Chapter 2

Summary Results of Earlier Study

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CHAPTER 2

Summary Results of Earlier Study

Study in 2011

In 2011, when the study was in its first phase, an indicator that could explain the energy security situation in quantitative terms had been developed. Based on statistical information, the value of the indicator was calculated, and past changes in the situation of energy security were analysed.

The definition of "energy security" changes depending on what the subject of energy security is ("what" is being protected), the threat to energy security ("against what" is it being protected), the measures for energy security ("who" "is doing what" to protect "with whom"), and how these points are recognised. There is no universal definition that transcends time periods.

For this study, energy security has been defined as "the securing of the amount of energy required for people's lives, economic, social, and defense activities, among other purposes, at an affordable prices."

Figure 2-1 indicates the components (major items) of energy security throughout the energy supply chain.

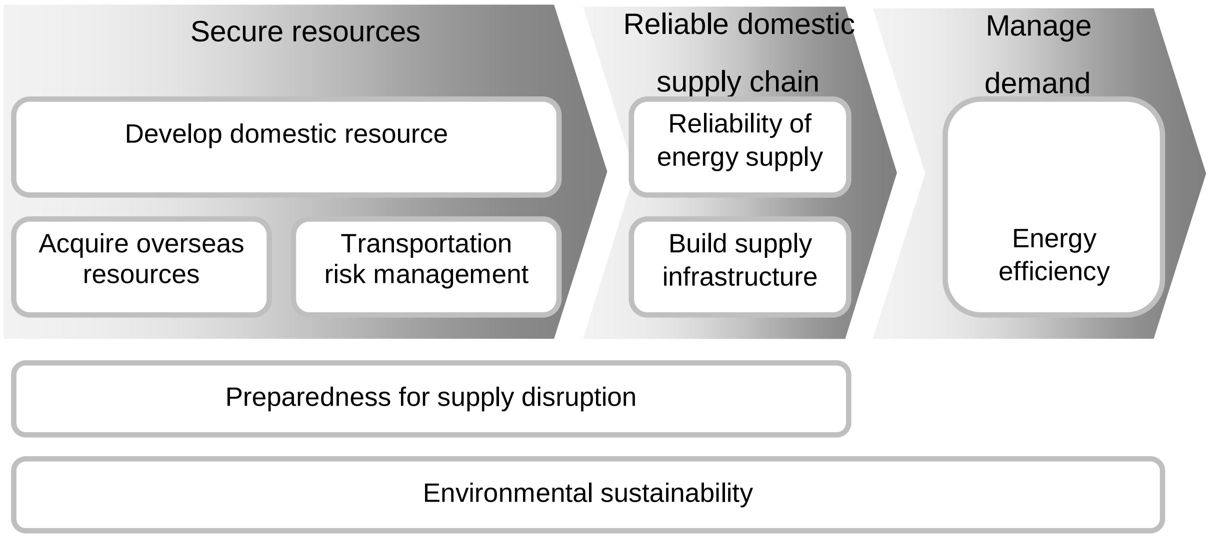
The principle is risk management and the improvement of the situation of energy security. Risk management includes the dispersion of risks (such as through the diversification of energy sources), the absorption of risks (such as the reserve margin of power generation capacities), and preparations against unavoidable supply disruptions (such as strategic reserves). The improvement of energy security includes developing domestic energy sources and enhancing resources acquisition in foreign countries.

The energy supply chain consists of three stages—"secure resources", "secure a reliable domestic supply chain", and "manage demand". A generally conceivable resource securing method is to develop or acquire resources at home or abroad and transport them to the domestic market. Therefore, the "development of domestic resources", "acquisition of overseas resources", and "transportation risk management" are deemed major items that constitute the first stage of the supply chain. The "reliability of the energy supply" and "construction of the supply infrastructure" are required to "secure a reliable domestic supply chain" are deemed major items for this stage. "Energy efficiency" is cited as a major item, indicating that something is being done to "manage demand". On top of these factors, "preparedness for supply disruptions" is adopted as a major component of energy security.

Environmental sustainability has been added to the factors comprising energy security in light of heightened issues concerning the global environment. Most greenhouse gas emissions are produced by energy sources, and so it goes without saying that an important aspect to ponder when thinking about energy issues is to consider the environment, including climate change issues.

If any of these factors is dropped, it may be structurally difficult for the supply chain to maintain a stable state of energy security.

Figure 2-1: Components of Energy Security



Source: Authors.

Table 2-1 shows the components of energy security, evaluation item, and representing indices. For details on the definition of energy security, refer to the 2011 report.

Table 2-1: List of Energy Security Index

Components of Energy Security	Evaluation Item	Index (ESI)
Development of domestic resources	1. Self-sufficiency	1-1. TPES self-sufficiency ratio (including nuclear) 1-2. Reserve/production ratio 1-3. Reserve/consumption ratio
Acquisition of overseas resources	2. Diversification of import source countries 3. Diversification of energy sources 4. Dependence on	2. Diversity of import source countries (oil, gas, and coal) 3. Diversity of energy sources of TPES/electricity 4. Middle East dependence

Components of Energy Security	**Evaluation Item**	**Index (ESI)**
	Middle East	for oil and gas
Transportation risk management	-	-
Securing a reliable domestic supply chain	5-1. Reliability of energy supply 5-2. Build supply infrastructure	5-1-1. Reserve margin of generation capacity 5-1-2. Power outage frequency/duration 5-2. Commercial energy access ratio
Management of demand	6. Energy efficiency	6-1. TPES/GDP ratio 6-2. TFEC/GDP ratio
Preparedness for supply disruptions	7. Strategic reserves	7. Days of on-land oil stocks
Environmental sustainability	8. CO_2 intensity	8-1. CO_2 emissions/TPES ratio 8-2. CO_2 emissions/Fossil fuel ratio 8-3. CO_2 emissions/GDP ratio 8-4. CO_2 emissions/Capita

Note : CO_2 = carbon dioxide, GDP = gross domestic product, TFEC = average final energy consumption, TPES = average primary energy supply.
Source: Authors.

Table 2-2 presents the ESI calculation method. For the description of each individual ESI, refer to the 2011 report.

Table 2-2: Calculation of Energy Security Index

ESI	**Calculation Method**
Self-sufficiency	(Indigenous production)/(TPES)*100
Reserve/Production (R/P) ratio	(Reserve)/(Production)
Reserve/Consumption (R/C) ratio	(Reserve)/(Consumption)
Diversity of import source countries	HHI
Diversity of energy sources	HHI
Middle East dependence	(Imports from Middle East)/(Average imports) *100
Reserve margin of generation capacity	(Average generation capacity)/(Peak demand) *100
Power outage duration	(Accumulated duration of power outage) /(Average number for customer)
Power outage frequency	(Outage frequency per year) /(Average number of customers)
Commercial energy access ratio	(TPES – Non-commercial energy)/(TPES) * 100 where: Non-commercial energy = (Primary supply of solid biofuels) – (Input energy for transformation purpose)
TPES/GDP	(TPES)/(GDP)
TFEC/GDP	(TFEC)/(GDP)
Days of on-land oil stocks	(Average stock)/(Forward demand) where: Average stock = industry stock + government stock Forward demand = forward quarter average daily demand calculated by the IEA
CO_2 emissions/TPES	(CO_2 emissions)/(TPES)

CO_2 emissions/Fossil fuel	(CO_2 emissions)/(Primary supply of fossil fuel)
CO_2 emissions/GDP	(CO_2 emissions)/(GDP)
CO_2 emissions/Capita	(CO_2 emissions)/(Population)

Note : CO_2 = carbon dioxide, GDP = gross domestic product, IEA = International Energy Agency, HHI = Hirschmann-Herfindahl Index, TFEC = average final energy consumption, TPES = average primary energy supply.
Source: Authors.

For details pertaining to the data source of each individual ESI, refer to the 2011 report. The data sources used to calculate the ESI are as follows:

- Energy balance of OECD, non-OECD Countries (IEA)
- CO_2 emissions from fuel combustion (IEA)
- Coal information, oil information, and natural gas information (IEA)
- Monthly Oil Market Report (IEA)
- World Energy Outlook (IEA)
- BP Statistical Review of World Energy
- WG on Analysis on Energy Saving Potential in East Asia (ERIA)
- Statistic of the World Bank
- Statistics of the Japan Electric Power Information Center
- National statistics of countries

Its purpose is to analyse changes in energy security situations from a long-term perspective, thus, a 10-year period was used as a block and average values were gathered within the entire period observed. However, in the 2000s, there was a striking economic growth in East Asian countries in particular, and this had a great effect on the energy environment. For this reason, this period was split in several five-year periods.

Period Abbreviation	**Period**
1970s	: 1970 - 1979
1980s	: 1980 - 1989
1990s	: 1990 - 1999
2000s-1	: 2000 - 2005
2000s-2	: 2006 – 2009

By having numbers of each index changing throughout the assessment period, the study yielded the following results:

1. While there are limitations to obtaining data, it is possible to develop an index that quantitatively indicates the energy security situation. For example, in the case of the indicator for the diverseness of energy source, ERIA averages show a trend toward the concentrated use of a specific energy across the years. This finding is consistent with the expanded use of coal for power generation.
2. Energy security is comprised by a variety of elements. The perspective from which a country is assessed varies diversely, depending on its situation. There is, thus, no single absolutely correct indicator, and it is important to assess multiple perspectives through a combination of several indicators.
3. With the cooperation of WG members, it was possible to access data that are difficult to obtain through publicly known statistics, such as statistics issued by the International Energy Agency (IEA) and BP Statistical Review of World Energy (BP), as well as to confirm and review data. This was one of the major results of this study.
4. Calculating the index using the data obtained yielded ESI values that were widely distributed and reflected the diversity of the countries.
5. In the case of the self-sufficiency ratio, it was possible to quantitatively confirm that despite having no domestic resources, a country could improve its self-sufficiency ratio by expanding its use of nuclear energy, and as a result, could improve its performance in terms of ESI. It is important that such policies underpinning the changes in indicator performance are analysed.

6. For country analyses, ESI has made it possible to quantitatively assess how the energy security situation has evolved over each decade.
7. Some indicators have a trade-off relationship, and therefore, it may be difficult to improve performances across all indicators simultaneously. This is observed, for example, between self-sufficiency and the diverseness of energy source.
8. Country situations shown by ESI vary, depending on the country's environment, including resource endowment and the extent of energy demand increases. Nevertheless, a number of common trends were identified:
   - Many of the resource countries experienced decreases in the self-sufficiency ratio or R/P ratio. It is thought that new resource development has not caught up with the speed of energy demand increase.
   - On the supply of primary energy and diversity of energy sources, few countries performed well compared to the Organisation for Economic Co-operation and Development (OECD) average. It was observed that while increasing the use of domestic resources, such as coal and hydropower, is favorable for improving the self-sufficiency ratio, this also limits the diversification of energy sources.
   - While access to commercial energy is improving, at the same time, this is causing a further increase in energy demand, including electricity demand.
   - Although efficiency in energy utilisation is improving in many countries, some countries still have low efficiency compared with OECD averages and there is yet room for improvement.

Study in 2012

In 2012, the study investigated the correlation between calculated ESI and past policies that were actually implemented in each country. The transition of ESI and relevant policies in the past became the focus of the analysis.

Although the change of ESI can be explained by various elements, including policies and economic situation, a few specific policies were selected to simplify the assessment work. Since the purpose of the study is to find the core element of correlation between the ESI and policies, this procedure does not deteriorate the analysis.

Table 2-3 shows selected policies that were analysed.

Table 2-3: List of Policies

Policy Area	**Policies Analysed**
Coal	Coal mining (indigenous) Coal use promotion Import source country diversity
Crude oil	Crude oil E&P (indigenous) Refinery construction Import source country diversity Oil stocks (SPR) Alternative fuel promotion (other than oil)
Natural gas	Natural gas E&P (indigenous) Natural gas use promotion Import source country diversity
Nuclear	Nuclear development
Hydro	Hydro development
Geothermal, wind, others	Renewable energy development
Biofuels and waste	Renewable energy development
Electricity	Electrification Supply reliability
All energy	Energy conservation/efficiency
CO_2 emission	CO_2 emission reduction
Price and subsidy (including tax incentive)	Coal production subsidies Coal consumer price control(below international prices/import costs)

	Crude oil production subsidies Oil product consumer price control(below international prices/import costs) Natural gas production subsidies Natural gas consumer price control(below international prices/import costs) Electricity tariff control(below costs)

CO_2 = carbon dioxide, E&P = exploration and production, SPR = strategic petroleum reserve.

Source: Authors.

The correlation between ESI and policy is summarised in Table 2-4. Looking at the records of an assessment, in most cases there was a correlation between past policy and change of ESI, with a few exceptions. While there are ESIs directly affected by specific energy policy, there are others that are believed to be impacted by multiple factors, such as changes in industrial structure, economic activity, technology development, and market conditions (costs and price). Hence, there is a need to be careful in these assessments.

Table 2-4: Correlation between Policy and Energy Security Index (Summary)

	ESI	KHM	CHN	IDN	JPN	KOR	LAO	MYS	MMR	NZL	PHL	THA	VNM
1	TPES self-sufficiency	No	No	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes
2	Coal self-sufficiency		No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes
3	Crude oil self-sufficiency							No	Yes	Yes	Yes	Yes	No
4	Natural gas self-sufficiency			No		Yes			Yes	No	Yes	No	Yes
5	Coal R/P		No	No	Yes	Yes				Yes	Yes	Yes	Yes
6	Crude oil R/P							No	Yes			No	Yes
7	Natural gas R/P			No				No	No		Yes	No	No
8	Coal R/C		No	Yes	Yes	Yes				Yes	Yes	Yes	Yes
9	Crude oil R/C			Yes				Yes	Yes			Yes	Yes
10	Natural gas R/C			Yes				Yes	No		Yes	Yes	Yes
11	Coal import source country diversity					Yes		Yes					
12	Crude oil import source country diversity		Yes		No	No							
13	Natural gas import source country diversity					Yes						No	
14	TPES diversity	Yes	No	Yes	Yes	Yes		Yes		Yes	Yes	Yes	Yes
1	Power generation fuel	Yes	No	Yes	Yes	Yes		Yes		Yes	Yes	No	Yes

5	diversity												
16	Crude oil Middle East dependence		No		No	No							
17	Natural gas Middle East dependence					Yes							
18	Reserve margin of generation capacity		Yes	No	Yes	No		Yes	-	No	Yes	Yes	Yes *
19	Power outage frequency			Yes	Yes	Yes		Yes		No			
20	Power outage duration			No	Yes	Yes		Yes		No			
21	Commercial energy access	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
22	Electrification	Yes	Yes	Yes	-	-	Yes	Yes	Yes	-	Yes	Yes	Yes
23	TPES/GDP		Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
24	TFEC/GDP		Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
25	Days of on-land oil stocks				Yes	Yes			Yes	No		Yes	
2	CO_2 emissions/TPES	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No

6													
27	CO_2 emissions/Fossil fuel	No	No	No	No	Yes	Yes	No	No	No	No	No	No
28	CO_2 emissions/GDP	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No
29	CO_2 emissions/Population	No	Yes	No	No	No	No	No	No	No	No	No	No

Note : KHM = Cambodia, CHN = China, IDN = Indonesia, JPN= Japan, KOR = Korea, LAO = Laos, MYS = Malaysia, MMR = Myanmar, NZL = New Zealand, PHL = Philippines, THA = Thailand, VNM = Viet Nam.

* Correction from 2012 report, from a comment by a WG member.

In 2012, the study delivered the following implications for the energy security of EAS countries:

1. Measuring the effects of policy is extremely important as a reference for future policy planning and for effectively allocating limited budgetary resources. In this sense, despite various restrictions, this research carries great significance because it attempts to qualitatively measure the existence of policy effects.

2. One ESI consists of multiple policy effects, making it difficult to qualitatively assess the effect of these policies on ESI changes. For example, changes in the TPES per gross domestic product (GDP) used to assess energy efficiency are affected by changes in energy consumption, as well as changes in industrial structure.

3. However, when examining both ESI changes averaged out over a long period of time, such as 5 or 10 years, and the existence of policy perceived to be correlated to such changes, assessments showed that a correlation existed between several policies and ESI, as follows:
   - Resource development promotion policy and R/C ratio,
   - Oil dependence reduction policy and diversity in primary energy as well as power supply,
   - Commercial energy supply policy or electrification rate improvement policy and commercial energy supply ratio or electrification rate,
   - Energy saving policy and energy efficiency, and
   - Oil stock policy and oil stock amounts.

4. Generally, policy requires a long period of time before it causes changes in the country's actual energy supply–demand situation. This is because investments in equipment and devices that use energy are typically large in nature, while such equipment and devices have a long service life, which means that it is difficult to change energy supply–demand situation over a short period of time.

   For example, several countries are implementing a policy on climate change, and such policy has only been rolled out recently. Consequently, enough time has yet to pass until such policy could make changes in the energy supply–demand situation, making it impossible to verify the effects.

5. Conversely, there are also policy effects that cannot be verified even if a sufficient amount of time has passed since the policy was implemented. One example is the dependence on the Middle East for oil supply. The study could not verify the declines in dependence despite the existence of policy for such purposes. This is believed to be due to geographic reasons, or the fact that large amounts of crude oil are existing in the Middle East and that there is no other supply source in the Asia- Pacific region that is large enough to replace the Middle East imports. Therefore, essentially, policy effects are difficult to obtain.

6. A combination of multiple indirect methods are believed to be useful toward achieving targets for which policy has a difficulty exerting effects. For example, on the Middle East dependence for oil supply as mentioned above, the fundamental purpose of policy is to avoid the serious geopolitical risks posed by the Middle East. This purpose can be achieved to some extent by implementing multiple layers of policy, including reducing the use of oil for which the country depends on Middle East imports, preparing for supply interruption risk with the use of oil stocks, and providing support aimed at long-term stability in the Middle East.

7. The strength of regulations on the energy industries or energy markets is an important element that determines the effects of energy policy. The strength of such regulations become weaker in the order of the following situations: (1) monopoly by state-owned enterprises (SOEs), (2) private sector companies play a leading role but business regulations are in place, and (3) private sector companies play a leading role and deregulation has been implemented (market oversight remains in place using environmental/safety regulations or government administration).

   Where SOEs have a monopoly over energy markets in which regulations are strong, this situation is believed to be the easiest way to reflect policy intention more directly in the market over a comparatively shorter period of time. In many of the countries studied, all or certain important parts of energy markets were monopolised by SOEs and this proved to be effective in implementing energy policy.

In situations with strong regulations, however, the screening and management ability of the market regulator, which is the government, largely determines market efficiency and the level of services provided to end consumers. Caution should also be heeded on the possibility that the heavy involvement of politics that typically occurs in such situations could inhibit policy execution.

8. Generally, it is believed that leaving the markets to open competition among private sector companies will result in more diverse services at a lower cost. However, it is important to note that private sector companies essentially do not take action beyond economic rationalities.

   For example, in selecting power sources, if attempting purely to fulfill economic rationalities, most private sector companies would choose subcritical pressure coal-fired power plants. However, this carries with it the potential to go against the requirements of energy security, which include risk dispersion through energy source diversification, reduced demand through improved energy efficiency, and environmental impact reductions. Energy security is a requirement of the nation that exceeds corporate behaviour. As such, it is impossible to completely eliminate the involvement of the national government in a country's energy markets.

   However, it has been proven that incorporating the capital, human resources, and innovation of private sector companies into energy markets will provide profits for the energy markets. Thus, an appropriate balance should be struck between the government and private sector companies depending on the unique situation of each country.