CHAPTER 1

CURRENT SITUATION ON SOLID WASTE MANAGEMENT IN THAILAND

1. OVERVIEW OF THAILAND SOLID WASTE SITUATION

1.1 WASTE GENERATION

As industrial expansion and rapid urbanization increase, the amount of municipal solid waste in Thailand has dramatically increased over the period of 1996-2004. Municipal solid waste generation was expanded to 39,959 tons/day (or 14.6 million tons/year) in 2004, increased by 9.67 percent from the year 1996. However, due to promotion and encouragement on waste separation and waste reduction, municipal solid waste generation trend slightly decreased 1.72 percent in 2005 compared to the previous year 2004 (as shown in Figure 1).

![Figure 1-1 Municipal Solid Waste Generation in Thailand 1996-2006](image)

\[\text{Figure 1-1 Municipal Solid Waste Generation in Thailand 1996-2006}^1\]

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$^1$ All sanitary Districts have been promoted as municipalities in accordance with the Decentralization Act B.E.2542 (1999)
1.2 PHYSICAL DISTRIBUTION

Urbanization and rising incomes have led to the production of enormous amount of waste to all over the country. In general, source of solid waste generation can be divided into three main sources, which are Bangkok, municipalities and sanitary districts including Pattaya City City (as called municipal areas and Pattaya City), and non-municipal areas. In 2005, it represented that 47 percent of the total waste generation was produced from non-municipal areas, following by 32 percent of the its total from municipal areas, and the remaining 21 percent from Bangkok and its vicinity.

Performance of waste management in different areas is varied. Solid waste collection and disposal in Bangkok had achieved 99 percent of the total waste volume, with employed private companies to handle waste disposal. For municipal areas, local governments usually play a role on solid waste collection and disposal management in those areas, however the significant problem of municipality is well beyond the ability of the municipal government. The requirement on proper solid waste collection and disposal is requested so that sanitary facilities have been increased to 117 locations in municipal areas. Therefore, the proper solid waste collection and disposal

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2 All sanitary Districts have been promoted as municipalities in accordance with the Decentralization Act B.E.2542 (1999)
in municipal areas reached 43 percent of the total waste volume in 2005, increased by 8 percent from the year 2003. For non-municipal areas, the proper solid waste collection and disposal in these areas was rarely found.

1.3 WASTE CHARACTERISTICS

Solid waste flux should be characterized by the sources, by their types of wastes produced, as well as by generation rates and composition. Relevant information from these areas is required in order to operate efficient solid waste management system, implement regulatory, financial and institutional decisions.

Municipal solid waste, which is made up of daily waste production by households and businesses, constitutes waste generation rates at 0.8-1.0 kg/capita/day or approximately 67 percent of total waste generation, whereas industrial waste generation is made up around 32 percent. The remainder of the waste in small amount is infectious waste from hospital and hazardous waste from industries and communities.

1.3.1 Municipal Solid Waste Generation

Municipal solid waste is contributed by a combination of residential and other sources, determined by the association of industrial, commercial or tourism activity in the area. For tourism area in Thailand, some areas – Phuket and Pattaya — demonstrated the high amount of solid waste per capita resulting from the high influx of tourists and supporting businesses. Nearly 80 percent of municipal solid waste composes of kitchen waste, plastic and foam. Almost two-thirds of the industrial hazardous waste are from metal and electrical industries, while more than half of the community hazardous waste is created by automotive service stations, and nearly all-infectious waste comes from hospitals.
Table 1: Waste Composition in Thailand

<table>
<thead>
<tr>
<th>Types of Waste</th>
<th>Major Sources</th>
<th>Major Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Solid Waste</td>
<td>Residential</td>
<td>Kitchen waste</td>
</tr>
<tr>
<td></td>
<td>Commercial/Tourism</td>
<td>Plastic and Foam</td>
</tr>
<tr>
<td></td>
<td>Agriculture</td>
<td>Paper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass</td>
</tr>
<tr>
<td>Infectious Waste</td>
<td>Hospitals</td>
<td>Tissue samples</td>
</tr>
<tr>
<td></td>
<td>Educational and Lab</td>
<td>Blood and other liquids</td>
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<tr>
<td></td>
<td></td>
<td>Surgical wastes and syringes</td>
</tr>
<tr>
<td>Industrial Hazardous</td>
<td>Metals industries</td>
<td>Filter material, waste sludge</td>
</tr>
<tr>
<td>Waste</td>
<td>Electronic industries</td>
<td>Fuel, oil and grease</td>
</tr>
<tr>
<td></td>
<td>Plastic industries</td>
<td>Liquid organic compounds</td>
</tr>
<tr>
<td></td>
<td>Chemicals and Petroleum industries</td>
<td></td>
</tr>
<tr>
<td>Industrial Non-</td>
<td>Metals industries</td>
<td>Metals and metal alloys</td>
</tr>
<tr>
<td>hazardous Waste</td>
<td>Food industries</td>
<td>Parts of wood</td>
</tr>
<tr>
<td></td>
<td>Furniture</td>
<td>Animal parts</td>
</tr>
<tr>
<td>Community Hazardous</td>
<td>Automotive stations</td>
<td>Recyclable waste oils</td>
</tr>
<tr>
<td>Waste</td>
<td>Residential</td>
<td>Lead acid batteries</td>
</tr>
<tr>
<td></td>
<td>Agricultural</td>
<td>Other toxic chemicals</td>
</tr>
<tr>
<td></td>
<td>Gas station</td>
<td>Other waste oils</td>
</tr>
</tbody>
</table>


Future growth of solid waste generation will depend upon the population growth, consumption, and recycling and reuse. Waste composition can be influenced by external factors, such as the population’s standard of living, geographical location, and the weather. Due to the cost of living, urban areas tend to produce higher quantity of waste than rural areas as the percentage of consumer packing waste increases relatively to the population’s degree of wealth and urbanization. It was found that waste generation rates were approximately 1.0-1.4 per capita (kg/capita/day) in major cities and tourism areas, 0.7-1.0 per capita in municipal areas, and 0.4-0.6 per capita in sub-district administrative organizations.
1.3.2 Hazardous Waste Generation

Corresponding to industrial development, hazardous waste is likely to grow with a strong economy. Between 75-80 percent of hazardous waste were from industrial sector, following by commercial sector and domestic sector, 13 percent and 5 percent respectively. The remainders were from agriculture sector, medical and laboratory sector, and port and shipping sector. It is obviously illustrated that Bangkok and its vicinities created 64 percent of the total hazardous waste, following by 11 percent of its waste from the northern part of Thailand.

![Figure 3: Percentage of Hazardous Waste generation by Sectors](image)

Source: PCD, 1999

Only 40-50 percent of hazardous industrial waste from Bangkok and its vicinities was disposed to the hazardous waste treatment plant as a result of environmental vision of the factory on waste management – waste collection and utilization. Whereas the rest of hazardous waste still remained in factories or was illegally eliminated in public areas. For community hazardous waste, example of this waste, mainly from petrol station, garage and householes, was batteries, light bulbs, lube oil, spray cans and cleaning solvents. Community hazardous waste was disposed together with general solid waste since no integrated hazardous waste treatment system for communities was available.
2. SOLID WASTE UTILIZATION

The quantities of waste utilization from municipal solid waste, industrial and agricultural waste in 2004 was 30 million tons, or 27 percent of the total waste generation (111.13 million tons). The proportion of waste generation was demonstrated that 62 percent of agricultural waste, 28 percent of industrial waste and only 10 percent of municipal waste was changed to the waste utilization (Figure 4). The waste utilization situation has risen resulting many related organizations have promoted solid waste management efficiency by improving existing solid waste management systems and promoting the private sector’s involvement in solid waste management. There are also some researches aimed to transfer waste to energy, especially agricultural solid waste.

![Figure 4: Proportion of Waste Utilization](image)

2.1 MUNICIPAL SOLID WASTE UTILIZATION

Correspoding to 14.6 million tons of municipal solid waste in the year 2004, this waste was reused only 3.1 million tons or 21 percent of the total municipal solid waste (Figure 5). About 0.2 million tons of municipal solid waste was transformed to fertilizer and effective bioorganism while 2.9 million tons was managed in the form of metal, paper, glass, plastic and rubber residues by recycled commercially and then reused in various manufacturing and industrial activities. The potential market value of these materials is various by types of waste and recycled market situation.
2.2 INDUSTRIAL SOLID WASTE UTILIZATION

Industrial solid waste produced by industries, mostly consisting of metal, paper, glass and plastic residues. Industrial waste utilization had applied 57 percent of the total industrial solid waste in 2004.

Procedure of industrial waste utilization has emphasized on recycle such as the use of waste exchange system, deposit-refund system, reward activity from sale agent, and take-buy system. As potential on recycled and reused waste was various by types of industrial waste, metal industry produced the greatest amount, 81 percent of industrial waste, with the highest recycled potential at 90 percent of the metal waste in 2004. The following industrial waste generations were aluminium industry and glass
industry with the potential of recycle and reuse 54 percent of aluminium waste and 64 percent of glass waste, respectively.

Figure 7: Types of Industry’s Waste Generation and Utilization in 2004

As can be seen from figure 7, it illustrated that majority industries have increased the potential on recycling, apart from plastic and rubber industries. As a result of this, the promotion on reused and recycled scheme should be increased such as industrial waste exchange center, industrial waste transformation, and public relation.

2.3 AGRICULTURAL SOLID WASTE UTILIZATION

There are ten kinds of agricultural waste that have the potential to be reused, which are residues from rice, cane, corn, coconut, plam, cassava, peanut, cotton, soybean and sorghum. Roughly 22 percent or 18.6 million tons of the total agricultural waste (82.23 million tons) has the potential to be recycled in 2004 (as shown in figure 8).

Figure 8: Agricultural Waste Generation and Utilization in 2002-2004

Majority of agricultural waste has utilized as a transformation to renewable energy, around 13.8 million tons or 75 percent of the total agricultural waste utilization whereas the rest has been reused as animal product, fertilizer and biogas.
3. FUTURE CHALLENGES TO DEVELOP SUSTAINABLE WASTE MANAGEMENT

Thailand has established solid and hazardous waste disposal facilities, improved municipal waste management, and support environmental friendly programmes. However, it still has some deficient issues on reducing and recycling waste; developing treatment and safe disposal of solid and hazardous waste; enhancing the supporting institutional, regulatory, and financing framework; and broadening public and community participation. Waste recycling and reduction are relevant aspect and have the potential to prompt reduction in the quantity of waste disposed more than introducing taxes, fees or other incentives. Examples of waste recycling and reduction are packaging waste reduction, separating the waste, and disseminating instructions concerning the proper waste management for household and other categories. In addition, effective training, supports, and increased staffing at the provincial and municipal level also need to fill the gaps in recycling activities built in many areas of the country.

For developing solid waste facilities, regulatory of municipal landfills has not been set, as landfills are not considered a pollution source under the 20-year plan. Open dumping of hazardous waste has been reported which this needs to be amended. Sustainable waste management cannot be successfully accomplished through the efforts of the public sector alone but it needs to increase public awareness and participation among the public, citizen and local government.

REFERENCES

Data on Material Exchange Center (MEC) available at website: [www.tei.or.th/mec/eng/about/data1.html](http://www.tei.or.th/mec/eng/about/data1.html)


CHAPTER 2
CURRENT POLICY FRAMEWORK FOR WASTE MANAGEMENT IN THAILAND

1. REGULATIONS AND LEGAL FRAMEWORK

In 1992, issuance of the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 had marked a milestone for environmental management in the country. According to the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992), the National Environment Board was given the responsibility to drawing up a plan and policy to promote and maintain the national environment and the Cabinet ministers had given their approval on 26th November 1996 in adopting the said plan and policy for a period of 20 years, starting from 1997 until 2016. There are two major national policies under the Policy and Prospective Plan for 20-year Enhancement and Conservation of National Environmental Quality to achieve proper waste management as follows:

- Provide systematic and effective wastes and hazardous material management: promote 3Rs hierarchy – Reduce, Reuse and Recycle – with participation from community and recycling business.

- Develop unified systems for administration and management of pollution and for formulation of pollution control policies, plans and implementation guidelines: encourage local administrations to establish central solid waste disposal facilities with integrated concept of appropriate technology and beneficial utilization of waste such as compost material and energy recovery.

In order to ensure practical application of the plan that fits current situation the Board had made a review of the 1999-2006 environment plan and came up with the 2002-2006 environment management plan to be used as framework for carrying out the job of national environmental protection and care in line with the Ninth Economic and Social Development Plan. In addition, there are a number of legislation related to waste management particularly in identifying and authorizing local governmental agencies to handle waste management at local levels, for example, the Public Health Act B.E.2535 and the Public Cleansing Act B.E.2535. The relevant regulation are summarized as presented in Table 2-1.
### Table 2-1  Relevant Legislation on Waste Management

<table>
<thead>
<tr>
<th>Significant Legislation</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>The Enhancement and Conservation of the National Environmental Quality Act B.E.2535</em></td>
<td>The Act is the fundamental environmental law of the country identifying institutional roles in policy formulation and planning; establishment of environmental quality standards; enforcement and monitoring; creation of incentives for environmental promotion and preservation; and establishment of the national environmental fund. The law also emphasizes on raising a greater public participatory role in addressing environmental problems.</td>
</tr>
<tr>
<td><em>The Factory Act B.E.2535</em></td>
<td>The Act contains the provision of the law associated with the controlling and monitoring of industrial factories, including that in relation to environment and safety and the overall scope and guidelines for management of solid waste and discarded substances from industrial operations.</td>
</tr>
<tr>
<td><em>The Hazardous Substances Act B.E.2535</em></td>
<td>The Act includes a provision on the controlling and overseeing of production processes, imports and exports, trading, transportation, storing, disposing and elimination of hazardous substances. This Act applies particularly to generators, importers, exporters and collectors of hazardous substances.</td>
</tr>
<tr>
<td><em>The Public Health Act B.E.2535</em></td>
<td>The Act contains a provision to minimize risks associated with public health hazards.</td>
</tr>
<tr>
<td><em>The Public Cleansing Act B.E.2535</em></td>
<td>This act involves with public cleansing in general regarding garbage, odor, nuisance and visual pollution.</td>
</tr>
<tr>
<td><em>The Decentralization Act B.E.2540</em></td>
<td>According to the Constitution of the Kingdom of Thailand B.E.2540 (1997), The State shall decentralise authorities to local agencies throughout the country. This includes management and conservation of natural resources and environment and for the continuously decentralization, that has been legislated. According to this Act, the Decentralisation to Localities Plan has been formulated including those of waste management.</td>
</tr>
</tbody>
</table>
2. INSTITUTIONAL FRAMEWORK

It can be seen from Table 2-1 that the overall framework of related legislation has laid the responsibility and authority regarding waste management in several agencies. At the central government level, the agencies that play the key role on support and encouraging proper waste management are Department of Environmental Quality Promotion (DEQP), Pollution Control Department (PCD), Department of Industrial Works (DIW) and local administrative organizations.

For municipal solid waste, the local administrative organizations have the direct responsibilities to handle municipal solid waste in their areas, while DEQP and PCD play supporting roles to solve the problems and standard and guideline preparation. For industrial waste, DIW is in the process of developing and control industrial hazardous waste and non-hazardous waste.

2.1 Structure of Ministry of Natural Resources and Environment and Department of Industrial Works

Thailand has undergone the bureaucratic reform in accordance with the Act Amending Ministry, Sub-Ministry and Department B.E. 2545 on 3 October 2002. The objectives of the reform are enhancing capacity and effectiveness of government agencies and officers, creating trust for Thai people in public administration as well as effectively utilize natural resources for public benefits. The structural reform of the Ministries has divided them into 3 types, including:

1) Ministries responsible for fundamental policies (6 Ministries)

2) Ministries for National Development Strategies (10 Ministries)

3) Small-sized ministries for urgent matters according to social situations (4 Ministries)

Both Ministry of Natural Resources and Environment and Ministry of Industry are categorized in those for National Development Strategies. Structure and Responsibilities of them are as below.

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2.1.1 Ministry of Natural Resources and Environment (MONRE)

MONRE has authorization relating to conservation and restoration of natural resources and environment as well as other duties pertained by the law. The Ministry is divided into 4 groups, consisting of 9 units.

Directing Group:

1) Office of the Permanent Secretary
2) Office of the Environment Policy and Planning

National Resource Affairs Group:

3) Department of Marine and Coastal Resources
4) Department of Mineral Resources
5) National Park, Wildlife and Plant Conservation Department

Environment Affairs Group:

6) Department of Environmental Quality Promotion
7) Pollution Control Department

Inland Water Affairs Group:

8) Department of Water Resources
9) Department of Groundwater Resources

Other 3 agencies are State Enterprises under the MONRE include (1) Queen Sirikit Botanic Garden (2) Water Management Organization, and (3) Zoological Park Organization.
2.1.2 Department of Industrial Works (DIW)

Department of Industrial Works is the agency under the Ministry of Industry, which is categorized into the ministries for national strategic development. DIW regulates and promotes industries to sustainable develop and operate their business with emphases on environment, safety and internationally acceptance.

The establishment, monitoring and enforcement of industrial pollution resignations and environmental quality standards have largely rested with DIW. The DIW controls industrial operation mainly through mandatory factory licensing in three-year intervals. Licenses can be revoked if factories violate standards. DIW is required to co-ordinate its environmental activities with the Pollution Control Department (PCD) and with other agencies\(^2\).

Organization Structure of the DIW consists of 4 groups, 10 bureaus, and 3 divisions as followed.

**Groups:**

1) Internal Audit Group

2) Policy and Planning Group

3) Administration Development Group

4) Advisory Group

**Bureaus:**

1) Office of Secretary

2) Central Office of Machinery Registration

3) Factory Environmental Technology Bureau

4) Hazardous Substances Control Bureau

5) Factory Control and Inspection Bureau 1

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6) Factory Control and Inspection Bureau 2
7) Factory Control and Inspection Bureau 3
8) Factory Control and Inspection Bureau 4
9) One Stop Service Center
10) Safety Technology Bureau

**Divisions:**

1) Finance Division
2) Legal Division

### 2.2 Local Offices of MONRE and DIW

#### 2.2.1 Ministry of Natural Resources and Environment (MONRE)

Local offices of the MONRE and officer posts can be concluded as below:

1) Provincial Environment Office 1-16 has 307 posts, under the **Office of the Permanent Secretary**

2) Provincial Natural Resource and Environment Office (75 provinces) 450 posts, under the **Office of the Permanent Secretary**

3) Local Operation Unit in 75 provinces, totaling 580 posts (both government officers and contracted employees), under the Department of Water Resources

4) Provincial Water Resources Bureau 1-8 have total 1,334 posts (both government officers and contracted employees), under the Department of Water Resources

5) Central Administrative Unit (Division of Groundwater Resources in provincial areas (75 provinces), totaling 174 posts, under the Department of Groundwater Resource
6) Wildlife Conservatory Management Bureau 1-21 have 5,555 posts, under the National Park, Wildlife and Plant Conservation Department

7) Khao Kheow Open Zoo 269 posts, Chiang Mai Zoo 162 posts, Nakhon Ratchasima Zoo 142 posts, Songkhla Zoo 141 posts, and Ubon Rachathani Zoo project 2 posts. These positions are under the Zoological Park Organization. Hence, local positions are totaling 716 posts.

2.2.2 Department of Industrial Works (DIW)

Present structure of Department of Industrial Works does not define the local posts in provincial administration. However, officers will be drawn from relating central administrative offices. For example, officers from Factory Environmental Technology Bureau, Factory Control and Inspection Bureau are distributed to all of Thailand provincial areas, totaling 247 posts.

2.3 Administration in Registration and Permission

2.3.1 Registration procedure by applicants at DIW and MONRE in compliance with the laws

Responsibilities of agencies under MONRE in compliance with the laws relating registration and issuance of permits are as followed.

1. Registration for Private Organization dealing with Environmental Protection and Conservation of Natural Resources

Eligible person (s) must be a juristic person according to domestic or international legislations. The person shall have activities directly relate with environmental protection or conservation of natural resources. It shall not has political objectives or aiming for profit making from such activities. The eligible persons include:

- Association or Foundation

In case it is an association or foundation under foreign legislations, it shall have a regional office operating in Thailand.

The registered private organization must submit the report concerning activities for environmental protection or conservation of natural resources to the Director General of the Department of Environment Quality Promotion at least 1 time per year.

2. License for prepare environmental impact assessment reports

Eligible person(s) who can apply for license for prepare environmental impact assessment report include:

- Educational institution equivalent to university level or research institute which is a juristic person under Thai legislation.

- Juristic person registered under Thai legislation (Partnership, Limited Partnership, Company Limited)

- Juristic person registered under foreign legislation

- State Enterprises

- Mining Council

The application for the license can be submitted to the Chairman of the National Environment Board or a person who is designated by the Chairman. The license is valid for not more than 5 years from the date of issuance.

2.3.2 Department of Industrial Works (DIW)

Factory Control and Inspection Bureaus under the Department of Industrial Works are responsible for issuance of Factory Business Permit, Renewal of Factory Permit, and Expansion of Factory business in compliance with the Factory Act B.E. 2535. The Act divided factories into 3 types, by taking into consideration the necessity for the control, prevention of nuisance, prevention of damage, and

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4 Ibid, page 44-45
prevention of danger in accordance with the gravity of impact on the public or environment by classifying as follows:

(1) Groups 1 factory are such factory of the type, kind, and size as capable of engaging in a factory business immediately upon desire of a person engaging in a factory business.

(2) Groups 2 factory are such factory of the type, kind, and size as, when engaging in a factory business, must be notified in advance to the Grantor. (Permanent Secretary of the Ministry or a person appropriately assigned by the Permanent Secretary of the Ministry.)

(3) Groups 3 factories are such factories of the type, kind, and size as to be granted a permit prior to the engagement.

In inspecting the nature of factory for classifying such factory to be in which group of factory, it requires information concerning type of the factory business (what kind of engagement in business), horsepowers of the machine and number of workers to be employed in the factory. Self-verification could be done against the Ministerial Rule No. 1 (B.E. 2535) prescribed pursuant to the Factory Act B.E. 2535.

Procedures for Factory Business Permit and duration of consideration are as follows (1) Inspection of factory location and preparation of inspection report shall be completed within 30 days; (2) Consideration of the report shall be completed within 50 days; (3) Notifying the result of the consideration to the applicant within 10 days.

2.3.2 Items that shall be permitted by the office

Other permits responsible by bureaus under the Ministry of Industry are:

1. Procedures relating with hazardous substances by Hazardous Substances Control Bureau

Before importation of hazardous substance, the importer shall acquire details of the product such as Safety Data or MSDS (Material Safety Data Sheet) from the producer. This information shall be checked against the Hazardous Substance Act B.E.2535 or from the website. The business

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5 http://www14.brinkster.com/hazdiw/
owner shall verify whether the permit is required for importation of such substance. At the initial stage, the importer must be aware of what kind of business the substance will be used. For example, if imported substance is to be used as fertilizer or insecticide, the regulating body is Fisheries Department and Department of Agriculture. If it will be used in household business such as consumer products or medicine, then the regulating agency is Food and Drug Administration. If imported substance is to be used as raw material or mixture in industrial production process, it relates with Ministry of Industry (Hazardous Substance Control Bureau). In addition, other related agencies are Department of Defense, Excise Department, etc.

Procedures relating to hazardous substances under the responsibility of the Hazardous Substances Control Bureau for those who inspected their products and found that they related in industrial business are as below:

*Hazardous Substance Type 1*

No registration is required. However, Notification Form Wor Or/Aor Kor 6 shall be submitted to the officers of Hazardous Substances Control Bureau, Department of Industrial Works before importation of such substance into the country.

*Hazardous Substance type 2*

Hazardous substance must be registered and there must be places to store those substances in comply with the Hazardous Substance Act and Notification of Ministry of Industry.

*Hazardous Substance Type 3*

Hazardous substance must be registered and a Permit must be granted and approved by officers before importation of such substance. In addition, there must be places to store those substance in comply with the Hazardous Substance Act and Notification of Ministry of Industry.

The license is valid for 1 year or 3 year. Some conditions are applied.
2. Registration of Hazardous Substances

The registration will show information relating with hazardous substance that will be produced or imported. It is also beneficial to determine preventive measures against dangers that might happen from such substance.

3. Application for import/export of Hazardous Substance Permit

This is to control import/export of hazardous substance. It is also beneficial to prevent dangers that might happen from such substance.

4. Application for Hazardous Substance Production Permit

5. Possession of the Hazardous Substance

This is to control storage or possession of hazardous substance, and to prevent dangers that might happen from such substance.

6. Permit for having possession of Used Lubricating Oil

Used lubricating oil is categorized as hazardous substance type 3 in the list B attaching the Notification of Ministry of Industry on List of Hazardous Substances B.E.2538. It falls into item 1 under the Chemical Waste Chapter. Consequently, any business that stores 20kg./20 Liters of this substance is needed to apply for the Permit, except those who already have specific provisions regulating treatment or disposal method of the substance.

Businesses that are required to apply for the Permit are Gasoline Station that provides change of engine oil service, and auto service centers.

7. Machine registration by Central Office for Machine Registration and Provincial Industry Office. These agencies have responsibilities in accordance

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6 Ibid
7 Ibid
8 Ibid
9 Ibid
10 Ibid
with the Machine Registration Act. B.E. 2514, which categorized the machine to be an asset that can be mortgaged and undertake other juristic acts under the Civil and Commercial Code.

2.4 **Governances by DIW and MONRE**

2.4.1 **Permissions, Severances, Order of improvements, Complains, Collection of Penalty, Sample analysis, Data Control and Other information**

1. Ministry of Natural Resources and Environment\textsuperscript{11} ***

   - *Thai environmental regulations\textsuperscript{12} by Pollution Control Department (PCD)*

   (1) The Enhancement and Conservation of National Environmental Quality Act B.E.2535

   (2) Air Quality and Noise Standards

      - Air Quality Standards

      - Emission Standard for Mobile Sources

      - Emission Standard for Point Sources

      - Noise and Vibration Standards

   (3) Water Quality Standards

      - Drinking Water such as Drinking Water Quality Standards, Bottled Water Standards, Groundwater Standards for Drinking Proposes

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\textsuperscript{12} Pollution Control Department 2003. ‘Thai Environmental Regulations’, [http://www.pcd.go.th](http://www.pcd.go.th), (7/10/03).
- Coastal Water Quality Standards such as Classification of Coastal Waters, Coastal Water Quality Standards, Areas Classification for the West Coastal of Phuket Island

- Groundwater Quality Standards

- Effluent such as Industrial Effluent Standards, Water Characteristics Discharged into Deep Wells, Housing Estate Effluent Standards, Water Dumping into water Curses, Effluent Standard for Pig Farm, (Draft) Gas Stationard Oil Terminal Effluent Standard

- Surface water such as Classification and Objectives, Surface Water Quality Standards, Restricted Zone for Protecting the Source of Water Supply in Bangkok Metropolitan Region(BMR)

- Water Quality for Fresh Water Animal such as Appropriated Water Quality Criteria for Aquatic Living, Maximum allowance in Water

(4) Notification of Pollution Control Development

- Other approved systems for average proportion of Gas or Dust measuring devices.

- **Suspension or revocation of the license for prepare environmental impact assessment reports**

Office of Environmental Policy and Planning is responsible for issuance the license for prepare environmental impact assessment reports. In practice, if the Office find mistakes in preparing the report, or receives the complaint, the Office shall present the case to Sub-Committee for consideration of the fault whether it falls into case of suspension or revocation of the license. The Office will file the allegation for the person to prepare supporting document in clearing up the charge.

However, apart from suspension and revocation of the license, the Office of Environmental Policy and Planning will issue a warning notice in case
the mistake is found. The suspension and revocation will not be immediately applied.

- **Service Fee for Pollution Control under the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535**

  - In any pollution control area or locality where a central wastewater treatment plant of a central waste disposal facility has been constructed and brought into operation as a public utility service, funded by government budget or revenue of the local administration and money allocated from the Fund as provided in this Act, the National Environment Board shall, with the advice of the Pollution Control Committee, fix the rates of service fee to be applicable within the limits of each pollution control area or locality, being the site of and served by the operation of such facility. The service fee rates fixed according to the foregoing first paragraph shall be notified and published in the Government Gazette.

  The rates of service fee fixed according to section 88 for treatment of wastewaters or for disposal of wastes eminated from point sources pursuant to section 71 and section 72 may be varied as appropriate.

  The owner or possessor of the point source of pollution governed by the provision of section 72, in the category of domestic household, that can be classified as a small-scale user is entitled to be exempted from the payment of service fees in accordance with the rules and conditions stipulated by the National Environment Board, with the advice of the Pollution Control Committee.

  - Any owner or possessor of the point source of pollution subject to the requirements of section 68 or section 70, who refrains from using his on-site facilities or equipment for the control of air pollution, noise pollution and vibrations, or refrains from

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operating his on-site facilities for the treatment of wastewaters or
disposal of wastes and illegally discharges such untreated
wastewaters or wastes into the environment outside the limits of
the site of the point source of pollution, shall be liable to pay as a
daily penalty four time as much the amount of daily expenses for
the normal operation of his facilities, equipment or process for
wastewater treatment or waste disposal throughout the duration of
such illegal discharge.

- The local authority or the competent official of the government
agency responsible for the operation of the public wastewater
treatment plant or waste disposal facility shall have the power and
duty to collect service fees, penalties and claim for damages as
provided in this Part, particularly in connection with the operation
of the central wastewater treatment plant or the central waste
disposal facility of the public service which is made available by
such local authority or government agency.

The service fees and penalties collectable in accordance with the
foregoing first paragraph shall be exempted from being remitted to
the Treasury as government revenues, but shall be deducted and
remitted to the Fund at the ratio specified by the Fund Committee,
whereas the balance therefrom shall be used as expenditures for
operation and maintenance of the central wastewater treatment
plant or the central waste disposal facility of the local authority or
government agency which is responsible to collect such service
fees and penalties.

- **Penalties and Fines***

- Any owner or possessor of point source of pollution who avoidedly
refrains from sending wastewaters or wastes to the central
wastewater treatment plant or the central waste disposal facility as
required by section 71 or section 72 and illegally discharges such
wastewaters or wastes into the environment outside the limits of
the site of the point source owned or possessed by him, or does
send the wastewaters or wastes to the central wastewater treatment
plant or the central waste disposal facility of the public service for treatment but fails or refuses to make payment for the service fees without being entitled to the exemption as provided by section 89, second paragraph, shall be liable to pay as a penalty four time as much the amount of service fee that he is liable to pay at the rate fixed in accordance with section 88 until the provision of this Act is observed by him.

- Any owner or possessor of the point source of pollution, required by section 70 to have an on-site facility for wastewater treatment or waste disposal, who illegally discharges wastewaters or wastes into the central wastewater treatment plant or the central waste disposal facility of the public service, shall be liable to pay as a daily penalty four time as much the amount of daily expenses for the normal operation of his on-site facility for wastewater treatment or waste disposal throughout the duration of such illegal discharge and shall also be liable to pay damages if such illegal discharge has caused any damage or defect to the central wastewater treatment plant or the central waste disposal facility of the public service.

- Any person who violates or refuses to observe the order issued by virtue of section 8 or obstructs any act done in compliance with such order shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both. In case the person who violates or refuses to observe the order or obstructs any act done in compliance with such order is the person who has caused danger or damage arisen from pollution, such person shall be punished by imprisonment not exceeding five years or fine not exceeding five hundred thousand baht, or both.

- Any person who illegally encroaches upon, occupies, or enters into public land to act in any manner which results in the destruction, loss or damage to natural resources or treasures worthy of being conserved, or causes the occurrence of pollution having impact on the environment within the limits of environmentally protected area designated by virtue of section 43 shall be punished by
imprisonment not exceeding five years or fine not exceeding five hundred thousand baht, or both.

- Any person who violates or refrains from observing the restrictions stipulated by ministerial regulation issued according to section 44 or by notification given by the Minister according to section 45 shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both.

- Any person who spreads or disseminates false information about the danger from any point source of pollution with the intention to destroy its reputation or to undermine public trust on the lawful operation of its business or activity shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both.

- If the spread or dissemination of information according to the foregoing first paragraph is done by means of publication, announcement, advertisement or reports through newspaper, radio, television or other forms of mass media, the person who commits such act shall be punished by imprisonment not exceeding five years or fine not exceeding five hundred thousand baht, or both.

- Any person who violates the order of competent official forbidding the use of vehicle according to section 65 shall be punished by fine not exceeding five thousand baht.

- Any person who refuses to observe the order given by competent official according to section 67 shall be punished by imprisonment not exceeding one month or fine not exceeding ten thousand baht, or both.

- Any owner or possessor of the point source of pollution who refrains from observing the provision of section 71, or any person who refrains from observing the provision of section 72, or the rules laid down by the local authority by virtue of section 74 or section 75, first paragraph, or the ministerial regulation issued by virtue of section 80 shall be punished by imprisonment not
exceeding one year or fine not exceeding one hundred thousand baht, or both.

- Any person who renders services as a Monitoring Control Operator or as a Service Contractor for wastewater treatment or waste disposal without the license granted according to section 73 shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both.

- Any owner or possessor of the point source of pollution or any Monitoring Control Operator or any Service Contractor rendering the services of wastewater treatment or waste disposal, who refrains from collecting statistics or data or from making notes or reports as required by Section 80 shall be punished by imprisonment not exceeding one month or fine not exceeding ten thousand baht, or both.

- Any Monitoring Control Operator or Service Contractor having the duty to make notes or reports according to this Act, who intentionally makes such notes or reports showing false information or statements shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both.

- Section 108 Any person who obstructs or refuses to comply with the order of the pollution control official given in the performance of his duty according to Section 82 (2) shall be punished by imprisonment not exceeding one month or fine not exceeding ten thousand baht, or both.

- Any Service Contractor rendering services for wastewater treatment or waste disposal ordered by the pollution control official to stop or close down his services pursuant to Section 82 (5), or any Monitoring Control Operator whose license has been revoked by the order of the pollution control official pursuant to Section 82 (6), who violates or refuses to comply with such order of the pollution control official or continues to carry on his service in violation of
such order shall be punished by imprisonment not exceeding one year or fine not exceeding one hundred thousand baht, or both.

- Any owner or possessor of the point source of pollution who employs the person, whose license to be a Monitoring Control Operator has been revoked, to supervise and monitor the operation of air pollution control, wastewater treatment or waste disposal facility that he has the duty install and operate according to this Act, shall be punished by fine not exceeding fifty thousand baht.

- In case the offender who is liable to be punished according to this Act is a juristic person, the directors or managers of such juristic person, or any person who is responsible for the business operation of such juristic person, shall also be punishable by the same penalties prescribed by law for such offence, unless it can be proved that they have no part to play in the commission of such offence.

2. Department of Industrial Works

- *Factory Business Permit:* those who wish to operate factories in Group 2 and 3, must notify the authority to receive permit not less than fifteen days prior to the commencing date of engagement in the factory business. The permit shall be valid until the last day of the fifth calendar year as from the year of commencement of the engagement in the business except in the case of moving of the factory or of dissolution of the engagement in the factory business, such permit shall be deemed to expire. In renewing a permit, a recipient of a permit shall file an application prior to the expiration of a permit, otherwise the fine will be applied.

- *Expansion of the Factory:* a recipient of a permit must be granted the permit to expand the factory. Examples of expansion of the factory are an increase of a number, change or alteration of the machines in order to increase
their aggregate powers, and an increase or modification of any part of the factory buildings.

- **Cease of Factory Business:** Any recipient of a permit who wants to cancel or change the conditions to be followed in engaging in a factory business shall file an application and explain the reasons to the Grantor. In case where the recipients of a permit transfers the factory business, leases or effects a hire-purchase of the factory, or sells the factory, such person shall be deemed to cease the engagement in the factory business as from the date of transfer of the factory business, lease or hire-purchase of the factory or sale of the factory.
- **Penalties**

(1) Suspension of business or Close Factory:

- In case where a person engaging in a factory business intentionally fails to comply with the order of the authority without reasonable ground or in case where it appears that the engagement in a business of any factory may cause serious harms, injuries or troubles to the persons or property in the factory or its vicinity, the Permanent Secretary or a person assigned by the Permanent Secretary shall have the power to order such person to stop temporarily engaging in all or part of the factory business and to modify such factory or to conform within the specified period.

- The persons engaging in a business of group 2 factory and group 3 factory fail to pay the annual fees in accordance with the criteria, procedures, and rates as provided in the ministerial regulations throughout the period of engagement in the business. If after being fined, they still refuse to pay the fees without reasonable ground, the authority shall have the power to order such person to stop the engagement in the business until the fees and additional money have been paid in full.

(2) Revoking the Permit:

- A person engaging in a factory group 3 intentionally fails to comply with the order of the authority without reasonable ground or in case where it appears that the engagement in a business of any factory may cause serious harms, injuries or troubles to the persons or
property in the factory or its vicinity, and fails to modify such factory within the specified period.

(3) Fines or Imprisonment:

- In case where the person engaging in the factory business fails to comply with the order of the authority and, there is a ground for the Government to take over the operations, the person engaging in the factory business must bear the expenses for such takeover for the amount actually paid together with the penalty at the rate of 30% per annum of the said amount.

- The persons engaging in a business of group 2 factory and group 3 fail to pay the annual fees in accordance with the criteria, procedures, and rates as provided for in the ministerial regulations throughout the period of engagement in the business. Failure to pay the fees within the specified period shall result in the payment of additional money at 5% per month.

- Any person engaging in a business of group 2 factory without notifying the authority shall be subject to an imprisonment not exceeding six months or fine not exceeding fifty thousand Baht or both.

- Any person engaging in a business of group 2 factory notifying of the engagement in business incorrectly or completely as provided for in the ministerial rules that the forms and particulars to be notified and the form of notification receipt shall be in accordance with those provided for in the ministerial rules or failing to comply with the dissolution of business, the transfer, lease, or hire-purchase of group 2 factory shall be
notified in writing by the person engaging in a factory business to authority within thirty days as from the date of such action, shall be subject to a fine not exceeding twenty thousand Baht.

- Any person engaging in a business of group 3 factory without a permit or establishing a factory without a permit shall be subject to an imprisonment not exceeding two years or a fine not exceeding two hundred thousand Baht or both. In case where the factory is that of the type or kind of which a number or size are specified in order to grant or deny an establishment in any area in accordance with the announcements prescribed pursuant to adopt a number and sizes of each type or kind of factory to be established or expanded or to refuse the establishment or expansion therefore in any area. Such offender shall be subject to an imprisonment not exceeding four years or a fine not exceeding four hundred thousand Baht or both.

- Any recipient of a permit failing to comply with Section 13 that a recipient of a permit in a factory business of group 3, if wishing to commence the engagement in any part of the factory business, must notify the authority not less than fifteen days prior to the commencing date of engagement in the factory business or if there shall be any operation test of the machines before commencement of the engagement in a factory business of group 3, the recipient of a permit must also notify the authority of the day, time, and duration of such operation test not less than fifteen days, any recipient of a permit failing to comply with Section 19 that when the recipient of a permit increases a number,
changes or alters the machines used for production, machines used for generating power or the energy of the machines to other forms but not amounting to the expansion of the factory or to the increase of the area of the factory building or to the new construction of the factory building for the direct benefits of the business of such factory rendering the area of the factory building to be increased from fifty percent or more in case where the area of the factory building does not exceed two hundred square meters or to be increased from one hundred square meters or more in case where the area of the factory exceeds two hundred square meters, the recipient of the permit shall notify in writing the authority within seven days as from the date of such increase, change or alteration of the machine or increase of the area of factory building or additional construction of the factory building, any recipient of a permit failing to comply with Section 28 that any recipient of a permit ceasing the engagement in a factory business or if the recipient of a permit wishes to change a group 3 factory to a group 1 factory or group 2 factory shall notify in writing the Grantor within fifteen days as from the date of cessation of the factory business, or any recipient of a permit failing to comply with Section 33 that if the group 2 factory or group 3 factory cease their operations consecutively for more than one year, a person engaging in the business of group 2 factory or a recipient of a permit for the business of group 3 factory as the case may be must notify in writing the authority within seven days as from the day following the
last date of one year. It shall be subject to a fine not exceeding twenty thousand Baht.

- Any recipient of a permit expanding the factory without a permit for factory expansion under Section 18 shall be subject to imprisonment not exceeding two years or a fine not exceeding two hundred thousand Baht or both. In case where the factory under paragraph one is that of the type or kind of which a number or sizes are specified in order to grant or deny an expansion in any area in accordance with the announcements prescribed pursuant to Section 32(1) that to adopt a number of sizes of each type or kind of factory to be established or expanded or to refuse the establishment or expansion thereof in any area, such offender shall be subject to imprisonment not exceeding four years or a fine not exceeding four hundred thousand Baht or both.

- Any recipient of a permit failing to comply with Section 23 that the recipient of a permit must present the permit at the open and noticeable place in his/her factory, Section 24 that upon changing of the name of the factory or of the name of the recipient of a permit, the recipient of a permit shall notify in writing the authority within fifteen days as from the date of such change, or Section 25 that in case of loss or destruction of a permit, the recipient of the permit shall apply for a substitute to the authority within fifteen days as from the date of learning of the loss or destruction shall be subject to a fine not exceeding five thousand Baht.
Section 54 Any person engaging in a factory business failing to comply with Section 34 paragraph one shall be subject to a fine not exceeding twenty thousand Baht.

Any person engaging in a factory business during the order to stop engaging in a factory business or after the order to close the factory shall be subject to an imprisonment not exceeding two years or a fine not exceeding two hundred thousand Baht or both and an additional fine of five thousand Baht daily until the cessation of the engagement in the business.

Any architect or engineer still working in the factory only in the part against which the order to stop engaging in the business has been given or still working in the factory against which the order to close has been given in order to continue the engagement in the business of the factory shall be subject to the same penalties as those for the person engaging in a factory business under paragraph one.

Any person working in a factory or any worker still working in the factory only in the part against which to order to stop engaging in the business has been given or still working in the factory against which the order to close has been given shall be presumed to be the accomplice or supporter of the offence under paragraph one as the case may be but the court may inflict the penalty to the least extent possible by taking into account the status, responsibility for the family, intention to violate the law and the substantial participation in the act.
- Any person obstructing or failing to facilitate the authority who performs the duties under Section 35 shall be subject to an imprisonment not exceeding one month or a fine not exceeding twenty thousand Baht or both.

- Any person failing to comply with the order of the authority given under Section 37 paragraph one shall be subject to an imprisonment not exceeding one year or a fine not exceeding one hundred thousand Baht or both and an additional fine not exceeding five thousand Baht throughout the period of violation or noncompliance.

- Any person doing any act to reactive the machine(s) bound and stamped by the authority under Section 37 paragraph two shall be subject to an imprisonment not exceeding one year or a fine not exceeding one hundred thousand Baht or both.

- Any person obstructing or failing to facilitate a person assigned by Permanent Secretary or by a person assigned by the Permanent Secretary undertaking the execution of the order under Section 42 shall be subject to an imprisonment not exceeding one year or a fine not exceeding one hundred thousand Baht or both.

- Any person doing any act causing defect or damage to the order to stop engagement in the factory business or to close the factory shall be subject to an imprisonment not exceeding six months or fine not exceeding fifty thousand Baht or both.
In case where a person engaging in a factory business committing an offence under this Act, the architect or engineer working in the factory and responsible for the part of work in which such offence has been committed shall be deemed to take part in or know of the commission with the person engaging in the factory business and shall be subject to the same penalties as those for the person engaging in the factory business unless it is proved that such person does not know of or consent to the commission of such offence.

Apart from the penalties under paragraph one, the Permanent Secretary shall notify the Board on the Control of Architectural profession or the Board on the Control of Engineering Profession of the name and commission of such person in order to proceed under the laws on architectural profession or on engineering profession accordingly.

Any person once punished for the commission of the offence under this Act, if again committed the same offence for which he/she has been punished, the court shall consider increasing the punishment for such persons at least one-third of the imprisonment penalty or increasing the punishment for another one-half of the fine penalty for such offence.

In case where a partnership, company or other juristic persons commit an offence under this Act, the directors, managers or any person responsible for such commission shall also be subject to the penalties provided for such offence unless it is proved that such offence has
been committed without their knowledge or consent.

- In Case where an offence is committed under this Act, a person residing near or adjacent to the factory in which the offence is committed or a person whose living is affected as a result of commission of the offence shall be deemed to be the injured person under the Criminal Procedures Code.

*Example of legal enforcement for pollution control in Thailand*¹⁴

Completed Case No. 958/2543 between Sonkla public prosecutor (Plaintiff) and Mr. Somneuk (Oot) Choomaung (Defendant), subject: Offences against Enhancement and Conservation of National Environmental Quality Act, B.E. 2535: “On 19 April B.E. 2543, Songkla Municipal Court rendered the determinate sentence to Mr. Somneuk Choomaung for 3 years imprisonment and 200,000 Baht fines. The defendant pleaded guilty which benefits the trial and deserves the reduction of the stipulated penalty moiety: imprisonment to be 1 year 6 months, and 100,000 Baht fines. The imprisonment is not suspended since Mr. Somnuek Choomaung conducted an act against the Order of Songkla Governor No. 1/2541 dated 15 December B.E. 2541 on Prohibition of Low-Salty System for Tiger Prawn Nursery in the Freshwater of Songkla Province. The act deems offensive to the Section 28, Para 2 of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535.”

**2.4.2 All data related on the above items**

Laws and regulations categorized by type of pollution:¹⁵

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(1) **Laws relating with Water Pollution**

- Canal Act R.S. 121 (Section 6)
- Navigation in Thai Waterways Act B.E. 2456 (Section 119, 119 bis, 121, 204) and No. 14 B.E. 2535 (Section 61)
- People Irrigation Act B.E. 2584 (Section 7, 10, 11)
- State Irrigation Act B.E. 2485 (Section 27-28)
- Fisheries Act B.E. 2490 (Section 19)
- Mineral Act B.E. 2510 (Section 63, 67, 68)
- Notification of the Revolutionary Council No. 68 B.E. 2515 (Control of Canal and River Mooring Official)
- Notification of the Revolutionary Council No. 286 B.E. 2515 (Land Allocation Section 9, 13)
- City Planning Act B.E. 2518 (Section 14, 26-28)
- Groundwater Act B.E. 2520 (Section 6, 29, 33, 34, 37)
- Investment Promotion Act B.E. 2520 (Section 20)
- Industrial Estate Authority Act B.E. 2522 (Section 6, 10, 23)
- Construction Building Control Act B.E. 2522 (Section 8) and Ministerial Regulations No. 33 B.E. 2535 (Article 30-35)
- Bangkok Administration Ordinance on Building Construction Control B.E. 2522 (84, 86-87)
- Water Supply Canal Act B.E. 2526 (Section 13-16)
- Bangkok Administration Ordinance on Wastewater Disposal Control B.E. 2534
• Clause concerning Land Allocation B.E. 2535 (Item 5, 9, 31-34)

• Criminal Code (Section 237, 375, 380)

• Cleanliness and Orderliness of the Country Act B.E. 2535 (Section 9, 22-25, 29-33)

• Factory Act B.E. 2535 (Section 8, 32, 37, 42) and Ministerial Regulations No. 2 B.E. 2535 (Article 5, 13-15), No. 3 B.E. 2535 (Article 4), No. 11 B.E. 2539 (Article 15 bis) and Notification of Ministry of Industry No. 2 B.E. 2513, No. 2 B.E. 2539

• Public Health Act B.E. 2535 (Section 18-20, 25-29, 35)

• Hazardous Substances Act B.E. 2535 (Section 16-20)

• Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (Section 32-36, 56, 60 and Section 69-77 which directly related to water pollution), and Notification of Ministry of Science No. 5 B.E. 2537, No. 7-8 B.E. 2539

(2) Laws relating with Air, Noise, Light and other Pollution

• Act Controlling Public Advertisement by Sound Amplifier B.E. 2493

• Notification of the Revolutionary Council No. 16 B.E. 2514 relating with Vehicles

• Notification of the Revolutionary Council No. 103 B.E. 2515 relating with Work environment

• Land Transportation Act B.E. 2522 (Section 72) and Ministerial Regulations No. 9 B.E. 2522

• Building Construction Control Act B.E. 2522 (Section 8)
• Bangkok Administration Ordinance on Building Construction Control B.E. 2522

• Automobile Act B.E. 2522

• Notification of Harbor Master 177/2527 on application of smoke detector and steam boat decimeter

• Notification of National Traffic Officers B.E. 2533 on Smoke and Noise

• Highway Act B.E. 2535 (Section 6)

• Fuel Oil Act B.E. 2535 (Section 13)

• Health Protection for Non-Smokers Act B.E. 2535

• Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (Section 17-20)

• Factory Act B.E. 2535(Section 32, 39, 42) Ministerial Regulations No. 2 B.E. 2535(Article 16,17), (15) No. 3 B.E. 2535(Article 1-4), No. 11 B.E. 2539 (Article 16 tri), Notification of Ministry of Industry No. 2(16) B.E. 2513, No. 4 B.E. 2514, No. 2 B.E. 2536, and No. 1 B.E. 2540

• Public Health Act B.E. 2535 (Section 21, 25-28,35)

• Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (Section 32-36, 56, 60 and Section 64-48 which directly related to air and noise pollution), and Notification of Ministry of Science No. 1 B.E. 2537, No. 3 B.E. 2536, No. 4 B.E. 2537, No. 6 B.E. 2538, No. 9-11 B.E. 2539

(3) Laws relating with Waste and Garbage Pollution

• Cleanliness and Orderliness of the Country Act B.E. 2535(Section 10, 13, 14, 18, 23, 26-34)
- Factory Act B.E. 2535 (Section 8, 32, 42) Ministerial Regulations No. 2 B.E. 2535, No. 3 B.E. 2535, Notification of Ministry of Industry 2 B.E. 2513, No. 4 B.E. 2514, No. 25 B.E. 2531, Notification of Ministry of Industry No. 6 B.E. 2540, and No. 1 B.E. 2541

- Public Health Act B.E. 2535 (Section 18-21, 25-28,35)

- Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (Section 32-36, 56, 60, 78)

(4) Laws relating with Hazardous Substances

- Navigation in Thai Waterways Act B.E.2456 (Section 121, 159)

- Fisheries Act B.E. 2490 (Section 19-20)

- Notification of the Revolutionary Council No. 103 B.E. 2515 relating with Work environment

- Factory Act B.E. 2535(Section 8, 32, 42) and Ministerial Regulations No. 2 B.E. 2535, No. 3 B.E. 2535, Notification of Ministry of Industry No. 2 B.E. 2513, No. 4 B.E. 2514, No. 25 B.E. 2531

- Public Health Act B.E. 2535 (Section 25-28,31-33)

- Hazardous Substances Act B.E. 2535

- Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (Section 32-36, 56, 60, 79)
CHAPTER 3

PROMOTION OF TECHNOLOGIES TO FACILITATE 3RS IN THAILAND

1. TECHNOLOGY ADOPTION TO PROMOTE 3R PRACTICES

Thailand has applied the concept of 3R for certain period and mainstreamed 3R practices as one of measures in the light of the national environmental management policies. Hence, the concept of 3R has been widely disseminated among various stakeholders, including general public, commercial, industrial as well as governmental sectors. In this regard, technology promotion is one of significant measures vitally important to achieve successful 3R implementation.

Technologies for promoting 3Rs may range from basic tools and equipment, such as a well-designed trashcan, to advance recycling technology or sophisticated networking systems. In order to realize roles of technology in promoting 3Rs, technology adopted each stage of product life-cycle can be identified in 3 stages, namely, eco-efficiency technology, waste collection technology and recycling technology.
Figure 1: Adoption of Technology in 3R Promotion Framework

As seen from Figure 1, technology adoption to promote 3Rs can be identified into 3 groups as follows.

1.1 ECO-EFFICIENCY TECHNOLOGY

According to concept of source-reduction or preventive approach, technology plays a key role in such implementation.

- application of technology to improve efficiency of production processes
- modification of existing equipment to achieve better resource efficiency
- application of new technology to accommodate changes in raw materials and chemicals, such as substitution of less toxic chemical, substitution of virgin materials with recycled ones, etc.

As learning from the Thai experience in operating 3R practices in a large scale, two major players in this area can be given as recycling industries and governmental waste disposal bodies. Each of these players may focus on different outcomes primarily, but both of them are considered playing an outstanding role in minimizing the waste to be disposed of significantly.

Department of Industrial Works (DIW) classifies industrial activities into 107 types based on the raw material input and processing practice. Thus, from this classification, industries employing waste handling as a core process can be seen in either one of the three industrial types, including

- Type 101 - Central waste treatment plant,
- Type 105 – Waste sorting or disposal, and
- Type 106 – Waste recycling under industrial manufacturing.

In terms of 3Rs, only the industries under industrial types 105 and 106 would be the focal issues to be addressed.

Other than the 3R activities implemented by the industrial sector, an efficient 3R site operated by local governments in the form of integrated waste management site can also be seen. The site may consist of such facilities as waste sorting, cleaning, recycling, composting and burning for energy.
For private sector, a number of 3R businesses are getting to know and accept the advantage of introducing 3R technologies into their works. Besides the facilitating functions provided by the 3R technology, an adoption of such technology can also present to the public technologically and environmentally sound image of the industry.

However, the introduction of 3R technology may depend on a number of factors, particularly the investment cost and level of technological know-how of the technology. Adoption of technology in private sector is mainly based on feasibility of such technology to enhance core competency and competitive advantage of a firm. Regarding this, businesses must be realizing that an adoption of any 3R technology to be commercially viable, a financial feasibility study needs to be conducted in order to evaluate the appropriateness of investing this exercise under the current situation of the business itself. In addition, the business adopting 3R technologies may also need to adjust their business administration as well as marketing approaches in order to make use the invested 3R technologies more efficiently. This means that the business owner may take this opportunity to earn more revenue through the use of this technology in terms of higher efficiency in resource use and better environmentally sound image. Hence, it can often be seen that these businesses tend to seek for some technologies that promote the use of the 3R technology invested as well. Examples of the technologies often seen include internet websites and 3R equipment and systems.

However, it is concerned that the investment cost of 3R technologies to be employed may be a significant barrier for 3R business establishers, especially those requiring for bank’s loans. This is because the 3R business may not be attracted to the bank, for the nature of this business is not so outstanding in terms of remarkable profitability.

1.2 EXPERIENCE OF THAI INDUSTRIES WITH TECHNOLOGY ADOPTION TO PROMOTE 3R PRACTICES

Wongpanit Company

Wongpanit is known as a leading company in 3R business in Thailand. The company was formerly set up as a small junk shop in 1974 in a province of Phitsanulok, in lower northern part of Thailand. The business covers purchasing of non-toxic industrial waste from local suppliers, and transforming it into the form of usable raw materials for further manufacturing as well as products. The types of waste and residues accepted by the business include mainly paper, metals, glass and plastic. It also welcomes other sorts of waste, for example coconut residues, used motor oil and vegetable oil and leftover foodstuff. Today, the Wongpanit Garbage Separation Plant has a capacity of 75,000 tons per year, which can be divided as paper 22,500 tons, metals 15,000 tons, glass bottles 11,550 tons, plastic 16,500 tons, and others 9,500 tons.

In terms of technology applied in the business, Mr. Somthai Wongcharoen, Wongpanit’s establisher and owner, has been introducing a variety of innovative
approaches in order to improve and expand his business’ performance, as well as raising public awareness of waste recycling and persuading public participation on 3R activities. The technologies introduced within his business span in three main types, including IT, know-how and hardware.

In terms of IT, Mr. Somthai has taken the advantage of today’s internet technology as he has developed a website entitled www.wongpanit.com. This website provides information of the company and its business, knowledge on ordinary and new recycling practices, recycling news and today’s trading prices of recyclable commodities. The information provided would help strengthen the capacity of readers in terms of 3R practices, i.e. instructions for waste separating or manure composting, and facilitates the waste traders for the updated price information.

For technological know-how in 3Rs, the Wongpanit’s management always discovers new ideas of 3R practices and 3R business management, and selectively adopts them within the business. For example, the company has been seeking for new types of waste able to be recycled, such as polystyrene foam and CDs, from waste piles. This effort is considered important for promoting the expansion of recyclable waste market, resulting in the more effectiveness of waste minimization. Further, Wongpanit has also adopted technology transfer both to improve its 3R practical skills such as the knowledge on e-waste separation, and to disseminate its experience to be further practiced among communities nationwide. Examples of this are the company’s training programs on proper waste separation and industrial visits at Wongpanit recycling site.

In terms of hardware, Wongpanit adopts various types of hardware in operating its waste separation activities. The hardware applied in this business is generally seen in the form of basic and easy-to-use facilities, for example

**Figure 1: Wongpanit web page (from www.wongpanit.com)**

In terms of hardware, Wongpanit adopts various types of hardware in operating its waste separation activities. The hardware applied in this business is generally seen in the form of basic and easy-to-use facilities, for example
volume reducing device and plastic breaking machine. However, the facilities for 3R practices of Wongpanit cover those applied with all types of recyclable waste that the plant is handling at the moment. The integrated waste separating plant is considered adequately efficient and effective to handle the amount of waste generated from the Phitsanulok area. The need to upgrade the existing facilities may depend on the need to expand separation capacities, additional types of waste to be sorted and the budget to be invested. The availability of 3R facilitating hardware within Wongpanit is also one of the key drivers contributing to the enhanced capacity of this business both at present and in long term.

1.3 EXPERIENCE OF GOVERNMENT AGENCIES WITH TECHNOLOGY ADOPTION TO PROMOTE 3R PRACTICES

Rayong Municipality Waste Management Center

The population of Rayong City has been rising considerably and continuously due to the expansion of economic and industrial activities in the area. Consequently, environmental concerns can widely be seen in various forms and higher degree. Municipal waste was once a serious problem for Rayong City as its amount tended to rise and exceed the disposal capacity without a proper way to sustainably control. As realizing this concern, in 1999 the Rayong Municipality decided to develop a waste management plant in order to systematically collect, transport, separate, recycle and disposal of its municipal waste, in particular.

The Rayong City’s waste management plant was then constructed with a main function of turning organic waste into manure and energy. The energy is to be obtained through an anaerobic digestion technology and a power generation plant, using biogas derived from the digestion as its fuel. The designed capacity of waste inlet is 60 tons per day, with designed power generation capacity of 625 kilowatts (Thongsatit, 2005). The raw material, organic waste, is to be obtained from waste separation process at source by the participation of Rayong citizens themselves. This system is considered technically complicated that it needs for preparation of the waste input, specific control conditions of the operation, and proper maintenance. Despite a high investment, this technology could benefit the Municipality in the form of its valuable outputs -- manure and electricity. As it is an operation of local government implemented for the sake of the city dwellers, the consideration on pay back period of the system investment may be not as necessary as that of the private sector.

The case study from Rayong Municipality Waste Management Center shows that 3R technologies can be used as a tool in promoting efficiency and effectiveness of 3R practices by government sector, as presented in the following statements.

In this waste management plant, technological hardware is playing a key role in the handling of municipal waste. The hardware facilities employed can be seen in the form of machines and equipment, for example vehicles facilitating waste collection, equipment and tools accommodating waste separation and
sludge removal, and so on. However, technical experts are also important to operate and maintain the life span of those facilities.

Besides the hardware that can be seen in the form of a waste management plant and its accessories, this implementation also requires for innovative expertise both for efficiently operating the system, and for further improving the system’s capacity and ability where possible. For instance, this expertise can lead to domestically-built waste management facilities instead of imported ones, and this could result in the lower investment cost that many local authorities can affordably adopt. In addition, information technology can also be used to help monitor the conditions of the digestion system in order to ensure the appropriateness for both the process operation and output quality.

1.4 EXPERIENCE OF OTHER AGENCIES WITH TECHNOLOGY ADOPTION TO PROMOTE 3R PRACTICES

Material Exchange Center (MEC)

As realizing the concern of a rising amount of solid waste being thrown away wastefully, the Thailand Environment Institute (TEI) as an environmental NGO has established a program aimed at handling such waste, particular industrial solid waste, in appropriate manners. This program, entitled Material Exchange Center or MEC, is functioning as a neutral body in coordinating the needs of factories or companies that have waste or discarded materials for recycling and those in need of materials for recycling. In this respect, the MEC has developed a website, namely [http://www.tei.or.th/mec/th/](http://www.tei.or.th/mec/th/), as a central information exchange source and communication channel among interested individuals, factories and MEC staff themselves. The activities of MEC are anticipated to promote waste reduction, reduce wasteful and inefficient energy consumption while carefully managing natural resources and sustainable development. At the moment, the MEC has more than 500 agencies that are involved in the recyclable exchange program, with a large number of recyclable waste and materials involved in the MEC list, including leather, polystyrene foam, used motor oil, used tires, bumpers and urethane resin, bricks, metals, batteries, catalysts, coolant, oil and chemical contaminated rug, and many more.
From the experience of the TEI, the exchange program created has employed a large extent of information technology within their operation. IT is playing a critical role as being a tool in creating computerized database of materials and also participants, organizing the exchange system and providing relevant information to the people interested. Introducing IT into the project development is considered improving efficiency of the application as well as facilitating the users. However, it is important that, to effectively benefit from this system, the users have sufficient IT skill to apply this application.

Figure 2: MEC web page (from www.tei.or.th/mec/th/)

2. DISCUSSION

The 3R practices of both private and public sectors given above present some portions of overall picture of environmental management activities, where technology is introduced, in Thailand.

- For private sector, a number of 3R businesses are getting to know and accept the advantage of introducing 3R technologies into their works. Besides the facilitating functions provided by the 3R technology, an adoption of such technology can also present to the public technologically and environmentally sound image of the industry. However, the introduction of 3R technology may depend on a number of factors, particularly the investment cost and level of technological know-how of the technology.

Regarding this, businesses must be realizing that an adoption of any 3R technology to be commercially viable, a financial feasibility study needs to be conducted in order to evaluate the appropriateness of investing this exercise under the current situation of the business itself. In addition, the business adopting 3R technologies may also need to adjust their business administration as well as marketing approaches in order to make use the
invested 3R technologies more efficiently. This means that the business owner may take this opportunity to earn more revenue through the use of this technology in terms of higher efficiency in resource use and better environmentally sound image. Hence, it can often be seen that these businesses tend to seek for some technologies that promote the use of the 3R technology invested as well. Examples of the technologies often seen include internet websites and 3R equipment and systems.

However, it is concerned that the investment cost of 3R technologies to be employed may be a significant barrier for 3R business establishers, especially those requiring for bank’s loans. This is because the 3R business may not be attracted to the bank, for the nature of this business is not so outstanding in terms of remarkable profitability. As such, it is important that the central government offer financial support or economic incentive for the entrepreneurs in order to promote the establishment of 3R activities (with technology included) in Thailand. The support might be offered in the form of loans with low interest rates and longer payment period. The supports provided from the government would result in the expansion of 3R entrepreneurs as well as boosting the recycling market and attracting households on 3R practices throughout Thailand.

- For government sector, there are only a limited number of local governments that have adopted particular 3R technologies within their waste management processes. A few factors that might limit this number could be seen as: the top management’s view on the needs for 3R technologies, the approved budget of the authority, and the preparedness of related personnel and facilities for the incoming technology. A distinguished criterion for the case of government sector in investing and operating a waste management system could be seen as the primary purpose of the practice. As private businesses doing 3R practices for profit as the major purpose, they tend to administer their businesses financially efficient and competitive. In contrary, governments generally have a primary task of providing service to their people, thus it is usual that the charge or fee imposed on the households for using the service provided is likely to be lower than the actual operation cost of the service system.

The technology promoting 3R practices in Thailand’s public sector could often be seen in the form of integrated waste management system that combines a number of 3R technologies in one place. The system may include some or all of these facilities: volume reducing device or truck, waste separating machine, composting system, anaerobic digester, bio-gas storage, sludge conveyor, power generation plant using bio-gas or waste as fuels, etc. In addition, the Thai government has initiated the use of internet technology as an efficient tool to promote the 3R activities among both private sector and government itself. The outcomes of applying this technology are widely perceived. Examples are alternative communication channels and information disseminating sources.
In investigating 3R technologies applied within 3R activities in Thailand, three main stages of a product life cycle, including production and design, distribution and consumption, and discarding and treatment, were raised. The technologies suitable for each stage of product life cycle would then be identified as follows.

For the stage of production and design, there are a range of manufacturers utilizing used or recycled materials as both partial and main ingredients in their production processes. These materials include used plastic, motor oil, metals, paper and board, glass, etc. These industries certainly need proper machines and know-how to deal with their recycled raw materials. Further, they must also have a network or certain supply chain to ensure sufficient recyclable supplies to maintain their businesses. To achieve these, efficient tools or technologies are to be present among the manufacturers and within the supply networks. In addition, product and process designs that help accommodate 3R practices are another significant element in this stage. For example, a product may be designed either to use recyclable materials as its main components or to facilitate disassembling of the components after its life span, or both. Regarding this, the technologies that facilitate or enhance capacity of the product and process designs are also required.

The stage of distribution and consumption involve the process of buying, selling and consuming recycled products as well as all other eco-products. These processes may adopt the approaches of green procurement, eco-labeling and green supply chain to promote 3R within this stage. Technologies involved in this stage can be seen in the form of tools that facilitate the use of these approaches in both technical and marketing terms. One example of 3R technologies in this stage is the development of database gathering green products and their suppliers as an accessible route for interested people.

The stage of discarding and treatment could be so important to 3R practices that waste and residues left from the product uses are appropriately managed either by minimizing or arranging them into the forms of recyclable materials or even fuels. Therefore, technologies related to waste handling such as waste sorting, purifying, disassembling, collection and transportation, and transforming are mostly required. In addition, the technologies that facilitate the use of this hardware are also desired. Examples of discarding and treatment technologies are equipment and machines designed for recycling purposes, computer models that facilitate waste management, and easy-to-use networking system for sharing relevant data among users, etc. As the country has performed integrated waste management plant in some provinces, the local governments may need to adopt integrated techniques, such as GIS, in the planning process (MOE, 2005). Technology research on the development
of 3R facilities and the integrated waste management system may be needed as well.

According to the 3R Workshop held on May 26, 2006, the technologies suitable for 3R promotion were discussed and addressed. A list of technologies for promoting 3Rs as derived from the Workshop can be presented in Table 1a - Table 1c below. The technologies would be sorted into 3 stages regarding product life cycle, and be divided into 3 categories including information technology (IT), know-how and hardware.
<table>
<thead>
<tr>
<th>Environmental approaches</th>
<th>Types of technology</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Information technology</td>
<td>Know-how</td>
</tr>
<tr>
<td>Standardization of recycled materials</td>
<td>- Demand-supply database of recyclable materials</td>
<td>- R&amp;D on recyclable material ratio standard. - Knowledge for improving quality of recyclable materials to meet standard.</td>
</tr>
<tr>
<td>Material exchange</td>
<td>- R&amp;D on recycled materials and recycling technologies.</td>
<td>- Processes and equipment designed for material and energy use efficiency.</td>
</tr>
<tr>
<td>Cleaner technology</td>
<td>- Database of CT experts and case studies. - Computer applications for facilitating efficient use of raw materials, such as pinch technology.</td>
<td>- Development of new good operating practices and management practices, such as lean manufacturing and six-sigma.</td>
</tr>
<tr>
<td>Environmental management system</td>
<td>- Online environmental monitoring system.</td>
<td>- Environmental management techniques</td>
</tr>
<tr>
<td>Life cycle assessment</td>
<td>- Improvement of Life cycle inventory (LCI) - LCA software</td>
<td>- Application of LCA methodology to local manufacturing process. - Life cycle costing, Life cycle impact assessment</td>
</tr>
<tr>
<td>Eco-products and designs</td>
<td>- Computer-aid design program - Eco-products and eco-product standard database for manufacturers. - Thai ROHs</td>
<td>- Market research of eco- products and designs. - Eco-efficiency and eco-effectiveness concepts to be applied to the production.</td>
</tr>
</tbody>
</table>
### Table 1b List of Technologies required for 3R Promotion – Distribution and Consumption Stage

<table>
<thead>
<tr>
<th>Environmental approaches</th>
<th>Types of technology</th>
<th>Information technology</th>
<th>Know-how</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eco-labelling</td>
<td></td>
<td>- Product and process R&amp;D to meet eco-labelling standard.</td>
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<td></td>
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<tr>
<td>Green supply chain</td>
<td></td>
<td>- Knowledge transfer from large firms to SME suppliers.</td>
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<td></td>
</tr>
<tr>
<td>Green procurement</td>
<td></td>
<td>- Database of eco-products and the producers to assist green procurement.</td>
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<td></td>
</tr>
</tbody>
</table>

### Table 1c List of Technologies required for 3R Promotion - Discarding and Treatment Stage

<table>
<thead>
<tr>
<th>Environmental approaches</th>
<th>Types of technology</th>
<th>Information technology</th>
<th>Know-how</th>
<th>Hardware</th>
</tr>
</thead>
</table>
| Community Network for Collection of Recyclables | - IT systems that share 3R good practices and raise awareness among communities.  
- Monitoring system of waste collection efficiency.  
- Management expertise for waste collection and separation. | - Waste pretreatment equipment, such as volume reducing device. (rice husks, tyres, plastic, polystyrene)  
- Well-designed garbage bins that efficiently support waste sorting at source. |
<p>| Public Awareness Campaign | - Effective communication channels for 3R campaign. | | | |
| Deposit-refund system    |                     | - Efficient waste collection equipment such as automatic refund machines. |
| Take-back system | - Design and management of collection and separation systems. |</p>
<table>
<thead>
<tr>
<th>Integrated Waste Management Facilities</th>
<th>- Computer model to facilitate waste management system.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Knowledge development to serve technology transfer, i.e. facility modification.</td>
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<tr>
<td></td>
<td>- R&amp;D on Pyrolysis technology for energy.</td>
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<td></td>
<td>- Lab waste handling R&amp;D.</td>
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<td></td>
<td>- Hazardous waste recycling plants.</td>
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<td></td>
<td>- Satellite recycling/pretreatment plants.</td>
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<td></td>
<td>- Processes that help improve material sorting quality and facilitation.</td>
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<td></td>
<td>- Waste to energy/manure processes and technologies (bio-gas and bio-mass).</td>
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<td></td>
<td>- Stuff repairing/donating centers available across communities.</td>
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<tr>
<td></td>
<td>- Efficient waste collection technologies to ensure supply security.</td>
</tr>
<tr>
<td></td>
<td>- Mobile units or systems for construction/demolition waste recycling and management.</td>
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<tr>
<td>Waste Management Business</td>
<td>- R&amp;D for innovative recycling technology.</td>
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<td></td>
<td>- R&amp;D for used oil applications.</td>
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<td></td>
<td>- Technology transfer of e-waste</td>
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<td></td>
<td>- Well-managed e-waste recycling centers.</td>
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<td></td>
<td>- Transport and logistic that facilitate accessing and delivering recyclable materials (Saling).</td>
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<tr>
<td></td>
<td>- Waste to energy technology including utilization of waste as fuel substitution.</td>
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</tbody>
</table>
and auto-waste recycling and management.

The list of technologies showed in Table 1a – 1c can be summarized as follows:

The technologies categorized into information technology or IT are mostly represented in the form of (1) electronic database development for effectively disseminating or sharing data among the public, and (2) appropriate computer programs that help facilitate 3R practices, processes and management systems.

The technologies appearing in the group of know-how can be seen as technical expertise required for creating or improving the 3R facilities or management system. The expertise could be obtained either from self-creating approach, domestic R&D, or from technology transfer both among companies and among countries. It is also noted that important factors contributing to sustainable 3R practice implementation include not only the 3R facilities, but also marketing tools that attract 3R businesses to get involved. Therefore, the technological expertise that facilitates those business people to grow further in this area, for example market research of eco-products, is also vital.

In terms of hardware, it is clearly seen for the necessity of this type of technology for 3R practice and promotion. More advanced technologies are generally required by 3R implementers for improving the efficiency and effectiveness of the 3R activities. These technological hardware is often seen in the form of innovative equipment, processes or systems that are more capable and efficient in coping with the waste – collection, transport, sorting and recycling – than traditional hardware.

Reference


PCD, 2006. Available at website: http://www.pcd.go.th

In line with the 3R technologies, skilled personnel occupying technological know-how and market opportunities for the 3R technology applications are also desired for implementing 3R technologies efficiently and effectively. Until recently, a range of individuals and agencies have already included 3R technologies within their activities. However, most 3R implementers are often applying only basic 3R technologies, which could be characterized as for example low cost, simple structure and components, average performance and easy managed, within their businesses. As such, more appropriate and advanced technologies with a reasonable cost may be needed to enhance the capacity of 3R activities in Thailand.
<table>
<thead>
<tr>
<th>Type of technology</th>
<th>Measures</th>
<th>Supporting factors</th>
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</thead>
<tbody>
<tr>
<td>IT</td>
<td>Computer Applications</td>
<td>Capacity building</td>
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<td></td>
<td></td>
<td>Application utilization</td>
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<td></td>
<td></td>
<td>Partnership</td>
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<td></td>
<td></td>
<td>Technology transfer</td>
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<tr>
<td>Database &amp; Network system</td>
<td>Partnership</td>
<td>Data availability</td>
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<td></td>
<td>Institutional arrangement</td>
<td>Maintenance, e.g. budget</td>
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<td></td>
<td>Economic incentive</td>
<td>Soft loan and subsidy</td>
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<tr>
<td>Know-how</td>
<td>Technology Modification</td>
<td>Capacity Building</td>
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<td></td>
<td></td>
<td>Operation</td>
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<td></td>
<td>Partnership</td>
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<td></td>
<td>Technology transfer</td>
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<td>Economic incentives</td>
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<td></td>
<td></td>
<td>Soft loan and subsidy</td>
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<td>R&amp;D Innovation</td>
<td>Capacity Building</td>
<td>Promote R&amp;D</td>
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<td></td>
<td></td>
<td>Partnership</td>
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<td></td>
<td></td>
<td>Research and private sector to promote technology, e.g. commercial scale</td>
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<td></td>
<td>Economic Incentives</td>
<td>Soft loan and subsidy, and economic instruments e.g. user charge</td>
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<td></td>
<td>Partnership</td>
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<td></td>
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<td>Technology transfer</td>
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<td></td>
<td>Capacity Building</td>
<td>Operation and Maintenance</td>
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<tr>
<td>Hardware</td>
<td>Process, machine, equipment</td>
<td>Economic incentives</td>
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<tr>
<td></td>
<td></td>
<td>Soft loan, subsidy and economic instruments, e.g. user charge</td>
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<td>Partnership</td>
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<td>Technology transfer</td>
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<td></td>
<td>Capacity building</td>
<td>Maintenance and operation</td>
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<td>Strategies</td>
<td>Measures/ practices</td>
<td>Approach</td>
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<td><strong>Stage 1: Production</strong></td>
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<tr>
<td>1.1 Promoting recycled material utilization</td>
<td>Standardization of recyclable materials</td>
<td>Regulatory</td>
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<tr>
<td></td>
<td>Material Exchange</td>
<td>Social</td>
</tr>
<tr>
<td>1.2 Improving resource efficiency</td>
<td>Clean Technology (CT)</td>
<td>Social</td>
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<tr>
<td></td>
<td>Environmental Management System (EMS)</td>
<td>Social</td>
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<tr>
<td>1.3 Promoting eco products</td>
<td>Life Cycle Assessment (LCA)</td>
<td>Social</td>
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<tr>
<td></td>
<td>Eco-design</td>
<td>Social</td>
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<tr>
<td><strong>Stage 2: Distribution and Consumption</strong></td>
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<td></td>
</tr>
<tr>
<td>2.1 Enhancing market mechanism/incentives</td>
<td>Eco-labelling</td>
<td>Social</td>
</tr>
<tr>
<td>2.2 Increasing demand of eco products</td>
<td>Green Supply Chain</td>
<td>Social</td>
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<tr>
<td></td>
<td>Green Procurement</td>
<td>Social</td>
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<tr>
<td><strong>Stage 3: Discarding and Treatment</strong></td>
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<tr>
<td>3.1 Increasing recyclable material recovery</td>
<td>Community Network for Collection of Recyclables</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>Public Awareness Campaign</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td>Deposit-refund system</td>
<td>Regulatory</td>
</tr>
<tr>
<td>3.2</td>
<td>Promoting reuse/recycling capacity</td>
<td>Take-back system</td>
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<td></td>
<td>Integrated Waste Management Facilities</td>
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<td>Waste Management Business</td>
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<tr>
<td>Strategies</td>
<td>Measures/ practices</td>
<td>Supporting Instruments</td>
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</tr>
<tr>
<td>Stage 1: Production</td>
<td></td>
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</tr>
</tbody>
</table>
| 1.1 Promoting recycled material utilization | Standardization of recyclable materials | • *Legislation & Standard* – Harmonized standards developed for typical recyclable materials  
• Capacity Building -  
Material Exchange | • *Partnership* – Matching waste providers and users  
• Awareness Raising – Promotion of the concept among potential industries  
• Institutional Arrangement – Establishing coordinating body  
• Technology – Developing database of supply and demand |
| 1.2 Improving resource efficiency | Clean Technology (CT) | • *Self-regulation* – Self implementation to improve resource efficiency  
• Awareness Raising – Promotion of the concept among potential sectors  
• Capacity Building – Training and demonstration on appropriate management practices and technology development  
• Economic incentives – Subsidies and soft-loans for process improvement  
• Institutional Arrangement – Supporting units/agencies for CT promotion  
• Partnership – Technology transfer through international cooperation  
• Technology – Application of appropriate technology for pollution prevention and resource efficiency improvement |
| Environmental Management System (EMS) | - **Self-regulation** – Self implementation to improve environmental performance
- Awareness Raising – Promotion of the concept among potential sectors
- Capacity Building – Training on system requirement and organizational improvement
- Economic incentives – Subsidies and tax differentiation for accredited firms
- Institutional Arrangement – Supporting units/agencies for EMS promotion and auditing agencies for accreditation
- Technology – Application of appropriate technology for environmental management |
<table>
<thead>
<tr>
<th>Strategies</th>
<th>Measures/ practices</th>
<th>Supporting Instruments</th>
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</thead>
<tbody>
<tr>
<td><strong>Stage 1: Production (cont'd)</strong></td>
<td></td>
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</tr>
<tr>
<td>1.3 Promoting eco products</td>
<td>Life Cycle Assessment (LCA)</td>
<td>• <em>Self-regulation</em> – <em>Self implementation to improve environmental performance</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Awareness Raising – Promotion of the concept among stakeholders including public and private sectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Capacity Building – Capacity building on LCA methodology and development of data inventories</td>
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<tr>
<td></td>
<td></td>
<td>• Institutional Arrangement – Key organization responsible for national inventories</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partnership – Technology transfer through international cooperation and information sharing among involved agencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Technology – Database development and application of available database to the local context</td>
</tr>
<tr>
<td>Eco-design</td>
<td></td>
<td>• <em>Self-regulation</em> – <em>Self implementation to minimize environmental impacts of products</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Awareness Raising – Promotion of the concept among potential producers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Capacity Building – Capacity building on product R&amp;D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Economic incentives – Subsidies and tax differentiation for eco-products</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partnership – Technology transfer through international cooperation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Technology – Technology development and modification for eco-product manufacturing</td>
</tr>
<tr>
<td>Stage 2: Distribution and Consumption</td>
<td>Eco-labelling</td>
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</tr>
<tr>
<td>--------------------------------------</td>
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<td></td>
</tr>
</tbody>
</table>
| 2.1 Enhancing market mechanism/incentives | • *Self-regulation* – *Self implementation minimize environmental impacts of products*
| | • Awareness Raising – Promotion of the concept among potential producers and consumers
| | • Capacity Building – Capacity building on product and service R&D
| | • Economic incentives – Subsidies and tax differentiation for labelled products/services
| | • Institutional Arrangement – Agencies for technical requirement establishment and label issuance
<p>| | • Technology – Technology development and modification for eco-product manufacturing and service providing |</p>
<table>
<thead>
<tr>
<th>Strategies</th>
<th>Measures/ practices</th>
<th>Supporting Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 2: Distribution and Consumption (cont’d)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Increasing demand of eco products</td>
<td>Green Supply Chain</td>
<td>• Partnership – Cooperation among producers and suppliers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Awareness Raising – Promotion of the concept among stakeholders including suppliers</td>
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<td>• Capacity Building – Capacity building on environmental management for suppliers (particularly SMEs)</td>
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<td>Green Procurement</td>
<td>• Self-regulation – Self implementation support eco-products/services</td>
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<td>• Awareness Raising – Promotion of the concept among huge buyers such as governmental agencies and large firms</td>
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<td>• Capacity Building – Capacity building on appropriate establishment of procurement criteria/requirements</td>
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<td>• Partnership – Cooperation among large firm and SMS suppliers</td>
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<td>• Technology – Development of eco-product/service database</td>
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<tr>
<td><strong>Stage 3: Discarding and Treatment</strong></td>
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| 3.1 | Increasing recyclable material recovery | Community Network for Collection of Recyclables | • **Partnership** – *Participation of stakeholders including general public, local government and waste management firms*
  • Awareness Raising – Promotion of environmental awareness particularly on waste segregation
  • Capacity Building – Capacity building on proper waste separation and collection
  • Economic incentives – Price incentives for quality recyclable waste
  • Institutional Arrangement – Networks of waste collection such as garbage banks, drop-off stations
  • Technology – Application of technology to facilitate waste collection such as aluminium can crushing machine |
| Public Awareness Campaign | • **Awareness Raising** – *Promotion of environmental awareness particularly on waste segregation*
  • Institutional Arrangement – Networks of involved organizations to enhance information accessibility for various target groups
  • Partnership – Participation of general public |
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<tr>
<th>Strategies</th>
<th>Measures/ practices</th>
<th>Supporting Instruments</th>
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<td><strong>Stage 3: Discarding and Treatment (cont’d)</strong></td>
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<tr>
<td>3.1 Increasing recyclable material recovery (cont’d)</td>
<td>Deposit-refund system</td>
<td><em>Regulation – Establishment of regulation for potential materials to participate in the system to avoid free-riders</em></td>
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<td><em>Awareness Raising – Promotion of the concept among producers and consumers</em></td>
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<td><em>Capacity Building – Capacity building on system development for related agencies</em></td>
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<td><em>Economic incentives – Deposit on materials/products</em></td>
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<td><em>Institutional Arrangement – Key organization responsible for system development and management</em></td>
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<td><em>Partnership – Cooperation between public and private sectors</em></td>
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<td>Take-back system</td>
<td><em>Regulation – Establishment of regulation for potential products to participate in the system to avoid free-riders</em></td>
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<td><em>Awareness Raising – Promotion of the concept among producers and consumers</em></td>
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<td><em>Capacity Building – Capacity building on development of appropriate take-back systems and management of the waste</em></td>
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<td><em>Institutional Arrangement – Key organization responsible for system development and management</em></td>
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<td><em>Partnership – Cooperation between public and private sectors</em></td>
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<td><em>Technology - Application of technology for waste management and disposal particularly hazardous waste</em></td>
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<td>3.2</td>
<td>Promoting reuse/recycling capacity</td>
<td>Integrated Waste Management Facilities</td>
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<td>• Technology - Application of technology for appropriate waste management and recycling</td>
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<td>• Capacity Building – Capacity building on technology development and maintenance</td>
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<td></td>
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<td>• Economic incentives – Private investment promotion</td>
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<td>• Partnership – Cooperation between public and private sectors</td>
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<td>• Regulation – Establishment of regulation for local government to move towards integrated facilities instead of landfill disposal</td>
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<td></td>
<td>Waste Management Business</td>
<td>• Technology - Application of technology for appropriate waste management and recycling</td>
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<td></td>
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<td>• Capacity Building – Capacity building on technology development and maintenance</td>
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<td>• Economic incentives – Investment privileges</td>
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<td>• Regulation – Establishment of regulation for waste management facilities (factory type 101, 105 and 106)</td>
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<td>Stage</td>
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| Production            | Promoting recycled material utilization | Standardization of recycled materials                   | - Technology modification to accommodate utilization of recycled material substitution.  
- Technology modification to improve quality of recyclable material to meet standard.  
- R&D of recyclable material ratio standard. | - Demand-Supply database of recycled materials.  
- Data interchange system among generators and users of recycled materials. | - R&D on recycling technology for various types of waste. | - Appropriate recycling technology to improve the quality of recycled materials.  
- WEEE technology for e-waste separation |
| Material exchange     |                                     |                                                          | - Computer application for minimizing the use of raw materials and other resources, such as pinch technology.  
- database of CT Expert | - On-line environmental monitoring system. | - Good management and operation practices.  
- Application of new management practices such as lean manufacturing, six-sigma. | - Processes that reduce raw material use -- energy and resource efficiency equipment. |
| Improving resource efficiency | Cleaner technology (CT) | Clean technology (CT)                                     | - Computer application for minimizing the use of raw materials and other resources, such as pinch technology.  
- database of CT Expert | - On-line environmental monitoring system. | - Good management and operation practices.  
- Application of new management practices such as lean manufacturing, six-sigma. | - Processes that reduce raw material use -- energy and resource efficiency equipment. |
| Environmental Management System (EMS) | Environmental Management System (EMS) | Environmental Management System (EMS)                  | - Life cycle inventory (LCI) database.  
- LCA software | - Application of LCA methodology to local manufacturing processes.  
| Promoting eco-products | Life cycle assessment (LCA)        | Life cycle assessment (LCA)                              | - Life cycle inventory (LCI) database.  
- LCA software | - Application of LCA methodology to local manufacturing processes.  
- Life Cycle Costing, Life Cycle Impact Assessment | - TEA Lab |
| Eco-design            | Eco-design                          | Eco-design                                               | - IT system that effectively shares information of eco-products and eco-product standard for entrepreneurs and customers.  
- Computer-aid design program.  
- Thai ROHs | - Product R&D to facilitate eco-product production, as well as lowering production cost.  
- Market research of eco-products. | - Product R&D to facilitate eco-product production, as well as lowering production cost.  
- Market research of eco-products. | - TEA Lab |
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<th>Technology</th>
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<tr>
<td>Distribution and Consumption</td>
<td>Enhancing market mechanism/incentives</td>
<td>Eco-labelling</td>
<td>- Product and process R&amp;D to comply with eco-labelling standards.</td>
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<td>Increasing demand for eco-products</td>
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<td>- Knowledge transfer from large firms to SME suppliers.</td>
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<td>Green procurement</td>
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<td>Database of eco-products to facilitate green procurement.</td>
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<td>Technology</td>
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| Discarding and Treatment     | Increasing recyclable material recovery         | Community Network for Collection of Recyclables                                     | - IT system that improves efficiency of waste management and recycling center network.  
- IT techniques that share information (good practices) and raise awareness among communities.  
- Monitoring system of waste collection efficiency.  
- Design and management of collection and separation systems.  
- Collection and pretreatment equipment, such as **volume reducing device.** (rice husks, tyres, plastic, poly styrene)  
- Well-designed garbage bins that efficiently support waste sorting at source. |
| Public Awareness Campaign    |                                                  | - Information technology as one of accessible communication channel.                |                                                                                                                                                                                                          |
| Deposit-refund system        |                                                  | - Design and management of collection and separation systems.                      |                                                                                                                                                                                                          |
| Take-back system             |                                                  | - Efficient collection equipment such as automatic refund machines.                |                                                                                                                                                                                                          |
| Promoting reuse/recycling capacity |                               | Integrated Waste Management Facilities                                             | - Computer model (such as Integrated Waste Management) to facilitate waste management.  
- Technology modification for effectively applying technology from foreign countries to local condition.  
- R&D Pyrolysis technology for energy.  
- Lab waste handling R&D.  
- Hazardous waste recycling plants.  
- Satellite recycling/ pretreatment plants.  
- Processes that help improve material sorting quality and facilitation.  
- Processes that transform organic waste to energy and/or manure and EM.  
- Composting technology and management system.  
- Stuff repairing centers and stuff donating centers available across communities.  
- Efficient waste collection technology to ensure supply security.  
- Mobile unit or system for construction/ demolition waste recycling and management. |

| Waste Management Business | - | - R&D for innovative recycling technology.  
| | | - R&D of used oil applications.  
| | | - Technology transfer of e-waste recycling management.  
| | | - Well-managed e-waste recycling centers.  
| | | - Transport and logistic that facilitate delivering sorted materials to recycling plants (Sa-leng). (Tyre)  
| | | - Technology that helps improve the processes of extracting, distillation or purification of chemical mixtures to be able to recycle.  
| | | - Waste to energy technology including utilization of waste as fuel substitution. |