16th May 2001

Workshop on International Electricity Grid Interconnection (IEGI)
for North East Asia

Perspectives from Local or National Power Companies

Japan – Fumio Arakawa (Global Engineering Institute, Inc.)

Restructuring Needed for IEGI

1. Technical Characteristics

1.1 Technical characteristics of Japanese Electric Power System
1.2 Status of transmission grid in Japan
1.3 Major issues in terms of Japanese power systems

2. Institutional Characteristics

2.1 Overall electricity authorities in Japanese government
2.2 Electricity supply companies and their organization
2.3 Ongoing power sector reform

3. Financial Characteristics

3.1 Feature and technology for IEGI
3.2 Promotion of IEGI; Meetings and Ideas
3.3 What is the Reality in front of Competitors?
3.4 The Silk Road Model: Will it be DSS?

4. Conclusion

4.1 Money is not the problem: it is the answer.
4.2 **Restructuring Needed for IEGI**

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1. Technical Characteristics

1.1 Technical characteristics of Japanese Electric Power System

The Nautilus cordially invited me to the Workshop on IEGI for NEA asking me to present participants technical characteristics of Japanese Electric Power System, in the first place. They are shown in Tables, **T-1** for the current electricity demand, **T-2** for the current sources of electricity supply and **T-3** for the demand forecasts and planned capacity additions in Japan

1.2 Status of transmission grid in Japan

In summary of the status of transmission grid in Japan, a figure (**F-1**) shows the main transmission system and power stations. As is well known, the land of Japan is composed of four major islands and the trunk power line runs through the islands, building not the "mesh type" but "fishbone type" network. Though Okinawa islands are still isolated, the trunk power line includes several marine cables between islands, HVDC transmission lines and AC/DC converter stations. They are not necessarily for the bulk power transmission but for the stable operation of power systems interconnected. As supply and demand in the local power systems, each maintained and operated mainly by 9 private power utility companies, is well balanced independently, they are interconnected with each other in a "loose" manner

1.3 Major issues in terms of Japanese power systems

Two of the major issues in terms of Japanese power systems will be the way to face with the new systems conditions developed by the introduction of the followings:

i) Distributed small power sources, like MGT, PVC, FC, WP, etc, from technological point of view
ii) Competitive market which will make charges of transmission one of the serious issues, for instance, from corporate point of view.

2. Institutional Characteristics

2.1 Overall electricity authorities in Japanese government

Then, the Nautilus asks me about the institutional characteristics of Japanese Electric Power System, that is, overall electricity authorities in Japanese government. Under the current dynamic circumstances in political and economic arena in Japan, none can tell the correct feature of the Japanese government. One fact without doubt is that the tide of deregulation strongly forces everyone concerned to make the authorities neutral in the competitive global market operation. Another explicit fact is the restructuring of government organizations, but, as experts often point it out, this kind of restructuring in Japan will not necessarily mean any substantial change in authority. Anyway, the name of authority in charge of energy and power policy, "MITI," has replaced with "METI" (Ministry of Economy, Trade and Industry).

2.2 Electricity supply companies and their organization

In regard to the electricity supply companies and their organization **F-1** and **T-2** shows their geographical location and generation capacities. Those private retail sellers of electricity are organized in the Federation of Electric Power Companies. (FEPC) There are many whole sellers of electricity in Japan, two majors of which being Electric Power Development Company (EPDC) and The Japan Atomic Power Company. (JAPC)

These whole sellers could be identified as IPP, but recent and upcoming changes in electricity sector institutions in Japan makes them identified as Power Producers and Suppliers (PPS), except EPDC and JAPC. The ongoing power sector reform makes the new comers participate in the Japanese power utility industries. They are, for instance, Diamond Power, Ennet, eREX, Summit Energy, etc. Enron Japan and its affiliate, E-Power, has been established but not registered as PPS yet, as of April 01. EPDC has long been quite active as a government supported power utility and is now on the way of privatization and restructuring since 1986, 35 years after its establishment in 1952.

2.3 Ongoing power sector reform

Needless to say that it is quite important to find the reality and to find the right path for our final goal, particularly at a time of such a chaotic confusion as today. In case of the power utility industry, its final goal is to provide customers with the best service, that is, to supply high quality, reasonable price and enough amount of electricity. Then a question will naturally be raised to ask what are the most important national priorities for the future in terms of electricity service. The most popular and general answer to the question in Japan will be the followings:

i) To give harmonious solutions between the stable supply of electricity and the dynamic restructuring of market mechanism and corporate organization for free competition, deregulation and effectiveness.

ii) To solve the environment protection problem particularly with regard to CO_2 emission and nuclear power development.

All of the power utility company in Japan are positively making every effort to find and implement the solution, which will guide them to the right path for their final goal under the current dynamic circumstances in the power utility industry all over the world.

During the course of the effort it is well understood that these two answers mentioned above shall not be achieved independently but that they are two aspects of the same issue.

3. Financial Characteristics

3.1 Feature and technology for IEGI

According to my definition, "engineering" is composed of two factors of technology and finance. From technological point of view there will be little difficulty to construct IEGI facilities in any place on the globe. Not only Japan but also every major country in North East Asia has established its technology needed for IEGI. **(F-2)** **(F-3)** HVDC is one of these technologies featuring the high potential of implementing IEGI projects. **(T-4)** Every engineer pays serious attention on the development of super conductivity technology. **(F-4)** Experts always point out the merit and demerit of power systems interconnection. Particularly in Japan the power system interconnection will be introduced to improve the security and the stability of system operation. Another merit of interconnection is, as is often cited, the bulk power supply from natural energy resource area far away from the demand area. As the case in California, US, last summer, power systems interconnection could make wide area supply failure, even though the failure is initiated in a small area in the system. To prevent such a heavy disaster to happen there must be a very sophisticated system control and careful maintenance of facilities.

3.2 Promotion of IEGI: Meetings and Ideas

In order to promote IEGI project many ideas have been proposed in many important international meetings including ICEE and WESC **(T-5)**, in which they discussed the matter mainly from technological point of view and talked about their dream. Even though there are so many projects proposed **(F-5)** **(F-6)** **(F-7)** and sound bases of engineering in regard to the promotion of IEGI, why the promoting thrust is not strong enough at this moment? One of the reasons will be that there is not enough review of the other factor of engineering, i.e. finance.

3.3 What is the Reality in front of Competitors?

If asked of the Japanese view on potential international grid interconnections, particularly of the view of Japanese electric power companies regarding power grid connections with other countries, I can not help pointing out the fact that executives show little interest in IEGI. The institutional reasons for the positions will be simply that they will not be able to find any financial interest, or to say, favorable opportunity of capital gain, in the investment in IEGI. This is the reality not only in Japan but also in the world, where there are many potent competitors in the field of energy supply industries. As we saw in Irkutsk, last September, the discussion was much more "hot" in the conference for gas pipe lines, partly due to the positive support of one of oil companies and to the fantastic idea proposed by a Japanese think-tank.

3.4 The Silk Road Model: Will it be DSS?

In order to analyze the reality and to find the potential benefits and liabilities of grid interconnection for Japan and for the region as a whole, I have developed a feasibility study model, "The Silk Road Model" (SRM), in cooperation with my colleague, Dr. KATO, Masakazu. The core of SRM is a formula, or an objective function, to annually calculate the capital and O/M cost of interconnected systems covering the area from Moscow to Tokyo under several constraints on generation plants, converter stations, transmission lines and demand/supply balance. **(F-8)** Several cases have been studied, one of which shows the feasibility of transmitting low cost solar and hydropower generated in Gobi desert and on Yenisay River respectively to Japan in some optimistic conditions. **(F-9)**

It is quite personal view of mine to point out the followings;

i) There will be little financial merit in IEGI between Japanese islands and Eurasian Continent, as there is little need for Japanese systems to have bulk amount of energy in the form of electric power.

ii) People in the area of North East Asia will be able to share large amount of merit, if they make full use of Japanese faculty in both technology and finance in order to promote IEGI in the area. It is also quite meaningful as a global contribution by the Japanese.

In order to implement the view mentioned above, I believe, SRM will provide people concerned with a tool for practical review and discussion for the project promotion, as the computer model is a flexible decision support system (DSS) under the uncertainty that can be used in discussions between decision makers and specialists to study power systems interconnection. Participants in the discussion can exchange practical views and rational opinions on the data and scenarios shown on the computer view panel.

4. Conclusion

4.1 Money is not the problem: it is the answer.

It is the last but not the least to answer the question, "Could, and under what conditions would, Japan help to secure financing for a regional grid project?" I make it a rule to quote an interesting remark made by Mr. Churchill, Anthony A., on the occasion of the 16th WEC, held in Tokyo, October, 1995. **(F-10)** He says "Money is not the problem: it is the answer." So fur as I understand, it means that executives will be interested in the project, on the condition that specialist will be able to present the project as a technologically sound and financially feasible to provide enough return to the investment.

4.2 Restructuring Needed for IEGI

The condition mentioned above will be met and IEGI project will be promoted, in case we are successful to restructure the government and the corporate organization really effective, the market mechanism freely competitive and the project promotion system productively well organized from engineering point of view. Then my dream embraced for a long time of more than 40 years will come true. I will never give it up!

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LIST OF TABLES AND FIGURES

(T-1)

Peak Capacity, Peak Load, Energy Requirement, Reserve Margin, and Load Factor

FY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Peak Capacity (GW)	141.8	148.6	158.2	162.4	171.5	171.5	178.9	183.3	188.8	194.1	195.9	↗
Peak Load (GW)	127.4	142.9	147.0	150.9	143.8	165.1	167.7	167.5	166.6	168.2	168.0	↗
Energy Requirement (TWh)	669.8	718.9	741.4	747.7	751.9	803.5	822.1	842.2	858.9	866.3	884.2	↗
Reserve (GW)	14.3	5.8	11.2	11.6	27.7	6.4	11.2	15.8	22.3	25.9	27.9	↗
Reserve Margin (%)	11.3	4.0	7.6	7.7	19.3	3.9	6.7	9.4	13.4	15.4	16.6	↗
Load Factor (%)	60.0	57.4	57.4	56.6	59.7	55.4	56.0	57.2	58.9	58.8	59.9	↘

Notes: 1. Peak capacity and peak load are for all electric utilities in Japan. Peak capacity is the largest possible supply capacity; peak load is the average value of the three highest daily loads at the transmission end occurring during the month in which the annual peak is recorded.
2. Energy requirement is the total annual demand for electric utilities in Japan.
3. Reserve = Peak Capacity − Peak Load

$$\text{Reserve Margin} = \frac{\text{Reserve} \times 100}{\text{Peak Load}}$$

4. $$\text{Load Factor} = \frac{\text{Energy Requirement} \times 100}{\text{Peak Load} \times 365\ (366)\ \text{days} \times 24\ \text{hours}}$$

Source: Japan Electric Power Survey Committee

(T-3)

Forecast of Supply/Demand Balance for Electric Power (Electric Utilities)

FY	1998 (Actual)	1999 (Actual)	2000	2001	2004	2009
Electric Energy Requirement (TWh)						
At Transmission End	866	884	887	903	959	1,049
At Customer End	818	835	838	853	905	991
Annual Peak Balance (GW)						
Peak Capability						
Thermal Power Plants*	116.7	119.9	121.3	124.8	132.4	139.2
Nuclear Power Plants	39.4	38.6	37.5	36.7	37.3	46.1
Hydroelectric Power Plants	36.2	35.8	35.3	34.9	36.4	40.7
Total Peak Capacity	192.3	194.2	194.0	196.5	206.2	225.9
Peak Load	168.2	168.0	174.3	177.6	188.4	205.6
Reserve	25.9	27.8	21.4	20.5	18.6	21.0
Reserve Margin (%)	15.4	16.6	12.3	11.6	9.9	10.2
Total Generating Capacity (GW)						
Thermal Power Plants*	135.2	137.6	142.8	145.6	154.8	167.4
Nuclear Power Plants	44.9	44.9	44.9	45.7	47.1	57.5
Hydroelectric Power Plants	43.9	44.4	44.9	45.0	45.8	50.2
Total	224.1	226.9	232.6	236.3	247.7	275.1

*Includes geothermal power plants.
Source: Japan Electric Power Survey Committee

Forecast of Long-term Energy Supply and Demand (as of June 1998)

	FY 1996 (Actual)		FY 2010 Standard Case		FY 2010 Corrected Case		
Coal (million tons)	132	(16.4)%	145	(15.4)%	124	(14.9)%	↘
Nuclear (TWh)	302	(12.3)	480	(15.4)	480	(17.4)	→
Natural Gas (million tons)	48	(11.4)	61	(12.3)	57	(13.0)	↘
Hydroelectric Power (TWh)	82	(3.4)	105	(3.4)	105	(3.8)	→
Geothermal (million kl)	1	(0.2)	4	(0.5)	4	(0.6)	→
Oil (million kl)	329	(55.2)	358	(51.6)	291	(47.2)	↘
New Energy (million kl)	7	(1.1)	9	(1.3)	19	(3.1)	↗
Total (million kl)	597	(100.0)%	693	(100.0)%	616	(100.0)%	

Notes: 1. "Standard case" is an estimate assuming a continuance of present user-side energy conservation policies.
2. "Corrected case" assumes maximum energy conservation from both providers and users.
3. One liter of crude has an energy value of 9,250 kcal.
4. "New energy" includes solar, compost, pulp liquid, and other non-traditional energy sources.
5. Figures for hydroelectric energy exclude pumped storage type.
6. One kiloliter of natural gas is 0.712 tons.
7. Figures in parentheses indicate the proportion of energy by source in terms of crude oil.
Source: MITI

(T-2)

Installed Generating Capacity (as of March 31)

(MW)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Thermal	115.551	119,304	124,984	127,183	130,745	134,101	138,049	141,665	146,074	152,202	159,054	161,869
Electric Utilities	99,987	102,373	106,905	108,389	111,039	113,196	116,420	119,204	123,242	127,920	132,925	134,312
Industry-owned	15,564	16,930	18,079	18,793	19,706	20,905	21,629	22,461	22,832	24,282	26,129	27,557
Nuclear	28,866	29,445	31,645	33,404	34,584	38,541	40,531	41,356	42,712	45,248	45,248	45,248
Electric Utilities	28,701	29,280	31,480	33,239	34,419	38,376	40,366	41,191	42,547	44,917	44,917	45,083
Industry-owned	165	165	165	165	165	165	165	165	165	165	165	165
Hydroelectric	37,291	37,483	37,831	39,117	39,523	39,965	41,932	43,455	44,407	44,462	45,382	45,860
Electric Utilities	36,134	36,322	36,452	37,734	38,140	38,593	40,558	42,082	43,054	43,106	43,888	44,399
Industry-owned	1,157	1,160	1,378	1,382	1,384	1,372	1,374	1,374	1,353	1,356	1,494	1,461
Geothermal	215	215	269	269	270	299	379	504	530	530	533	533
Electric Utilities	180	180	235	235	235	263	343	468	494	494	497	497
Industry-owned	35	35	34	34	35	36	36	36	36	36	36	36
Fuel Cell				11	11	7	6	13	12	3	1	
Electric Utilities				0	0	0	0	0	0	0	0	
Industry-owned				11	11	7	6	13	12	3	1	
Solar Cell			1	1				1	1	1		
Electric Utilities			0	0				0	0	0		
Industry-owned			1	1				1	1	1		
Wind Power						1	1	1	1	1	6	34
Electric Utilities						0	0	0	0	0	0	1
Industry-owned						1	1	1	1	1	6	33
Total	181,708	186,231	194,730	199,985	205,133	212,914	220,898	226,994	233,737	242,447	250,124	253,544
Electric Utilities	164,822	167,976	175,072	179,598	183,832	190,427	197,687	202,944	209,337	216,603	222,227	224,291
Industry-owned	16,886	18,256	19,658	20,387	21,301	22,487	23,212	24,051	24,400	25,844	27,897	29,253

Source: FEPC

Installed Generating Capacity and Electric Power Generation by Electric Utilities (Fiscal Year 1999)

	Thermal*		Nuclear		Hydroelectric		Total		
Company	MW**	GWh	MW**	GWh	MW**	GWh	MW**	GWh	
Hokkaido EPCo	3,500	15,835	1,158	9,175	1,278	4,016	5,936	29,025	
Tohoku EPCo	11,430	56,271	1,349	9,880	2,431	9,093	15,209	75,243	
Tokyo EPCo	32,434	123,056	17,308	128,265	8,103	13,017	57,846	264,338	
Chubu EPCo	22,941	86,545	3,617	25,070	5,211	8,791	31,769	120,407	
Hokuriku EPCo	3,862	15,897	540	3,581	1,806	5,952	6,209	25,429	
Kansai EPCo	19,921	45,306	9,768	70,388	8,107	13,880	37,796	129,574	
Chugoku EPCo	7,765	35,241	1,280	10,059	2,893	3,506	11,938	48,806	
Shikoku EPCo	3,171	11,890	2,022	14,661	1,123	2,326	6,316	28,878	
Kyushu EPCo	11,327	28,688	5,258	38,774	2,370	4,559	18,955	72,021	
Okinawa EPCo	1,445	5,355	—	—	—	—	1,445	5,355	
Subtotal	117,796	424,083	42,300	309,852	33,321	65,141	193,418	799,077	87%
EPDC	5,655	32,407	—	—	8,261	12,596	13,915	45,003	
Others	11,358	60,379	2,617	6,061	2,817	10,542	16,958	76,982	
Total	134,809	516,869	44,917	315,914	44,399	88,279	224,291	921,062	100%

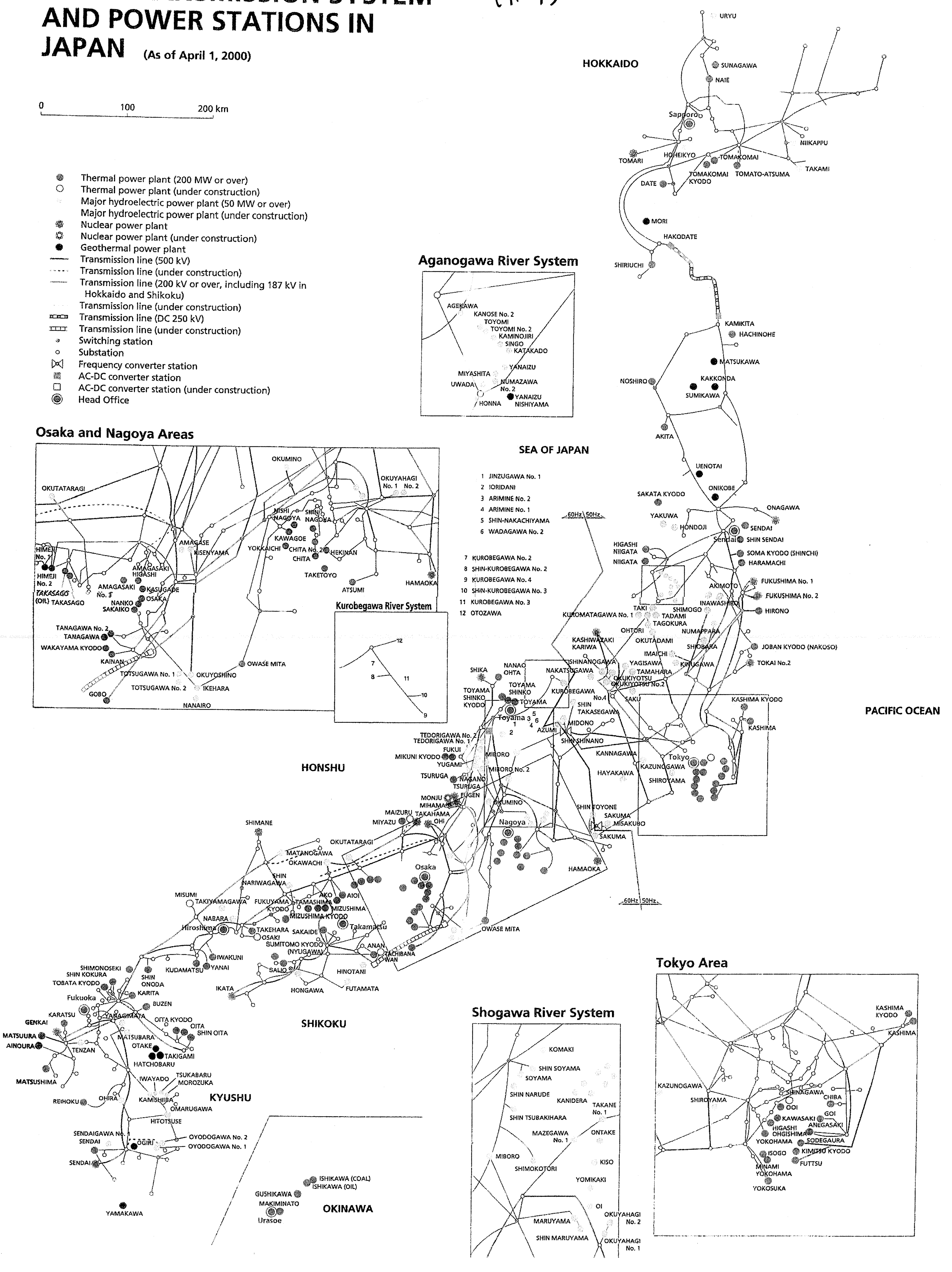
*Thermal includes geothermal.
**Figures are as of March 31, 2000.
Note: The "Others" category includes Japan Atomic Power Co., municipal power-generating enterprises, joint venture generating companies, and special electricity suppliers.
Source: FEPC

MAIN TRANSMISSION SYSTEM AND POWER STATIONS IN JAPAN (As of April 1, 2000)

(F-1)

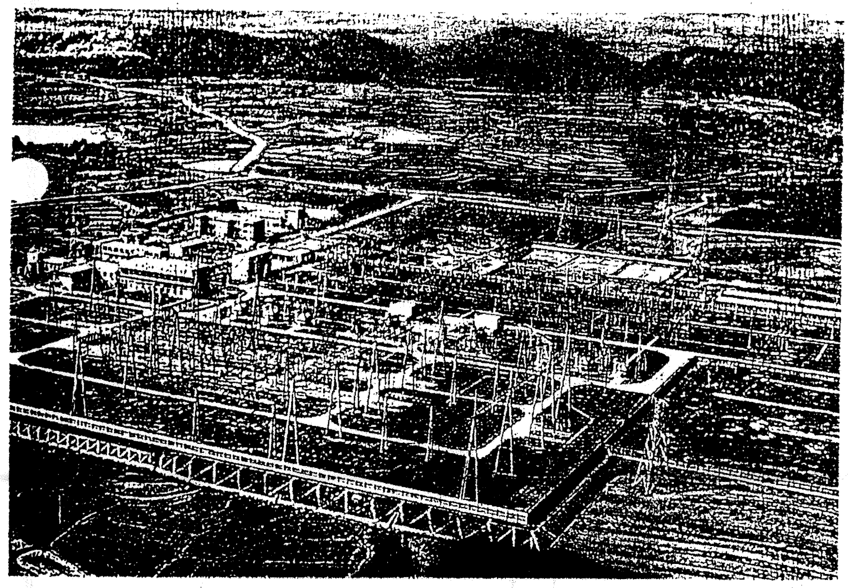
0 100 200 km

- Thermal power plant (200 MW or over)
- Thermal power plant (under construction)
- Major hydroelectric power plant (50 MW or over)
- Major hydroelectric power plant (under construction)
- Nuclear power plant
- Nuclear power plant (under construction)
- Geothermal power plant
- Transmission line (500 kV)
- Transmission line (under construction)
- Transmission line (200 kV or over, including 187 kV in Hokkaido and Shikoku)
- Transmission line (under construction)
- Transmission line (DC 250 kV)
- Transmission line (under construction)
- Switching station
- Substation
- Frequency converter station
- AC-DC converter station
- AC-DC converter station (under construction)
- Head Office



在網絡建設上，華中電網已形成一個以葛洲壩爲中心，北至河南鄭州、南抵湖南株洲的 500 千伏骨干網架。從河南平頂山到武昌鳳凰山的全國第一條 500 千伏輸電綫路于一九八一年底建成后，到目前已相繼建成 10 條 500 千伏輸電綫路，總長度 1720 公里；220 千伏綫路縱横交錯，總長度 13000 多公里，華中四省均實現强聯網。全國目前最大的變電站也巍然座落在武昌鳳凰山上，變壓器總容量 150 萬千伏安。尤其是葛洲壩至上海正負 500 千伏直流輸變電工程的投産，實現了華中、華東兩大電網的聯網，在我國電力發展史上又樹立起一座雄偉的里程碑。

So far as the construction of the power network is concerned, CCPN has already shaped up a 500 kV grid skeleton, which takes Gezhouba as its centre, extends to Zhengzhou, Henan Province in the north and reaches Zhuzhou, Hunan Province in the south. After China's first 500 kV transmission line from Pingdingshan (Henan) to Fenghuangshan (Wuhan) was commissioned in 1981, there were 1,720 km of 500 kV transmission lines, totalling 10 in number which were built up successively. The 220 kV transmission lines crisscross in the whole grid with aggregate length of over 13,000 km. All these result in a strong connected grid within the CCPN. At present, the largest substation in CCPN is Fenghuangshan Substation in Wuhan, with total capacity of 1,500 MVA. Especially, the completion and operation of ±500 kV HVDC transmission project from Gezhouba Hydraulic Power Plant to Shanghai has formed the first united power network in China, i. e. Central China-East China United Power Network, which is a magnificent mile-stone in the history of power development In China.

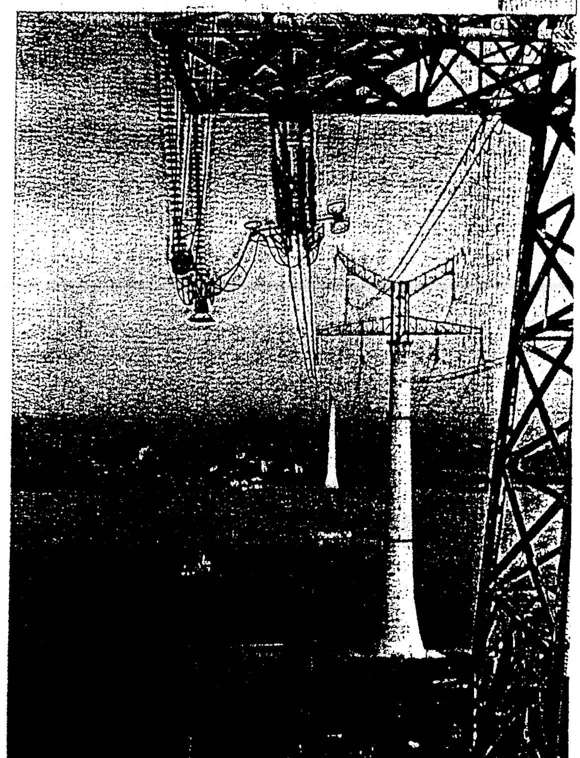


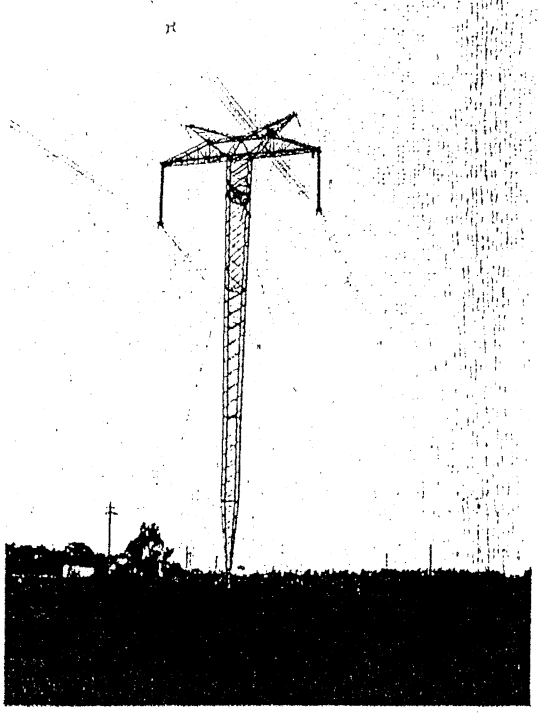
鳳凰山 500 千伏變電站

The 500 kV Fenghuangshan Substation

500 千伏輸電綫路跨越長江

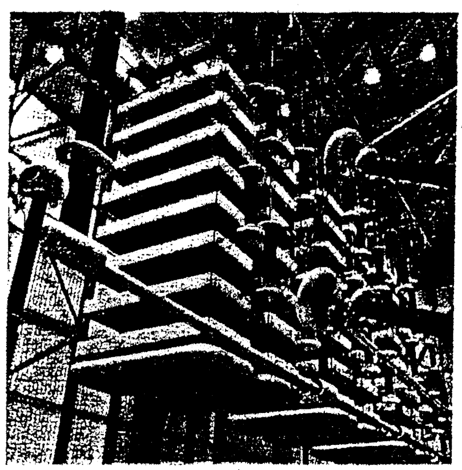
500 kV Transmission Line striding across the Yangtze River





±500 千伏直流輸變電綫路

500 kV HVDC Transmission Line



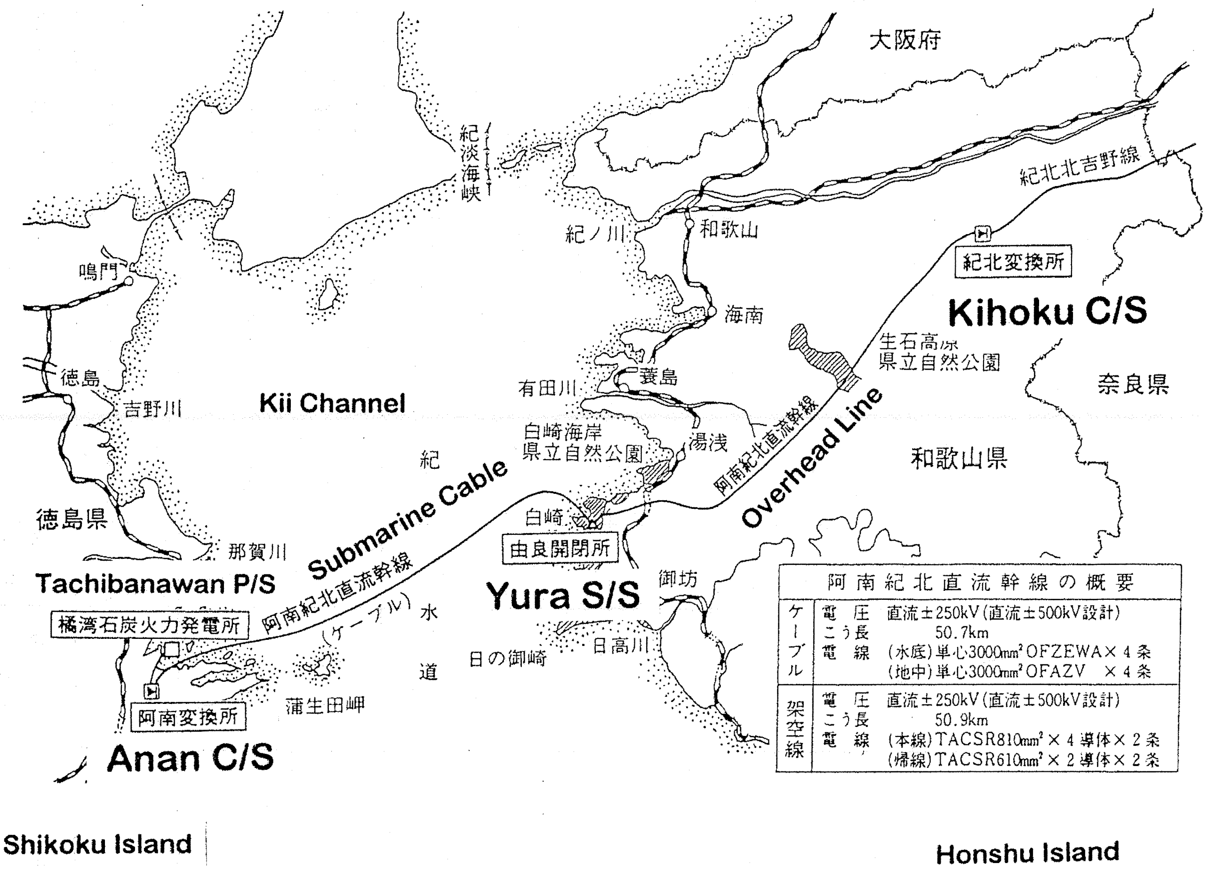
±500 千伏直流輸變電工程換流站閥廳

The Valve Hall of ±500 KV HVDC Converter Station

(F-3)

紀伊水道直流連系設備

ルート概要　　**Kii Channel HVDC Link**



阿南紀北直流幹線の概要		
ケーブル	電圧	直流±250kV（直流±500kV設計）
	こう長	50.7km
	電線	（水底）単心3000mm² OFZEWA×4条
		（地中）単心3000mm² OFAZV ×4条
架空線	電圧	直流±250kV（直流±500kV設計）
	こう長	50.9km
	電線	（本線）TACSR810mm²×4導体×2条
		（帰線）TACSR610mm²×2導体×2条

REASON OF H V D C APPLICATION (T-4)

COMPARISON

ITEM	D C	A C
Line construction cost	low	high
Total construction cost		
long distance	low	high
short distance	high	low
System Stability	no limit	limited
Power Flow Control	stable	unstable
Harmonics	high	low
Var Supply Needs	high	low

HVDC APPLICATION

long distance

sub-marine cable

heavy demand

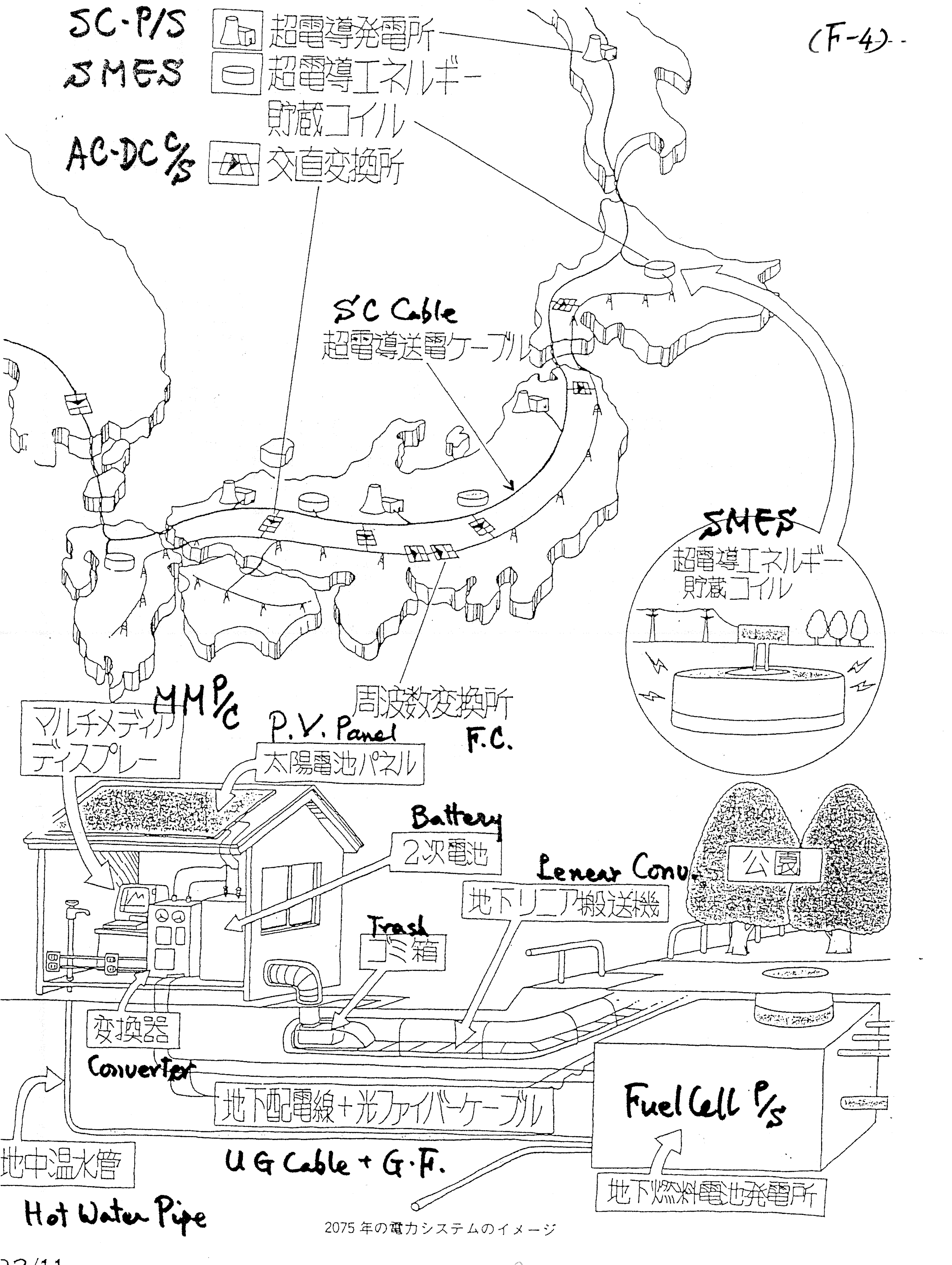
assynchronous interconnection

(B T B)

multi-terminal HVDC link

Power System in mid 2000 in JPN

(F-4)



2075 年の電力システムのイメージ

Conference Scope

The problem of energy integration of Northeast Asian (NEA) countries is of real importance. It is caused by uneven distribution of energy resources and their consumption over the territory of the region and necessity of energy and fuel transport and exchange among various countries. Seasonal diversity of electricity and fuel consumption among countries also takes place. Besides, Northeast Asian countries are mutually complementary with their financial, labor and other resources. Formation of interstate electricity infrastructure in the region will lead to decrease in cost of energy carriers, improvement of energy supply reliability and will make solution of environmental problems easier.

Therefore there is a need to elaborate a joint complex strategy which should take into consideration not only the agreed policy for different electricity industries and concrete electric power projects but the related economic, social, political and other factors. Such a complex strategy of international energy integration in the region can only be created by common efforts of all the interested countries and international organizations.

The major objective of the International Conference is to promote joint efforts on the way of energy integration in Northeast Asia.

Conference Major Concerns

- Perspectives for Electricity Demand, Generation and Fuel Supply
- Potential System' Effects
- International Electricity Markets and their Deregulation
- Projects of Interstate Electric Ties
- Operation and Control Requirements, Stability, Reliability and Development of Interstate Electric Power Systems
- Comprehensive Analysis of Interstate Electric Power Grids
- Effectiveness of International Electric Power Grids and Systems
- Energy Security, Economic Conditions and Sustainable Development Requirements
- Environmental and Social Impacts of Energy Options
- Implementation of Kyoto Mechanisms to Northeast Asian Energy Markets
- Political Conditions and International Legislative Framework
- Electricity and Natural Gas/Hydrogen Alternatives for Interstate Energy Flows

Conference is Organized by

Energy Systems Institute, Irkutsk, Russia
Canadian Institute of World Energy System, Toronto, Canada
Ryerson Polytechnic University, Toronto, Canada

In Collaboration with

Siberian Branch of the Russian Academy of Sciences
Department of Physical and Technical Problems in Energy of Russian Academy of Sciences
Ministry of Energy of Russia
Russian Joint-Stock Company "EES Rossii"
Joint-Stock Company "Irkutskenergo"

10:20 – 10:40	*Power Integration In Northeast Asia: Studies and Prospects* L.S. Belyaev, S.V. Podkovalnikov, V.A.Savelyev, O.V. Khamisov, L.Yu. Chudinova (Russia)
10:40 – 11:00	Coffee-break
11:00 – 11:20	*Preliminary Economic Assessment of Power System Interconnections in the Northeast sian Coun tries* J.Y. Yoon, D.W. Park, H.Y. Kim, H.J. Kang, J.Y. Hwang, Ch.I. Nahm (Republic of Korea)
11:20 – 11:40	*Nuclear Power of Primorye Region as a Part of Interconnected Power Systems of East Asia* G.A. Lipatnikov (Russia)
11:40 – 12:00	*Introduction to the Silk Road Model for the Study on Energy Integration in Northeast Asia: Perspectives for the Creation of I nterstate Electric Power Systems* F. Arakawa (Japan)
12:00 – 12:20	*Approaches to Reliability Assessment of I nterstate Electric Ties and Interconnected Power Systems* G.F. Kovalev, L.M. Lebedeva (Russia)
12:20 – 12:40	*Bulk Electric System Reliability Evaluation with Consideration of Longer-Term Voltage Stability* G. Yongji, Ch.Lim (China)
12:40 – 13:10	Discussion
13:10 – 14:20	Lunch

September 21, 2000, Thursday, Session 2. "Interstate Power Projects and Innovations", 14:20 – 17:30, Co-chairs D. Woodford, Dr. Ch.I. Nahm, Conference Room of Baikal Business Center

14:20 – 14:40	*Russia-Japan Power Bridge* L.A. Koshcheev, Yu.N. Kucherov (Russia), T.Sakemi, K. Natori (Japan)
14:40 – 15:00	*Russia-China Electricity Export Project* A.N. Svidtchenko (Russia)
15:00 – 15:20	*Preliminary Results of a Long Distance HVDC Transmission Line to Japan* M. Ishikawa, M. Maeda (Japan)
15:20 – 15:40	*Development of Multi-Terminal HVDC System Using Voltage Sourced Converters* M. Sampei, N. Seki, T. Hayashi, T. Sakurai (Japan)
15:40 – 16:00	Coffee-Break
16:00 – 16:20	*Possible Effect to the Reinforcement of Electric Power Facilities of North Korea by the Power Systems Interconnection in the Northeast Asia Region* R. Kim (USA), K. K. Yoon, K. W. Park (Republic of Korea)
16:20 – 16:40	*Mongolian Power Industry and Related Aspects of Creating Power System of Northeast Asian Countries* S. Batkhuyag (Mongolia)
16:40 – 17:00	*R&D on Distributed Power Generation from Solid Fuels* K. Yoshikawa (Japan)
17:00 – 17:30	Discussion

September 22, 2000, Friday, Session 3. "Energy and Power Markets", 9:00 – 12:50, Co-chairs Prof. H. Burkhardt, Dr. V.S. Lyashenko, Conference Room of Baikal Business Center

9:00 – 9:20	*Globalization and Energy* H. Burkhardt, V. Nitu (Canada)
9:20 – 9:40	*Requirements and Prospects of the Kyoto Mechanisms in Northeast Asian Energy Market* H.S. Kim (Republic of Korea)
9:40 – 10:00	*Prospective Position of Russian Utilities at the Northeast Asia Electricity Markets* F.V. Veselov, V.S. Shulgina (Russia)
10:00 – 10:20	*Potentialities of Electricity Export from Russia to Countries of Asia-Pacific Region* V.V. Trufanov, E.D. Volkova, V.V. Selifanov, G.I. Sheveleva (Russia)
10:20 – 10:40	*Comparative Economic Efficiency Assessment of Electricity and Other Energy Carriers Export from East Regions of Russia to Countries of Northeast Asia* À.Ì. Kler, B.G. Saneev, À.D. Sokolov, S.P. Popov, E.À. Tyurina, S.Yu. Muzichuk (Russia)
10:40 – 11:00	Coffee-break
11:00 – 11:20	*Restructuring of the Electricity and Gas Supply Industries of Korea* H.J. Kang, Y.Ch. Kim, H.H. Jung (Republic of Korea)
11:20 – 11:40	*Feasibility Study of Nuclear Power Plants to be Constructed on the Russian Far East for Potential Electricity Export to Japan, China and Korea* E.A. Reshetnikov, V.M. Somov, V.V. Patov, V.G. Terentjev, A.V. Tyurin, V.I. Chemodanov, S.A. Kuvardin, V.F. Ermolaev, O.S. Kolodezny (Russia)
11:40 – 12:00	*Optimization of Energy Balances in Siberia and Far East in View of Nuclear Power Development*
12:00 – 12:20	*Electric Power Industry of Yakutiya: Prospects for Power Export and Integration to Energy Space of Asian Region* K.K. Ilkovsky (Russia)
12:20 – 12:50	Discussion
12:50 – 14:00	Lunch

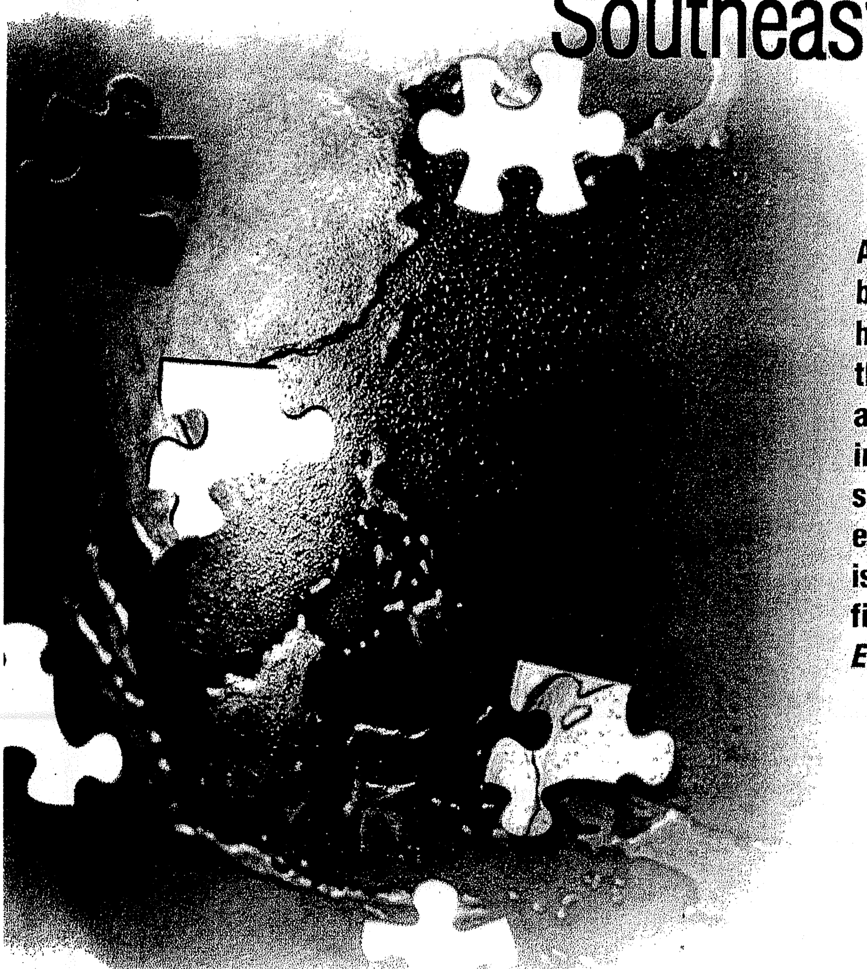
September 22, 2000, Friday, Session 4. "Technical Issues of Long Distance Transmission and Generation of Electricity", 14:00 – 17:10, Co-chairs Prof. K. Yokobori, Prof. L.A. Koshcheev, Conference Room of Baikal Business Center

14:00 – 14:20	*Technical Innovation at Construction of Back-Bone and Interstate Power Transmission Lines* O.P. Obrusnik, V.P. Kobilin, V.A. Sedalishchev (Russia)
14:20 – 14:40	*Operation and Stability of Long AC Transmis sion Lines with Controllable Shunt Compensa tion* G.N. Alexandrov, S.V. Smolovik (Russia)

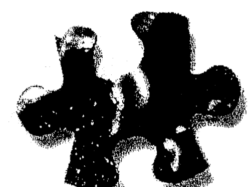
(F-5)

Putting the pieces together

Southeast Asian integration



Asia's economic crisis, sparked-off in July 1997 by the devaluation of the Thai baht, halted halcyon years of surging expansion and tripped the breaker on international funding of ambitious development schemes in industry and infrastructure. However, after a number of spluttering efforts to revive Southeast Asia's economy, there are now signs that the damage is beginning to be repaired and the region is finding itself on a much more even keel. *Electricity International* reports.



BY RICHARD MOGG

ASEAN energy ministers, at their annual meeting in Hanoi, in early July this year, announced plans to accelerate construction of a regional energy grid. An integrated ASEAN-wide electricity transmission grid and natural gas network, it is hoped, will eventually link all ASEAN member states, and also reach into Yunnan, in southern China. Despite the huge amount of investment needed for the project, completion of both systems is being accelerated ahead of the original target date, 2020.

Master plans for pipeline and grid connections are being fast-tracked for submission to ASEAN energy ministers at their next annual meeting, in July 2001. A task force has been formed to look into technical problems, regulatory issues, and a trading format for cross-border marketing of power. Future energy security in ASEAN is seen in terms of source diversification, infrastructure development and efficiency.

INVESTMENT & DEVELOPMENT

Known as the ASEAN Power Grid (APG), the ten-nation interconnection will integrate power transmission throughout peninsula Southeast Asia, and eventually include offshore Indonesia and the Philippines. Capital expenditure to the tune of over US$90 billion is forecast by 2005. G.A. Delgado, Chief Executive Officer of the Philippines National Power Corporation (NAPOCOR), points out: "On a technical level, it will provide new engineering challenges and opportunities in the power transmission technology such as HVDC, EHV and submarine cables."

According to a World Bank analysis, the APG will save at least US$10 billion in funding the capital cost of power stations and transmission systems throughout the ASEAN countries. At the beginning of 1999, the Jakarta-based ASEAN Centre for Energy (ACE) opened to coordinate project development.

The ASEAN Plan of Action for Energy Cooperation (APAEC) 1999-2004 was approved at the 17th ASEAN Ministers of Energy Meeting (AMEM), on 3 July 1999, in Bangkok. The Heads of ASEAN Power Utilities and Authorities (HAPUA) chief executives, at their 16th annual meeting in Chiang Mai in April 2000, outlined practical initiatives in response to ministerial policy. Altogether, HAPUA and ACE are to focus on six regional energy-related programmes:

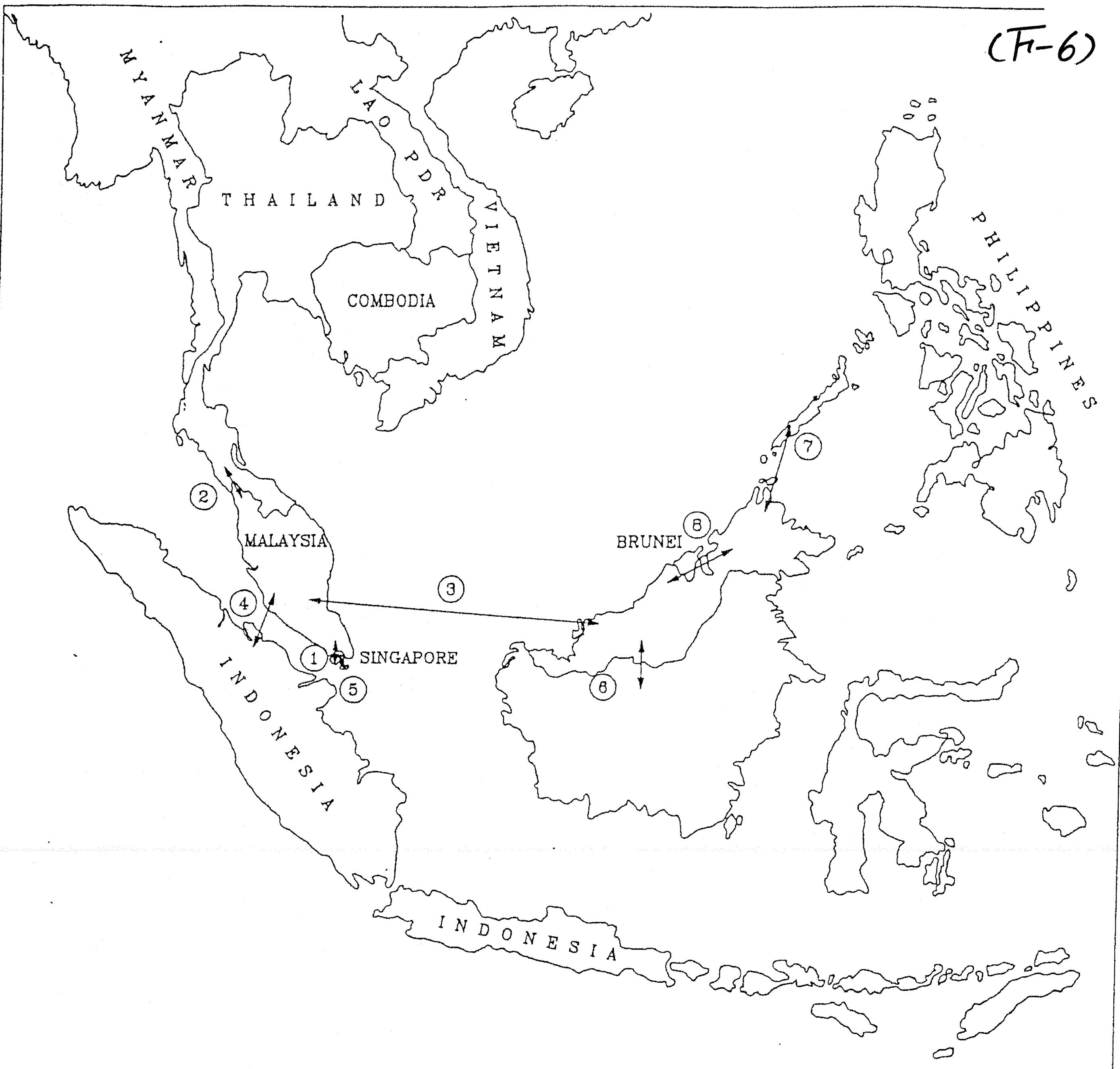
- ASEAN Power Grid (APG);
- Trans-ASEAN Gas Pipeline (TAG);
- Energy Efficiency & Conservation;
- New & Renewable Sources Of Energy;
- Coal as a Fuel for Energy Production; and
- Regional Energy Outlook, Energy Policy & Environmental Analysis.

Each of the six programme area is matched with a corresponding subsector organisation of ASEAN:

- Heads of ASEAN Power Utilities/Authorities (HAPUA);

11

(F-6)



ASEAN INTERCONNECTION PROJECT

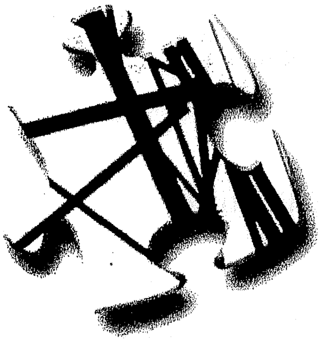
1. PENINSULAR MALAYSIA – SINGAPORE
2. PENINSULAR MALAYSIA – THAILAND
3. PENINSULAR MALAYSIA – SARAWAK
4. PENINSULAR MALAYSIA – SUMATRA
5. SINGAPORE – BATAM
6. SARAWAK – WEST KALIMANTAN
7. SABAH – PHILIPPINES
8. SARAWAK – BRUNEI – SABAH

The Eight ASEAN Power Interconnection Project

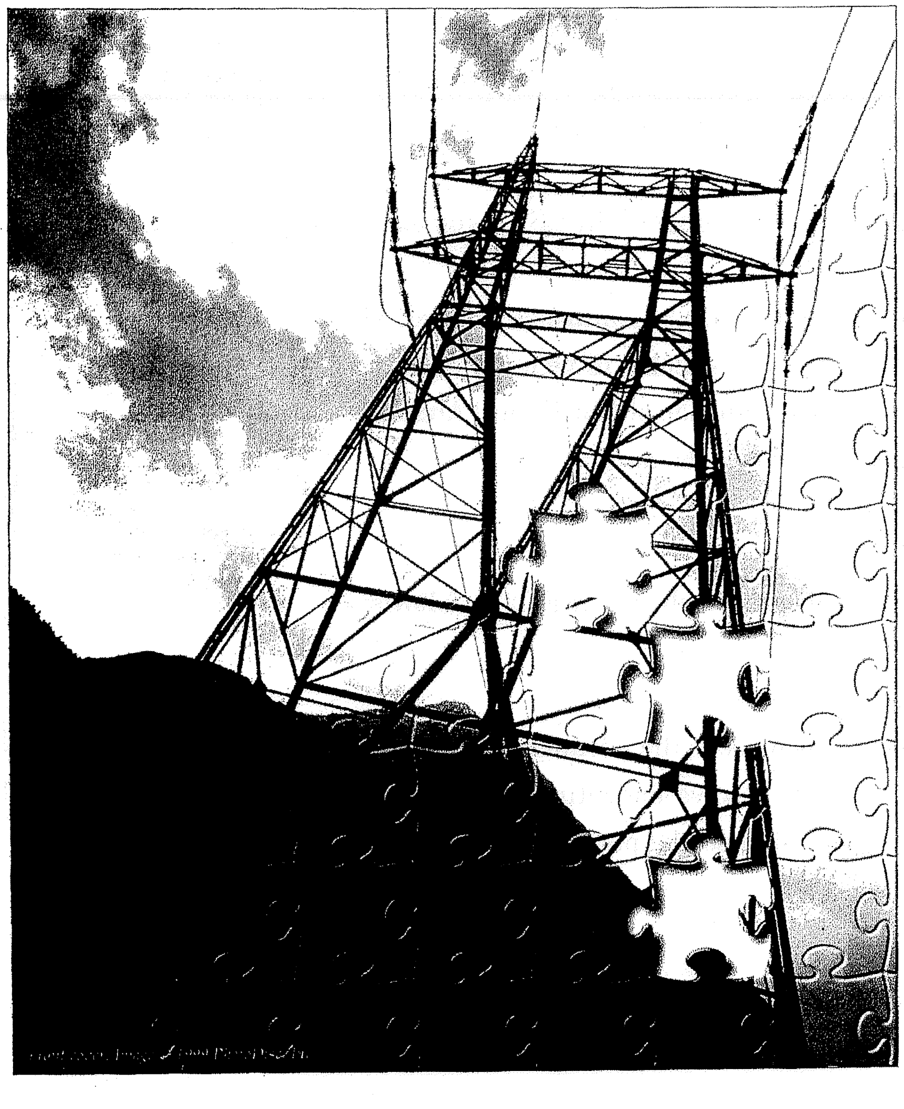
(F-7)

Connecting

A CONTINENT



In recent years, the demand for electricity in the Asian region has far outstripped supply. As such, there is a need for rapid expansion of generation and distribution facilities to meet this ever increasing need for power. The construction of transmission grids across the region is now high on the agenda and will be fundamental in meeting the growing demand. *Anne-Marie Misconi* and *Corinna Tey* report on what is being done to initiate and improve Asia's power network.



The increase in demand, as discussed at the recent 15th Meeting of the Heads of ASEAN Power Utilities/Authorities (HAPUA), could be an indication that the economic situation in Asia is on the road to recovery. HAPUA XV is lending its support to building up electricity capacity by increasing the number of the ASEAN Interconnection Projects from ten to 14 this year. The new projects are those linking Thailand-Myanmar, Vietnam-Cambodia, Laos-Cambodia and Thailand-Cambodia.

Such trans-border grid projects are a boom for these countries, as some of them have emerged as potential growth centres in the Asia-Pacific region. The interconnection of grids will not only reduce the needed capacity through effective sharing of reserves, but also enable the deferment of additional baseload plants and lower production cost as a result of the overall pooling of resources.

ENERGY DEVELOPMENTS IN ASIA

If current trends in the power industry are anything to go by, it is clear that Asian governments - as elsewhere - are progressively deregulating the power industry and privatising utilities. They seek to reduce their involvement in large power infrastructure projects by encouraging large-scale private sector investment and power project ownership. In the region's developing countries, it is hoped that liberalising regulations would not only ensure efficient financing, but also deliver the additional capacity required.

Such reforms are crucial, since Asia (especially among the weaker economies) has to struggle with an energy shortfall, usually in the form of frequent, costly and

13.

Interstate Interconnections (F-8)

< Formulation >

Objective Function : *Total Annual Cost* =

$$\sum_{\substack{t \\ (Time)}} \sum_{\substack{i \\ (System)}} \sum_{\substack{j \\ (UnitType)}} C_{ij} \times G_{ij}^{(t)} + \sum_{\substack{ij \\ (Transmission Line)}} \alpha_{ij} \times P_{ij\max} + \sum_{\substack{i \\ (System)}} \beta_i \times I_{i\max} \rightarrow \min$$

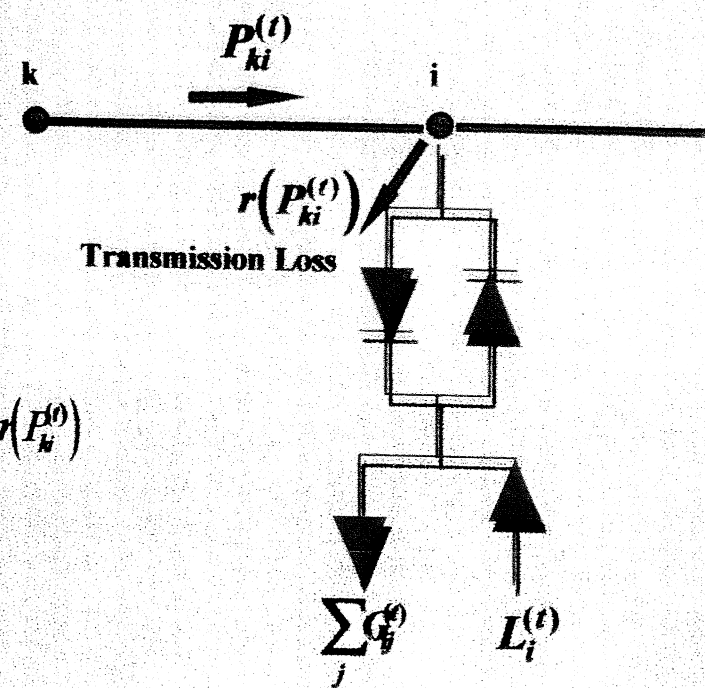
Constraints :

Generation Plant Capacity $G_{ij}^{(t)} \leq G_{ij\max}$

Converter Station Capacity $\left| \sum G_{ij}^{(t)} - L_i^{(t)} \right| \leq I_{i\max}$

Transmission Line Capacity $\left| P_{ki}^{(t)} \right| \leq P_{ki\max}$

Demand Supply Balance $\sum_j G_{ij}^{(t)} + \sum P_{ki}^{(t)} = L_i^{(t)} + r\left(P_{ki}^{(t)}\right)$

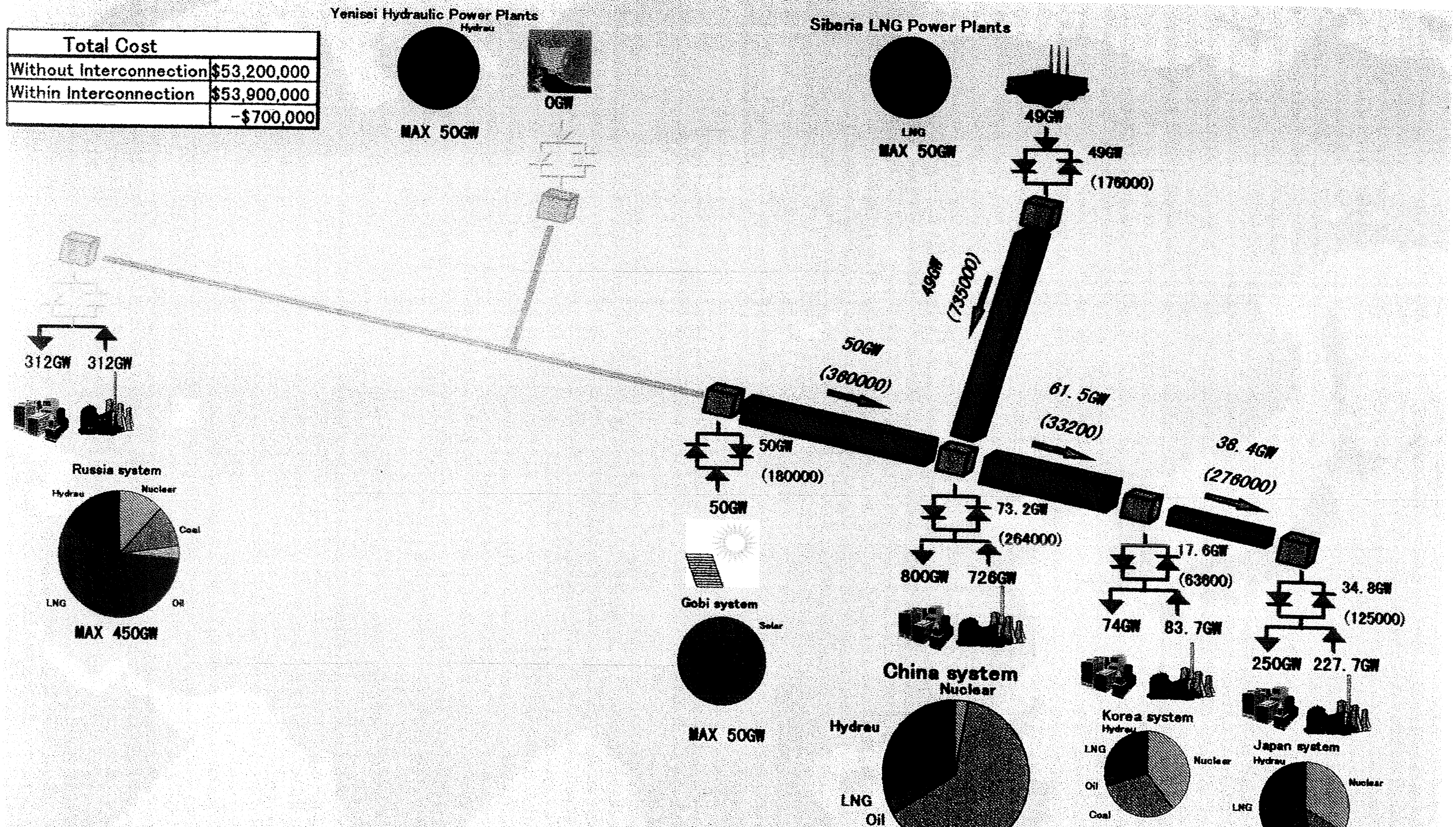


(F-9)

Interstate Interconnections <Case-2 -Droughtiness in Summer in China> Peak period in Summer

( ):Annual Cpaital Cost unit:$10,000

Total Cost	
Without Interconnection	$53,200,000
Within Interconnection	$53,900,000
	-$700,000



Annual Generation Cost

	Russia	Yenisei	Gobi	Siberia	China	Korea	Japan	Total
Without Interconnection	$14,180,000	$0	$0	$0	$21,940,000	$3,740,000	$13,370,000	$53,230,000
Within Interconnection	$14,180,000	$0	$219,000	$2,150,000	$21,210,000	$3,080,000	$10,590,000	$51,429,000
	$0	$0	-$219,000	-$2,150,000	$730,000	$660,000	$2,780,000	$1,801,000

(F-10)

16th World Energy Congress
Tokyo October 1995

MONEY IS NOT THE PROBLEM: IT IS THE ANSWER

L'ARGENT N'EST PAS LE PROBLEME, C'EST LA SOLUTION

CHURCHILL, Anthony A.
Washington International Energy Group, U.S.A.

The Overview

16