ✓ It is important to avoid or minimize damages caused by electric power infrastructure
  - ✓ It is important to secure the lives/safety of the workers (Operators, guards, construction workers)

2. How to accurately measure/evaluate “Safety”?

- P/Q（Confirm the appropriateness of the indication of safety in the technical proposal）

3. How to ensure “Safety”?

- P/Q and Tendering Stage
  - ✓ Make EHS（Environment, Health and Safety） consideration a requirement
  - ✓ Confirm the appropriateness of the labor safety plan, disaster prevention plan, security plan etc. indicated in the technical proposal

- Construction and O&M Stage
  - ✓ Make sure the facility manager education program (labor safety, disaster and security related education) is carried out
  - ✓ Confirm the safety of temporary establishment when the construction plan is submitted

【Ex：Labor Safety Standards issued by OSHA (United States)】

- Labor safety standards in relation to electric power transmission and distribution construction
- Contractors are required to assess labor environment before commencement of construction

Provision	Assessment required	Type of information to be provided under § 1926.950(c)(1)(iii)
§ 1926.953(a)	Whether an enclosed space must be entered as a permit-required confined space.	Whether an enclosed space contains hazards, other than electrical and atmospheric hazards, that could endanger the life of an entrant or could interfere with escape from the space.
§ 1926.953(m)	Whether forced air ventilation has been maintained long enough that a safe atmosphere exists.	The size of the enclosed space.
§ 1926.960(c)(1)(i)	What is the appropriate minimum approach distance for the work to be performed.	What the operating conditions are for the value of the maximum transient overvoltage provided to the contract employer.[1]
§ 1926.960(g)(1)	Whether employees are exposed to hazards from flames or electric arcs.	Information on electric equipment, such as safety information provided by manufacturers, that relates to the required hazard assessment.
§ 1926.960(g)(2)	What is the estimated incident energy from an electric arc.	The electrical parameters needed to calculate incident energy, such as maximum fault current, bus spacings, and clearing times.
§ 1926.960(k)	Whether devices are designed to open or close circuits under load conditions.	Load current for, and the opening and closing ratings of, devices used to open and close circuits under load.
§§ 1926.961 and 1926.967(h).	What are the known sources of electric energy (including known sources of backfeed) supplying electric circuits.	All known sources of electric energy, including known sources of backfeed.
§ 1926.962(d)(1)(i)	Whether protective grounds have adequate current-carrying capacity.	The maximum fault current and clearing time for the circuit.
§ 1926.962(g)	Whether there is a possibility of hazardous transfer of potential should a fault occur.	Potential rise on remote grounds under fault conditions.
§ 1926.964(a)(2)	Whether overhead structures such as poles and towers are capable of sustaining stresses imposed by the work.	The design strength of the pole or structure.

[1] Includes information on conditions that must be in place for the maximum transient overvoltage to be valid, such as whether circuit reclosing devices are disabled.

Source: The U.S. Government Publishing Office, "Federal Register / Vol. 79, No. 70 / Friday, April 11, 2014 / Proposed Rules" (2014)

⑤Safety

【Ex：IFC's EHS Guideline】

IFC has set the following standards to protect safety of workers

- General Facility Design and Operation
- Communication and Training
- Physical Hazards
- Chemical Hazards
- Biological Hazards
- Radiological Hazards
- Personal Protective Equipment
- Special Hazard Environments
- Monitoring

⑥Life Cycle Cost

1. What is “Life Cycle Cost”?

- The sum of the cost throughout the life cycle from construction to decommissioning of electric power infrastructure
  - ✓ Total cost from construction to maintenance, operation and decommissioning of the electric power infrastructure has to be considered
  - ✓ In general, maintenance performance and quality have to be considered to minimize life cycle cost

⑥Life Cycle Cost

2. How to accurately measure/evaluate “Life Cycle Cost”?

- P/Q (Estimated life cycle cost of the power plant specified in the technical proposal is below a certain value)
- Net Present Value of the life cycle cost

⑥Life Cycle Cost

3. How to ensure “Life Cycle Cost”?

- P/Q and Tendering Stage
  - ✓ Request for fundamental data and assumptions used for computing the life cycle cost
  - ✓ Exclude contractors bidding at a significantly low value, as lack of ability/integrity can be inferred

- Construction and O&M Stage
  - ✓ Request for an estimate of life cycle cost at the development/design phase
  - ✓ Establish a structure to collect relevant data in order to precisely break down the components of cost

⑥Life Cycle Cost

【Ex: Elements of Life Cycle Cost】

	Plan, Design, Construction	Operation	Maintenance	End of Life
Cost for Orderer	Costs such as: ・Plan proposal ・Selection of operator ・Licensure ・Supervision	Costs such as: ・Supervision	Costs such as: ・Supervision	Costs such as: ・Supervision
Cost for Constructor, Operator	Costs such as: ・Design ・Construction ・Installation of component ・Test operation ・Quality control	Costs such as: ・Operating facilities ・Fuel ・Employment ・Training ・Quality control	Costs such as: ・Facility inspection ・Repairing ・Quality control	Costs such as: ・Disposal ・Restitution ・Quality control
Cost for Society and Environment	Costs such as: ・Environmental assessment ・Safety assessment ・Consideration for community	Costs such as: ・Preventing environmental pollution ・Consideration for community	Costs such as: ・Preventing environmental pollution	Costs such as: ・Preventing environmental pollution

Source: Ministry of Economy, Trade and Industry (Japan) ,"APEC Guidebook on Quality of Infrastructure Development and Investment" (2015)

Conclusion

- We have attempted to break down the “Quality of Electric Power Infrastructure” into six elements (① Initial Performance, ②Availability, ③Resilience, ④ Environmental Consideration, ⑤Safety and ⑥Life Cycle Cost)
- In addition, we have analyzed 1. Definition, 2. Measurement/Evaluation methodology and 3. Methods to ensure quality, for each of the elements

Thank you very much for listening