# Technological transfer: Thailand's perspectives

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## Introduction

Since the "Earth Summit" in Rio de Janeiro, Thailand has actively participated in climate change activities. During the 1990s, several research and implementation activities related to climate change had been conducted in Thailand. Over the course of activities, technological issues emerged on and off. This paper starts with an overview of the climate change activities, its development and recent experiences. Then, the paper discusses technological transfer and capacity building needs of Thailand. The opportunities, barriers and concerns are identified. The paper then concludes.

## General characteristics of Thailand

### *Topography and climate*

Thailand lies between latitudes 5° 40' and 20° 30' N and longitudes 97° 20' and 105° 45' E in the southeastern part of the Asian mainland. It borders Myanmar to the west and north, Laos to the northeast, Kampuchea to the east, and Malaysia to the south (see Figure 1). The total land area of the country is 320.7 million rai or 513,115 square kilometers.

The climate in Thailand can generally be classified into three distinct seasons—hot, rainy and cool seasons. The mean annual temperature is between 33-38°C, with the peak normally occurring in April. The highest recorded temperature during the period 1951-1980 was 44.5°C. Average annual precipitation is 1,550 mm, although exceeding 2,000 mm is common in the Southern Peninsula.

The area of Thailand is divided into four regions—North, Northeast, Central and South. The North is mainly mountainous with average altitudes rising over 200 meters above mean sea level. The Northeast comprises the Korat Plateau, which lies 100-200 meters above sea level. The Central Plains are the alluvial basin of country's principal river, the Chao Phraya, which feeds this most fertile area known as "the rice bowl of Asia". Most of the land area in this region lies below 50 meters elevation and is prone to flooding. The Southern Peninsula, which stretches downward to the Malaysian border, consists of a narrow strip of land where mountain ranges run north to south separating the east and west coasts, named the Gulf of Thailand and the Andaman Sea, respectively. Thailand has a coastline of more than 2,500 kms long.


**Figure 1 Map of Thailand.**

Thus situated, Thailand is quite vulnerable to severe weather events such as tropical storms, floods and droughts. Flood and drought have become common in recent years, and are increasingly damaging. During the years 1951 to 1991, almost all of 145 tropical cyclones fell into the category of "tropical depressions," the least severe of storm classifications. In some years, visiting storms have been more devastating. After 1991 at least 2 tropical storms have hit Thailand annually, causing variable damage to lives and property. New areas affected by flooding seem to be on the increase.

## Climate change research and development in Thailand

### *Inventory and mitigation*

Several inventory studies were conducted in Thailand. At the initial stage, Thailand applied OECD approach to estimate the 1990 GHG emissions. The COPATH model developed by LBL for inventory in forestry was also applied to compare the estimates of forestry sector. The default emission factors were used at this stage. The later studies applied local emission factors for agriculture. The estimated results based on default and local emission factors were different substantially. Local factors appear to be very important in estimating GHG emissions. Besides the local factors, limited data also hindered the estimation quality. Thailand is giving priority to development of local emission factors, especially on rice, livestock and waste disposals. The recent

special report on emissions from land use change and forestry prepared by IPCC also indicates the potential to refine several points on inventory study for Thailand.

Most inventory studies were accompanied by the mitigation option analysis. Thailand has adopted the "no-regret" option as a primary GHG mitigation policy. The potential options identified were generally similar as those of other developing countries. They were improvement of energy efficiency; energy substitution; development of renewable energy; reforestation, afforestation and protection of conserved forests. Least-cost options was attempted in the energy sector. But the results were considered preliminary. Thailand now focuses on a more comprehensive least-cost modelling of emission mitigation options in energy sector. Mitigation options for other sectors also require comprehensive analytical tool and information development such as alternative technology for agriculture, data development for waste sector, forestry etc. Note that these studies emphasised the "no-regret" options that Thailand could pursue immediately taking into consideration of national development priority. Thus, several projects contributing to climate change have already been implemented in Thailand. The technological acquisition in this case is from normal market.

***Vulnerability and adaptation***

While research on inventory and mitigation had been regularly conducted, studies on vulnerability and adaptation, although started earlier, progressed relatively slowly. Various constraints were identified. The most important one is the approach used in applying the global climate models to the local areas. At present, all studies on vulnerability and adaptation used direct interpolation approach to transfer climate data from the global circulation models. Another constraint is the development of the models for specific issues. For instance, in agriculture, only few economic crop models in Thailand were verified and applied only to limited areas. Vulnerability in forestry was based on simple analytical method. Studies on potential impacts of climate change on coastal areas and water resources were just started. The same is true for health aspect. Development of vulnerability study is important for the analysis of potential adaptation. These areas are vital for sustainable development of Thailand, particularly for agriculture sector. The lack of comprehensive research in this area, however, results in the limitation of policy implication and adaptation analysis.

To enhance research capability on vulnerability and adaptation, development of climate models suitable to the area should be developed. A regional climate model will reflect the regional climate conditions better than the global one. Some attempts are now underway to develop the regional climate models for Asia. Application of climate impact models should also intensify to cover the largest possible area of the country. Adaptation analysis is still lacking.

***Flexibility mechanism: CDM***

Originally, CDM was proposed to assist developing countries to attain sustainable development. The Kyoto Protocol finally compromised the difference by establishing CDM as another flexibility mechanism to assist developed countries achieving compliance while helping developing countries toward realistic long-term sustainable development path. Thus, while credit from GHG emission reduction is the prime incentive for developed countries to invest in the host countries, the objectives of sustainable development of the host countries must always be priority in developing the CDM projects.

Thailand, similar to other developing countries, is confronting the challenge of sustainable development process. Thailand views CDM as another opportunity, within the KP agreement, to shape up her sustainable development objectives. Thus, the CDM projects should provide real, long-term, additional, measurable, and certifiable reductions as well as assist in sustainable development of Thailand. CDM projects should be those in addition to present bilateral or multilateral economic and social development co-operation. Note that at present, rules and procedures of CDM are not yet defined, any options developed are still subject to such outcome.

Thailand has just started to analyse the CDM project potentials in the country. Given the national sustainable development objectives, CDM project potentials will be analysed and prioritised according to mitigation cost and national development targets

## Technological needs and technological needs assessments

Technology refers to knowledge, skills and practices involved in the production, consumption and distribution of goods and services in an economic development process. For climate change, technology transfer means the communication of knowledge, skills and practices in dealing with climate change issues such as inventory and mitigation, vulnerability and adaptation.

Actually, co-operation in research work on climate change always attach with it technological transfer and exchange to certain extent. Countries participate in climate change research, in one way or another, gain certain knowledge and skills. Over the period of climate change research and development, Thailand has accessed to “soft technology” in research methodologies. There are technological needs in different stages and areas of work that could be highlighted as follows:

*Inventory* Greenhouse gas inventory is a basic work for all parties participating in climate change convention. Thailand conducted a few research works on greenhouse gas inventory. Several weaknesses identified during the course of the research. The main constraints to the development of inventory in Thailand are the lack of local emission factors for the key sectors, including agriculture, energy and forests and the lack of sufficient data for the inventory estimation. As inventory work should be done on regular basis, Thailand also encounters the lack of personnel to regularly engage in the inventory works. Most of the inventory work is relied on the experts in the specific areas rather than staff of the agencies directly responsible for

the sector. The more dynamic the development of inventory methodology, the more difficult in getting regular staff to carry out the works.

Building local emission factors require intensive research work. Thailand has extended the research work on emission factors for rice sector. There are also the need to develop local emission factors for other sectors, including livestock, energy and waste sector. Mainly experts from academic institutes who carry out development of local emission factors. International technological exchange such as information network could facilitate this work. Capacity buildings for staff of relevant agencies to be able to update the inventory on regular basis are also vital to enhance the development of national inventory work.

*Mitigation* National inventory gives the status of emission and provides the background for development of mitigation options. Mitigation options were identified based mainly on technical potentials. The "no-regret" options were used to specify the more practical options for Thailand. No-regret options have long been followed as Thailand's main strategy for climate change. These options will not add higher costs to a particular activity but contribute to climate change benefits. Examples are prevalent: demand-side management in the energy sector; energy switching from fossil fuels to natural gas and hydropower; increasing energy efficiency etc. Sink enhancement has also been identified as a good potential option for greenhouse gas mitigation. Afforestation and reforestation as well as protection of conserved forests have long been the Thai government's policy of forestry sector. Increasing forest-covered areas will help enhancing the carbon sink.

The GHG mitigation options in the energy sector (power, industry, and transportation) can be grouped into six principal approaches as follow:

- Technology development;
- Demand-side management;
- Fuel switching;
- Using renewable energy;
- Recycling; and
- Combined measures.

Below illustrates the potential application of options in each energy sub-sector.

| **Principle mitigation measures** | **Power** | **Industry** | **Transport** |
|---|---|---|---|
| Technology development | A | A | A |
| Demand-side management | A | A | A |
| Fuel switching | A | A | A |
| Renewable energy | A | NA | NA |
| Recycling | NA | A | NA |
| Combined measures | A | A | A |

Note: A - Available, NA - Not Available

Technology development extends to all areas. In power sector, advanced environmental-friendly technology is preferred for new power plants while technical and management efficiencies are promoted for existing ones. Another potential sector for technological development is transportation. Technology development is even more promising in industry sector due to its large varieties of choices. For instance:

- Technology to improve boiler efficiency (e.g., boiler combustion control; waste heat recovery).
- Technology to improve electric are furnace in the steel industry (e.g., combustion control; improve process control; process integration).
- Technology to improve the ceramic kiln (e.g., use of ceramic fibre lined kiln; improvement of combustion efficiency).
- Technology to improve hot air oven (e.g., use microwave in drying process; improvement of combustion efficiency).
- Technology improvement in the cement industry (e.g., grinding process improvement; improvement in pyroprocessing).

Thailand has implemented Demand-side Management (DSM) in power sector. In commercial and industrial sector, energy efficiency through management has been implement via Energy Conservation Act. Energy auditing system is applied in large power consumers to ensure appropriate system is applied. In transport sector, urban planning and promoting mass transit system are the main policy to enhance traffic efficiency.

Switching of energy sources from high to low carbon content are promoted in power, industry and transport sector. Similarly, renewable energy has been promoted where possible including the use of biogas from animal wastes and methane from sanitary landfills. Sometimes, these options are combined or integrated with other development projects to achieve energy efficiency and other objectives. Note that technology used in the above mitigation option is so far acquired from the ordinary market.

*Vulnerability and adaptation* Development of vulnerability and adaptation in Thailand is at research stage. Even then, technological improvement is critically needed. Experiences suggest that development of climate change models with least uncertainty (such as regional or sub-regional climate models) is vital for reliable vulnerability analysis. The specific models to analyse vulnerability of major areas (such as rice, water resources, forest, coastal and health) must also be sufficient to make reasonable scenario development. These areas are critically lacking in Thailand. In this particular case, soft technology transfer should be emphasised.

Unless uncertainty is reasonably reduced, it is difficult to develop meaningful policies for practical adaptation to climate change. The situation was hampered by the economic crisis when all resources were channelled to economic recovery measures. The appropriate soft technology transfer will improve research capacity of Thailand and further lead to meaningful preparation of adaptation process.

*AIJ projects* The first AIJ project implemented in Thailand was the "Model project on effective utilisation of energy in re-heating furnace in steel industry in

Thailand" in early 1998. Another three projects under the AIJ signed between Japan and Thailand in 1999 were the "Model project on equipment for recovery of heat from combustion of waste in paper and pulp mill", "The Bangna intersection traffic congestion improvement project" and the "Model project for utilisation of waste heat from incineration of industrial waste at industrial estate".

In the first AIJ project, the equipment was installed and operated satisfactorily. The performance is now being evaluated. The later three projects are in progress.

Technological transfer is required at all stage of research and development on climate change issues. Thailand needs to develop skills and capacity in greenhouse gas inventory process. The high uncertainty of vulnerability assessment needs strong experiences in methodological development and knowledge. The spreading issues across sectors demand specific experts in different areas. Climate change agreement also requires national capacity buildings in different aspects. The AIJ pilot phase transferred certain technology in particular sectors. The newly emerged CDM has broadened the potential technological transfer to address sustainable development issue of the nations.

## Capacity building need

Capacity building is highly important for Thailand to participate in climate change convention effectively. The climate change issues are new, very dynamic and complex. New technical issues emerge on and off. National experts must be built up. The dynamic of issues and technical aspects require the experts of Thailand to continuously and closely follow up and learn new technical development. Capacity buildings for national staff are vital to Thailand to engage in climate change convention. Below are some specific capacity building needs for Thailand:

Soft technology to enhance national capacity to address the following:

- local emission factors for inventory assessment in different sectors
- comprehensive vulnerability assessment
- mitigation and adaptation options
- CDM related issues

Technology transfer to build local capacity must not be one way. Exchange of information and experiences and participation at regional and international should be promoted. The international interaction and exchange of research experiences will have more effects on capacity buildings.

After the mitigation options and adaptation potentials are concretely analysed, the steps could be taken to implement the options selected. Another important capacity building is expected here. Beside other necessary measures, capacity building for local personnel must be attained to operate and develop the technologies transferred to the country. Technological transfer must be comprehensive enough so that it can be operated sustainably by local personnel. It is very regrettable if the transferred technologies are terminated after the co-operation period because the lack of personnel capable to carry out the task.

Hard technology is usually emphasised during the implementation stage. Hard technology such as equipment is good only within the operational capacity of the particular equipment. Most co-operations within climate change context are constrained by the property right or patent issues. Unless the issues could be solved favourably, hard technology transfer could end up by eroding financial resources of the recipient countries. Capacity of the local people must be developed to enable them to further develop their own technology from the imported technology base and fully utilise local resources to sustain such development. It is such capacity building that in Thailand's view, is compulsory for implementation of mitigation, adaptation or CDM programs.

## Barrier to technological transfer

A short list of potential barriers has been identified[1]. Barriers could also be viewed from recipient or supplier or international community context.

### *Domestic barriers*

Since Thailand has participated in climate change convention, the national focal point has been established. A national sub-committee on climate change has been set up under the National Environmental Board. The committee members comprise of representative from different government agencies, private sector and experts. A technical advisory sub-committee has also been established to provide technical support for the national sub-committee. All climate change activities are channelled through the national sub-committee. The institutional setting of Thailand is in general, supportive to participation in climate change activities, including technological transfer. The domestic political environment is also good for international co-operation.

Thailand also has several research and development institutes supporting technological transfer and capacity building. The National Science and Technology Development Agency is an important supporter of research, development and engineering in scientific and technological areas critical to the country's development. The Environmental Training Center of Department of Environment Quality Promotion provides support for environmental training. There are other governmental and non-government research and development institutes in different aspects of climate change issues such as Thailand Productivity Center, Center for Scientific and Technological Research of Thailand etc.

Some potential domestic barriers to technological transfer to Thailand are recent economic crisis and the lack of information network. The economic crisis causes the government to give priority to economic recovery. The tight budgets allocated to public agencies seriously deter the action plans or development program. Another potential barrier to technological transfer to Thailand is the insufficient flows of technical and financial information related to climate change technology. There is a need to regularly update and disseminate the technical and financial information to the related agencies as well as general public. The regular and up-to-date information

[1] UNFCCC, document FCCC/TP/1998/1)

flow requires not only sufficient human resource but also good information system and this needs strong international support.

***External barriers***

While some domestic barriers could hinder the national development of technological transfer and capacity building, external barriers are even more critical to the successful technological transfer. Since the advanced technologies are in the hand of the suppliers, unless clear conditions are well defined, there are possibilities of transfer of outdated and inappropriate technologies to the recipient countries. This is of particular concerns to Thailand. The recipient countries like Thailand must be given sufficient information and experiences at international level to choose the technology deem appropriate for their country's socio-economic and cultural conditions. How could this kind of supportive international environment for technological transfer be developed?

Besides barrier from technological export countries, development of the system could potentially hinder the transfer itself. As has been elaborated in many cases[2], the role of the private sector is believed to be critical to effective technological transfer. Unfortunately, the private sector is driven by profit motivation, not merely for the sake of global greenhouse gas reduction. Business secret and patent right are main concerned of the private sector. They are also vital to low-cost environmental sound technologies to the developing countries. It is difficult to envisage a transfer of high cost advanced technology without public policy support. How could the technological exporting countries intervene the market so that the transfer of technology is not only profit motivated?

## Possible actions and initiatives to remove barriers

On our side, Thailand has developed all possible potentials to promote international co-operation and facilitate technological transfer. To support environmental protection, Thailand is now critically evaluating the environmental tax system, promoting the application of "Polluter Pays Principle" and "Benefiter Pays Principle" in environmental and resource management. At regional level, Thailand fully supports the ASEAN co-operation in climate change initiatives. Even during the economic crisis, Thailand had fully been aware of environmental problem, but measures taken were limited by fiscal and monetary capability. To reduce barriers to technical transfer, Thailand is evaluating the past research and development of climate change issues and seeking ways to improve inventory and mitigation analysis as well as vulnerability and adaptation potentials.

The national development of research and policy study will pave way to national initiatives of research and development agenda of climate change. Through capacity building and technological transfer, developing countries, like Thailand, could then meaningfully identify national needs in their respective sustainable development cum greenhouse gas mitigation options. By this way, mitigation or adaptation options will

[2] see for example Zhou P.P., "Practical experience and lessons learned in the climate related transfer of technologies in Africa"; Wereko-Brobby C.Y., "Turning up the heat while lowering the temperature"

be appropriately integrated into the national economic and social development process.

As development initiated locally tends to have less domestic barriers than those dominated by external influences, maximum utilisation of local expertise is highly recommended. Thus, one possible action that could be adopted to reduce barriers to technological transfer is to promote local capacity as much as possible. It is the task of international community to promote such capacity building process.

Possible actions could also be initiated by investing countries. At least, these countries could seriously consider facilitating technological transfer via public policy measures. They can intervene when environmental sound technologies, under the market forces, are not feasible to developing countries. They could also develop measures to ensure that the technology development is sustained beyond the project life cycle.

## Opportunities for investment and private sector participation

In Thailand, the past mitigation measures were done within the national development goals as "no-regret" policy. Greenhouse gas reduction was a fringe benefit, in addition to the national development objectives. Since the programs were developed as normal public investment projects, participation of the private sector, through the market operation, were active in program such as demand side management program in power sector, mass transit system and reforestation program.

It is possible and indeed necessary for Thailand to look beyond no-regret options. A careful analysis of this should be implemented prior to committing any mitigation activities under this category.

Regret options could be key strategies for Thailand to engage in AIJ and any other project-based mechanisms of the Kyoto Protocol. This could enable Thailand to speed up technology transfer and spearhead new investment opportunities which could reduce subsequent investment requirements in the long term. Such a potential cost saving comes from capacity building or technological transfer, including the management of projects. Undertaking projects of this nature (i.e., with cost subsidy or cost-sharing investment) will also effectively turn regret options into no-regret options for Thailand, enabling it to contribute more to GHG emission reduction activities.

The recent development of CDM provides new opportunities for investment and private sector participation. Developed countries now look for potential to invest in developing countries and receive carbon credit in return while developing countries see CDM as a mechanism to speed up their sustainable development process. Potentials of developed countries to invest in developing countries like Thailand through CDM is still uncertain until rules and procedures are clearly defined. At this stage, Thailand welcomes the CDM provided that the development of the mechanism conforms with and is consistent to the priority of the sustainable development objectives of Thailand. The mechanism must also treats Thailand fairly and equally compared to other parties. The technological transfer in CDM must also be sustained in long run.

## Notable elements of a framework for meaningful and effective actions to enhance implementation of Article 4.5 of the Convention

The article 4.5 requires developed countries, apart from their own transition to low greenhouse gas emission level, to take practical steps to promote, facilitate and finance as appropriate the transfer of or access to environmental sound technologies and know-how to developing country parties.

There are several elements that are important to support effective implementation of Article 4.5 for Thailand to expand its capacity in addressing climate change issues:

*Balance of efficiency and equity* Efficiency and equity issues must be appropriately addressed in climate change convention. As long as there is a need to give more equity in solving climate change problems, market approach alone will not be acceptable. It is in this aspect that environmental sound technologies and know-how, although potentially dominated by private sector, must be guided, facilitated or even financed by developed countries, to provide favourable conditions for the transfer. The public policies or incentives could be use to reduce patent problem and ensure long term sustainable application of the technologies.

*Development of local initiatives* One of the most serious drawbacks of present technological transfers is that very often the implementation is lack of local initiatives and lasted only during the project period. Local initiatives are vital for appropriate technological development and transfer. The local initiated programs will also be in line with the overall national development priority. To promote this, capacity building for local personnel to analyse and identify the needs for soft and hard technological transfer. As for Thailand, refinement of research methodologies on inventory and mitigation as well as vulnerability and adaptation is still needed to improve the reliability of the analysis.

*Development of technology information network* Appropriate information is a key to climate change related policy development and planning. Regional technological information network will facilitate the technological information flow between countries in the region. Thailand encourages the establishment of such information network.

*Development of effective financial mechanism* The highly dynamic climate change issues requires extensive human and financial resources to enable parties to participate effectively. Financial mechanism must be flexible enough for developing countries to initiate and define their needs. It must also ensure that the financial resource is utilised effectively and appropriately. The economic crisis in Thailand has substantially deteriorated the financial capacity of the country. Financial support is critical to capacity building and technological transfer to Thailand.

*Strengthening the local capacity* Building capacity of the researchers in Thailand will enable the country to perform research and development of climate change issues effectively. Capacity building should not limit to the learning from experiences of international experts. Capacity of the local researchers should be developed through interaction and communication, exchange of information and

experiences at regional and international levels. The convention should promote such development for the developing countries like Thailand.

*Appropriate roles of private sector* Private sector is profit motivated and public policy is needed to ensure efficiency and equity are equally count in implementation of mitigation or adaptation options. A system must be developed to ensure that long-term social and economic gain to recipient countries outweighs the short-term business profit of the technology suppliers.

## Conclusion

Thailand, a non-annex1 party to the Convention has actively participated in research and development activities related to the climate change issues. Geenhouse gas mitigation options have been identified and several of them have been voluntarily implemented via "no-regret" policy. Regret policy to mitigate greenhouse gases can be pursued if international support is adequate. The common mitigation options are energy efficiency in power and industrial sector, energy substitution, reforestation, afforestation and forest protection.

Development of research and development on inventory and mitigation and vulnerability and adaptation indicates the needs for technology and know-how to improve the research and development capacity. This includes the refinement of local emission factors of different sectors; comprehensive cost analysis of mitigation options; basic research methodologies of climate and crop models to reduce uncertainty of vulnerability and adaptation analysis.

On the implementation part, Thailand has gradually promoted national policy and developed institutions to support climate change related technological transfer. Domestic barriers have been gradually reduced. However, there are potential external barriers that need immediate attention. The technological exporting parties should ensure that the environmental-sound technologies are not out dated and appropriate for long-term application. The developed countries should establish favourable conditions for technological transfer such that the recipient countries are not exploited from profit motivation of the suppliers. Information network is vital for technological information exchange and development for development countries. Thailand sees local initiatives on research and development and implementation options, with effective financial mechanism are vital for successful technology transfer.

There are some notable elements that could enhance the development of technology transfer to Non-annex1 countries: Balance of efficiency and equity; development of local initiatives; development of information network and strengthening the local capacity in addressing climate change issues; appropriate roles of the private sector.