

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ELECTRICITY OF VIETNAM (EVN)
THE SOCIALIST REPUBLIC OF VIETNAM

MASTER PLAN STUDY
ON
PUMPED STORAGE POWER PROJECT
AND OPTIMIZATION
FOR PEAKING POWER GENERATION
IN
VIETNAM

FINAL REPORT

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THE TOKYO ELECTRIC POWER CO., INC.
TOKYO ELECTRIC POWER SERVICES CO., LTD.

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Preface

In response to a request from the Government of Socialist Republic of Vietnam, the Government of Japan decided to conduct the Master Plan Study on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent a study team led by Mr. Masayuki Ito, Tokyo Electric Power Co., Inc. and Tokyo Electric Power Services Co., Ltd. to Vietnam six times from December 2002 to June 2004.

The study team held discussions with the officials concerned of the Government of Vietnam and conducted a series of field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope this report will be utilized for contributing to optimization for power development planning of Vietnam and to the promotion of amity between our two countries.

I also express my sincere appreciation to the officials concerned of the Government of Socialist Republic of Vietnam for their close cooperation throughout the study.

June 2004

Tadashi IZAWA
Vice President
Japan International Cooperation Agency

June 2004

Tadashi IZAWA
Vice President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the report of the Master Plan Study on Pumped Storage Power Project and Optimization for Peaking Power Generation in Vietnam. The report reflects the comments made by the Electricity of Vietnam and related institutions in the Socialist Republic of Vietnam, as well as the advice of the related institutions of the Government of Japan.

This report presents appropriate power development planning and recommendations on power system development from the view point of financial perspective and environmental considerations in Vietnam. We firmly believe that it will contribute to ensure the cheap and stable power supply and preparation of the next power development plan (No. 6th Master Plan), and will help promote the rise in standards of living and industrial development in the country.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs and Ministry of Economy, Trade and Industry. We would also like to express our gratitude to the officials concerned of the Government of Vietnam, Electricity of Vietnam, JICA Vietnam Office and Embassy of Japan in the Socialist Republic of Vietnam for their cooperation and assistance throughout our field survey.

Very truly yours,

Masayuki Ito
Team Leader,
The Master Plan Study on Pumped
Storage Power Project and
Optimization for Peaking Power
Generation in Vietnam

**MASTER PLAN STUDY ON
PUMPED STORAGE POWER PROJECT
AND
OPTIMIZATION FOR PEAKING POWER GENERATION
IN VIETNAM

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ACRONYMS / ABBREVIATIONS

ABB	: Asea Brow Boveri
ACSR	: Alumunum Conductor Steel Reinforced
ADB	: Asian Development Bank
AFC	: Automatic Frequency Control
ASEAN	: Association of Southeast Asian Nations
BOD	: Board of Directors
BOM	: Board of Management
BOT	: Build -Operate-Transfer
CC	: Combined Cycle
CDM	: Clean Development Mechanism
C/P	: Counterpart
DO	: Diesel Oil
DSCR	: Debt Service Coverage Ratio
DSM	: Demand Side Management
DSS	: Daily Start and Stop
DWT	: Dead Weight Tonnage
EGAT	: Electricity Generating Authority of Thailand
EIA	: Environmental Impact Assessment
EL	: Elevation
EVN	: Elctricity of Vietnam
FO	: Furnace Oil
FPD	: Forest Protection Department
F/S	: Feasibility Study
GDP	: Gross Domestic Product
GMS	: Greater Mekong Sulregaion
GT	: Gas Turbine
HPC	: Hydro Power Station
IE	: Institute of Energy
IGA	: Inter Government Agreement
IMPACT	: Integrated & Multi-purpose Package of Advanced Computational Tools for power system engineering
IPP	: Independent Power Producer
JBIC	: Japan Bank for International Cooperation
JETRO	: Japan External Trade Organization
JICA	: Japan International Cooperation Agency
LOLE	: Loss-of-Load Expectation
M/P, MP	: Master Plan
MARD	: Ministry of Agriculture and Rural Development
MOI	: Ministry of Industry
MOF	: Ministry of Finance
MONRE	: Ministry of Natural Resources and Environment
MOSTE	: Ministry of Science Technology and Environment
MPI	: Ministry of Planning and Investment
NCMPC	: Ho Chi Minh Power Company
NEDO	: New Energy and Industrial Technology Development Organization
NGO(s)	: Non-Government Organization(s)
NLDC	: National Load Dispatching Centers
NTFP	: Non-Timber Forest Products

ACRONYMS / ABBREVIATIONS

ODA	: Official Development Assistance
OE	: Oil Equivalent
OECD	: The Overseas Economic Cooperation
OJT	: On the Job Training
Pre-F/S	: Preliminary Feasibility Study
P/S	: Power Station
PDPAT II	: Power Development Planning Assist Tool
PECC1	: Power Engineering Consulting Company 1
PLN	: Perusahaan Umum Listrik Negara
PP	: Power Purchase
PSPP	: Pumped Storage Power Plant
PSS/E	: Power System Simulator for Engineering
RETICS	: Reliability Evaluation Tool for Inter-Connected System
SCADA	: Supervisory Control and Data Acquisition
SEA	: Strategic Environmental Assessment
SFR	: Self Financing Ratio
Son La PMB	: Son La Hydropower Project Management Board
S/S	: Substation
ST	: Steam Turbine
TA	: Technical Assistance
TEPCO	: Tokyo Electric Power Company
TEPCO	: Tokyo Electric Power Services Co., Ltd.
T/L	: Transmission Line
VEEA	: Vietnam Electricity Engineering Association
WASP	: Wien Automatic System Planning Package
WB	: The World Bank
WSS	: Weekly Start and Stop
WWF	: World Wide Fund for Nature

UNITS

Prefixes

μ	:	micro-	=	10^{-6}
m	:	milli-	=	10^{-3}
c	:	centi-	=	10^{-2}
d	:	deci-	=	10^{-1}
da	:	deca-	=	10^1
h	:	hecto-	=	10^2
k	:	kilo-	=	10^3
M	:	mega-	=	10^6
G	:	giga-	=	10^9

Units of Length

m	:	meter
km	:	kilometer

Units of Area

m^2	:	square meter
km^2	:	square kilometer

Units of Volume

m^3	:	cubic meter
l	:	liter
kl	:	kiloliter

Units of Mass

kg	:	kilogram
t	:	ton (metric)
DWT	:	Dead Weight Tonnage

Units of Energy

kcal	:	kilocalorie
kWh	:	kilowatt-hour
MWh	:	megawatt-hour
GWh	:	gigawatt-hour
Btu	:	British thermal unit

Units of Heating Value

kcal/kg	:	kilocalorie per kilogram
Btu/kWh	:	British thermal unit per kilo watt hour

Units of Temperature

$^{\circ}C$:	degree Celsius or Centigrade
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Units of Electricity

W	:	watt
kW	:	kilowatt
MW	:	megawatt
GW	:	gigawatt
A	:	ampere
V	:	volt
kV	:	kilovolt
kVA	:	kilovolt ampere
MVA	:	megavolt ampere
MVar	:	megavar (mega volt-ampere-reactive)
Ω	:	ohm

Units of Time

s	:	second
min	:	minute
h	:	hour
d	:	day
m	:	month
y	:	year

Units of Flow Rate

m/s	:	meter per second
m^3/s	:	cubic meter per second

Units of Currency

VND	:	Vietnam Dong
US\$/USD	:	US Dollar

Exchange Rate

1 US\$	=	VND 15,375	As of March 2003
1 US\$	=	VND 15,430	As of June 2003
1 US\$	=	VND 15,570	As of December 2003

CHAPTER 1 INTRODUCTION

Chapter 1. Introduction

1.1 Background

Both electric power consumption and maximum demand in the Socialist Republic of Viet Nam (hereinafter referred to as “Vietnam”) have shown high growth rates of 13% per year for the last 10 years. Therefore, the development of power sources and transmission systems has been an important issue for Vietnam. In addition, daily electricity demand fluctuates significantly: the daily maximum demand occurs at 6pm to 7pm and is more than double the lowest demand late in the middle of the night. Thus, the annual load factor in Vietnam is as low as 65%, while that of other Southeast Asian countries reaches approximately 70%.

Nevertheless, measures to increase peaking supply capacity have not been taken but demand side management (DSM) has been promoted by just placing different electricity tariffs between peak hours and off-peak hours.

Under the situation, in March 2001, Electricity of Viet Nam (EVN) requested the Government of JAPAN to carry out a development study to increase power system reliability and peaking supply capacity. Accordingly, a basic study mission for project formulation was dispatched in January 2002 and discussed the requested development study with the Government of Vietnam.

Based on the discussion, preliminary study mission was dispatched in July 2002 and the S/W of the Master Plan Study on PSPP and Optimization for Peaking Power Generation (hereinafter referred to as “the Study”) was agreed upon with EVN, which was named as a counterpart of the Study.

1.2 Objectives and Scope of the Study

1.2.1 Objectives

Objectives of this study are as follows.

- (1) To study, based on supply and demand projections, the optimization of peaking power source development through examination of optimal power sources composition.
- (2) To formulate a master plan of peaking power sources development by confirming system reliability in consideration of domestic and international power exchange and international power purchases.
- (3) To contribute to balance future electricity demand and supply in Vietnam.

1.2.2 Geographical Scope

The Study covers the whole country of Vietnam.

1.2.3 Scope of the Study

According to the S/W and M/M signed between EVN and JICA on July 16, 2002, the study will be carried out in the following three (3) stages.

Stage 1: Preliminary Assessment

- Related data and information are collected and analyzed to understand the existing systems of power supply.
- Demand forecasts and power development plans up to the year 2020 are reviewed and data for examining peaking power sources development are prepared.
- Especially demand forecast of every region (North, Center, South) and the expansion plan of interconnected transmission lines are reviewed.

Stage 2: Project Identification

- Criteria for selection of pumped storage potential sites are prepared.
- The pumped storage candidate sites selected by Vietnam are reviewed and fresh candidate sites are selected and identified.
- Priority sites are narrowed down from the candidate sites.

Stage 3: System Optimization

- Economic viability of alternatives of peaking supply power other than pumped storage hydropower is examined.
- Master plan of peaking power sources development up to year 2020 is proposed through examination of the optimal power sources composition.

1.3 Methodologies of the Study

1.3.1 Composition of the Study Team and Study Flow

The Study Team can be divided into two groups and four fields as shown in Figure 1-3-1. The studies in each field are closely coordinated to compile the master plan of power development. In order to reflect comments of related organizations, W/S is held in each study stage.

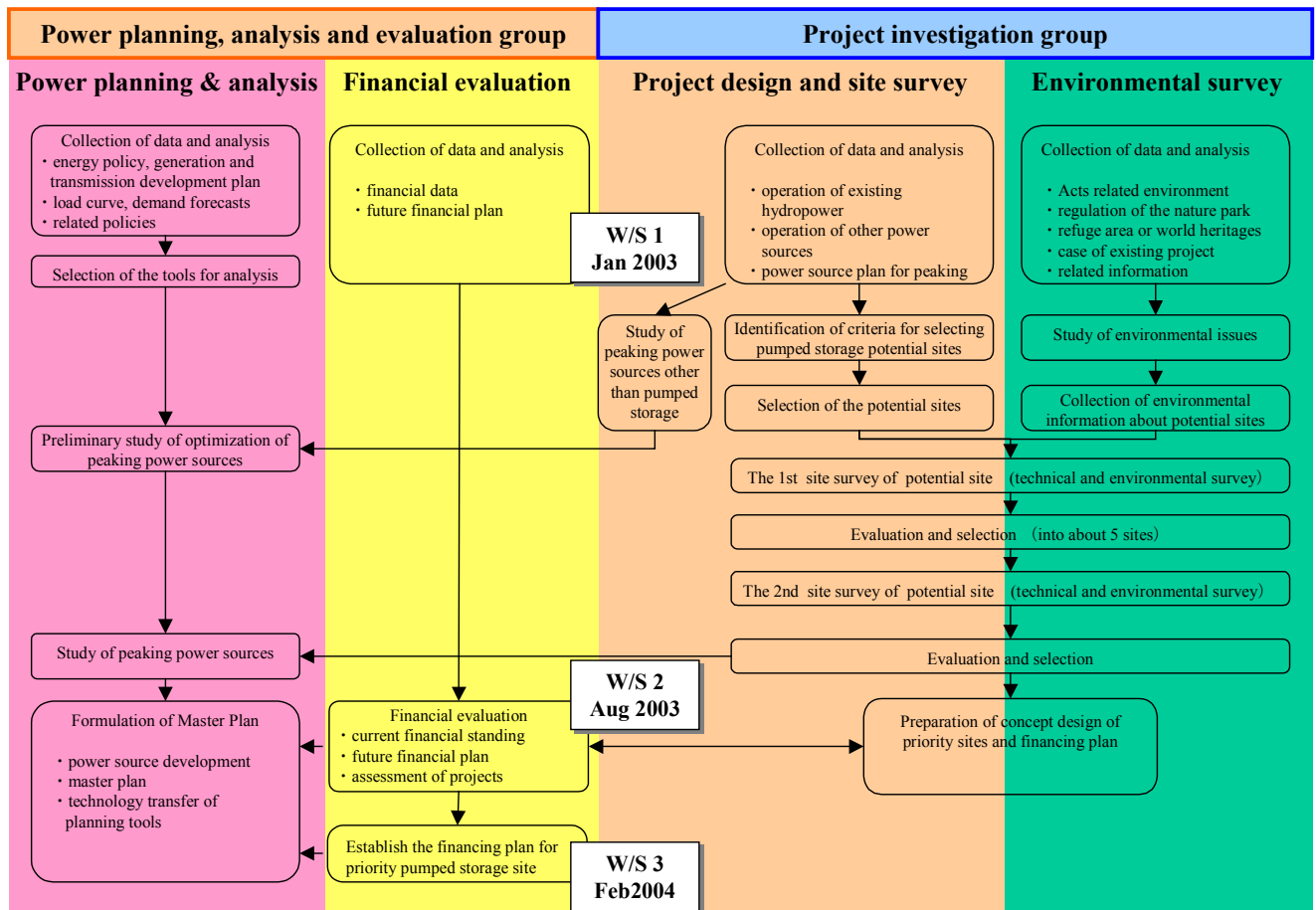


Figure 1-3-1 Study Flow

1.3.2 Work Schedule

This study is carries out from December 2002 to June 2004.

Table 1-3-1 shows work schedule of the study.

Table 1-3-1 Work Schedule

	year month	2003												2004								
		12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	
Overall schedule																						
Study reports																						
TASK																						
STAGE 1 :Preliminary assessment																						
Preparation in Japan																						
1) Collection & analysis of related data and information																						
2) Identification of the significance of peaking power sources optimization																						
3) Selection of the tools for examining peaking power sources optimization and system reliability																						
4) Preparation of the inception report																						
5) Examination of the specification of sub-contract																						
1st study in Vietnam																						
1) Explanation and discussion on the inception report																						
2) Assessment of related data																						
a) energy policy and power sources development plan																						
b) current situation of power source development																						
c) present transmission system and expansion plan																						
d) electricity consumption, peak demand, load curve																						
e) related policy																						
f) current situation of environmental policy																						
g) financial standings of EVN																						
3) Preliminary study of peaking power sources																						
4) The 1st work shop(▼)																						
5) Site survey																						
a) existing generation facilities, potential sites other than pumped storage																						
b) potential pumped storage hydropower sites																						
STAGE 2 :Selection of priority project																						
6) Identification of criteria for selecting pumped storage hydropower sites																						
7) Selection of the potential sites																						
a) evaluation of proposed site																						
b) identification of additional site																						
c) site survey																						
8) Submission of progress report (No.1)																						
1st study in Japan																						
1) Analysis of the result of site survey (preparation in Japan)																						
2) Selection of priority pumped storage sites (Draft)																						
3) Preparation of technology transfer to C/P																						
2nd study in Vietnam																						
1) Selection of priority pumped storage sites																						
2) Site survey																						
3) Technology transfer to C/P																						
2nd study in Japan																						
1) Selection of priority pumped storage sites (continue)																						
2) Preparation of the 2nd workshop																						
3) Preparation of interim report																						
STAGE 3 :System optimization																						
3rd study in Vietnam																						
1) Study of peaking power sources other than pumped storage																						
2) Preparation of the scenarios of peaking power sources development																						
3) The 2nd workshop(▼)																						
3rd study in Japan																						
1) Review of the development scenarios																						
2) Formulation of development master plan																						
3) Preparation of technology transfer to C/P																						
4) Submission of progress report (No.2)																						
4th study in Vietnam																						
1) Discussion on the results of optimization study																						
2) Discussion on progress report (No.2)																						
4th study in Japan																						
1) Preparation of concept design of priority sites																						
2) Preparation of project proposal and financing plan																						
3) Preparation of draft final report																						
4) Preparation of the 3rd workshop																						
5th study in Vietnam																						
1) Explanation and discussion on the draft final report																						
2) The 3rd workshop(▼)																						
5th study in Japan																						
1) Additional formulation of optimization study																						
2) Preparation of the final report																						

1.4 Organization and Progress of the Study

1.4.1 Members of Counterpart Personnel

In order to explain the Inception Report, which had been submitted to EVN in advance, the Study Team headed by Mr. Masayuki ITO held kick-off meetings with the Electricity of Vietnam (referred to as EVN) and the Son La Project Management Board (referred to as Son La PMB) on Jan. 8 and 9, 2003 respectively.

Son La PMB agreed that the Study would be carried out team by team and that it would assign appropriate counterpart personnel for each group of the Study Team as follows;

- General and Financial Group; Son La PMB and related department of EVN
- Project Investigation Group; Power Engineering Consulting Company No. 1
(referred to as PECC1)
- Planning and Analysis Group; Institute of Energy (referred to as IE)

1.4.2 Members of the Study Team

The Study Team comprises the following members.

Masayuki ITO	Team Leader / Power Development Planning A
Hitoshi FURUKOSHI	Power Development Planning A / Demand Forecast and Analysis A
Kazuhiko SHIBA	Demand Forecast and Analysis B
Yasuhiro YOKOSAWA	System Planning
Muneo KAWAGUCHI	Economics and Finance
Masaharu YOGO	Transmission System Planning
Shunji USUI	Social and Natural Environment
Nobuya NARITA	Geological Features A
Takeshi SUIDO	Geological Features B
Noboru SEKI	Simulation Programs Instruction A
Yasuyuki TADA	Simulation Programs Instruction B
Hiroshi WATABE	Coordinator

1.4.3 Progress of the Study

Figure1-4-1 and Table 1-4-1 show the assignment schedule for the Study and the work programs respectively.

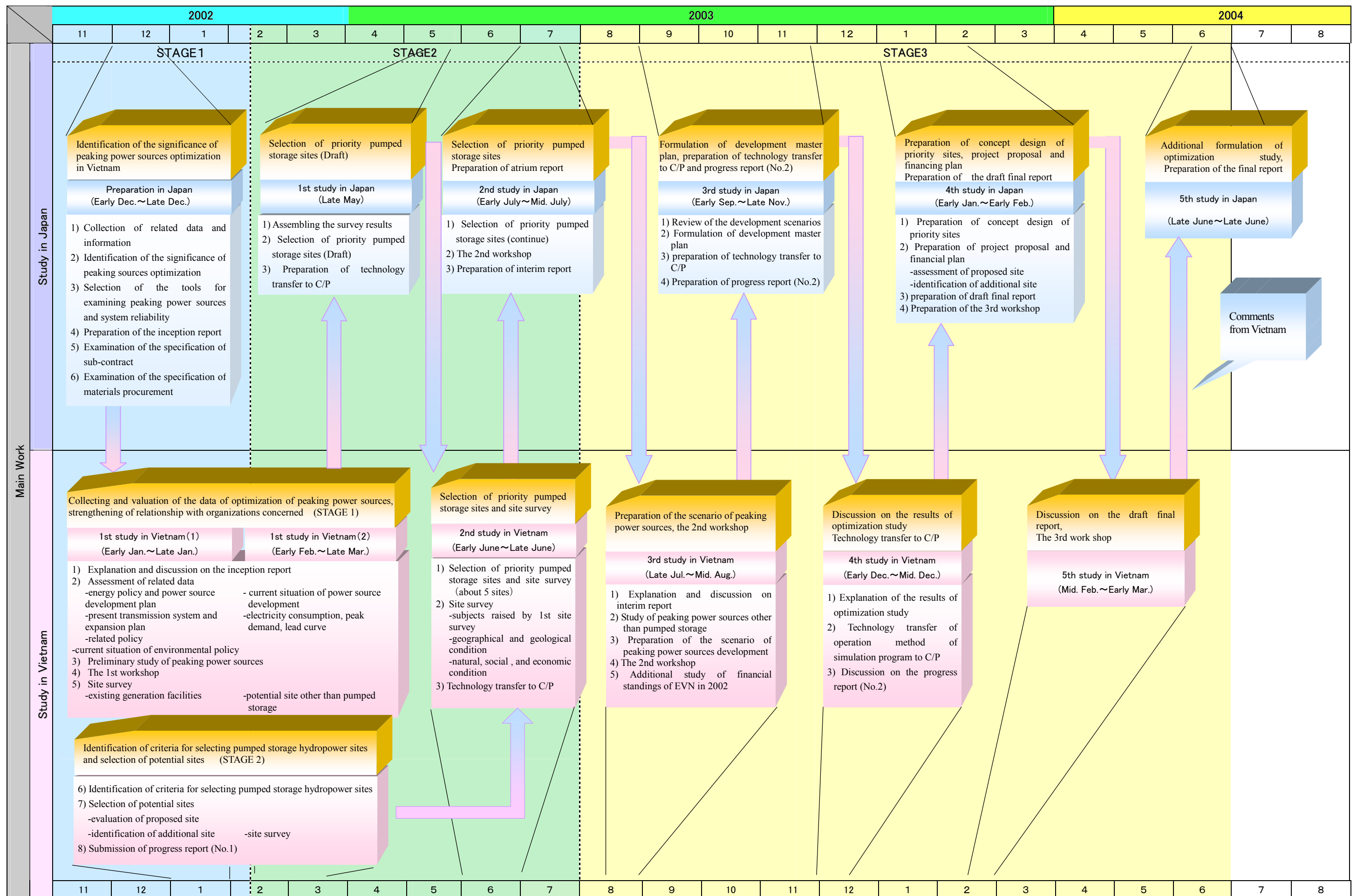


Figure 1-4-1 Time-Series Study Flow

Table 1-4-1 Work Programs

Stage	Work stage	Main work
STAGE 1	Preparation in Japan Early Dec. 2002 ~Late Dec. 2002	1) Collection of related data and information 2) Identification of the significance of peaking power sources optimization 3) Selection of the tools for examining peaking power sources optimization and system reliability 4) Preparation of the inception report 5) Examination of the specification of sub-contract 6) Examination of the specification of materials procurement
	1st study in Vietnam Early Jan. 2003 ~Late Mar. 2003	1) Explanation and discussion on the inception report 2) Assessment of related data <ul style="list-style-type: none"> energy policy and power sources development plan current situation of power source development present transmission system and expansion plan electricity consumption, peak demand, load curve related policy current situation of environmental policy financial standings of EVN 3) Preliminary study of peaking power sources 4) 1 st work shop 5) Site survey <ul style="list-style-type: none"> existing generation facilities potential sites other than pumped storage potential pumped storage hydropower sites
		6) Identification of criteria for selecting pumped storage hydropower sites 7) Selection of the potential sites <ul style="list-style-type: none"> evaluation of proposed site identification of additional site site survey 8) Submission of progress report (No.1)
STAGE 2	1st study in Japan Late May 2003	1) Selection of priority pumped storage sites (Draft) 2) Preparation of Technology transfer to C/P
	2nd study in Vietnam Early June 2003 ~Late June 2003	1) Selection of priority pumped storage sites <ul style="list-style-type: none"> Geographical and geological condition Natural, social, and economic condition 2) Technology transfer to C/P

Stage	Work stage	Main work
	2nd study in Japan Early July 2003 ~Mid. July 2003	1) Selection of priority pumped storage sites (continue) 2) Preparation of the 2 nd work shop 3) Preparation of interim report
STAGE 3	3rd study in Vietnam Late Jul. 2003 ~Mid. Aug. 2003	1) Study of peaking power sources other than pumped storage 2) Preparation of the scenarios of peaking power sources development 3) 2 nd workshop
	3rd study in Japan Early Sep. 2003 ~Late Nov. 2003	1) Preliminary structural design of the priority PSPP 2) Review of the development scenarios 3) Formulation of development master plan 4) Preparation of technology transfer to C/P 5) Submission of progress report (No.2)
	4th study in Vietnam Early Dec. 2003 ~Mid. Dec. 2003	1) Discussion on the results of optimization study 2) Study of financing plan 3) Discussion on progress report (No.2)
	4th study in Japan Early Jan. 2004 ~Early Feb. 2004	1) Preparation of concept design of priority sites 2) Review of the development master plan 3) Preparation of project proposal and financing plan <ul style="list-style-type: none"> Assessment of proposed sites Identification of additional sites 4) Preparation of the draft final report 5) Preparation of 3 rd work shop
	5th study in Vietnam Mid. Feb. 2004 ~Early Mar. 2004	1) Explanation and discussion on the draft final report 2) 3 rd work shop
	5th study in Japan Late May 2004 ~Late June 2004	1) Additional formulation of optimization study 2) Preparation of the final report