Chapter 5

Key Findings and Next Step

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CHAPTER 5

Major Findings and Next Step

1. Key Findings

The following things have become clear through this study.

1. Not all power demand can be met through a single form of energy. Therefore, a mix that appropriately combines multiple power sources is essential. Each power source has its own characteristics, and effort is needed to maximize the advantages and minimize the disadvantages of each of them.

Table 5-1: Comparison of Each Fuel

	Resource availability	Stable electricity output	Generating cost	Environmental friendliness	Necessary action
Coal	Good	Good	Good	Poor	Improve efficiency
Natural gas	Fair	Good	Fair	Fair	Reduce price of natural gas
Hydro	Fair	Good	Good	Good	Develop potential capacity
Biomass Geothermal	Fair	Good	Fair	Good	Financial support for initial stage
Wind Solar	Good	Poor	Poor	Good	R&D for smart grid Support for cost reduction

2. Power interchange through international interconnected lines will bring changes to the entire power source mixes of the countries and region.
   - International power trade can adjust surplus and deficit of annual electricity supply-demand. However, we should be careful on the point that this study does not reflect a necessity for balancing daily peak demand (GW). This study considered only annual energy demand and supply (GWh)..

- Utilization of low-cost power sources available in the region can be maximized. Namely, total power generating cost can be reduced by expanding the interchange capacity of international interconnected lines.
- Emissions of air pollutants including carbon dioxide can be reduced by maximizing utilization of hydropower generation and renewable energy. It is, however, depending on hydropower and renewables potential in the region.

3. Total investment in power sources can be reduced for the entire region through power interchange via international interconnected grid networks. The total investment reduction effect will be largest under lax regulations for carbon dioxide emissions. On the other hand, as regulations on carbon dioxide emissions are tightened, use of relatively inexpensive coal-fired thermal power will fall, while supplying of more expensive but cleaner gas-fired thermal power will increase, diminishing the total investment reduction effect. In short, there is a tradeoff relationship between the reduction effect on total investment in power infrastructure and the strength of carbon dioxide emission regulations. In other words, the strength of environmental regulations has a significant impact on the selection of fuels for power generation.

4. Through power interchange, countries can alleviate discrepancies between power demand and energy resources for power generation. Expanding the interchange capacity of international interconnected grid networks enables stabilization of power supply throughout an entire region and reduction of dependence on imported fuels. This contributes to greater energy security throughout the region.

5. In countries and regions where domestic power grids themselves are insufficient, international interconnected grid networks can be expected to supplement them. On the other hand, it is conceivable that in some cases, upgrading the domestic power grid is necessary in order to maximize utilization of the energy resources that exist in a region. Therefore, domestic power grids should be upgraded at the same time international interconnected grid networks are improved.

In light of the above outcomes, the following points should be borne in mind for future power source development.

- Development of potential resources for power generation shall be quick. In a development, it is necessary to consider the roles of each power source for the base, middle, and peak load purpose and to combine them appropriately.
  - Develop hydropower, which is economical and environmentally-friendly (except during construction), and for which there is still much untapped resources in the region.
  - Develop coal-fired power plant, which is outstanding in terms of economy and amount of resources, especially in China, Indonesia and Vietnam.
  - Develop renewable energy that is relatively economical, such as geothermal and biomass, except solar power.

- Energy utilization that ignores environmental impact is impossible. For power generation as well, initiatives that move towards cleaner energy utilization should be strengthened.
  - Promote higher efficiency in coal-fired power generation. Reducing the emission in flue gas through higher efficiency will alleviate the sole disadvantage of coal utilization.
  - Expanded use of natural gas with its outstanding environmental performances is desirable from the perspective of reducing environmental impact, but natural-gas-fired power plant is less economical than coal-fired. It is, therefore, necessary to mitigate the economic disadvantage of natural-gas-fired power plant by working to lower the procurement cost as well as price of natural gas.

Along with power source development, in order to maximize cross border power trading, improvement and expansion of international grid networks are necessary. As noted above, the ADB's GMS program and HAPUA's ASEAN Power Grid are underway. However, there seem remains some barriers to the realization of those

plans. It is necessary to recognize those barriers and steadily undertake measures to eliminate them. Initiatives such as the following are necessary for their elimination.

- First, it is necessary to clarify the degree to which integration of the intra-regional electricity market is ultimately to be carried. If the goal is a single electricity market transcending national boundaries, such as that for which the European Union aims, a highly-independent regulatory body with powerful legal authority must be organized. On the other hand, if integration of the electricity market for the entire region is not a goal, and if national electricity markets are to be the rule, there are options for carrying out power interchange within rational political and economic parameters.
  Clearly, if the advantages of an international power grid as shown by this study are to be brought out fully, creation of a single electricity market transcending national borders is necessary.

- Although they will vary depending on the degree of market integration that is the goal, in any case, a coordinator that can balance interests in the region and set direction is necessary. The coordinator (organization) should have the following functions. If integration is to be deepened, the coordinating organization will need to concentrate on more functions; and it will need to be given the necessary authority.
  - The ability to establish systems and technical standards for the creation of a regional electricity market
  - The ability to make future plans related to power source development and the international power grid connections
  - Monitoring and guidance of plan implementation in each country
  - The ability to coordinate daily supply and demand

- Integration of systems and technical standards related to power interchange must be advanced. More concretely, that might include the following.
  - Standard connection conditions for transmission equipment (connection methods, measurement methods, division of ownership/management)

- Quality standards for power that is interchanged (voltage, frequency, and acceptable variation)
- Operating rules (load-dispatch instructions, contact methods)
- Rules for handling and responding to emergencies
- Standard contractual conditions for interchange contracts (standard contract)
- Standards for calculating rates for power that is interchanged
- Taxes that apply to power that is interchanged

- Schemes to procure the funds needed for power source development and grid interconnection project investment are required. Whether financing can be provided is an important key to materialize international grid interconnection plan. When considering the possibility of loans and their conditions, it should probably be remembered that the benefits of international grid interconnection will spread to multiple countries and will contribute to improve energy security. However, it would be somewhat unreasonable to ask private-sector financial institutions to evaluate the benefits, which are difficult to quantify. Governments and international financial institutions should undertake some initiatives.
  - Loan guarantees from governments in the countries concerned
  - Creation of a regional fund for power infrastructure improvement, with loan or loan guarantee functions. East Asian governments would finance the fund.
  - Loans from international financial institutions such as the ADB
  - Loans from development banks in developed countries (however, that will be conditioned on benefit to the lending country)

2. Next Step

This year's study obtained the above knowledge and findings, but there are still areas where analysis remains insufficient or deeper inquiry is needed. Those are subjects for study in the coming fiscal year and beyond.

- For the optimal power source mix for the entire region's power supply, if one does not consider carbon dioxide emission volume, resettlement due to hydropower development, or environmental issues such as NOx and SOx from

coal-fired power plants, then the answer one obtains is to begin developing the cheapest power sources. However, each country has its own energy policy, which of course affects the choice of power sources. If such policy factors can be incorporated into a model's constraints, then more realistic results can be obtained.

- The analytical model in this study focuses on optimal power supply for the region as a whole. It is constructed from a macro perspective that simulates balanced electricity supply and demand throughout the year. Therefore, elements related to each country's load curve data and state of domestic power grid, transmission loss and transmission costs accompanying international grid interconnection are not incorporated. In addition, in actual equipment planning, it is important to consider the roles of each power source in the base, middle, and peak and to combine them appropriately. If such micro elements can be reflected in the models, more exact results can be obtained.
- The cost effectiveness of international grid interconnection will likely vary by route. Since budget funds that can be devoted to international grid interconnection are limited, development of those routes with higher investment efficiency should be prioritized. If this study is able to identify which routes offer such investment efficiency, then it will contribute to real-world improvements rather than just being a subject for academic debate.
- Interconnection grid network cost should be taken into account in the model for optimal solution of electricity import-export for balancing electricity demand and supply.