



9.5.2 Low Emission Vehicles (LEV: NG Urban Buses)

9.5.2.1 Current Financial Supports for introduction of NG buses

The financial support schemes and economic incentives listed below are planned or set up for the BMTA and the private bus companies to support their finance by the government and the related agencies as shown in the Tables below.

Table 9.5.2.1 Financial Support for BMTA

Related Agencies	Contents	M BT	NB
Environmental Conservation fund (ENCON) (EPPO*)	purchase of dedicated NG buses and EURO 2 buses (2003-2008)	680	Source: the Resolution of NEPC** This fund is not applicable for the private sector and is used for the demonstration project.
	support maintenance cost for new NG buses (2003-2012)	643	Source: the Resolution of NEPC
PTT	support 10,000-15,000 Bt for one bus (2003-2008)	600	only for conversion kits Source: the Resolution of NEPC

* Energy Policy and Plan Office; former NEPO

** NEPC: National Energy Policy Committee

Table 9.5.2.2 Financial Support for Private bus operators

Related Agencies	Contents	M BT	NB
Environmental fund (ONEPP**)	soft loan with low interest and long term repayment period by governmental bank or financial companies*	-	refer to the Environmental Fund in Chapter 7 of Supporting Report
PTT	support 10,000-15,000 Bt for one bus (2003-2008)	600	only for conversion kits Source: the Resolution of NEPC

* Bangkok Bank, Krung Thai Bank, Thai Farmers Bank, and Siam Commercial Bank

**Office of Natural Resources and Environment Policy and Planning, Ministry of Natural Resource and Environment, former OEPP

Table 9.5.2.3 Economic Incentives for NGV

Type	Contents	Responsible agencies	NB
Tax reduction/exemption	Reduction of import tax for NGV Tanks (from 10%) and NGV compressor units (from 3%) to 1%	Department of Customs/ Revenue/Excise	Source the Resolution of NEPC
	Reduction or exemption of import tax or revenue tax for CKD* of KGV cars, buses and trucks		
	Reduction Annual tax for NGV - 75% for dedicated NGV - 50% for bi-fuel vehicles	Ministry of Communication and Transport	
Price policy	Selling price of natural gas is set at 50% of diesel oil's		

* Completely Knocked Down

9.5.2.2 Financial Arrangement for Introduction of NG buses

The EPPO (Energy Plan and Policy Office) and other agencies are now making efforts to convert LPG taxis to NG ones by engine replacements or purchases. As Table 9.5.2.1 and 9.5.2.2 shown above, the EPPO and other agencies plan to provide financial support to the BMTA and private bus companies, the support is not enough to achieve the goal of the countermeasures, because the available funds are too little for the targeted bus replacements.

For the proposed countermeasure here proposed it is assumed that as Table 9.5.2.4 shows, 8,500 buses that are owned by the BMTA and private bus operators must be replaced into new NG buses. The actual purchase by the EPPO (refer to Table 9.5.2.1) is about 100 of NG buses. In order to achieve the goal, the rest of the buses have to be replaced somehow. The point is how to create some reasonable financial resources that could minimize the financial burden and ensure the necessary investment for the BMTA and the private operators. In this study, possible financial resources and arrangements are examined below, and the problems are identified.

Table 9.5.2.4 Replacement Plan and Required Investment for BMTA and Private Operators

Type of Countermeasures \ Year	2004	2005	2006	2007	2008	2009	2010	2011	Total
NG2: No of Buses (BMTA)	500	600	800	1,000	1,200	1,700	2,300	3,300	11,400
NG3: No of Buses (Private Operators)	300	600	900	700	900	1,000	700	1,000	6,100
Total No.	800	1,200	1,700	1,700	2,100	2,700	3,000	4,300	17,500
NG2 required invest. by leasing (MBt)	200	400	600	1,000	1,400	1,900	2,700	3,800	12,000
NG3 required invest. by leasing (MBt)	400	1,100	2,200	3,100	4,200	5,500	6,300	7,600	30,400
Total cost	600	1,500	2,800	4,100	5,600	7,400	9,000	11,400	42,400
NG2 required invest. by purchase (MBt)	1,000	1,200	1,600	2,000	2,400	3,400	4,600	6,600	22,800
NG3 required invest. by purchase (MBt)	2,300	4,500	6,800	5,300	6,800	7,500	5,300	7,500	46,000
Total cost	3,300	5,700	8,400	7,300	9,200	10,900	9,900	14,100	68,800

1) Financial sources

(1) Option 1: Leasing by Self-finance

Generally the leasing system can reduce the capital investment. If the leasing system is acceptable for the new NG buses as same as the new diesel buses, the system should be applied for the BMTA and private operators rather than purchase. In addition, NG buses can save energy costs due to the price difference and the daily expenditure can be estimated almost same as the EURO 2 diesel buses because of little increase of the expenditure.

While, for private operators, even for leasing, the cost is completely additional for them and burdens their financial situation seriously, because they are usually using old buses which used to be the BMTA's the age of which are over 10 years.



As described in detail in Chapter 7 of the Supporting Report, the leasing fee for NG buses is estimated at 3,000 Bt per day based upon the existing leasing fee for EURO 2 and it is higher than that of EURO 2, on the other hand, energy saving from fuel conversion is estimated at about 700 Bt. In this calculation, the total daily expenditure excluding the energy saving for bus operation are almost the same between the NG and the EURO 2 buses. However, the additional expenditure of 2,800 Bt amounts to half of the total daily revenue of 5,000 Bt.

From this analysis, the leasing fee is not payable for the private operators. In order to solve the problems the governmental financial support is indispensable.

(2) Option 2: Purchase by Governmental Subsidies

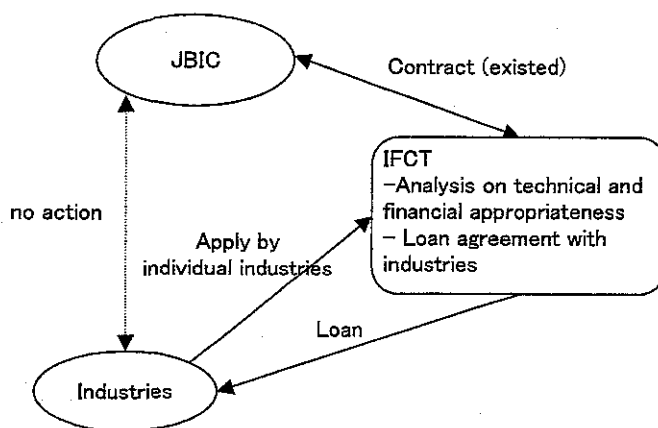
The ENCON fund is one of the governmental subsidies. Such subsidy is expected to provide the private operators as well as the BMTA to purchase or lease NG buses continuously.

(3) Option 3: Purchase by Soft Loans

There are two soft loan schemes available. One is the Environmental Fund by the ONREPP (refer to Table 9.5.2.2, Section 8.7.1.1 and Chapter 7 of the Supporting Report). The other is the two-step loan that the Japan Bank for International Cooperation (JBIC) provides (refer to Chapter 7 of the Supporting Report).

The two-step loan services for the Industrial Finance Corporation of Thailand (IFCT) until 27/01/2003 (the deadline is going to be postponed until the year 2005 according to the JBIC) in order to enhance the environmental conservation activities by the Thailand enterprises.

In this loan scheme, the individual private operators can apply for the loan directly to the IFCT. Basically the private operators that are under the categories and the conditions of the loan scheme are accepted after the financial audit by the IFCT. Loans are provided with the accepted private operators by the IFCT (secondary lender agency) as below, based upon the primarily contracted loan agreement between the JBIC and the IFCT.





When the bus companies lend the money by an overseas loan, their financial affordability of is very important. In fact, not only the private companies but also the BMTA do not have a good financial situations because of the current low fare system and their improper management. Financial improvement of the related bus companies is indispensable before loans.

A project called the 'Technical proposal for consulting service for BMTA Route Planning and Scheduling under the Traffic Planning and Management Sector Loan' has been conducted from the beginning of last year under the supervision of OCMLT. This project included rearrange of the bus operating system and improvement of the financial conditions by restructuring of fare system. Based upon the result of the project, the financial affordability should be examined and necessary funds should be identified.

(4) Option 4 : Purchase of NG buses by CDM

This is the case that assumes to invite overseas investment from the government or enterprises in the developed countries. The CDM (Clean Development Mechanism) is one possible measure although the Thai government ratified the Kyoto Protocol but does not have complete domestic procedures. The general concept of the CDM application is described in Table 8.7.1.3 of Chapter 8.

As Table 9.5.2.4 shows, in case all buses of 17,500 in the BMA are replaced into new NG buses, 22,600 C-T of CO₂ will be reduced per year and 4,500 M Bt of energy costs will be saved using the emission factors derived from the National Energy Development Organization (NEDO) in Japan and the actual fuel consumption data on NG bus and EURO 2 derived from BMTA (refer to Table 7.1.1.3 of the Supporting Report). In addition, the CO₂ amount reduced by the countermeasure values 100 MBt by the calculation using the average price of CO₂ as 10 US\$ and assuming that life time of bus is 10 years. As a result of this analysis, there is a big gap between the price of the reduced CO₂ amount and the necessary investment cost. That means that investors may not be willing to pay for the investment cost of 42 B Bt but they would pay for 100 M Bt which is the price of the CO₂ reduction amount. Therefore, the rest needs to be financed by other sources.

In this study, the reduction amount by the countermeasure is calculated tentatively. But in order to ensure the possibility and smooth registration, it is recommended to conduct a feasibility study in advance.

Case	Energy Cost saving	Reduction Amount of CO ₂	Price of Reduced CO ₂ Amount
1 year	4,500M Bt	22,600 C-T	10 M Bt
10 years	45,000M Bt	226,000 C-T	100 M Bt
21 years	90,000M Bt	452,000 C-T	200 M Bt



2) Conclusion

The table below summarizes the possible financial sources and their problems.

Table 9.5.2.5 Financial Sources and the Problems

Option	Type of Financial Sources	Problems
1	Lease NG buses by self-finance	Especially for private operators, additional cost by leasing burdens their financial situation seriously. Therefore, the introduction of NG buses requires substantial financial support to maintain proper operation. So that, based upon the restructuring of fare system and governmental subsidies financial improvement must be parallel.
2	Purchase NG buses by Governmental Subsidies	The necessary investment cost of about 42 billion bahts for private operators is almost three times of the annual budget for the Ministry of Natural Resources and Environment. It not realistic for the bus companies to rely on the governmental subsidies as a sole financial resource.
3	Purchase NG buses by Soft Loans	It is difficult to use loans without outlook of financial improvement, the financial problems should be settled first.
4	Purchase NG buses by Overseas Investment (e.g. CDM)	In case the project is accepted as a CDM project, which could invite an overseas investment from foreign government or enterprise. However, the possible overseas investment gives a little contribution to the total investment.

Considering the above-mentioned problems of each financial source, the following financial arrangement should be taken.

- Any single financial source cannot cover the necessary investment cost and therefore a mixed application of the possible financial sources needs to be considered.
- The BMTA could replace their buses (except private operators') by themselves as much as possible because NG buses will able to reduce its operational expenses rather than diesel buses due to energy cost saving (refer to Option1).
- In order to minimize the uncovered investment cost, although the ENCON fund is basically provided by the governmental entities, it should be sent around for the financially weak private operators that cannot utilize the soft loan services of JBIC or local banks (refer to Figure 9.5.2.1).
- The point is how to share the uncovered investment of about 42.4 billion baths by the available financial sources as illustrated in Figure 9.5.2.1. In order to seek a best solution for the investment, governmental subsidies or loans need to be considered among the relevant agencies.

The chart in Table 9.5.2.6 shows a tentative implementation schedule by financial source.

Figure 9.5.2.1 Financial Sources and Arrangement

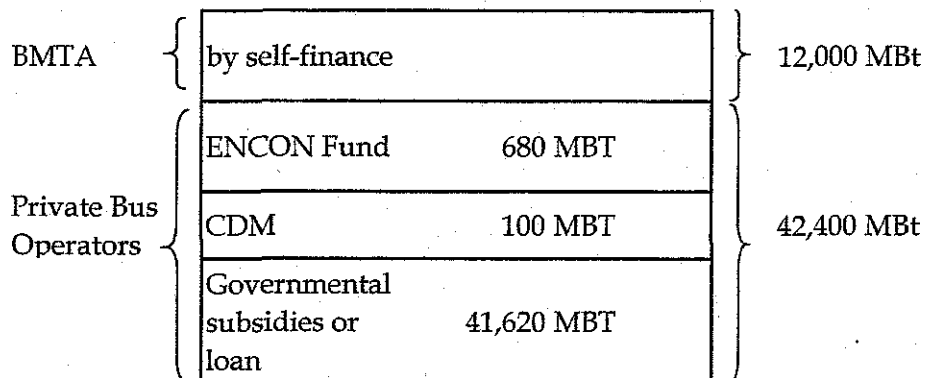


Table 9.5.2.6 Implementation Schedule

year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Financial Improvement of BMTA & Private Bus Operators									
Study on Financial Improvement	■								
Governmental Support for Financial Improvement		■	■	■	■	■	■	■	■
Purchase of NG buses by ENCON Fund		▨	▨	▨	▨	▨	▨		
Exploration of Possibility for Purchase of NG buses by CDM*									
Preparation for CDM project by Thai Gov.	■								
Feasibility Study		■	■						
Purchase of NG buses by Soft Loan									
Approved by local banks (IFCT etc)			■	■	■	■	■	■	■
Purchase of NG bus by individual private bus operator			▨	▨	▨	▨	▨	▨	▨
Purchase of NG buses by Governmental subsidies or loan			▨	▨	▨	▨	▨	▨	▨

▨ means that NG buses will be purchased occasionally by using each financial source.

* Process of CDM: refer to Figure 8.7.1.3



9.5.3 Overage Vehicle Retirement (OVR: HDDV/T)

9.5.3.1 Financial Arrangement

The proposed countermeasure here proposed is assumed that as Table 9.5.3.1 shows, totally about 6,100 old aged buses owned by the private bus companies operating under the BMTA need to be replaced into new diesel buses during the period between year 2004 and 2011. A large amount of investment about 36.8 billion baths are necessary for the replacement in case of purchase. In order to replace all buses in some wise, it is necessary to create some reasonable financial sources that could minimize financial burden and ensure the necessary investment for the private operators. In this study, possible financial resources and arrangement are examined as below, and the problems are identified.

Table 9.5.3.1 Replacement Plan and Required Investment for Old Aged Buses (VR1 case)

Type of Countermeasures \ Year	2004	2005	2006	2007	2008	2009	2010	2011	Total
No of Buses (Private Operators)	300	600	900	700	900	1,000	700	1,000	6,100
Required invest. by leasing (MBt)	100	300	900	1,700	2,300	3,100	4,000	4,600	17,000
Required invest. by purchase (MBt)	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	36,800

1) Financial Sources

Possible financial sources applicable for purchase or leasing of new diesel buses for the private bus operators are follows;

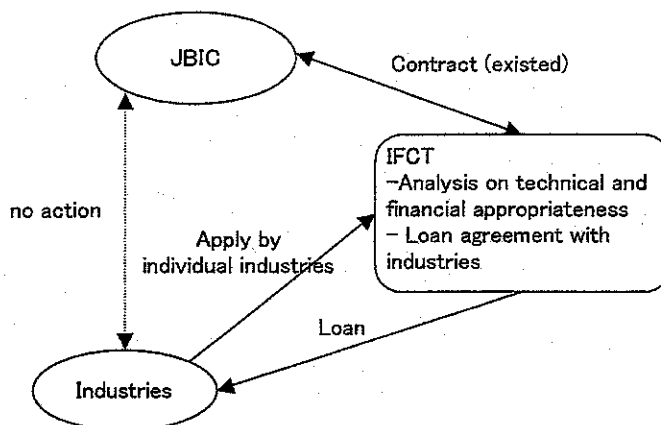
(1) Option 1: Purchase by Soft Loans

There are two soft loan schemes available. One is the Environmental Fund by the ONREPP (refer to Table 9.5.2.2, Section 8.7.1.1 and Chapter 7 of the Supporting Report). The other is the two-step loan that the Japan Bank for International Cooperation (JBIC) provides (refer to Chapter 7 of the Supporting Report).

The two-step loan services for the Industrial Finance Corporation of Thailand (IFCT) until 27/01/2003 (the deadline is going to be postponed until the year 2005 according to the JBIC) in order to enhance the environmental conservation activities by the Thai enterprises.



In this loan scheme, the individual private bus companies can apply for the loan directly to the IFCT. Basically the companies which are under the categories and the conditions of the loan scheme are accepted after the financial audit by the IFCT. Loans are provided with the accepted private bus companies by the IFCT (secondary lender agency) as below, based upon the primarily contracted loan agreement between the JBIC and the IFCT.



When the bus companies lend the money by overseas loan, their financial affordability of is very important. In fact, the private companies have not good financial situations because of the current low fare system and their improper management. Financial improvement is indispensable before loan.

A project called the 'Technical proposal for consulting service for BMTA Route Planning and Scheduling under the Traffic Planning and Management Sector Loan' has been conducted from the beginning of last year under the supervision of the OCMLT. This project included rearrange of bus operating system and improvement of financial conditions by restructuring of fare system. Based upon the result of the project, the financial affordability should be examined and necessary fund should be identified.

(2) Option 2: Purchase by Governmental Subsidies

The ENCON fund is one of the governmental subsidies. Such subsidy is expected to provide the private operators in order to purchase or lease new diesel buses however currently only governmental bodies is applicable.



2) Conclusion

The below summarizes the possible financial resources and their problems.

Table 9.5.3.2 Financial Sources and the Problems

Option	Type of Financial Sources	Problems
1	Purchase of new diesel buses by Soft Loans	It is difficult to use loan without outlook of financial improvement, the financial problems should be settled first.
2	Purchase of new diesel buses by Governmental Subsidies	The necessary investment cost of about 57 billion bahts for private operators is almost three times of the annual budget for the Ministry of Natural Resources and Environment. It not realistic for the bus companies to rely on the governmental subsidies as a sole financial resource.

Considering limited financial source for private operators, the following financial arrangement should be taken.

The private operators have not good financial situation due to the current low fare system. In particular, financially weak bus operators that cannot use the loans above need to rely on the governmental subsidies or loans. The point is how they can obtain the governmental investment as illustrated in Figure 9.5.3.1. In order to seek for a best solution for the investment, an appropriate governmental subsidy or loan scheme need to be discussed among the relevant agencies identifying vulnerable operators based upon the detailed financial analysis for the private operators. The chart in Table 9.5.3.3 shows implementation schedule by the possible financial sources.

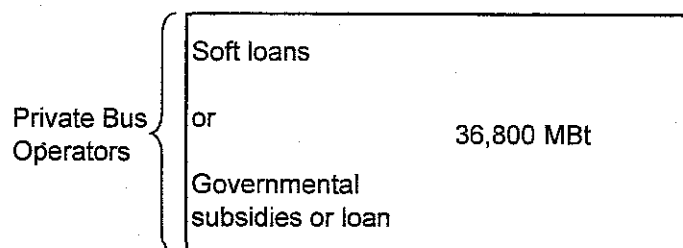



Figure 9.5.3.1 Financial Sources and Arrangement



Table 9.5.3.3 Implementation Schedule

year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Financial Improvement of BMTA & Private Bus Operators									
Study on Financial Improvement									
Governmental Support for Financial Improvement									
Purchase of New Diesel Buses by Soft Loan									
Approved by local banks (IFCT etc)									
Purchase of New Diesel Buses by individual private bus operator									
Purchase of New Diesel Buses by Governmental subsidies or loan									

 means that New Diesel Buses will be purchased occasionally by using each financial source.

Chapter 10

Acid Deposition Control Strategy



10. Acid Deposition Control Strategy

10.1 Introduction

Innumerable pollutants are discharged by a variety of human activities. Sulfur oxides and nitrogen oxides are typical pollutants, and cause acid deposition and ambient air pollution. Currently acid deposition and ambient air pollution are both subjects of public concern in Thailand. Major causing materials of acid deposition are sulfur oxides and nitrogen oxides, and they bring about SO₂ and NO₂ ambient air pollution also. Therefore, on the one hand, countermeasures for acid deposition and ambient air pollution cannot be separated. The points of countermeasures for both issues are the reduction of emission amount of sulfur oxides and nitrogen oxides. On the other hand, acid deposition has its own characteristics. It is a consequence of a series of physical and chemical processes. The spatial expanse of acid deposition is wide and complex, and reaches to East Asia. And it is not a short-term issue. Sometimes, the effects of acid deposition appear after many years.

Therefore, the control strategy tackling acid deposition should include various activities. The collaboration of respective activity will enable a mitigation of issues. Figure 10.1.1.1 shows relating activities. Control Strategy should cover these activities.

Control strategy has two faucets, i.e. countermeasure and management for acid deposition and air pollution. Regarding countermeasure,

according to evaluation and

prioritization in Chapter 7, the direct countermeasure for acid deposition includes ambient air pollution aims the reduction of nitrogen oxides and sulfur oxides in the BMR. In Chapters 8

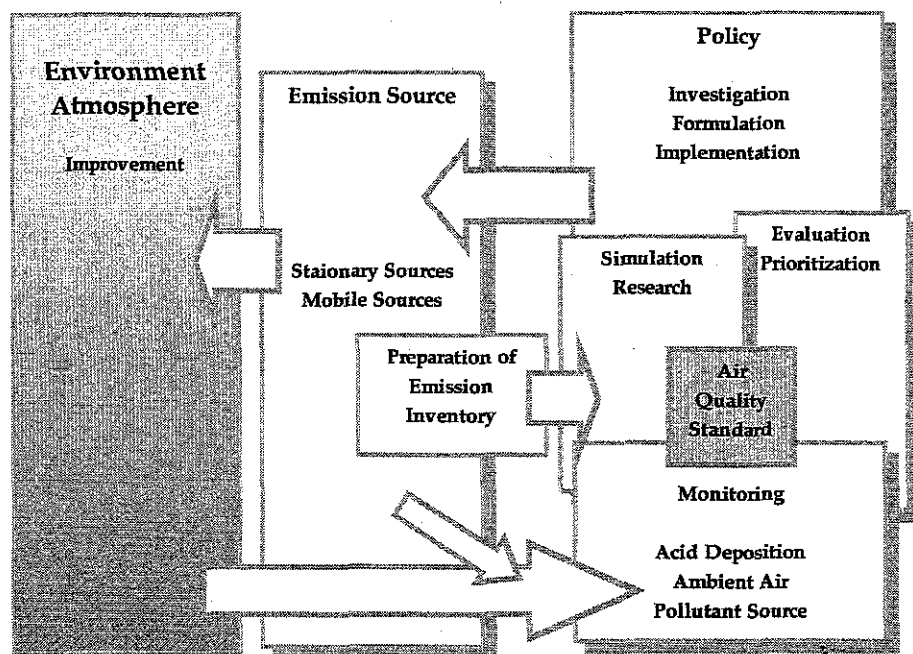


Figure 10.1.1.1 Acid Deposition Control

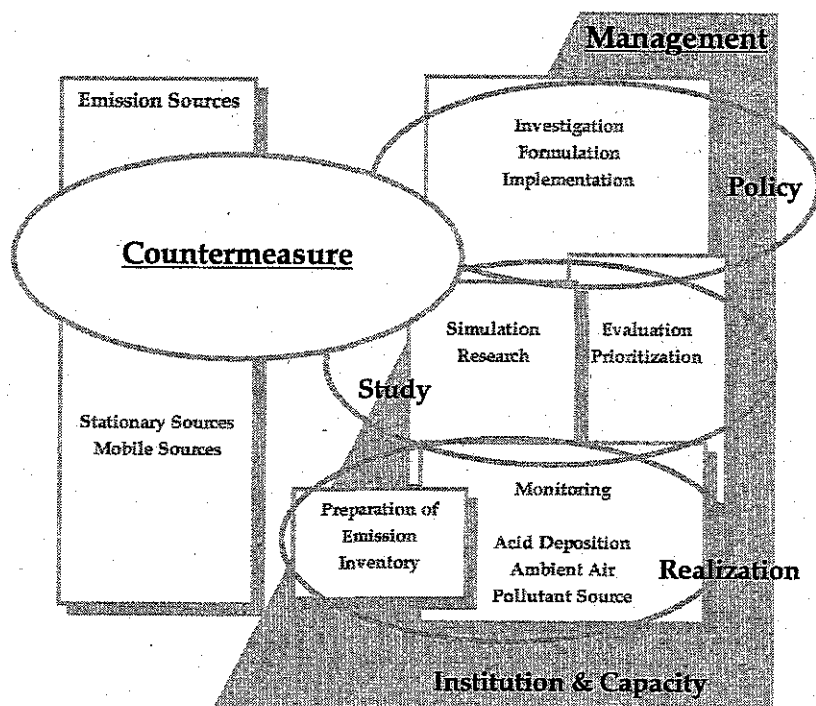


Figure 10.1.1.2 Countermeasure and Management

and 9, countermeasures are described. The management, acid deposition management including ambient air pollution management should cover the diversity of activities. That is the field of realization, study, and policy. The series of management is realization, study and policy. Through the series of management, the countermeasures are formulated. And the basis for management is

definite setting of function and improved capacity. Those activities and basis for management are illustrated with countermeasure in Figure 10.1.1.2

10.2 Control Strategy

According to the concept of countermeasure and management (Figure 10.1.1.2), following integrated control strategy is proposed.

Concerning the countermeasure for mitigating air pollution in the BMR, following two strategies are proposed.

Strategy A: Shift to natural gas by stationary sources

Strategy B: Introduction of substantial compliance with the emission standard (Real-Euro), low emission vehicle promotion (LEV), and over age vehicle retirement (OVR).

The selection of these strategies is described in Chapters 8 and 9.

Concerning acid deposition and air pollution management,

Strategy C: Enhancement of Environmental Management

The Strategy C is the prioritized approach in the series of management and the reinforcement of institution and capacity to tackle problems of acid deposition and air pollution.

Figure 10.2.1.1 shows proposed strategy for acid deposition and air pollution.

Concerning the strategy for countermeasures derived by critical load approach, because of current discussion of critical load, they were regarded as reference in the Study. For the sake of reference, it can be commented as follows. According to Chapter 8, the deposition value in the BMR by ATMOS2 exceeds critical load value in the 2011 control case. Therefore, it will be necessary to introduce

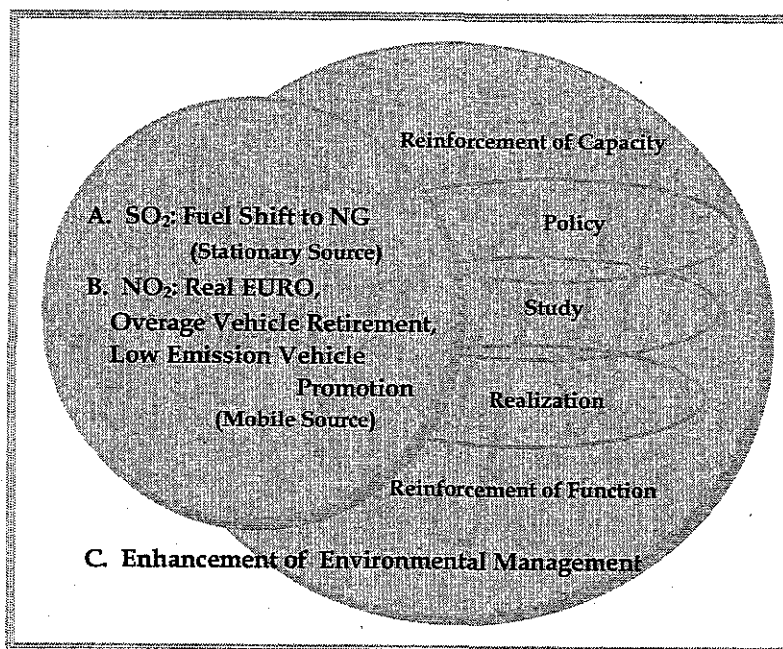


Figure 10.2.1.1 Strategy

larger reduction measures for SOx. And the situation will be similar to some extent in Eastern and Central regions. It is necessary to follow critical load approach in future.

10.3 Strategy A: Shift to Natural Gas for SO₂ Mitigation in the BMR

10.3.1 Outline for the Recommended Countermeasure

The shift to natural gas is a countermeasure of the first priority for mitigation of SO₂ concentration in the BMR. It can be introduced by economic mechanisms, and do not need preparing new or more stringent regulations. It is consistent with the national policy to enhance natural gas in the manufacturing sector.

Natural gas is an almost domestic energy in Thailand. And in many cases, the shift to natural gas brings energy saving effects. Moreover it is an environmentally friendly measure in many aspects, such as lower dusts and SOx emissions and lower chances of black smoke.

Currently in the BMR, the trunk pipeline is laid in the eastern area. Another trunk line in the western area will be laid by the end of the year 2005. After the completion of the western part, Bangkok Gas Ring will be finished and available. Bangkok Gas Ring will enable many areas in the BMR to shift to natural gas, mainly in industrial estate.

The price of natural gas is competitive enough with other fuels. In the case of a shift to natural gas, it is necessary to lay branch pipes and gas pipes in factory premises, and to install meters and gas burners. Even considering these costs, because of the energy saving merit, natural gas has competitiveness with other conventional fuels.

10.3.2 Step by Step Implementation

Currently, Thai SO₂ standard was satisfied in the BMR. According to the simulation result, some limited grids would not satisfy the standard in the year 2011. For the mitigation of this possible deterioration of the environment in the future, the shift to natural gas is recommended. The shift to natural gas can be introduced by economic mechanisms without new or more stringent regulations, i.e. the introduction will not burden private companies with extra economic costs.

In order to mitigate possible deterioration beforehand, it is appropriate and realistic to enhance step by step introduction. The first priority is the introduction of shift in and around high concentration grids. After the introduction of the shift in and around high concentration grids, other grids become targets of the introduction of shift to natural gas.

At actual stage of implementation, it is important to take into consideration that the mitigation measure for some factories depend on specific conditions, not general conditions. In such cases, various measures can be regarded as possible. In order to satisfy the environmental and economic requirement, the best way can be selected.

Concerning the WHO guideline, the shift to natural gas would be able to reduce the number of grids exceeding the guideline significantly. However still 35 grids showed exceeding values by Airviro simulation in the 2011 Control case. The attainment of the WHO guideline is a future long-term issue. According to NEQA, B.E. 2535, ambient air quality standard shall be modified and improved in the light of scientific and technological progresses and changes in economic and social conditions of the country. The WHO guideline values will be important reference values for modification. Therefore in the course of modification of Thai Ambient air quality standard, countermeasures for modified standard will be studied and introduced. This process will satisfy the WHO guideline further.

10.3.3 Financial Arrangement

The shift to natural gas is an option for individual private companies. Even the pipeline is laid down, the connection of industries to the pipelines depends upon their willingness. In fact, even the area where the pipeline is laid down, limited industries that could obtain benefits from the fuel conversion have connected to the network.

The price scheme that PTT provides gives incentives for the big industries that can produce a profit from the conversion due to price differences, but does not work well for the small and medium-size industries as incentives. For such industries that especially encounter financial problems due to the economic crisis and cannot afford the connection, financial support is indispensable. It is necessary to publicize the economic and environmental benefits to such industries, and to enhance the introduction to shift to natural gas.

In order to support the fuel shift to natural gas financially, soft loans by the Environmental Fund and the JBIC's two-step loan are applicable mechanisms. And if overseas investment by CDM can be introduced, it will be one of the economic mechanisms for supporting the shift to natural gas.

10.3.4 Institutional Issues and Capacity Building

The shift to natural gas is consistent with the national policy to encourage natural gas in the manufacturing sector, and it can be introduced by economic mechanisms, and need not prepare new or more stringent regulations. However, it is necessary to enhance the shift by environmental administration.

Natural gas is distributed solely by Petroleum Authority of Thailand (PTT). PTT has an intention to promote gas distribution in the BMR. Therefore PCD should discuss with PTT the plan of the shift, i.e. what area should be prioritized for the shift and how apply supporting mechanisms by the Government. The base data for selection of areas is the simulation result of the Study. After the arrangement of plan, PCD should raise the public awareness for the shift to natural gas.

For enhancement of the shift to natural gas, major subjects for expansion of capacity of PCD are the designation of an analysis and simulation group and an inventory group. The role of an analyzing and simulation group is not collecting monitoring data but analyzing the causes and results of environmental issues. Besides, it is necessary to analyze the effect of policy options by simulation. Thus PCD with an analyzing and simulation group has the capability of taking the initiative in environmental administration. The function of an analysis and simulation cannot be completed by government agencies only. Involvement of the private sector after adequate and clear job assignment is necessary.

In order to analyze causes of environmental issues, the inventory data are indispensable. Currently the inventory databases of environmental field in Thailand are not sufficient. Data sets of other agencies are not sufficient for the administration of PCD. Inventory databases are essential for analyses. The periodical and continuous compilation of inventory data should be assigned to the group of PCD. The function of preparation of inventory cannot be completed by government agencies only. The involvement of the private sector after adequate and clear job assignment is necessary.



10.3.5 Action Plan for the Shift to Natural Gas

In order to enhance the shift to natural gas, because of natural gas is distributed solely by Petroleum Authority of Thailand (PTT), PCD should discuss with PTT the plan of the shift, i.e. what area should be prioritized and how apply supporting mechanism by the Government. After the arrangement of plan, PCD should raise public awareness for shift to natural gas.

Table 10.3.5.1 shows tentative schedule of the shift to natural gas and reinforcement of institution and capacity for PCD.

Table 10.3.5.1 Action Plan for the Shift to Natural Gas

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Countermeasure: Shift to Natural Gas Western Part of Bangkok NG Ring (Main Pipeline by PTT) Installation Planning (PCD and PTT) Supporting Planning (PCD, PTT, and IFCT) Public Relation for Shift to NG Installation of Necessary Facilities by Individual Industries (Application of Environmental Fund, JBIC's Two Step Loan)									
Reinforcement of Institution and Capacity of PCD Designation of Analyzing & Simulation Group Designation of Inventory Group Nurturing Private Sector									

10.4 Strategy B: Enhancement of Real-EURO and LEV/OVR for NO₂ Mitigation in the BMR

10.4.1 Outline for the Recommended Countermeasures

The countermeasures are recommended as follows,

- (1) Substantial compliance with the latest emission standard (Real-EURO)
 - All HDDV/Ts should comply more strictly with the latest emission standard when they come onto the market (Real-EURO)
- (2) Low Emission Vehicle Promotion (LEV)
 - New NG Urban Buses should be purchased instead of conventional diesel ones (NG2),
 - Over aged Urban Bus (over 10 years) should be replaced with New NG ones (NG3)
- (3) Overage Vehicle Retirement (OVR)
 - Over aged Urban Bus (over 10 years) should be replaced with New Diesel ones (VR1)

Substantial Compliance with the Latest emission standard (Real-EURO) was considered essential for NO_x emission reduction in the BMR, since it could reduce nearly a third of the

total NO_x emission from vehicle there even by itself. Therefore it was concluded that Real-EURO should be assigned as the highest priority countermeasure among them. It was highly recommended that government of Thailand should consider Real-EURO as emergency countermeasures and should implement Real-EURO as soon as possible.

The other countermeasures, namely Low Emission Vehicle Promotion (LEV) and Overage Vehicle Retirement (OVR), should be launched with Real-EURO at the further steps for additional NO_x reduction although their additional effects were estimated relatively small. Because the traditional countermeasures for NO_x reduction, namely enforcement or compliance of stricter emission standard for new vehicles, would have their definite limits in the near future like that Japan is confronting. Therefore LEV and OVR should be provided for future full implementation immediately.

10.4.1.1 Substantial Compliance with the Latest emission standard (Real-EURO)

As mentioned in Chapter 4 "4.2.2 Mobile Source Inventory of the Year 2000 in the BMR", the vehicle emission factors were determined by chassis dynamometer test data collected in Thailand and only the test data of HDDV/T complying with EURO 2 showed much higher emission level than they are supposed if they really comply. Furthermore, according to PCD, it was possible that HDDV/Ts might be modified when they were installed with type-approved engines since engine dynamometer test instead of chassis dynamometer controlled them. Therefore the study team proposed further investigation and substantial (stricter) compliance with the standard.

10.4.1.2 Low Emission Vehicle Promotion (LEV)

Natural Gas Vehicle (NGV) was selected to be promoted as LEV, since BMTA has operated few NGVs and the NGV infrastructure would be developed through PTT's natural gas promotion strategy.

Urban Bus operated by BMTA was targeted, while Heavy Truck and the other Bus, namely Coach or Long-haul Bus, were not since they are likely to be operated beyond the area supplied with natural gas and proper garages.

BMTA were proposed to purchase NGV instead of the conventional diesel and replace their old buses (over 10 years) with NGV successively.

10.4.1.3 Overage Vehicle Retirement (OVR)

Although more stringent emission standard limits the emission from new vehicles, the effect would be limited usually and the ambient NO₂ level could not be improved drastically, since the worn-out vehicles from overwork and overage engines, especially overage

HDDV/Ts emit considerable amount in total. There would be considerable number of worn-out HDDV/Ts still in-use at the target year in Thailand, therefore the retirement program of them was considered effective.

However only Urban Bus operated by BMTA was targeted since it was considered quite difficult in financial aspect to conduct this program on private commercial vehicle, namely Heavy Truck or Coach.

10.4.2 Effectiveness

The Real-EURO implementation would reduce around 34% of vehicle NO_x emission of 2011 (BAU Case). The implementation of Real-EURO with LEV (NG2+NG3) and Real-EURO with OVR (VR1) would reduce around 38%.

Accordingly, the Real-EURO implementation would reduce the grids over Thai ambient NO₂ standard from 60 to 7 and over the WHO guideline from 2,127 to 1,237, the Real-EURO with LEV (NG2+NG3) would reduce over-Thai grids from 60 to 5 and over-WHO grids from 2,127 to 1,075, the Real-EURO with LEV (NG2) and OVR (VR1) would reduce over-Thai grids from 60 to 5 and over-WHO grids from 2,127 to 1,086.

10.4.3 Institutional Arrangement

Real-EURO would require some institutional arrangement for its implementation although it would have little financial problem. Therefore the study team proposed the absolutely necessary tasks to be assigned to the relevant agencies as follows.

First, in advance to the institutional arrangements for the relevant agencies, PCD should Feasibility Study for Real-EURO to confirm the validity of the Real-EURO enforcement by close and diligent investigation concerning the emission factor of Thai HDDV/T. The major tasks were presumed as, Data collection of chassis and engine dynamometer test of in-use/new HDDV/Ts to estimate Thai conversion factor, and Recheck the attainment of HDDV/T engine emission standard although they were once type-approved.

Secondly, TISI should call technical committee to discuss the amendment of TIS to enable TISI to implement the additional conformity inspection for the stricter compliance, namely Unannounced (surprise) inspection of Thai HDDV/T manufacturers' assembly lines with the authority to order the manufacturers to remove the engines for the retest.

Thirdly, MOTC should amend Land Transport Act from the viewpoint of anti-tampering program for HDDV/T, which can detect any damage, disablement or removal of emission control components. Once detected, the owner would be required to restore the vehicle's emission control system and have the vehicle re-inspected.



Fourthly, LTD should follow the amended Land Transport Act and inspect tampering like engine replacement in addition to the existing checkpoints after appropriate training program for technical service staff.

Lastly, RTP should conduct random roadside emission test to complement the periodic IM program, which was considered not to detect tampering efficiently since it is predictable and gives vehicle owners an opportunity to evade the program.

On the other hand, neither LEV nor OVR would demand such institutional arrangements for its implementation as long as they target only BMTA's Urban Bus since BMTA has already operated NGV for LEV and OVR is just to accelerate conventional vehicle retirement program of BMTA.

10.4.4 Capacity Building

LEV would need to train more technicians with enough skill of NGV maintenance and Real-EURO might need to augment the appointed staff for the inspection proposed. However they were considered to be achieved enough by the existing institutional system and additional arrangement would not be necessary to be proposed in the study.

OVR would not either as long as it target BMTA's Urban Bus since its inspection would not be necessary for BMTA, which can be controlled by the government policy.

10.4.5 Financial Arrangement

LEV would require a large amount of financial allocation to implement the fuel conversion policy by introduction of LEV although there are a few technical problems. Therefore, the Study proposed its financial arrangement with the Clean Development Mechanism and supplementary governmental subsidies or loan in addition to the existing subsidies presumed available.

OVR would require a large amount of investment about 49 billion bahts for its implementation and it would give considerable financial burden on the bus companies. Although soft loans of the JBIC and local banks are available, its application would be quite limited due to the severe financial conditions of the private bus companies. This Study proposed supplementary governmental subsidies or loans for the financially weak companies that cannot utilize the soft loans.

On the other hand, Real-EURO would not demand it since it could be achieved by the existing staff though it burden them with little tasks additionally.



10.5 Strategy C: Enhancement of Environmental Management

Because environmental management covers various fields, many agencies are allocated respective responsibility and manage them in Thailand as in other countries. Among such agencies, PCD is expected to conserve and improve the environment, based on scientific knowledge.

In order to satisfy the mission highly on the outcome of the Study, PCD should reinforce its institutional facet and build its capacity of staff further.

As the concept of strategy is already illustrated in Figure 10.2.1.1, the management strategy should be integrated with countermeasure strategy. And as shown in Table 10.5.1.1, it is divided into two groups. They are intensification of focused and prioritized approach and reinforcement of institution and capacity. Concerning the focused and prioritized approach, as shown in Figure 10.1.1.2, various activities of management are divided into three fields, i.e. realization, study and policy.

Table 10.5.1.1 Strategy for Environmental Management

C Enhancement of Environmental Management	
C-1 Intensification of Focused Activity	
<i>Realization</i>	Regular Monitoring Specific Monitoring for Investigation Establishment of Emission Inventory
<i>Study</i>	Evaluation of Acid Deposition & Atmospheric Condition Data Application of International Simulation Model Research of Acid Deposition Prioritization of Acid Deposition Issues
<i>Policy</i>	Investigation of Policy Formulation and Implementation of Policy
C-2 Reinforcement of Institution & Capacity	
<i>Institution</i>	Inventory Group Analyzing and Simulation Group Scientific Advisory Function Policy Investigation Function
<i>Capacity</i>	Systematization of Environmental Knowledge Investigation of Policy

10.5.1 Intensification of Focused Activity

10.5.1.1 Realization

Realization is the starting point of environmental administration. The monitoring of environmental conditions and knowledge of pollutant emission by human activities is a major part of realization.



1) Regular Monitoring

Steady monitoring of atmospheric conditions and acid deposition has been conducted by PCD. This activity is a vital issue for environmental management. It is very important to continue the current activity. Acid deposition is monitored in 5 locations. However, it is necessary to expand monitoring to cover developing areas such as the industrial area in eastern part of the country.

2) Specific Monitoring for Investigation

Regular monitoring by PCD cannot always cover every issue. Specific monitoring for topics and research should be undertaken by relating agencies, such as institutes, universities and government agencies. Concerning acid deposition, the realization of the current situation in a typical area in the country is one of examples of specific monitoring. It contributes to realize acid deposition and air pollution in Thailand. It is necessary for PCD to plan and implement specific monitoring for pollution control policy. And it is necessary for PCD to support and co-operate these types of activities of other agencies.

3) Establishment of Emission Inventory

The origins of the causing substances of acid deposition are scattered broadly across the country. In order to get information of the causing substances, it is necessary that the inventory covers the whole Thailand. Here the inventory is prepared by the Study. It is necessary to revise the prepared inventory periodically. And the system for preparing the inventory should be arranged for revision of the inventory.

For the implementation of the scientific environmental administration, one of the important starting points is the quantitative emission inventory, and the revision of the inventory is a forthcoming issue. The designation of the inventory group is commented in the institution part.

(1) Establishment of Methodology

For the mobile source inventory, plans and data of relevant agencies are vital. Without information of such plans and data, the mobile source inventory cannot be established. For the stationary source inventory, information by the EIA report is vital. Besides, the national energy balance is substantial information.

The implementing group should establish the methodology of preparing the inventory in the first instance. The following points are necessary for the methodology;

- What data is adopted,
- With what agencies PCD co-operate,
- How to process the elemental data,
- How to check processed results, and
- What part of the preparation is commissioned to the private sector.



(2) Periodic Revision

Thailand is changing its social and economic condition. Its development is fast. Therefore, the change of inventory is quite fast. It is necessary to revise the inventory by the adequate time span. And by revision, the preparing method of the inventory can be improved.

10.5.1.2 Study

The monitoring data and quantitative inventory enable further study. In the first place, evaluation reveals the objectives for simulation and research, and provides the basis for simulation. Simulation and research is an indispensable tool for investigation and study policy. Prioritization of issue is the bridge to policy preparation. The designation of the analyzing and simulation group for study is mentioned in the institution part.

1) Evaluation of Acid Deposition and Atmospheric Condition Data

The data collected by the monitoring activities are the materials of the evaluation. The evaluated data are the basis for the simulation analysis and public relations. It is necessary to evaluate and publish the results periodically. This activity is one important method for capacity building. Without evaluation, the value of the monitoring will be reduced.

2) Application of International Simulation Model

Because acid deposition is a global issue, it should be analyzed by an internationally approved model. International models are developed by international discussion. The outcome of the Study can be regarded as the basis of participation to the international modeling activity. It is necessary to contribute to the international developing activity. In order to have participation from Thailand, PCD should support researchers of the model.

3) Research of Acid Deposition

Many agencies research acid deposition in Thailand. They are King Mongkut University of Thonburi, Chiang Mai University, Khon Kaen University, Burapha University, Silpakorn University, Prince of Songkhla University, and ERTC. Royal Forest Department researches also. It is necessary for PCD to arrange the direction of research and support activities.

4) Prioritization of Acid Deposition Issue

In order to bridge the study activities and policy activities, prioritization is important. Through evaluation of the monitored data compared with Thai standard and the WHO guideline, simulation analysis by the international model, and the outcomes of research, the most urgent issues for mitigation in Thailand will be prioritized. After prioritization, the investigation of policy starts.

10.5.1.3 Policy

For acid deposition control, on account of the complexity of the phenomena, there are points for investigation and the formulation/implementation of policy. Thailand has experienced the mitigation of various environmental problems, and the administrative process for the environment is established.

1) Investigation of Policy

A series of tasks are necessary to consolidate the investigation of policy. In the first place, the possible countermeasures are investigated. Many aspects of the countermeasures, effect, cost, environmental impact, and social acceptance should be deliberated. Simulation is important for investigation. The environmental effect of the policy can be evaluated quantitatively by simulation analysis. International framework, such as Clean Development Mechanism (CDM), ISO and Cleaner Production are indispensable factor for the introduction of the countermeasure from now.

The adequate application of the command and control method and the economic incentive method is important. CDM has an international framework and is an economic incentive method. One of the economic incentive methods is emission trading. However, application cases of emission trading are scarce now.

PCD, based on its assigned scientific function, should investigate policy independently or by cooperation with other agencies. The Study investigated the wide range of issues and prepared policy. The outcome of the Study is one of precedent materials for investigation.

2) Formulation and Implementation of Policy

The acid deposition issue has a complex nature. It is an environmental issue and also an energy issue. And sometimes it is a transportation issue. The sulfur content of oil products is related to the national energy policy and the national environmental policy for stationary sources and mobile sources. Moreover it is a matter of commercial activity. Sometimes the economic incentive of the Government is the key factor. Therefore, in order to formulate and implement the policy, the allocation of tasks for relating agencies by the responsible agency is quite important.

It is necessary to assign the responsible agency and the relevant agencies when formulation and implementation of policy occurs. According to the nature of the policy, PCD will be the responsible agency or cooperating agency.

10.5.2 Reinforcement of Institution and Capacity

10.5.2.1 Institution

In the course of the Study, the necessity of the inventory group and the analyzing and simulation group is focused upon. And the reinforcement of the function of scientific advice and policy investigation are focused upon also.

1) Designation of Inventory Group

The preparation of the inventory needs experience and a huge volume of study. Information of the energy balance of Thailand, the traffic volume of major roads and the focus of economic growth are examples of vital materials. It needs specialty. A specific implementing group for the inventory is a starting point for preparing inventory. And the commissioning of adequate parts of the study to the private sector is important.

2) Designation of Analysis and Simulation Group

Analysis and simulation is important for scientific administration. Every administration group has an analyzing function. However, it is necessary to set up a group for analysis and simulation for PCD. Concerning acid deposition, the evaluation of ambient air quality and critical load and simulation analysis are typical subjects of the group. Simulation by the international model is one function of this group. The role of the group is not collecting monitoring data but rationalizing the causes and results of environmental issues. Besides, it is necessary to analyze the effect of the policy options by simulation. Thus PCD with an analysis and simulation group has the capability of taking initiatives in the environmental administration. The group undertakes the core function of evaluation, simulation and prioritization of environmental issues.

The function of analysis and simulation cannot be completed by government agencies alone. Involvement of the private sector after adequate and clear job assignment is necessary.

3) Reinforcement of Policy Investigation and Scientific Advice

The capacity of scientific approach enables the formulation of adequate policy. The scientific approach is an assigned core function of PCD. In order to reinforce this function, it is necessary to assign an analysis/simulation group and an inventory group, as mentioned above. And it is necessary to systematize various environmental knowledge and integrate them into policy. The function of systematization can be undertaken by reinforcement of the planning group.

Moreover, the scientific advisory function for the policy setting committees, i.e. National Environment Board and others is a necessary function. However, because of limited



resources, PCD cannot fulfil all necessary function literally. This function should be performed by a well-formulated body. The body that mobilizes core scientists of the field can perform the scientific advisory function. PCD undertakes the secretary function of the body, which includes studying the topics beforehand.

10.5.2.2 Capacity

Capacity building for systematized knowledge is an important point of capacity building. Environmental administration can not be undertaken without systematic knowledge.

In order to get systematized knowledge, it is necessary to experience the preparation of annual reports or similar reports that integrate various fields. The investigations of policy is another important chance for this capacity building. Policy is a result of synthesis. It cannot be established by the consideration of only narrow fields. Studies for social issues, economic situation, and scientific facts should be integrated. Many administration fields, i.e. energy, transportation, commerce, revenue and environment should be investigated simultaneously.

Concerning institutional side for capacity building, it is necessary to discuss with other groups or agencies regularly. It is also necessary to move to the other section of PCD by adequate term. Through these processes, a systematized knowledge will be developed.

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