ENERGY ADVISORY COMMITTEE

Electricity Market Review: Planning Criteria and Reliability Standard

The Issue

To review the range of existing planning criteria and reliability standards, and consider options for the electricity market in Hong Kong.

Background

2. Reliable supply of electricity, measured by "**Adequacy**" and "S**ecurity**", depends to a great extent on the **planning criteria** and **reliability standard**. "**Adequacy**" is the ability of the electric power system to supply the aggregate electricity demand at all times, taking into account scheduled and reasonably expected unscheduled outages of generation resources and network facilities. "**Security**" is the ability of the system to withstand disturbances such as system faults or unanticipated sudden loss of system components and hence is a measure of the system's robustness. To meet the **adequacy** requirement, power companies apply a set of **planning criteria** to develop system expansion plans, for generation and transmission, to meet future needs. To meet the **security** requirement, **reliability standards** are developed to ensure acceptable system performance and security in everyday operation.

Planning Criteria

3. **Planning criteria,** as the basis of which the power system is planned to meet forecast demand, ensure an expected level of supply reliability. These criteria are, however, different from the reliability in electricity supply perceived by consumers. For the latter, the power companies in Hong Kong have established Average System Availability Index as the indicator. Performance reflected by this index is nevertheless a measure to ascertain the validity and adequacy of the planning criteria.

(I) Overseas Practice

4. Most power companies adopt the Loss of Load Probability (LOLP) as the primary criterion for **generation** planning. LOLP is the probability of electricity demand exceeding power supply capability, taking into account planned maintenance and unforeseen outages of generating units. Others

develop generation expansion plans based on a pre-fixed capacity margin over maximum forecast demand to guard against planned and unforeseen generation outages. This criterion can be used as the primary criterion, or as a secondary criterion in addition to the LOLP criterion. Power companies will evaluate the LOLP and/or capacity margin in each year of the planning horizon of the forecast period (e.g. 10 years) and compare the results with the LOLP or pre-fixed criteria. New generation resources are added in those years when the evaluation indicates that the criteria cannot be met by existing and projected resources.

5. For **transmission** planning, power companies generally design their networks to cater for the loss of critical network components (e.g. an overhead line, a cable or a transformer) without causing network overloads or unstable operation. Most companies adopt the loss of a single piece of component as their basic planning criterion, without regard to the probability of its occurrence. This is usually referred to as the "N-1" deterministic criterion. More stringent criterion that considers simultaneous outage of two critical components (i.e. "N-2") may also be adopted in critical parts of a network that require a higher level of reliability.

(II) Hong Kong Practice

6. Due to historical reasons, the two local power companies adopt different planning criteria for both generation and transmission. While there is some coordination such as exchange of planning information, the two companies draw up their own plans for generation resources and transmission networks individually to meet the reliability targets for their respective supply areas. Nonetheless, these criteria are generally in line with those adopted by other developed countries.

(III) Possible Options

(a) Independent Individual Planning: Status Quo

7. If the electricity supply industry in Hong Kong should continue in a form similar to the present arrangement, the existing individual planning practices would and has been demonstrated to serve the purpose of maintaining the current level of system reliability. This mode of planning has nevertheless given rise to -

(i) the perceived large amount of capacity margin that each company needs to carry to meet its own planning criteria requirements;

(ii) the inefficient use of the total generation resource in Hong Kong; and

(iii) potential adverse impact of network developments in one system on another not being properly assessed.

(b) Coordinated/Joint Planning

8. To maximize utilization of available generation capacity in the two systems and to minimize potential adverse impact of changes to either company's network (e.g. adding transmission lines and cables), more coordinated planning or even joint planning (where the two systems are planned as one) may be considered. Economic benefits can be realized by sharing of capacity margin and contingency reserve, without compromising supply reliability. This mode of planning, however, means that-

(i) more time is required for coordinating generation planning activities;

(ii) longer lead time which could lead to greater inaccuracy in load forecast which in turn impacts on the capacity margin required;

(iii) there will be additional administrative burden for the companies concerned, resulting in inefficient business operation and therefore additional cost; and

(iv) in the case of joint planning a new player would have to be introduced to do the planning, hence further increasing the administrative burden, extra cost and potential disputes between this planning agent and the power companies. And perceived intrusions into business decisions of the power companies are foregone conclusions.

Moreover, for more coordinated and possibly joint planning, increased interconnection capability and a common set of reliability standards (vide on Reliability Standards paragraphs 12 to 18 below) are the other pre-requisites.

(c) Central Planning: Open Market

9. In an open market where generation development plans would be prompted by market force and determined by individual market participants' business decisions i.e. objectives and strategies, risk assessments and forecast returns. The potential benefits are maximizing the utilization of available generation resources and having just sufficient and "just-in-time" generation additions.

10. This mode of planning however runs the risk of supply reliability being compromised because of inaccurate assessments of demands (of consumers) and supply (by competitors) and/or reluctances or untimely investment in infrastructure by market participants. To guard such eventually, there would be the need for a central planning agent that would use established generation planning criteria to forecast future resource needs and to introduce investors to build sufficient generation to meet future needs. While this central planning authority approach and a central planning are rather common practice in competitive electricity market, it would nevertheless be perceived as an intrusion into business decisions, by the two power companies in Hong Kong.

11. The central planning agent would also assess future needs for transmission reinforcement, and provide market signals for investment. The advantages lie in achieving near optimal transmission reinforcement solutions and the elimination of potential adverse impact of un-coordinated network development plans. The implications relating to central planning of generation facilities are equally applicable.

Reliability Standards

12. **Reliability standard** measures the minimum acceptable performance level at which the power system is planned and operated to achieve the expected level of supply reliability. There is no universal norm regarding the scope and format of reliability standards. Different power systems in different economies have different ways of developing and administering their reliability standards.

(I) Overseas Practice

13. In North America, a not-for-profit organization is responsible for overseeing the reliability of interconnected power systems. This organization, known as the North American Electric Reliability Council (NERC), has promulgated some high-level reliability standards for members to comply on a voluntary basis. As many of the electricity markets in the U.S.A. and Canada become liberalized, NERC has found that voluntary compliance is no longer sufficient to ensure power system reliability under the competitive environment, and hence is now seeking a mandatory and legally supported framework to enforce compliance.

14. Other countries such as the U.K. and Australia have adopted a slightly different approach. Their reliability standards are basically embedded in a set of codes[1] developed at the time when competitive electricity markets were established. These codes define in detail the technical requirements under which their power systems are planned and operated. They have also established requirements for market participants to connect to the power grid and to exchange reliability related information to ensure that the power systems are developed and operated reliably. Standard compliance is legally enforced by virtue of the market rules.

(II) Hong Kong Practice

15. In Hong Kong, the obligation to provide reliable electricity supply currently rests with the two power companies. They determine their own reliability standards, and plan their systems independently and operate their rather weak interconnection for emergency use only.

(III) Possible Options

(a) Individual Differing Standards – Status Quo

16. This approach assures the sanctity and security of each system and in a way ensures life-line support for the other system in the event of a mishap. The corollary however is that the differing standards, and therefore differing

[1] In the U.K., it is known as the Grid Code which is implemented by the system operator - the National Grid Company. In Australia, it is known as the National Electricity Code which is administered by the National Electricity Code Administrator.

system configuration, may adversely affect or prohibit developments in the Hong Kong electricity market, including its infrastructure.

(b) Common Standards

17. A common set of reliability standards would enable market players i.e. the power companies to establish a more stable operating framework to support electricity transfers, facilitate entry into market and hence increased competition in power supply. To achieve the objectives of a level playing field for participants while maintaining the required level of supply reliability, the standards would need to be measurable, and compliance enforceable. Developing common reliability standards nevertheless gives rise to additional administrative burden, potential disputes, additional resolution process requirements and additional investments by the companies concerned to resolve standard differences, where exist. And monitoring compliance with the standards and resolving disputes on violations entail additional administrative arrangements at costs. Some of the key elements to be considered in a common set of standard are-

(i) System Performance Standards

- Supply interruption: Frequency, duration and recovery time
- Generation contingency: Recovery amount and time
- System frequency: Deviation and recovery from disturbance
- System voltage: Max/min levels and control requirements

(ii) System Operation Standards

- Coordination: control authority, communication and information exchange
- Emergency plan: Load shedding requirements, communication protocol and recovery procedures

(iii) Network Planning and Connection Standard

- Planning: Contingency criteria, performance criteria and auxiliary requirements
- Connection: Equipment standards, interface requirements, deployment procedures, controlling authorities, etc.

18. A common set of reliability standards could be developed in Hong Kong-

(i) by the Government in legislation. This option offers the advantage of having one authority to set standards, direct intrusion into business operations is inevitable; or

(ii) by the power companies for endorsement by the Government. This option offers the advantage that the power companies propose standards that they feel appropriate and in line with their business objectives. This could on the other hand be perceived as self-serving motive and lack of public inputs; or

(iii) by a standard-setting authority with participation by relevant parties. This option offers the advantage that it is a transparent process, with appropriate level of public participants. The consequence is of course increased administrative burden and the requirement for a dispute resolution process.

Observations

19. Development and implementation of generation expansion plans based on established planning criteria is an objective and mechanical exercise. Selection of planning criteria and reliability standards is nevertheless subjective, as different stakeholders could hold different views of an acceptable level of supply reliability.

20. Thus, theoretically, supply reliability is dependent on generation availability and actual performance of a power system. In effect, both factors are inevitably linked to external factors such as the weather, economic development, living habits, urban development, etc. To ensure supply reliability, such variations and uncertainties would have to be provided for in planned generation availability, leading inevitably to additional investments and possibly higher tariff. The stakeholders and the clients they serve should therefore be made aware that the investment in electricity supply infrastructure, generation and network, is proportional to the level of supply reliability.

Members' Advice

21. This paper and the others to follow examine the various issues relating to the electricity market per se. The applicability of the option and the possible way forward for Hong Kong would have to be carefully considered in the light of the existing electricity supply situation in Hong Kong. Members' views are invited.

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