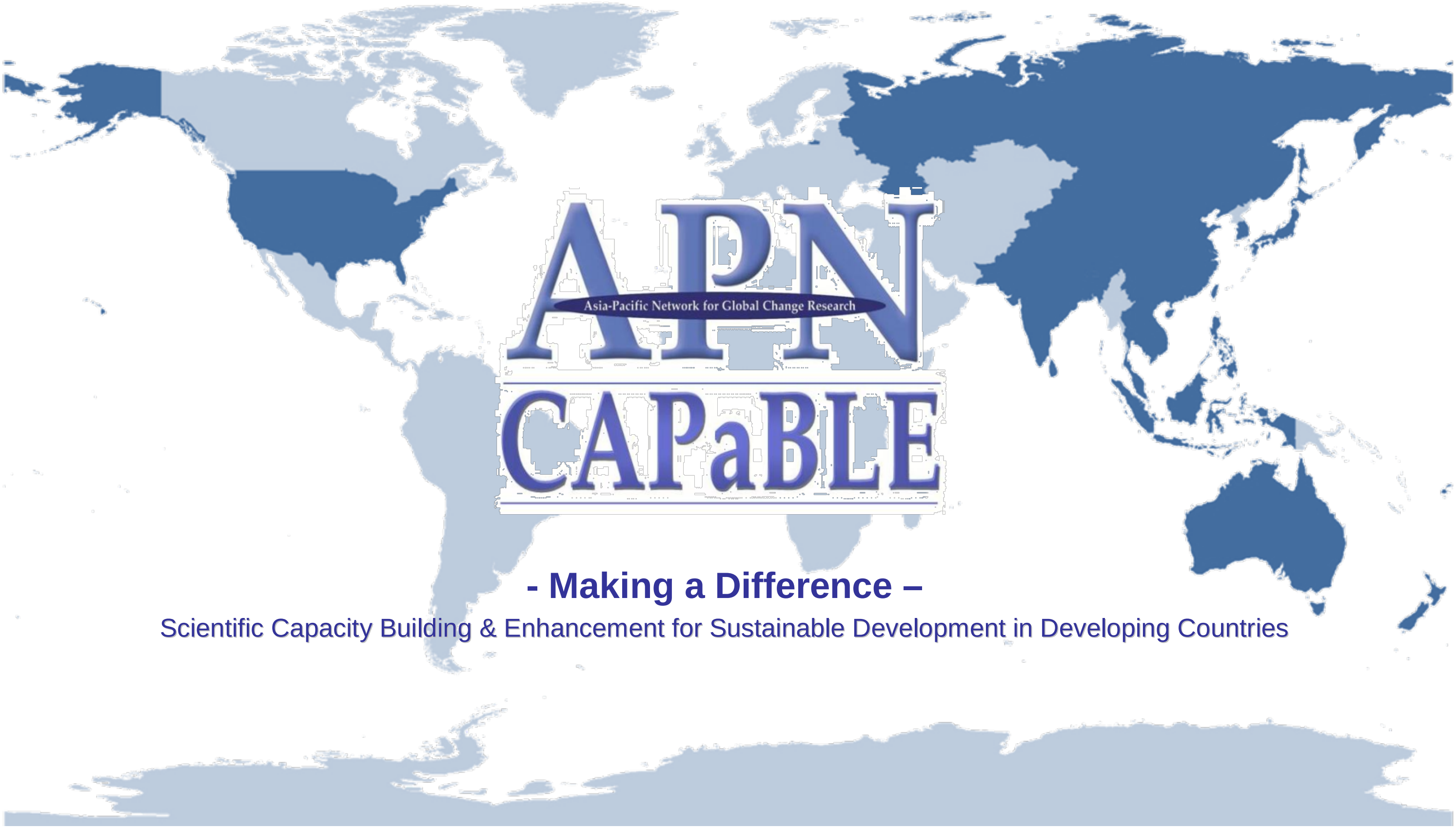
FINAL REPORT for APN PROJECT
Project Reference: CBA2010-01CMY-Sang-arun



Promoting Sustainable Use of Waste Biomass in Cambodia, Lao People's Democratic Republic and Thailand: Combining Food Security, Bio-energy, and Climate Protection Benefits

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Final Report submitted to APN

OVERVIEW OF PROJECT WORK AND OUTCOMES

Minimum 2 pages (maximum 4 pages)

Non-technical summary < 200 words >

This project aims to promote the use of waste biomass for food and energy production, and identify viable approaches for utilizing biomass conversion technology in the target countries: Cambodia, Lao PDR, and Thailand. This project has endeavored to involve relevant stakeholders since the beginning of project implementation. Those stakeholders are national governments, local governments, private sector organizations, and non-governmental organizations (NGOs), who are important for sustaining the project activities in the target countries. The project reviewed laws, regulations, notifications and relevant documents on solid waste management in the target countries. In addition to field surveys, difficulties facing the operation of waste treatment facilities, as well as local government policies on waste-related issues, were discussed intensively with officers-in-charge.

Based on the reviews and surveys, composting and anaerobic digestion were found to be viable technologies for converting waste biomass to a useful resource. These technologies are being used for agricultural waste, but the application for urban organic waste is not yet widely practiced. Most implemented waste utilization technologies were found in Thailand. There is a high potential for shared learning and technology transfer between these neighboring countries. However, piloting of transferred technology is required to ensure successful implementation.

Guides for technology selection and implementation of urban organic waste utilization projects in Cambodia, Lao PDR, and Thailand were developed based on local condition and capacities of local governments. The guides were translated into local languages: Khmer, Laotian, and Thai and distributed to participants of the country's workshop. Workshop participants included representatives from national government, local governments, universities, NGOs, and private sectors. Most participants are interested in introducing these waste utilization technology, especially composting, to their cities. In addition, they are able to estimate GHG emission reduction from solid waste management practices.

Objectives

The main objectives of the project were:

1) Promote sustainable waste biomass management options for climate change mitigation, food and bio-energy production for sustainable livelihoods and self-reliance in Cambodia, Lao PDR, and Thailand.
2) Improve capacity of local authorities to select and implement suitable waste biomass management approaches and technologies relying mainly on local resources.
3) Increase awareness of local stakeholders of potential benefits of proper waste biomass management: climate change mitigation, food security, renewable energy source, income generation and health.

Amount received and number of years supported

The Grant awarded to this project was:

US$ 30,000 for Year 1: 2009

US$ 30,000 for Year 2: 2010

Activity undertaken

1) Regular communication with relevant governmental organizations about the project and related activities (throughout the project period)
2) Review of relevant documents such as law and regulations related to waste biomass and waste management in general in studied countries.

3) Analysis of waste composition in four major cities in Cambodia and Lao PDR.
4) Field surveys and interviews relevant stakeholders including local governments and private sectors involved in solid waste management in major cities in studied countries. In Cambodia, the survey was conducted in Phnom Penh, Battambang, Kampong Cham, and Siem Reap. In Lao PDR, the survey was conducted in Vientiane Capital, Luangprabang, Savanakhet, and Champasak. In Thailand, the survey was carried out in Bangkok Metropolitan, Rayong, Samui Island, Phitsanulok, and Nakorn Rachasima.
5) Field visits to some agricultural waste utilization facilities such as a rice husk gasification plant, a community gasification plant using non-forest timber and agricultural waste, and a cassava waste utilization project of a tapioca starch company in Cambodia.
6) Intensive study of composting and biogas generation for reducing waste to disposal site and avoiding greenhouse gas emissions from landfill site. In Lao PDR, an experiment on organic waste utilization for energy purpose was conducted.
7) Analysis of collected data to identify possible urban organic waste utilization technologies for local governments in each country.
8) Development of the guides for technology selection and implementation of urban organic waste utilization project, specific for each studied country.
9) Submission of the draft version of the guides to international and local experts for reviews and revising the guides.
10) Translation of the guides into local languages (Khmer, Laotian, Thai) and distributing to participants of the country's workshops.
11) Organizing capacity building workshops in studied countries in collaboration with national governments in each country.
12) Revising the guides in English and making it publicly available online and hard copies.
13) Dissemination of research findings and output including making presentation at international conference and academia.

Results

The project investigated utilization of agricultural waste in comparison with the urban solid waste in studied countries. However, the authorities managing this waste are different and the problems related to urban solid waste are more critical than agricultural waste that can be naturally degraded with less environmental, social, and economic impacts. Therefore, the project focused on urban organic waste which largely contributes to health hazards, environmental pollution, and global warming.

Based on the literature reviews, field surveys and interviews with relevant stakeholders in studied countries (Cambodia, Lao PDR, and Thailand), solid waste management service in Cambodia, and Lao PDR have relied on a fee collected from residents. The urban solid waste in these two countries is disposed of in a designated dumping area. Almost half of residents are self-disposing by mean of dumping and burning. The situation of solid waste management in Thailand is more advanced than in Cambodia and Lao PDR because the Government of Thailand provides subsidies to local governments. In some cases, local governments in Thailand arrange the solid waste management budget using tax income with a small contribution from a waste collection fee.

There is no concrete urban organic waste utilization activity in Lao PDR, except for food waste collection for animal feed which is practiced by farm owners. There was one centralized urban composting project during our field study in Phnom Penh in 2009. However, this facility was closed due to a change of landfill site and lack of local government interest in composting. Fortunately, the composting operator could secure funding and build a new composting facility in Battambang City where the local government is concerned over the solid waste management issue. Several urban organic waste utilization projects (e.g. composting, anaerobic digestion) exist in Thailand. However, the replication is limited in model cities and not yet widely transferred to other cities.

Waste composition analysis was carried out in Cambodia (Phnom Penh, Battambang, Kampong Cham and Siem Reap) and Lao PDR (Vientiane Capital, Luangprabang, Savannhakhet, and Champasak), to identify potential use of the solid waste, as the waste data in these countries are limited and out of date. A simple waste composition analysis in the studied cities found that the fractions of urban organic waste shares were 66-76% in Cambodia and 30-62% in Lao PDR. Due to budget constraints, waste pickers are assigned to conduct waste composition analysis and sorting waste by hand. Once budget is available, more accurate waste sampling technology should be conducted. This analysis revealed that an urban organic waste utilization project could largely contribute to improved solid waste management, increased food and energy security, reducing the potential health hazards, and creating job opportunities in these countries.

In addition, the project members conducted field visits to some agricultural waste utilization facilities such as a rice husk gasification plant, a community gasification plant using non-forest timber and agricultural waste, and a cassava waste utilization project of a tapioca starch company in Cambodia. These technologies are well adopted to the local condition of Cambodia. However, these activities were not included in the guides because the local authorities responsible for these wastes are different from those responsible for urban solid waste management.

Due to a different level of development and local conditions, a country specific guide for technology selection and implementation of urban organic waste utilization projects was developed. Composting and anaerobic digestion are identified as the most promising technologies in the studied countries as local governments have some information and familiarity with these technologies.

Capacity building workshops were organized in Cambodia (Battambang), Lao PDR (Vientiane Capital) and Thailand (Bangkok). There were 86, 55, and 115 participants from local and national governments, academia, NGOs and private sector, at the workshops in Cambodia, Lao PDR, and Thailand, respectively. Participants understood the linkage between waste management and climate change and could estimate GHG emissions (simple equations) from their waste management practices and see its benefits on fundraising. In addition, they requested follow-up workshops (Thailand) and onsite training (Cambodia and Lao PDR).

Relevance to the APN Goals and Science Agenda, Scientific Capacity Development, and Sustainable Development

The project is relevant to the APN science and policy agenda on (i) climate change mitigation options and their implication for sustainable development - reduce greenhouse gas emission from waste and burning of crop residues, (ii) use of resources and pathways for sustainable development – renewable energy systems and sources, and (iii) crosscutting-global change and food and health management as well as technologies that are environmentally friendly.

Self evaluation

It was very hard to carry out this project in a timely manner due to various external factors such as border conflicts between Thailand and Cambodia, flooding in Thailand, and institutional requests. However, we did our best to carry out this project successfully and encourage national and local governments to improve urban organic waste management, by moving from conventional landfill to a resource efficiency approach, incorporating composting and anaerobic digestion. In addition, we did fundraising to scale-up the training workshop into a national scale with more participants. Our works can influent national movement towards the 3Rs and resource efficiency to improved organic waste management. For instance, the Cambodia Government will incorporate our findings into the new law that is currently drafted, the Government of Laos requests copies of our publication to be used as a reference manual for a government officer-in-charge of solid waste management, and Thailand will consider the 3R benefits of climate change mitigation.

Potential for further work

We are looking forward to actual implementation of projects for utilizing urban organic waste in the studied countries, especially in Cambodia where national and local government show strong interest in implementation. In 2012, we could secure funding from the Ministry of Environment of Japan and the UNESCAP to conduct a pilot project on organic waste separation at source for composting in Cambodia. As part of this project implementation, the project receives an in-kind contribution from Phitsanulok Municipality, Thailand providing on-site training and monitoring the implementation.

Publications (please write the complete citation)

1. Sang-Arun, J., Chau, K. H., Sam, P., Uch R. (2011) A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia. IGES policy report 2011-06, 88P (in English).
2. Sang-Arun, J., Chau, K. H., Sam, P., Uch R. (2011) A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia. IGES policy report 2011-06, 94P (in Khmer).
3. Sharp, A., Sang-Arun, J. (2012) A Guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy and Climate Co-benefits. IGES policy report 2012-02, 126P (in English)
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5. Pasomsouk, K. and Sang-Arun, J. (2011) A guide for the promotion of urban organic waste utilization in Lao PDR. National University of Laos and IGES, 80P. (in Laotian)
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9. Pasomsouk, K., Sang-Arun, J. (2012) Study on organic waste utilization to energy in the Lao PDR. ASEAN Engineering Journal. (submitted).

References

See specific references in each document in attachment.

Acknowledgments

The project members are very grateful to local governments in Cambodia, Lao PDR, and Thailand for their cooperation on data collection and active participation in the country workshops that were held in each country. We are also would like to express our sincere thanks to kind contribution of the Ministry of Environment of Cambodia, the Ministry of Public Works and Transport of Lao PDR and the Pollution Control Department of Thailand, for co-organizing and participating in the country's workshops. We are very grateful to financial support from the Asia Pacific Network for Global Change Research, the Ministry of Environment of Japan, and the Pollution Control Department of Thailand. Last but not least, we would like to deliver our sincere thanks to the Institute for Global Environmental Strategies, the Cambodian Education and Waste Management Organization, the National University of Laos, and the Sirindhorn International Institute of Technology for letting us carry out this project and always providing support to fulfill our needs in successfully implementation of this project.

TECHNICAL REPORT

Minimum 15-20 pages (excluding appendix)

Preface (Limit to 100 words)

Recently, urban solid waste generation is increasing rapidly but the capacity of local governments is improving slowly, especially in least developing countries. As a result, most waste is being disposed of by means of open dumping and open burning. However, there is a high percentage of valuable resource in the waste, which could be recovered for further benefits.

Organic waste is the main composition of solid waste in developing Asia. It can be utilized for soil improvement, animal feed and energy sources. However, this waste is being disposed of at open dumping site or landfill which thereby releases methane into the atmosphere and contribute to global warming.

Therefore, this study aims to promote and facilitate utilization of urban organic waste for either food production or energy generation, avoiding landfill of this waste which will thereby mitigate climate change.

Table of Contents

1.0 Introduction

Waste biomass management in Cambodia, Lao PDR, and Thailand are mainly treated by means of open dumping. In some cities in Cambodia and Lao PDR, open burning is applied to decrease volume of waste and reclaim landfill area.

Urban waste in these countries comprise 60-70% of organic waste[1,2,3], which can be utilized by means of animal feed, composting, and anaerobic digestion that can contribute to food production, energy generation, and climate change mitigation[4]. At the same time, utilization of urban organic waste can reduce quantity of waste dispose in landfill, and thus save landfill space and thereby expanding the lifespan of the landfill.

Additionally, use of waste biomass for food production can increase income and accessibility to food, and reduce import of chemical fertilizers and mitigate the associated environmental impacts related to chemical fertilizer production and utilization. Use of waste biomass for energy production[5] can create jobs, increase income and reduce import of energy.

Despite the clear benefits of improved waste management approaches and technologies, implementation is currently weak due to lack of awareness, skilled personnel, and financial constraints[6,7]. Most improvement projects rely on external support to select and implement new technologies and many such projects have finally failed to meet the local conditions. The shutting down of large scale composting plants in China and terminated biogas projects in India are just a few examples where inappropriate technologies have led to failure.

Therefore, it is necessary to explore the potential of a comprehensive approach to sustainable waste biomass management especially in urban areas and to increase the capacity of local authorities to select and implement the most suitable technologies for their local contexts as well as to stimulate the development of supportive national policies and institutions.

Main objectives of this project are:

i) To promote sustainable waste biomass management options for climate change mitigation, food and bio-energy production for sustainable livelihoods and self-reliance in Cambodia, Lao PDR, and Thailand,
ii) To develop the capacity of local authorities to select and implement suitable waste biomass management approaches and technologies relying mainly on local resources, and
iii) To increase the awareness of local stakeholders on potential benefits of proper waste biomass management: climate change mitigation, food security, renewable energy source, income generation, and minimizing health risks.

The outcomes are disseminated locally by national collaborators and internationally by the proponent. After the project ends, Thailand, as the most developed among the three countries, is expected to play a role to coordinate and sustain a regional movement on this issue in the form of South-South cooperation among the target countries.

2.0 Methodology

2.1 Involvement of local and international stakeholders

National and local policy makers and staff in charge of waste management were involved in the project from the early stages. A number of international organizations, such as IPCC's Technical Support Unit for National Greenhouse Gas Inventories (IPCC/TSU) and UNEP's International Environmental Technology Centre (UNEP-IETC) were involved in the project as experts and advisors.

2.2 Assessment of technology

The project reviewed technologies that can convert urban waste biomass to a useful resource for food and energy, and identify viable approaches for utilizing such technologies. Specific interest was given to composting, biogas, and other waste-to-energy technologies. The literature review and document analysis focused on main features namely: efficiency of resource recovery, waste reduction, investment cost, operation and maintenance costs, socio-economic and environmental impacts, failure factors, and successful strategies for implementation and management. The priority was given to the technologies that are simple, low cost, and have high recovery efficiency, and positive impact on socio-economic and environment.

2.3 Identification and analysis of good approach

Experiences from cities in Asia that have already implemented composting and conversion of waste to energy were reviewed. Interviews and questionnaire surveys were carried out, in selected cities, to gather data from developers, implementing agencies, authorities, and where applicable, citizens. Field surveys were carried out in selected cities. The local capacity, awareness, and financial situation of the municipalities that have implemented technologies for composting and conversion of waste to energy were investigated and compared with selected cities in Cambodia, Lao PDR, and Thailand. Comparison of successful cases and failed projects were carried out. The evaluation criteria for a good approach included reduction of waste to landfill, reduction of environmental impact, economic viability, potential for operation by the cities, satisfaction of the residents, and so on.

2.4 Feasibility studies and capacity assessment

The feasibility studies and capacity assessment covered three aspects: technology, local capacity, and national policy. Comprehensive field and questionnaire surveys and interviews were carried out to evaluate the potential to implement technology for composting and conversion of waste to energy. Four cities each from Cambodia and Lao PDR, and five cities from Thailand were selected for feasibility studies. The preliminary list of cities comprises Phnom Penh, Battambang, Siem Reap, and Kompong Cham in Cambodia; Vientiane Capital, Luang Prabang, Savannakhet, and Champasak in Lao PDR; Bangkok, Nakorn Rachasima, Surat Thani, Phitsanulok, and Rayong in Thailand. Additional locations such as Phitsanulok were included. The current situation and background of target cities were evaluated to identify the matching of technologies. The potential of national policy to assist the capacity building of the local authorities and the promotion of technology for waste biomass utilization were also evaluated.

The information obtained was used, in association with results of the literature reviews and the field surveys, for evaluation of approaches and technologies suitable for the selected cities.

2.5 Development of decision tools and implementation guides

Decision tools and implementation guides that are specific for each country were developed, in collaboration with country collaborators, based on the findings of the information gathering outlined above. The decision tools and implementation guides introduced the finding of the research, the strategies of implementation, and factors for success and failure. The tools and guides were developed in English and local languages (Khmer, Laotian and Thai) which enabling use by local governments.

2.6 Pilot test of the tools and guides

A pilot test of the tool and guides with selected local authorities, government officials, policy makers, and stakeholders were carried out in order to ensure its applicability in the studied countries. The guides were revised many times according to comments from reviewers.

2.7 Training local authorities

Training programmes to promote beneficial use of waste biomass for food and energy were developed in collaboration with the country collaborators. Related governmental bodies, local authorities, and relevant NGOs in each country were invited to participate in the training. The project involved local experts to increase the momentum on this issue in the target countries and to develop capacity which will remain after the project ends.

The trainings were organized separately in Cambodia, Lao PDR, and Thailand. The proponent and all country's collaborators facilitated and monitored the training in every country as a part of information and experience sharing. Local languages were used and interpreters assisted the trainings. The program was approximately three days. Post workshop consultation was expected to be taken care of by the country's collaborators and national government concerns.

2.8 Dissemination of research output

Research findings and project output were disseminated through a website, trainings, workshops, international conferences, and academic journals throughout the project period. Report and findings were delivered to the governments, local authorities, and interested parties in the target countries, and also distributed to related international and national organizations.

3.0 Results & Discussion

3.1 Involvement of local and international stakeholders

The Ministry of Environment of Cambodia, the Ministry of Public Work and Transport, and the Ministry of Natural Resource and Environment of Lao PDR, and the Pollution Control Department of Thailand participated in this project. Due to personnel constraints, the participation of national governments in the project is mainly supporting the training program and providing comments to the output of the project. The Pollution Control Department of Thailand took an active role as a main organizer for organization of the training program in Thailand as well as providing both in-kind and financial supports to the event. Overall, the national governments were satisfied with our project activities and willing to see the continuity of the project especially in implementation.

The IPCC's Technical Support Unit for National Greenhouse Gas Inventories (IPCC/TSU), the UNEP's International Environmental Technology Centre (UNEP-IETC) and the National Institute of Advanced Industrial Science and Technology (AIST) participated in the projects as international experts providing input to the training workshops and development of guides for promoting urban organic waste utilization projects.

Local governments, private company, NGOs and universities in Cambodia, Lao PDR, Thailand, and India that have experience in utilization of urban organic waste contributed and shared their experience at the capacity building workshop. This approach encouraged active interaction between the project collaborators, local experts and the local governments that were interested in implementation of the organic waste utilization technology. As a result, some stakeholders discussed cooperation on improving solid waste management projects in the near future, such as composting in Cambodia that is funded by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP).

3.2 Assessment of technology

The project reviewed technologies that can convert urban biomass to a useful resource for food and energy which including animal feed, composting, anaerobic digestion, biodigestion, fuel briquette, mechanical biological treatment (MBT), sanitary landfill, and incineration.

The use of food waste for animal feed has been practiced for as long as humans have kept domestic animals. This practice is still common in rural areas of the studied countries, but mostly limited in large cities. It is carried out by farmers in order to minimize the cost for feeding. This technique is very simple and cheap, but sometimes there is a concern over animal health and growth.

Composting is a technique to enhance the degradation of organic matter under aerobic conditions. This technique generates carbon dioxide, water, and humus-like products (compost). Composting can reduce the volume of the waste, generally by 30-50%. The residual product, compost, is pathogen free and applicable for improving soil structure and for adding nutrients to soil. Most types of soil can benefit from adding compost. Using compost can reduce the use of chemical fertilizer while increasing crop productivity. In general, composting is technically uncomplicated and may be an economically realistic alternative for many municipalities in Cambodia, Lao PDR, and Thailand. It can be applied at various scales from individual household to large centralized facilities. However, there are some risks and disadvantages of composting such as foul odors, and vector-borne diseases can spread if the composting process is poorly managed. Under-well managed conditions, composting generates very small amounts of greenhouse gas (GHG).

Anaerobic digestion is a technique that enhances degradation of organic matter under an oxygen-free environment and generates biogas which has a high proportion of methane. Methane is captured and used as an alternative energy for cooking, lighting, generating electricity, and fueling vehicles. The discharge can be used for soil amendment, similar to compost. Some leakage of methane may occur but it is likely to be lower than from methane that may occur under composting. Anaerobic digestion has many advantages over composting in terms of products, types of waste inputs, land requirement, efficiency of resource recovery, and environmental impacts. However, the investment cost for anaerobic digestion is higher than composting[4].

Biodigestion is a new technology in Thailand. Therefore, it is very expensive in terms of capital investment per tonne of waste. However, the cost is affordable by a small municipality as the system is designed for small scale facilities. Moreover, this system can be considered as pre-treatment prior to composting and anaerobic digestion as the system can efficiently separate solid and liquid composition. Solid fraction can be applied directly as soil amendment. The liquid fraction can be processed to either anaerobic digestion or bio-extract (fermentation). The discharge after fermentation can be used as soil amendment. There is no concise investigation on GHG emissions reduction; however it can be assumed as similar as in-vessel composting.

A fuel briquette is a block of flammable materials that is used for starting and maintaining a fire. It can be used as an alternative to fuel wood, charcoal, and kerosene. It is suited to urban fringe areas where residents practice agriculture and do not have sufficient electricity and gas supply such as in Lao PDR and Cambodia. Investment cost for this technique is very low and possible for individual household practice.

Mechanical biological treatment (MBT) is a group of hybrid methods where unsorted waste undergoes pre-treatment prior to landfill or incineration. There are many possible designs, but a common MBT pre-treatment system includes (i) mechanical treatment to homogenize the waste and separating valuable materials such as metals, glass and plastics and (ii) biological treatment where the organic fraction is decomposed. The biological process can include either anaerobic (generating biogas) or aerobic (composting) treatments. MBT is an alternative to enhance resource recovery from unsorted waste. It can significantly reduce the volume of the waste (approximately 50%) and lower the leakage and gas emissions from landfills. Therefore, it can extend the lifetime of the landfill by approximately 50% (depending on quantity of organic waste), reduce environmental impacts, avoid public nuisance (e.g. odours and flies), and decrease risk of health hazards. However, it requires labour, infrastructure, hard machinery, energy, and working space for mechanical and biological processes. Decomposed organic matter that contains low heavy metals can be applied for soil amendment. Separation of recyclable materials and refuse-derived fuel (RDF) from MBT can create income for the facility. Inert waste after the MBT can be easily disposed of in landfills or incinerators.

Sanitary landfill is a disposal site that has proper siting, design, operation, and long term environmental impact control. Basically, a sanitary landfill site should have an effective liner to cover the bottom and the side walls of the landfill to prevent underground water contamination. Many recyclable materials such as metals, glass, paper, and plastic are buried in a landfill. Although landfill mining is applicable, it can be practiced safely only after the landfill is closed for years. For this, the mining will have very little contribution to climate change mitigation. Capture of landfill gas for energy use is an alternative to reduce climate impact from landfill but the landfill gas collection system should be installed properly within one year after the waste is deposited in order to achieve 60-85% collection efficiency[8].

Incineration is a waste treatment technology for destroying waste under controlled burning at high temperatures. It can effectively eliminate the hygiene hazards associated with organic waste as well as drastically decrease the volume of waste (80-95% volume reduction)[9]. Methane generation is completely avoided and the process can also generate electricity and heat which can replace energy from fossil fuels. However, the incineration process can produce fossil based carbon dioxide from plastic burning, carbon monoxide, dioxins, and other harmful substances. Investment and operation cost is the major constraints to establish the waste incineration system in developing countries.

Table 1 describes advantages of technologies versus indicators on environmental impacts, GHG emissions, utilization, and job creation. Waste reduction could reduce cost for the whole system of waste collection, transportation, and disposal; however it requires active cooperation from residents. Waste reduction is an economic incentive for individual households, but it does not create jobs for low-income and non-skilled labourers.

Table 1: *Advantages Of Waste Utilisation And Treatment Technologies*[10]

Technology	Reducing authority expense for waste collection	Reducing authority expense for waste disposal	Reducing household expenses	Applicable with budget less than 100,000 US$	Avoiding GHG emissions from landfill and incineration	Avoiding GHG emissions from non-waste sectors	Avoiding environmental impacts induced by open dumping and open burning	Avoiding environmental impacts induced by landfill	Avoiding environmental impacts induced by incineration	Recovery of nutrients (contribute to food security)	Recovery of energy	Recovery of valuable materials	Creating jobs
Waste reduction	O	O	O	O	O	O	O	O	O	X	X	X	X
Animal feed	O	O	Δ	O	O	O	O	O	O	O	X	X	O
Composting	Δ	Δ	Δ	Δ	O	O	O	O	O	O	X	X	O
Anaerobic digestion	Δ	Δ	Δ	Δ	O	O	O	O	O	O	O	X	O
MBT	X	X	X	X	O	Δ	O	O	O	Δ	Δ	O	O
Sanitary landfill	X	X	X	X	Δ	Δ	O	Δ	O	X	Δ	Δ	O
Incineration	X	X	X	X	Δ	X	O	O	Δ	X	Δ	X	O

Remarks: O is advantage, △ is likely advantage or may be advantage, depends on specific conditions, X is disadvantage.

Animal feed has advantages over composting and anaerobic digestion in terms of investment and resource input. It is practiced by individual household and farmers, thus minimizing workload of local governments.

Commonly, composting is cheaper and simpler than anaerobic digestion, but it has a disadvantage with regards to energy recovery. Anaerobic digestion is technically more complicated than composting and the process needs to be operated by trained staff in order to function well. Composting is a labour intensive method and therefore generates more jobs. Low investment requirements make composting especially suitable for projects with limited funding. Together with its low-tech nature and the possibility of introducing it on a very small scale, composting is a highly suitable option for community-driven waste management initiatives.

For unsorted waste, MBT is more favorable than sanitary landfill and incineration in terms of resource efficiency and climate change mitigation.

Table 2 compares the requirements for implementation of anaerobic digestion, composting, MBT, and sanitary landfill. Animal feed and fuel briquette are not included in this table as these technologies are very simple and mainly not carried out by local governments. Each technology has advantages and disadvantages. Biodigestion is very new and can be used as pretreatment prior to composting or anaerobic digestion, thus, it is excluded from the table.

Composting is an attractive technology for developing Asian countries in terms of the investment and the flexibility of scale. Implementation of MBT and sanitary landfill are generally practiced on a large scale, and so require high capital investment which may require international aids.

Table 2: *Comparison of composting, anaerobic digestion, mechanical biological treatment, sanitary landfill and incineration*[10]

Factors	Composting	Anaerobic digestion	MBT	Sanitary landfill	Incineration
Capital investment per tonne of waste	Very low-low	Medium	Low	Low	High
Operation cost per tonne of waste	Low-medium	Medium	Medium	Low	High
Land requirement	Medium	Low	High	Very high	Low
Labour inputs	Medium-high	Low	Medium-high	Low	Low
Personnel skill	Low-medium	Medium-high	Medium-high	Low-medium	Medium-high
Energy use	Low-medium	Low-medium	Medium	Low	Medium-high
Scales	Household-large	Household-large	Medium-large	Medium-large	Medium-large
Time requirement to treat the waste safely	1-12 weeks	3-4 weeks	5-9 months	>2-100 yrs	1 day
Maintenance skill	Low-high	Medium-high	Low	Low	Very high
GHG emissions	Low	Very low	Low	Medium-high	Low

Note: This estimation referred to small-medium scale of composting and anaerobic digestion with simple technology that possible to implement in Cambodia, Lao PDR, and Thailand. The MBT and sanitary landfill is generally implemented for centralised of medium-large scale, therefore the table is reflecting its general facility.

Table 3 presents examples of capital investment for solid waste treatment projects found in Thailand and Cambodia (there is no project in Lao PDR). This cost estimation does not include expense for land because many local authorities did not purchase the land. Incineration is too costly or unfeasible for high moisture and low calorific value waste. Anaerobic digestion for energy recovery in medium to large scale is also expensive, but it is attractive for cities where electricity costs are high. In-vessel composting is more costly than sanitary landfill construction. Windrow composting is the cheapest option where laborers cost is not high.

From a sustainability perspective, waste reduction, and use of food waste for animal feed should be prioritized as they requires less resource input. Composting and anaerobic digestion are favorable. Technologies for these options range from manual to automated systems and also vary from household to large scale.

Table 3: *Examples of capital investment for solid waste treatment projects*[10]

Solid waste treatments	Waste input (tonne/day)	Capital investment* (million US$)	Capital investment for capacity of one tonne of waste input per day (US$)	Area (ha)
Incineration				
- Phuket, Thailand	280	24.63	88,000	
- Samui, Thailand	140	15.66	112,000	
Anaerobic digestion				
- Rayong, Thailand	60	4.53	75,500	
- Koh Chang, Thailand	30	1.77	58,900	
Sanitary landfill (no gas recovery)				
- Samutprakarn, Thailand	85	2.06	24,100	16.5 ha (15 yrs)
- Phnom Penh, Cambodia	1,200	NA	NA	31 ha
Mechanical biological treatment				
- Phitsanulok, Thailand	80	1.60 (including landfill site)	20,000	10 ha (approx. 24 yrs)
Composting				
- In-vessel, Bangkok, Thailand	1,000	27.97	28,000	
- Windrow, Phnom Penh, Cambodia	5	0.065	13,000	

Note: *This cost is for construction only, not including land purchase or rent.

3.3 *Identification and analysis of good approach*

Experiences from cities in Asia that have already implemented composting and conversion of waste to energy were reviewed. Interviews and site observation were carried out in Phnom Penh (windrow composting, animal feed), Kradang-Nga sub-district of Samutsongkram (biodigester), Bangkok (large scale in-vessel composting), Rayong (anaerobic digestion), Vientiane Capital (animal feed), Phitsanulok (MBT), Samui district of Suratthani (incineration), and landfills in selected cities of the studied countries. Detailed results can be found in attachment.

Animal feed in many cities in Cambodia, Lao DPR and Thailand is carried out by farmers. Thus, it can minimize work of the municipality. The farmers asked restaurants and sellers in markets to separate leftover food. For this case the farmers must keep good relations with the restaurants and markets.

Windrow composting in Phnom Penh was located at the Stung Meanchey Dumpsite. It was initiated by COMPED with financial support from Germany. The capacity of the facility was 30 tonnes/day but it was terminated in 2011 due to change of final disposal site. Currently, COMPED has established a new composting facility at Battambang City.

A biodigestion in Kradang-Nga sub-district is located at the municipal office. The system is similar to small scale in-vessel composting, however, this system provides both compost and liquid fertilizer. It was initiated by the technology provider. The capacity of the facility is 1 tonne/day. During the trial process, the municipality collected approximately 450 kg of food waste per day for processing and distributed the compost to residents. Recently, the activity was terminated as the municipality could not secure the land for permanently installation of the equipments.

Large scale in-vessel composting in Bangkok is located at On-Nuch waste transfer station. It was invested in by Bangkok Metropolitan Administration but operated by a contracted company. The facility was designed for 1,000 tonnes/day of waste for composting. However, approximately 1,200 tonnes/day of unsorted waste were delivered to the facility. Compost is sold to farmers.

Anaerobic digestion in Rayong is located at the landfill site of the city. The project was funded by the Ministry of Energy. The capacity of the facility is 70 tonnes/day of input. All machines are imported, thus, it is not working well with the character of waste in Thailand. The operator needs to shutdown the facility for repairing from time to time. It was estimated that this facility could generate an income of US$14 per tonne of waste. However, the facility could not earn enough income to sustain the operation because the quantity and quality of waste input are not sufficient and electricity generation is much lower than estimated due to lower input. Compost is distributed as incentive to residents.

MBT in Phitsanulok is located at the final disposal site of the city. It was initiated in 1999 with support from Germany. The facility currently handles 100 tonnes/day of unsorted waste. The municipality is very satisfied with the system as it requires very little land for disposal of inert waste. Currently, the municipality uses a pyrolysis facility to converting plastic waste that is segregated from the MBT process to oil.

Incineration in Samui is located at the landfill site of the island. The facility was designed to incinerate 140 tonnes/day of waste. At the beginning, only one incinerator operated every 10 days as the island did not generate much waste. Later on, the incineration plant needed to run at full capacity due to a rapid increase in waste generation. Recently, this incinerator was shut down for maintenance. There is no electricity generation from this plant.

As a result from the technology assessment, animal feed, composting, and anaerobic digestion are appropriate for utilization of sorted waste in the studied countries. MBT is a recommended option for unsorted waste. However, they are not competing options as each technology has advantages and disadvantages.

Figure 1 shows preferable hierarchy of urban organic waste based on the concept of resource efficiency, investment and environmental impacts. Overall, reduction of over consumption should be prioritized. High quality leftover food should be cooked for next meals. Good quality food waste can be used for animal feed as it does not need complicated processing. In general, anaerobic digestion has more advantages over composting in term of resource recovery, however, high investment is required. For the studied countries, composting is more appropriate than anaerobic digestion in terms of budget and personnel skills. For unsorted waste, MBT and sanitary landfill are more preferable, especially in small towns where landfill gas recovery is not economically viable.

Figure 2 presents some of potential technologies for organic waste utilization based on quality of waste input. Animal feed, composting, and anaerobic digestion are appropriate for sorted kitchen waste. Composting is suitable for mixture of garden and kitchen waste. MBT is recommended for unsorted waste that has high percentage of organic waste as it can contribute to alternative energy sources (refused derived fuel, RDF), recycling and composting.

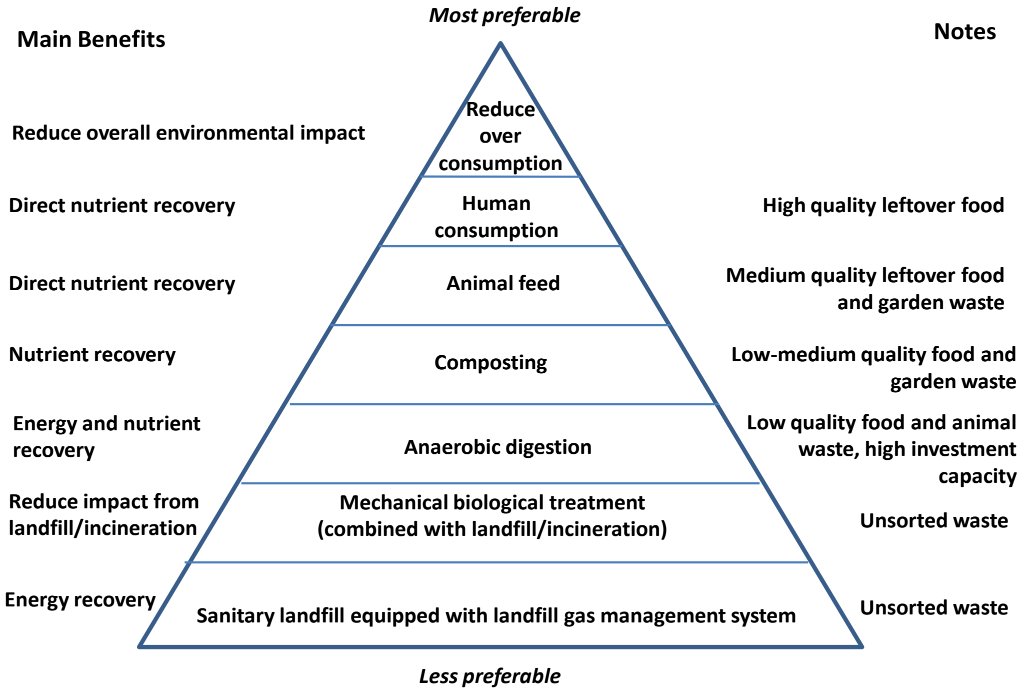

Figure 1: *Recommended hierarchy for urban organic waste management in developing countries* [4,10]

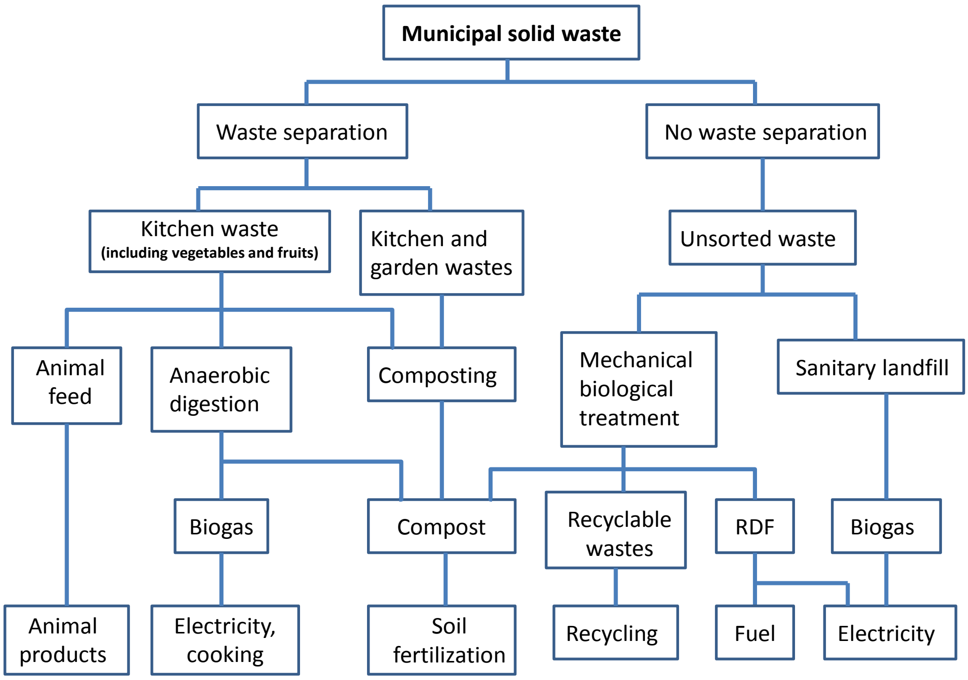

Figure 2: *Flow of appropriate urban organic waste management routes and benefits*[10]

CBA2010-01CMY-Sang-Arun-FINAL REPORT

3.4 Feasibility studies and capacity assessment

Site visits and interviewed were carried out in four cities of each countries: Phnom Penh, Battambang, Siem Reap, and Kompong Cham in Cambodia; Vientiane, Luang Prabang, Savannakhet, and Champasak in Laos; Bangkok, Nakorn Rachasima, Surat Thani, Phitsanulok, and Rayong in Thailand.

3.4.1 Cambodia

The Government of Cambodia notified the sub-decree No. 36 on solid waste management in April 1999. Unfortunately, the detailed regulations, standards and guidelines which have to be established in accordance to this sub-decree and declaration are not yet complete due to lack of personnel and budget constraints.

In 2008, the Ministry of Environment (MOE) with support from the United Nations Environment Programme (UNEP), drafted a strategy on the 3Rs (reduce, reuse, recycle) for sustainable solid waste management. The strategy aims to establish an efficient solid waste management system through increased waste collection service, promote waste separation for recycling, enhance organic waste composting, and improve disposal sites. By 2015, the government plans to compost 20% of organic waste from all sectors, and increase to 40%, organic waste from household by 2020.

Data on quantity and composition of municipal solid waste in Cambodia is not systematically collected. Therefore, it is construed that the quantity of waste generation in Cambodia is underestimated. Consequently, environmental problems which are related to improper waste management would be higher than the expectation.

Under this project, COMPED conducted a preliminary waste composition analysis to identify potential organic waste utilization. It was found that food waste amounted to 70% in Phnom Penh, 71% in Battambang, 54% in Siem Reap, and 60% in Kampong Cham. Unfortunately, the traditional practices of using food waste for animal feed remain relatively low. Therefore, most of this waste is being discarded in empty lots, water resources, and landfill.

Due to the limitation of budget and personnel, the local authorities transferred their responsibility on waste collection and disposal to contracted private companies without monetary compensation. Therefore, waste collection service is based on the waste fee that private companies collect from the residents. Many of them failed to recover the cost and went bankrupt.

The coverage of waste collection services in four major cities is 80% on average (51-100%). Generally, the waste collected by the private company is simply dumped in the disposal sites without considering basic management practices, due to budget constraints. Often the disposal site generates foul odors and outbreaks of houseflies. Sometimes, burning of waste is practiced to reduce volume of waste and reclaim landfill space. The residents that live close to the dumpsites are exposed to hazardous substances and pathogens.

Despite an increasing waste generation rate in Cambodia, there is a very little improvement of financial and institutional capacities development in local governments or contracted private sectors for enhancing the situation of waste disposal sites. In addition, transportation costs increase as the disposal site is located far away from town due to the rapid increase of land price.

There is one composting plant in Cambodia which was implemented by COMPED. This composting can be a model case for promoting urban organic waste composting in Cambodia.

Personnel-in-charge of solid waste management in Cambodia is relatively young, thus active in learning new technology.

3.4.2 Lao PDR

Regulation and framework for solid waste management in Lao PDR is in progress, and thus no concrete law or policy to promote urban organic waste utilization.

Solid waste management is a new concept for Lao PDR. There is no systematic data collection for analysis of waste generation. Under this project, National University of Laos conducted a preliminary study on waste composition in major cities: Vientiane Capital, Luangprabang, Savannakhet, and Champasak. It was found that approximately 30% of waste in Vientiane Capital, 51% in Luangprabang, 54% in Savannakhet, and 62% in Champasak is food waste. Some food waste is being collected for animal feed. However, most waste is disposed at empty lots or delivered to a designated disposal site.

The coverage of waste collection services in four major cities is 59% on average (42-70%) and it is difficult to increase the coverage further due to budget constraints. In addition, trucks and vehicles using for waste collection are very old and there is a high possibility that the collection coverage will be decreased because local governments cannot afford to buy new vehicles. Outsourcing this task to a private company would be an alternative to improve waste collection service.

There is no model case for urban organic waste utilization in Lao PDR. However, food waste collection for animal feed is being carried out by farmers. A private initiative on composting is carried out by a restaurant in Luangprabang. Technical competence in Lao PDR is very weak. Personnel-in-charge of solid waste management in Lao PDR are not experienced with this issue and thus lack the capacity to handle it in an environmentally sound manner.

3.4.3 Thailand

Solid waste management in Thailand is more advanced than Cambodia and Lao PDR. Thailand could manage to collect waste generation and disposal data systematically at national level. In addition, there is a mechanism for subsidy of the waste management system. Personnel-in-charge of solid waste management are well educated, compared to other studied countries. In addition, the national policy is clearly promoted utilization of urban organic waste for either compost or energy. Lessons learned within Thailand are valuable for Cambodia and Lao PDR as they share similar culture.

The Government of Thailand intends to promote sustainable solid waste management by promoting the 3Rs and improving final disposal site. However, most local governments put more attention on improvement of final disposal site as they experience negative environmental impacts and social resistance, blocking access to the disposal site. In addition, the local governments are more familiar with the end-of-pipe solution as it has less interaction with citizens.

Each municipality employs different waste management systems, but many of them, to some extent, implement urban organic waste utilization technologies, for instance, composting in BMA, anaerobic digestion in Rayong, MBT in Phitsanulok.

Organic waste separation at source is being promoted in some cities. However, it is not sustained due to various reasons such as the system to receive waste for further treatment is not well maintained, market for products is not well established, or economic incentives are not significant.

3.5 Development of decision tool and implementation guides

Country's specific guides that facilitate decision making on technology selection and implementation of urban organic waste utilization project were developed based on local conditions. As the size of local administrative offices varies, the ability in solid waste management is also different. Common constraints that can be found include lack of trained personnel, and financial constraints as technology can be expensive for local governments to purchase. Therefore, appropriate technology for one locality does not mean that it is appropriate for other places. Selection of technology should be made based on local conditions, budget availability, personnel skill requirements, users or marketing of the products, and so on.

The guides basically comprise background information of the country, current solid waste management including regulation and policy, examples of available urban organic waste utilization technology, guides for technology selection, and guides for implementation of the project.

In the selection of appropriate urban organic waste utilization technology for each locality, there are at least two main groups of criteria that the local government authorities should take into consideration: technical criteria and economical criteria. Sometimes, the most environmental friendly technology may not be selected due to the constraints on technology and economic issues. Nevertheless, public hearing should be carried out prior to technology selection in order to minimize risk of project termination due to strong public opposition or fail in implementation due to lack of public cooperation.

The guide of each country is different in its content and advice due to the difference in status of solid waste management and capacity of local governments. To enabling use of local governments, the guides of each country are available in English and local language (Khmer, Thai, Laotian).

3.6 Pilot test of the tools and guides

The draft versions of the guides are being reviewed by both international and local experts including local governments. The drafts were reviewed and revised many times to ensure their quality to meet the needs and capacity of the local actors. Full publications of the guides are available in **Attachment I to VI**.

3.7 Training local authorities

Training workshops for local governments and relevant stakeholders were carried out in Cambodia, Lao PDR, and Thailand. The program is approximately 3 days. In all countries, the workshop consists of five sessions: i) presentation from international and local experts, ii) site visit (no site visit in Lao PDR), iii) estimation of GHG emissions, iv) group exercises, and v) evaluation of the workshop. Project proponent and all country's collaborators facilitated the training in every country as a part of information and experience sharing.

The workshop in Cambodia was carried out in August 2011. There are 86 participants from 10 provinces, including domestic and international speakers. The Secretary State of Environment attended the workshop and deliver keynote speech. The workshop was mainly conducted in Khmer with simultaneous interpretation. Summary of the workshop is included in **Attachment VII**.

The workshop in Lao PDR was carried out in October 2011. There are 55 participants from 7 provinces, National University of Laos, Ministry of Public Work and Transport, Ministry of Environment and a private company attended the workshop. The Director of the Department of Housing and Urban Planning of the Ministry of Public Work and Transport delivered the keynote speech. Summary of the workshop is included in **Attachment VIII**.

The workshop in Thailand was carried out in January 2012. It was delayed due to serious flooding in Thailand. There are 115 participants from 42 provinces: Ministry of Energy, Pollution Control Department, Land Development Department, universities, and a private company attended the workshop. The Pollution Control Department play active role in organizing the workshop and providing financial support to the event. The Deputy Director of the Pollution Control Department delivered the keynote speech. Summary of the workshop is included in **Attachment IX**.

The workshops were successfully carried out with active participation of trainees. They learned various organic waste management technology including failure and successful factors of implementation that found in some cities. In addition, they could estimate GHG emission through solid waste management using a simple calculation sheet.

Many participants requested continuous activities to disseminate the knowledge to more stakeholders and conducting regional workshops which enabling participants of many local stakeholders. In addition, some requested for supports in actual implementation.

3.8 Dissemination of research output

Research findings and project output were disseminated through training workshops, international conferences, and IGES Environscope. Publications of the guides for specific country are distributed to local governments, national governments and other stakeholders where appropriate. The guide of Cambodia that was edited to an IGES policy report was disseminated through IPLA and ISWA websites which are available for international audiences.

Examples of dissemination are as follows:

1) Sang-Arun, J. (2010/03) Good practices of the 3Rs for organic waste management in Thailand, Laos, and Cambodia. At *The 2nd Workshop of Asia Resource Circulation Policy Research*. 15-16 March 2010, Tokyo.
2) Sang-Arun, J. (2010/07) Utilization or urban organic waste in GMS towards climate change mitigation. At *The regional workshop of the GMS: Viet Nam experience on NSISWM/3Rs*. 28-29 July 2010, Hanoi.
3) Sang-Arun, J. (2010/10) GHG emission reduction through urban organic waste utilization: cases of Cambodia and Thailand. At *The 5th workshop on improvement of solid waste management and reduction of GHG emission in Asia*. 21-23 October 2010, NIES, Tsukuba.
4) Sang-Arun, J., Bengtsson, M., Sharp, A., and Chau, K. H. (2011/03) Promoting urban organic waste utilization in developing Asian countries: the case of Cambodia and Thailand. In *Regional Development Dialogue (RDD)*, 184-199. Nagoya. UNCRD.
5) Chau, K.M. (2011/08) Introducing guide for a decision making and implementation of urban organic waste utilization projects and centralized composting in Cambodia. Presentation at the Capacity Building Workshop on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Cambodia held on 29-31 August 2011 at Battambang City, Cambodia.
6) Sang-Arun, J., Chau, K. H., Sam, P., Uch R. (2011/08) Draft guide for technology selection and implementation of urban organic waste utilization projects in Cambodia. Distributed to all participants of the Capacity Building Workshop on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Cambodia held on 29-31 August 2011 at Battambang City, Cambodia.
7) Chau, K.M. (2011/08) Centralize Composting. Presentation at the Capacity Building Workshop on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Cambodia held on 29-31 August 2011 at Battambang City, Cambodia.
8) Pasomsouk, K. (2011/08) Development of a small scale urban organic waste treatment plant in Laos.

Presentation at the Capacity Building Workshop on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Cambodia held on 29-31 August 2011 at Battambang City, Cambodia.

9) Sharp, A. (2011/08) Overview of urban organic waste management for climate change mitigation in Thailand. Presentation at the Capacity Building Workshop on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Cambodia held on 29-31 August 2011 at Battambang City, Cambodia.

10) Sang-Arun, J. (2011/09) Organic Waste in Asia: 3Rs Tackle Climate Change. In *Waste Management World*, 3. International Solid Waste Association.

11) Pasomsouk, K. (2011/10) Organic waste utilization for energy in Laos. Presentation at Training Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Developing Asian Countries, held on 4-6 October 2011 at Vientiane Capital, Lao PDR.

12) Pasomsouk, K., Sang-Arun, J. (2011/10) Draft guide for the promotion of urban organic waste utilization in Lao PDR. Distributed to all participants at the Training Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Developing Asian Countries, held on 4-6 October 2011 at Vientiane Capital, Lao PDR. (in Laotian)

13) Sharp, A. (2011/10) Overview of Urban organic waste management for climate change mitigation in Thailand. Presentation at Training Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Developing Asian Countries, held on 4-6 October 2011 at Vientiane Capital, Lao PDR.

14) Chau, K.M. (2011/10) Centralised composting. Presentation at Training Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste Management Actors in Developing Asian Countries, held on 4-6 October 2011 at Vientiane Capital, Lao PDR.

15) Sang-Arun, J., Chau, K. H., Sam, P., Uch R. (2011/12) A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia. IGES policy report 2011-06, 88P (in English).

16) Pasomsouk, K., Sang-Arun, J. (2012/01) Study on Organic Waste Utilization to Energy in the Lao PDR. Presentation at Hochiminh University of Technology, Viet Nam. January 2012.

17) Sharp, A. (2012/01) Guidelines in supporting organic waste's benefits. Presentation at Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste management Actors in Thailand, held on 25-27 January 2012 at Bangkok, Thailand.

18) Sharp, A., Sang-Arun, J. (2012/01) Draft guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy and Climate Co-benefits. Distributed to all participants at the Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste management Actors in Thailand, held on 25-27 January 2012 at Bangkok, Thailand. (in Thai)

19) Chau, K.M. (2012/01) Centralised composting. Presentation at Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste management Actors in Thailand, held on 25-27 January 2012 at Bangkok, Thailand.

20) Pasomsouk, K. (2012/01) Organic waste utilization for energy in Laos. Presentation at Workshop on Capacity Building on Accounting and Utilizing GHG Emission Reduction Measures for Local Waste management Actors in Thailand, held on 25-27 January 2012 at Bangkok, Thailand.

21) Pasomsouk, K., Sang-Arun, J. (2012/02) Study on organic waste utilization to energy in the Lao PDR. ASEAN Engineering Journal. (submitted)

22) Sang-Arun, J., Chau, K. H., Sam, P., Uch R. (2012/05) A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia. IGES policy report 2011-06, 94P (in Khmer).

23) Sharp, A., Sang-Arun, J. (2012/06) A Guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy and Climate Co-benefits. IGES policy report 2012-02, 126P (in

English)
24) Sharp, A., Sang-Arun, J. (2012/06) A Guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy and Climate Co-benefits. IGES policy report 2012-02, 80P (in Thai)

4.0 Conclusions

Urban organic waste utilization is an approach to improve municipal solid waste management while contributing to other national agendas on food, energy and climate change. As organic waste shares more than 50% of total municipal solid waste, utilization of this waste can greatly contribute to reduction of waste to a final disposal site, and saving landfill space.

There are many technologies available for utilization of urban organic waste in Thailand, but these are limited in Cambodia and Lao PDR. However, lessons learned from Thailand and other developing Asian countries can be applied to Cambodia and Lao DPR as they share similar culture and economic condition.

Food waste collection for animal feed that is practiced by farmers should be encouraged as it could significantly reduce workload on waste collection and disposal of the local governments. In addition, this practice could circulate nutrients for food production with less environmental impacts. However, there needs to reassurances for quality of food waste that will not affect animal health.

Composting is a promising technology for these countries as it is simple and flexible in scale and quality of waste input. However, it takes a lot of time for composting. There is potential for co-composting with agricultural waste and garden waste.

Anaerobic digestion is an alternative for urban organic waste utilization, but budget is required and experience in this technology is limited in studied countries. There is potential to increase implementation of this technology, especially in Cambodia and Lao PDR where a national biogas project exists.

Fuel briquette would be an alternative for household in many cities in Lao PDR and Cambodia where firewood and charcoal are main source of energy for cooking.

These technologies can be implemented with small investment as it is flexible in scale. For a large scale project, the local government may go through the guide for selection of urban organic waste utilization technology and implementation that is specifically developed for each country: Cambodia, Lao PDR, and Thailand.

The capacity building workshops that were organized in the studied countries are the first workshops in these countries to indicate climate benefits of urban organic waste utilization projects and build the capacity of local governments to estimate potential GHG emissions. Therefore, many local governments request continuity of the project and are willing to implement it in their cities.

5.0 Future Directions

We are looking forward to actual implementation of projects for utilizing urban organic waste in the studied countries, especially in Cambodia where national and local government show strong interest in implementation. In 2012, we could secure funding from the Ministry of Environment of Japan and the UNESCAP to conduct a pilot project on organic waste separation at source for composting in Cambodia. As part of this project implementation, the project receives an in-kind contribution from Phitsanulok Municipality, Thailand, which consists of on-site training and monitoring the implementation.

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See more references in each attachment.

Attachments

1. A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia (in English) – 88 pages.
2. A guide for technology selection and implementation of urban organic waste utilization projects in Cambodia (in Khmer) – 104 pages
3. A guide for the promotion of urban organic waste utilization in Lao PDR (in English) – 64 pages
4. A guide for the promotion of urban organic waste utilization in Lao PDR (in Laotian) – 80 pages
5. A guide for sustainable urban organic waste management in Thailand: combining food, energy and climate co-benefits (in English) – 126 pages
6. A guide for sustainable urban organic waste management in Thailand: combining food, energy and climate co-benefits (in Thai) – 80 pages
7. Report on capacity building workshop on accounting and utilizing GHG emission reduction measures for local waste management actors in Cambodia – 321 pages
8. Report on capacity building workshop on accounting and utilizing GHG emission reduction measures for local waste management actors in Lao PDR – 451 pages
9. Report on capacity building workshop on accounting and utilizing GHG emission reduction measures for local waste management actors in Thailand - 280 pages.

Funding sources outside the APN

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