



asia eco-design electronics

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## Country report on the Thai electronics sector

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Issues and capacity building needs in relation to international and national product-related environmental regulations and other requirements

By Electrical and Electronics Institute (EEI), Thailand

Supported by the European Commission and coordinated by The Centre for Sustainable Design (UK)



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Asia Eco-Design Electronics ([www.cfsd.org.uk/aede](http://www.cfsd.org.uk/aede)) aims to raise awareness of product-related environmental issues and develop eco-design tools for the Chinese, Indian and Thai electronics industries

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# Foreword

## Purpose of the report

- To provide a general analysis of the electrical and electronic industries in Thailand at the present time.
- To learn more about the industry and regulatory situation in the European Union and Japan, and what initiatives exist which relate to environmental sustainability.
- To study the impact on industrial markets concerning the rules and regulations imposed by the European Union and Japan.
- To identify the management, personnel and technical needs of the industry to meet existing and future legislation.

## Background

The electrical and electronic equipment (EEE) industry consists of assemblers and suppliers. While most electrical equipment suppliers are Thai SMEs, electronic suppliers are mainly joint-ventures that produce brand name products for domestic and international markets. Some electronic suppliers deliver 'ready-to-use' parts to assemblers for use in the production process. These include, for example:

- Matsushita Electrics Co, Ltd. producer of Panasonic
- Kang Yong Electrics Public Co, Ltd. producer of Mitsubishi
- Federal Electrics Co. Ltd. producer of Sharp.

The overall picture of the EEE industry is a reflection of supply and demand. Thai domestic demand for EEE product drives production volumes for the domestic market and for imports. Electrical goods are mainly for local use and comprise items such as electric rice cookers, refrigerators, electric fans, and televisions, etc. Electronic product makers are joint-ventures with non-Thai companies such as Taiwanese, Koreans and the large producers, which are generally foreign owned. The perceived trend in demand for both electrical and electronic products is upward.

The development of the EEE industries in Thailand began 40 years ago when electricity was first introduced on a national scale. Electric appliances have increasingly played an important role in Thai daily life and include electric fans, refrigerators, air-conditioners, radio-tape recorders, televisions, etc. These appliances were initially imported merchandise from Japan and Taiwan. However, the Thai government later created an investment promotion policy for appliance production in response to the overwhelming domestic need. Around the same time Japanese investors moved their production bases to Thailand to mitigate the high cost of production in Japan. Several domestic manufacturers were established and the numbers have increased over time. Electric appliance production has since evolved from the assembly of imported components to the production of components. This shift has been strongly supported by the Thai government.

# 1.0 Introduction

## 1.1 Overview of the electronics sector

**Table 1: Number of electrical and electronic factories by size: 2006 (unit = number)**

	Registered capital (million baht)			Not specified	Total
	< 50	50–200	> 200		
Electrical manufacturers	602	126	94	6	828
Electronic manufacturers	572	196	143	1	912
Traders	117	16	5	3	141
Repairers	74	6	1	0	81
Not specified	254	42	41	64	401
<b>Total</b>	<b>1,619</b>	<b>386</b>	<b>284</b>	<b>74</b>	<b>2,363</b>

Source: Electrical and Electronics Institute (EEI), 2007

**Table 2: Number of factories by size and investment type (unit = number)**

	Investment capital (million baht)			Total
	< 50	50–200	> 200	
<i>Electrical product</i>				
100% Thai	449	52	12	513
Joint venture	112	43	38	193
100% foreign	54	24	38	116
<i>Electronic product</i>				
100% Thai	309	44	21	374
Joint venture	112	76	46	234
100% foreign	98	68	67	233

Source: EEI, 2007

Of the total enterprises in Table 2, most Thai entrepreneurs have small electrical businesses, whereas most foreign entrepreneurs have small to medium sized electronic businesses. Medium to large electronic businesses are mostly joint ventures.

Multinational corporation (MNC) investment in 2006 was significant. Foreign investors invested in 349 Electrical and Electronic (EE) factories – 152 small enterprises, 105 large enterprises, and 92 medium-sized enterprises. Joint ventures amounted to 427 factories – 224 small enterprises, 119 medium enterprises and 84 large enterprises.

### Employment

587 SMEs in the EEE industry included those benefiting from foreign investments. These factories, especially the large ones (189), play an important role in generating domestic employment. According to the Electrical and Electronics Institute (EEI) statistics, it was found that SMEs employed 197,316 workers and 336,687 workers were employed by the larger companies.

Thailand's major export markets are Japan, USA, ASEAN, EU and China (details in Table 3). For electrical products, Japan ranked first in the Thai export market with a value of 104,603 million Baht (mB), and the EU ranked fourth with 83,062 mB. For electronic exports, the EU was the second largest market with a value of 166,571 mB, and Japan was the fifth with a value of 118,645 mB.

### Characteristics of SMEs

According to the Ministry of Industry Ordinance, medium to small businesses are classified for manufacturing as follows:

**Small enterprises** are businesses that employ not more than 50 workers or own business assets of at least 50 mB for manufacturing.

**Medium enterprises** are businesses that employ no less than 50, but not more than 200 employees; these enterprises must also hold at least 50 mB business assets, no more than 200 mB for manufacturing.

In some cases the employment levels match the definition of small enterprises, although the assets match the definition of a medium enterprise, or vice versa. In this case, the industrial code sets the criteria on the basis of lower employment levels.

### Domestic consumption

Thais have consumed large amounts of EEE over the last three years ([www.nso.go.th](http://www.nso.go.th)). The total market size of certain EEE categories (as gathered by Asia Pte Ltd (GfK)) are shown in Table 4.

EEE becomes 'end-of-life' (EoL) when it can no longer be used. From the 2005 survey results from Basel Convention Regional Centre in China (BCRC), television (TV) and personal computer (PC) owners are likely to have TVs/PCs repaired. This implies a prolonging of the lifetime of TVs and PCs with worn-out parts being replaced by used or new parts. EoL TVs and PCs are also donated to charity or refurbished and resold for further use.

**Table 3: Export market of Thai electrical and electronic products: 2006**

Market	Value (million Baht)	Proportion (%)
<i>Electrical products</i>		
Japan	104,603.20	18.65
USA	97,960.00	17.46
ASEAN	87,252.61	15.55
European Union	83,062.33	14.81
China	27,272.11	4.86
Others	160,849.33	28.67
<b>Total</b>	<b>560,999.58</b>	<b>100.00</b>
<i>Electronic products</i>		
ASEAN	174,066.84	17.43
European Union	166,571.23	16.68
USA	161,571.30	16.18
China	129,714.72	12.99
Japan	118,645.43	11.88
Others	248,238.43	24.85
<b>Total</b>	<b>998,807.95</b>	<b>100.00</b>

**Table 4: Thai market share of certain electrical and electronic products (unit = unit)**

Product	2006	2005	2004	2003
Air conditioners	768,968	371,812	288,786	237,695
Colour television sets	2,659,245	2,462,800	2,114,067	1,894,712
Desktops & laptops (Bangkok & vicinity)	409,315	357,137	561,701	366,275

Source: EEI, January 2007

TVs, PCs, and cathode ray tube waste exists largely in the Bangkok Metropolis. Upcountry, they are more likely to be found in the central area. Mobile phone waste is prevalent both in Bangkok and the east of the country.

Thailand's waste management has been very systematic for CRT manufacturing scrap. However other categories of EEE, eg. TV, PC, and CRT products, have not been uniformly managed at EoL. EoL household products are dismantled by informal collectors with saleable parts needed by material recycling business generally sold to private traders. Off-specification or defective products in factories are destroyed and sent to landfill.

## 1.2 Key electronics industry associations, multipliers and information dissemination routes

### Key electronics industry associations are:

- 1 The Federation of Thai Industries (FTI)
- 2 The Association of Thai Electrical and Electronic Industries
- 3 Thailand Computer Industries Club
- 4 Thailand Air-Condenser Industries Club
- 5 Thailand Telecommunications Club
- 6 The Engineering Institute of Thailand Under H.M. The King's Patronage (EIT)
- 7 Air Conditioning Engineering Association of Thailand (ACAT)
- 8 Thai Mechanical and Electrical Design and Consulting Engineer Association (MECT)
- 9 Illuminating Engineering Association of Thailand (TIEA)
- 10 Thai Electrical and Mechanical Contractors Association (TEMCA)

### Industry associations within the FTI are:

- 11 The Electrical, Electronics and Allied Industries Club
- 12 Air-conditioner/condenser Industries
- 13 Plastic Industries
- 14 Metal Industries
- 15 Sustainable Materials Industries

### Non-government organisations that act as information dissemination routes are:

- 16 Thailand Environment Institute (TEI)
- 17 Electricity Generating Authority of Thailand (EGAT) – a Federation Enterprise
- 18 National Metal and Materials Technology Center (MTEC)
- 19 National Electronics and Computer Technology Center (NECTEC) and Software Industry Promotion Agency (SIPA). These are multipliers.

### Government offices that act as information dissemination routes such as:

- 20 The Department of Industrial Works (DIW)
- 21 Department of Industrial Promotion (DIP)
- 22 The Board of Investment of Thailand (BOI)
- 23 The Office of Industrial of Economics (OIE)
- 24 Thai Industrial Standards Institute (TISI)
- 25 Pollution Control Department (PCD)

### Public and private universities include:

- 26 King Mongkut's Institute of Technology, Ladkrabang (KMITL)
- 27 Asian Institute of Technology (AIT)
- 28 Chulalongkorn University (CU)
- 29 Kasetsart University (KU)
- 30 Rangsit University
- 31 King Mongkut's Institute of Technology, North Bangkok (KMITNB)
- 32 Ram Khamhaeng University (RU), etc.

## 2.0 Legislation and industry initiatives

### 2.1 Existing legislation relating to environmental and sustainability requirements in the EU and Japan

#### Waste Electrical and Electronic Equipment directive (WEEE)

The WEEE Directive, based on the 'producer responsibility' principle, was set-up to be used as a measure to prevent increases in quantities of waste electrical and electronic equipment (WEEE), to promote the reuse, recycling, and recovery of parts and materials through 'take-back' and collection by producers, and to reduce the risks and environmental impacts of WEEE treatment.

Key aspects of the WEEE Directive can be summarised as:

- 1 Producer Responsibility – EU producers and importers are required to 'take back' the EoL WEEE without any charges, regardless of how the products were sold (including e-commerce sales).
- 2 The EC determined minimum targets for WEEE recycling and recovery that were implemented by 31 December 2006.
- 3 The EC determined producers' responsibility for WEEE management expenditures, from collection, recovery, adjustment, recycling and treatment.
- 4 Producers must provide the following information:
  - 4.1 Provide consumers with information about procedures to implement at product EoL.
  - 4.2 Provide recyclers with information about dismantling and the details of hazardous substances contained in the products.
  - 4.3 Provide the government with information about sales, take-back, and recycling.

The WEEE Directive covers 10 product groups existing before and after enforcement. The categories were set out and designed for use with a voltage rating not exceeding 1,000 volts for alternating current and 1,500 volts for direct current.

Coverage and minimum targets of recovery, reuse, and recycling are shown in Table 5.

After the enforcement, there will be a five year transitional period, i.e. the producers currently in business will be collectively responsible for expenditure associated with historical WEEE management.

The impact of the WEEE Directive in Thailand is largely reflected in increased imported quantities of WEEE, despite the Department of Industrial Works (DIW) Notification on Permitted Conditions of Importing the Used Electrical and Electronic Equipment as Hazardous Substances into the Kingdom (2003). The imported WEEE quantities which have complied with the Thai department's notification as well as the Basel Convention have increased. According to DIW statistics, there were 2.9 million items or 222,000 tons of old e-products imported into Thailand between February 2004 and January 2005. EEI constructed an e-waste inventory with Japanese support using industrial information derived from the government and private

**Table 5: Target coverage of WEEE treatment**

Group	Product group	Recovery*	Re-use/recycling*
1	Large household appliances	80%	75%
2	Small household appliances	70%	50%
3	IT Telecommunication equipment	75%	65%
4	Consumer equipment	75%	65%
5	Lighting equipment	70%	50%
6	Electrical and electronic tools	70%	50%
7	Toys, leisure and sports equipment	70%	50%
8	Medical devices with the exception of all implanted and infected products	To be specified on 31 December 2008	
9	Monitoring and control instruments	70%	50%
10	Automatic dispensers	80%	75%
Exception	Gas discharge lamps		80%

Note: (\*) weight/product weight



**Table 6: Trading of electrical and electronic products in Thailand (unit = unit)**

Year	Used television		Used personal computer		Used refrigerator		Used air conditioner		Used washing machine	
	import	export	import	export	import	export	import	export	import	export
2001	20,840	17,044	199,112	3,132	–	–	–	1,328	852	5,299
2002	11,983	20,052	83,348	18,188	1,255	1,274	3,714	1,563	544	6,234
2003	29,236	23,590	52,221	18,553	3,415	9,461	5,535	1,839	2,830	7,334
2004	22,870	27,753	74,928	22,664	9,501	9,647	13,285	2,163	38,420	8,628
2005	31,624	32,651	53,754	18,481	7,891	7,353	17,706	2,545	19,366	10,151
2006	102,083	59,944	49,574	20,476	3,600	11,313	36,384	2,994	12,116	11,942

sectors. Trading in used electrical and electronic products was estimated – see Table 6. New EEE produced domestically and for export maintains the strategy of delivering quality products with after-sales service including repairing and refurbishing (EEI, 2005). The increased quantities of WEEE place an increased burden on government quality control measures. The DIW has proposed to regulate importers and recyclers efficiently and conveniently using online methods to identify and accredit recycled materials for producing new products.

#### **Restriction of the Use of Certain Hazardous Substance in Electrical and Electronic Equipment (RoHS)**

RoHS aims to limit the use of hazardous substances which impact on the environment by the restriction of certain hazardous substances in EEE. RoHS covers the same product categories as WEEE, except categories 8 and 9. RoHS requires the following substances to be replaced: Lead, Mercury, Cadmium, Hexavalent Chromium, Polybrominated Biphenyls, and Polybrominated Diphenyl Ether in EEE. The following applications are exempt from the requirements:

- 1 Mercury in compact fluorescent lamps must contain no more than 5 milligrams per unit.
- 2 Mercury in straight fluorescent lamps for general use contains:
  - Halo phosphate no more than 10 milligrams
  - Tri phosphate (normal life cycle) no more than 5 milligrams
  - Tri phosphate (long lasting life cycle) no more than 8 milligrams.
- 3 Mercury in straight fluorescent lamps for special purposes
- 4 Mercury in other lamps not specifically mentioned in the RoHS Annex

- 5 Lead in cathode ray tubes
- 6 Lead in electronic parts and fluorescent lamps
- 7 Lead in alloy metals – ferrous with less than or equal to 0.35% by weight, aluminum with less than or equal to 0.4% by weight, and copper with less than or equal to 4%
- 8 Lead for soldering with high melting point (e.g. alloy soldering substances of tin and lead containing lead more than 85%)
- 9 Lead for soldering in server storage and the storage array system (exempt until 2010)
- 10 Lead for soldering in components of switching network structures, transmission signals and the network management of telecommunications
- 11 Cadmium plating, except as prohibited in the 91/338/EEC Directive
- 12 Hexavalent chromium that is used to prevent corrosion of ferrous carbon in cooling systems for carbon steel in absorption refrigerators

Substances prohibited will include those to be investigated, dependent on the progress of technology and science in related areas. Applications of scientific and technical progress may improve the annexes by setting up the substance concentrations following Article 4 (1) in any given parts of EEE components.

In May 2006, when Thai manufacturers were asked about RoHS in a survey, 84% of the respondents were aware of RoHS, 9% were very aware of RoHS, and 7% were not aware of RoHS. Of the respondents, 20% needed further information regarding RoHS. In addition, 44% needed training and 12.5% needed consulting on RoHS.

### Eco-design Requirements for Energy-using Products (EuP)

On 1 August 2003, the European Commission announced the Directive on Eco-design Requirements for Energy-using Products (EuP). EuP covers products, components and parts that consume all types of energy including electric energy, fossil energy and renewable energy. The product coverage is as follows:

- 1 Heating and water heating equipment
- 2 Electric motor systems
- 3 Lighting in both the domestic and tertiary sectors
- 4 Domestic appliances
- 5 Office equipment in both domestic and tertiary sectors
- 6 Consumer electronics
- 7 Heating, ventilating, and air conditioning systems

The following conformity will be presumed for EuP:

- 1 CE marked
- 2 Self-assessment performed in the internal design control or the environmental management audit system
- 3 Eco-label or other European harmonized standards marked.

Most EEE exported to the EU requires only the CE mark that Thai exporters are familiar with. Eco-design and energy efficiency are requirements that will need to be complied with. Thai producers of room air-conditioners and household refrigerators are also familiar with energy efficiency requirements (EER) however, EER of these products is already compulsory in Thailand. Another requirement is eco-labeling and internal design controls or the EU's eco-management and audit scheme (EMAS). EMAS has the potential for becoming a technical barrier to trade.

EuP was officially announced on 6 July 2005 and has been in force since 26 July 2006. The EC stated that the implementing measures that will be enforced will be announced no later than 6 July 2007 (however, at the time of writing no implementing measures have been defined).

For Thai manufacturers, conformity assessment and declaration of conformity will mean documentation, resulting in increased cost of production. EuP specifies that ecological profiles will also be required, highlighting the environmental impacts of the product in each product life cycle. This will mean that it will be necessary for Thai SMEs to understand the concept of the product lifecycle, which they presently lack. It is also a concern that 48% of the respondents surveyed by EEI in May 2006 did not know about EuP, 28% knew very little, and only 8% had sufficient information.

Since eco-design is a tool for EuP implementation, eco-design needs to be applied by manufacturers. It was found that 68% of manufacturers did not implement eco-design and only 5% implemented eco-design on one or more models per year. In terms of assistance, 24% of the survey respondents needed technical support in eco-design and 20% of the respondents needed financial support. In addition, 64% of SMEs needed eco-design training and 44% needed consulting.

### Japanese Laws

In 1990, the Waste Treatment and Recycling Committee of the Industrial Structure Council established the Guideline for Waste Treatment and Recycling for 10 business sectors and 15 commodities. The guidelines, which stipulated rules and objectives for businesses to follow, were intended to facilitate voluntary 3R-related efforts in all relevant industries. In 1994, the guidelines were revised. Measures and objectives under the Guidelines have been expanded and intensified and new commodities, such as nickel-cadmium batteries, motorbikes, tyres, lead batteries for automobiles, small gas cylinders and fire extinguishers have been added. ([www.meti.go.jp](http://www.meti.go.jp))

The legal framework to promote a recycling society in Japan can be separated into three parts:

#### Part 1: Fundamental laws' which include:

##### 1.1 *Fundamental Environment Law, August 1994*

This includes a fundamental environment plan including natural cycles and materials cycles in society.

##### 1.2 *Fundamental Law for Establishing a Sound Material-Cycle Society (Basic Framework Law), April 2001*

This aims to achieve material cycles in society, restrain the consumption of natural resources and reduce environment loads. It provided basic principles on the responsibilities of the state and local governments, business and society.

#### Part 2: A general framework, which includes the following:

##### 2.1 *Waste Disposal and Public Cleansing Law (Waste Management Law), April 2001*

This aims to strengthen countermeasures against improper disposal of industrial waste, ensures reliability of waste disposal, improves waste disposal facilities with involvement of the public and promotes reduced waste volume.

##### 2.2 *Law for Promotion of Effective Utilisation of Resources, April 2001*

This law outlines the fundamental principles, obligations of the public, manufacturers, local and central government offices, and government policies regarding a recycling-based society, natural resource utilisation, environmental impact reduction, and fundamental plans for promoting a recycling-based society and other national plans.

### Part 3: Product specific laws which include, for example:

#### 1.1 Containers and Packaging Recycling Law, April 2000

This law makes labeling to facilitate sorting and recovery a requirement for plastic and paper containers and packaging. Greater efforts to implement separate collection of packaging wastes in municipalities are expected.

#### 1.2 Home Appliances Recycling Law, April 2001

The law provides for recycling of household electrical goods. In response, the seven leading manufacturers of household appliances formed themselves into two groups (a Matsushita-Toshiba alliance, and a second group comprising Hitachi, Sanyo, Sharp, Mitsubishi, and Sony). Each group started its own recycling network by establishing facilities such as recycling plants and designated collection depots and setting recycling fees.

#### 1.3 Green Purchasing Law, April 2001

The law was established to actively procure environmentally friendly goods eg. recycled goods and to promote the provision of useful data concerning green purchasing. The law specifies the types of environmental goods to be promoted as a priority for procurement e.g. communication and printing paper (recycled paper), cars (low pollution vehicles), copiers (energy-saving types), etc.

#### 1.4 Electrical Appliance and Material Safety Law, April 2001

This included a revision of the Electrical Appliance and Material Control Law; in addition, the system was transformed into a system for ensuring 'safety' by the private sector.

or experts for quality control of installation or implementation of waste treatment systems.

The Act requires the establishment of Environmental Funds (Article 22) for activity expenditures specified in Article 23. This includes waste treatment systems funded and implemented by government or local government offices, or leased by the local governments of the federal enterprises in need of waste treatment systems, or leased by those in the private sector who are also required to manage waste treatment systems, or individuals permitted to operate as sub-contractors for waste treatment services. Support and finance for businesses related to environmental promotion and conservation are limited by Funding Committee approval and agreed by the National Environment Board.

Article 52 stipulates that the Pollution Control Committee proposes action plans and recommends amendments or revisions of related laws in controlling, preventing, reducing, or treating pollution; it also recommends measures related to tax promotion, private investment in pollution control, promotion of environmental conservation and recommends service fees for overall waste treatment systems.

Enforcement of the Act lays down the environmental policies, formulation of environmental quality standards, planning of environmental quality management, promulgation of conservation areas and environmental coverage areas, and for major projects to report environmental impacts, etc. Waste recycling is however not included in the Act.

### Industrial Product Standards Act (1968)

The Act formulates industrial product standards for industrial promotion, safety, or damage that might be caused to the public, industry or the national economy.

Persons allowed to use the labels of these standards must produce products complying with standards or import standardised products. Industrial standards labels are to be placed on the product. The misuse of the labels by those not eligible to use them and the imitation of labels are strictly prohibited and enforced.

Activities of the Thai Industrial Standards Institute consist of the following.

- Formulation of standards e.g. domestic standards (Thai Industrial Standards (TIS)), international standards (ISO, IEC, etc.), Codex
- Product quality certification eg. TIS certification, product registration, inspection for international standards institute, green label certification (cooperation with the Ministry of Industry and Thailand Environment Institute)
- Management system certification, e.g. HACCP certification, food hygiene certification, TIS 7000 certification

## 2.2 Existing legislation in Thailand

### The Enhancement and Conservation of the National Environmental Quality Act (1992)

The Act aims to prevent the deterioration of environmental quality, e.g. soil, water and air pollution, unsustainable forestry practices, population increases on waterways, improper utilisation of resources, etc. The Act encourages the public and the private sector to participate in environmental quality promotion and conservation. It defines the functions of government, public enterprises, and local government. It also defines pollution control measures including the management of air pollution treatment systems, water pollution treatment systems, sewage treatment systems and tools or equipment to resolve the pollution problems. In addition, responsibilities of parties related to pollutants and the use of environmental funds are also established.

For measures related to environmental promotion in factories, the Act requires factory owners (or sources of pollutants) to be responsible for waste treatment systems of air, water and others. They are entitled to government support and import tax reduction for waste treatment equipment, foreign consultants

- Accreditation of certification bodies, laboratories, inspection bodies, registration offices for experts, curriculum, and training organisations related to standards
- Testing
- Information service
- Implementation following the agreements on technical barriers to trade (TBT) on the application of sanitary and phytosanitary measures.

This Act is a tool for controlling industrial products complying with the standards and permitting import of products complying with the standards. Therefore, it is used for selection of products complying with safety standards to be permitted to be imported or sold in the country. Producer's 'take back' of WEEE for treatment or recycling is not under the Act's coverage.

### **Hazardous Substances Act (1992)**

Hazardous substances are used in a variety of businesses and some hazardous substances cause severe harm to humans, animals, plants, property, and the environment. Despite existing acts that controlled hazardous substances, there were many acts that fall under the authority of many ministries, departments and divisions issued in different eras, resulting in differently regulated and insufficient coverage. The Hazardous Substances Act (1992) was instituted to improve control of existing hazardous substance acts to cover every hazardous substance, and formulate criteria and means to appropriately control hazardous substances. In administration systems, it requires cooperation between the offices engaged in monitoring and controlling hazardous substances.

Hazardous substances are defined as follows.

- Substances that can be explosive.
- Substance that is flammable.
- Substances that are oxidized and peroxide substances.
- Substance that is poisonous.
- Substances that causes disease.
- Substances that are or can become radioactive.
- Substances that cause genetic modification.
- Substances that are eroded.
- Substances that cause irritation.
- Other substances including chemicals or others that can harm humans, animals, property, or the environment.

Hazardous substances are categorised for control as follows.

- Hazardous substances type 1 includes hazardous substances produced, imported, exported, or occupied; there must be compliance with criteria and methods defined.

- Hazardous substances type 2 includes hazardous substances produced, imported, exported, or occupied; authorities need to be notified and there needs to be compliance and criteria and methods need to be defined.
- Hazardous substances type 3 including hazardous substances produced, imported, exported, or occupied must be controlled by a permit granted by the authorities.
- Hazardous substances type 4 including hazardous substances produced, imported, exported, or occupied are prohibited.

Producers, importers, transporters, or storers of hazardous substances are responsible for any harm caused by the hazardous substance unless proved to be accidental or caused by the damaged person.

The Act stipulates a filing time in which damages caused by the hazardous substances must be requested. This must be within 3 years of when the damaged person is aware of the damage or hazard. Otherwise the claim for damages expires.

In cases where a hazardous substance is harmful to a person, animal, plant, or environment, if the government has incurred costs due to support subsidisation, removal, treatment, relaxation, or eradication of the damage, these costs are to be recovered. The recovered costs can be up to the level of the pre-existing condition, or nearly to, or to non-possessioned property, or natural resources, or the country asset. The public prosecutor may authorise suing for substitution of the amount lost from the producer, importer, transporter, or occupant of the said hazardous substances.

The Act applies to persons who produce, import, export, or store hazardous substances. However, the producer is not required to take back waste for treatment or recycling.

### **Industrial Estate Authority of Thailand Act (1979)**

The Act established the Industrial Estate Authority of Thailand (IEAT) to locate industrial estate areas, rented, leased, or sold; the Act provides manufacturers and business owners useful and continuous service in industrial estates.

Industrial estates may be established in a general industrial zone or export processing zone (EPZ). In EPZs special fees will be waived according to the Board of Investment Act, these include import tax, value added tax (VAT), excise tax for machinery, tool and equipment and parts necessary to manufacture products and accessories for factory or building installations.

Items imported into Thailand and brought into the EPZ for manufacturing products will be exempt of certain fees including import tax, VAT, and excise tax. Exports of by-products produced in the EPZ will be exempt from export tax. This includes VAT and excise tax exemptions.

Furthermore, a specific export processing zone (EPZ++) was also designed to modify existing EPZs to implement a one-stop economical service including production, trading, and servicing.

Producers on industrial estates need to comply with the Factory Act, 1992, which deals with waste management in production processes.

### **Factory Act (1992)**

The Act is issued to appropriately controlled factory businesses by categorising factories into 3 types. The Minister is authorised to promulgate the ministry decree to define case-by-case what factory is in which type. Factory types are defined as follows:

- A factory that can operate immediately without official notification and permission
- A factory that can operate with official notification
- A factory that can operate with official permission.

The Act enforces factories to comply with location, environmental conditions, characteristics of the building and the internal factory, characteristics and types of machinery, equipment, workers knowledge of the type or size of factory, implementation criteria, production procedures and tools. By these methods, the Acts aims to prevent, inhibit or abate danger, damage, concerns caused to persons or property in the factory or nearby residences. Standards and control methods for releasing waste and pollution impacts on the environment are also defined.

The Minister of Industry is authorised by posting factories type 1 or 2 in the government gazette in local industrial areas or industrial estates, following the Industrial Estate Authority of Thailand Act. The factory must comply with the criteria of the ministry decree.

All factories regardless of location must comply with various criteria and measures and are obliged to not make any impacts on the environment. The Minister is authorised to issue ministerial acts to formulate implementation criteria, production procedures, tools to prevent or inhibit or abate danger, damage and concern to persons or property in the factory or nearby residences. This authority is utilised to implement recycling related to production waste and to prohibit certain substances being used in production processes. The requirement of producers to take-back products for recycling is however out of the Act's authority.

### **Export and Import of Goods Act (1969)**

The Act authorises the government to collect special fees for certain imported or exported goods. The Act also authorises structural foreign trade to take place for the country's economy, security, and international recognition.

In cases of preserving the security of economics, public affairs, public health, national security, public peacefulness or other government activities, the Minister is authorised (with the cabinet's approval) to announce in the government gazette the following:

- Any commodity prohibited for import or export
- Any commodity permitted for import or export
- Any categories, kinds, quality, kinds, standards, quantity, volume, size, weight, prices, trade names, sign, trade marks, origin for the goods to be exported or imported as well as the countries to or from which the goods are exported or imported
- Formulation of types and kinds of commodity paying special export or import fees
- Formulation of exported or imported commodities to have documents of origin certification, quality certification, or other certification, agreed by international trade
- Other measures to beneficially organise import or export following the Act.

The Minister with the cabinet approval is authorised to determine special fees including revision or cancellation of special fees for export and import.

Where there is determination of certain goods to be permitted prior to export or import, exporting or importing those goods would be prohibited, except where the permit was granted by the Minister of Commerce or representative.

The Act is a tool for controlling imported and exported goods, allowing only goods complying with safety standards to be imported. There is no formulation for the producer or importer to take-back used products to be treated or recycled.

### **Public Health Act (1992)**

The principles of the Act are outlined below:

- The Act protects people with regard to hygiene and environmental health or environmental sanitation covering every activity, act. It covers various businesses that affect the population's environment and health at individual, household, and community levels, including SMEs, e.g. hawkers, stalls, restaurants, fresh markets, 125 other health risk related businesses and animal farming.
- The Act authorises local authorities to administer, supervise and enforce local requirements. The official can permit, not permit, suspend, withdraw, or fine. This system has been set-up because local administration is locally elected and is therefore closest to the people, and is likely to conform to the people's interests.



- Local authorities can efficiently implement by-laws that stipulate public-health authorities as educated and authorised authorities, to inspect and advise on environmental problems. These duties include consulting and advising authorities in the diagnosis, commanding, or issuing of orders.
- The Act stipulates the National Public Health Board as a centre including the Department of Health to be responsible for environmental sanitation. The centre has the roles of controlling, monitoring, and supporting implementation through local authorities by proposing health policies, and measures including ministry decrees and ministry notifications to the Minister. The Director General of the Department of Health is also authorised to take action in cases of severe or very urgent danger.
- The Act awards people or business owners the entitlement to file complaints to the Minister, if they have been unfairly treated by local authorities. In the case of misconduct made by an authority the authority is legally presumed to be guilty.

The Act expands the regulatory boundaries to various broader public health activities and enables improvements to occur simultaneously. The Act defines sufficient and effective in controls and prevention measures related to environmental health. It improves regulations for controlling monitoring and follow up. Control authorities are changed to supervision and follow-up authorities. Official authorities and legal punishments are improved to make them practical in their restrictions in order to efficiently supervise and prevent environment-related health problems.

The Act authorises local offices and authorities to control, monitor, and permit businesses that harm public health. Waste collection and treatment are local office responsibilities. Therefore, local authorities are specifically authorised but unable to force producers to take back products already sold to consumers. The waste may be collected and treated by law at the consumers own cost.

### **The Act of Marine Transportation in Thai Territorial Waters (1913)**

The Act controls all marine transportation in Thai territorial waters including loading, transporting, towing, leading, pushing, lifting, or digging with an engine or under any other power. The Minister is authorised to issue ministry decrees for defining the direction of rivers, canals, or sea territory used for ports and parking, defining marine lines, and making other definitions.

The act prohibits anybody to pour, dispose of, or to cause rock, stone, soil, mud, or other waste excluding petroleum and chemicals to enter Thai territorial waters, which may result in dirty water resources. It also prohibits anybody to pour, dispose of, or otherwise cause oil and chemicals or other things to be introduced into Thai territorial waters. Violation will be punished by imprisonment or fines.

### **Investment Promotion Act (1977)**

The Act promotes investment in major activities beneficial to the economic and social well-being and security of the country. Investment is encouraged in production for export, high value investments and in businesses that utilises agricultural products or natural resources/raw materials produced by Thailand, that the Investment Promotion Committee deems to be lacking, inadequate, or at a technically 'low level'.

The Act is an important tool to motivate investors to invest in Thailand, because it authorises the Board of Investment Promotion to define investment promotion territories. The investment promotion territories are used to formulate supporting policies to disperse industries into regions.

Tax-related privileges include exemptions from import taxes on machinery and accessories, raw materials or necessary items produced for export. Tax reductions on transportation, electric fees, water fees, are also permitted. The reduction also applies to the installation or construction of any facilities for conveniences accounting for 25% of the taxes to be paid in the said investment. Non-tax related privileges are: permission for foreigners to study investment channels; permission for technicians and experts to work in the promoted businesses; and the holding of land, occupying, importing or exporting currencies including the provision of guards and security.

Fundamental to the Act is to motivate foreigner investment in Thailand competing with the better offers of neighbouring countries. It was found that conditions offered to foreign investors need to be continually relaxed. The Board of Investment may not formulate investment conditions for promoted producers to take back used products for treatment or recycling.

## 3.0 Implications for suppliers

### 3.1 Implications for suppliers of existing EU, Japanese legislation and industry initiatives

#### Impacts on employment creation, labour standards

Personnel in the EEE industry are in demand in other industries especially in the automotive industry, which is growing in Thailand. Therefore, engineers in the EEE sector may be persuaded to leave the electronics industry due to higher wages in other sectors. This can have a knock-on effect on other engineers in the same firm.

EEL and the Electrical, Electronics and Allied Industries Club (EEAIC) have proposed a strategic development of capacity building in the EEE industry due to the critical lack of personnel working in the EE sector and the rapid development of EEE technology. The EEL, EEAIC and the Ministry of Labour expect the following to be improved and be supported as part of the long term plan between 2007 and 2008:

- 1 Technician training
- 2 Development of new graduates for the EEE industry
- 3 Development of labourers in industries that input into the EEE industry
- 4 Development of industrial trainers

To achieve the above targets, the following activities need to be implemented:

- Curriculum development
- Development of a national labour skill certification and wages in the EE industry
- Preparation of unskilled workers
- Development of trainers and EE manufacturers

#### Small suppliers and possible marginalisation

In 2002 sixty-nine EEE exporters to EU were surveyed, and results reported in a study by EEI (2005). It was found that most producers did not know about the RoHS Directive despite the fact that they would be directly affected. Up-to-date information, suitable technology, and RoHS consultants were identified as being needed.

Dialogue with factories was held by the Ministry of Industry on 9 September 2005 (DIW Memorandum, 2005). It was reported that manufacturers' readiness varied by business type, e.g. makers of basic parts, makers of semi-finished parts and makers of EEE products for export. At present, producers of EEE for export comply with the Restriction of Hazardous Substances directive (RoHS); others who are suppliers have not yet complied. Those that do not comply risk their business customers switching to other suppliers or that raw materials may be imported.

In mid-June 2006, the EEE producer representative at the Federation of Thai Industries (FTI) reported to the press that some European importers have demanded RoHS compliance certificates from Thai exporters prior to knowing the details of the RoHS requirements. As a consequence, Thai producers were concerned that they would require higher part standards than European suppliers. This issue heavily impacted SMEs and exports in the short-term.

#### Poverty alleviation

In May 2006, EEI held a manufacturer dialogue and the meeting concluded that the producers of own brands would be responsible for WEEE treatment. This would increase the cost of treatment incurred by the producers. For producers who were not original equipment manufacturers (OEM) or did not have their own brands, and to whom no information was given by buyers on RoHS requirements, the production lines would be suspended until further notice of production was approved. This resulted in a 50% downsizing of manpower to lower overhead costs.

The OEMs have insufficient information about the restrictions of RoHS. Producers that were not MNC subsidiaries lost the advantage of being able to product-test results to ensure the reliability of the product. This resulted in increased testing costs. This has a direct impact on future Asian exports. SMEs struggle to source new RoHS compliant materials at reasonable prices, because they do not conduct R&D on new types of materials. Large producers however can benefit from the economies of scale associated with the practice of purchasing large volumes of materials, which results in less expensive prices.

#### Costs of compliance

A 2002 survey (EEI, 2005) indicated the major obstacles to RoHS adjustment included material cost and information relating to materials and technology.

SMEs have been facing uneven burdens relative to the large producers. These include management, product re-evaluation and capital costs including new processes and new quality control schemes, lower yield and generation of more waste, and waste management costs.

Thailand has invested resources and efforts to increase management capability i.e. information gathering on new legislations, document preparation for proof of compliance, e.g. process examination and test reports, quality and composition controls, parallel production lines that need both materials and products inventory. Design for recycling has not been high on the agenda in meeting WEEE requirements and has had less focus.

Environmental concerns are a key cost for 2nd and 3rd tier suppliers compared to 1st tier suppliers. SMEs in the 2nd and 3rd tiers bear an uneven burden compared to the 1st tier. Third tier suppliers have undertaken adjustments and have incurred a heavier burden of the costs.

### Testing facilities

Adjustment to new legislation has a number of difficulties (Ramungul, 2006): proof of compliance, new material quality or reliability testing, and monitoring compliance and re-evaluation schemes. For proof of compliance, product and process data analysed by certification bodies needs to be obtained. Many forms need to be filled out and kept, and many audits need to be met. For material qualification and reliability tests, both time and resources are consumed. Material reliability needs to be tested through time and knowledge as numerous material 'behaviours' are still unknown. Support or data on new materials is limited. For monitoring compliance and re-evaluation schemes, product and processes need to be retested, double checked and cross checked. 68% of the respondents surveyed by EEI (May, 2006) replied that RoHS substances were tested and test reports and certifications were requested from vendors. However, Thai standards comparable to the EU are not in existence, causing implementation problems as to whether the standards are comparable to the buyers' standards.

Thai manufacturers however did not agree with the need to have a new laboratory established to reduce testing costs in parts analysis. Manufacturers expected to have existing laboratories expanded to cover all necessary analyses. If laboratories need assistance, the government stated that it would consider support in response to individual business plans proposed.

### Technology and process changes

In the 2002 survey (EEI, 2005) respondents indicated that they needed technical support in terms of information and technological development. In addition, government measures were also needed, especially financial and tax support and legal improvements. The substances that created problems were lead, PBBs, and PBDEs, respectively because the substituted substances could not be used by the implementation date. But from the 2006 survey, more than 50% of respondents were sure that their products were RoHS compliant (13.6% very sure, 41.8% sure, 22.2% moderate, 6.8% not so sure, 3.9% not sure). Among those who responded that suppliers' products were RoHS compliant, 35.9% of them were sure, 6.8% very sure and 26.2% moderately sure. Most buyers trusted imported parts to be RoHS compliant rather than local parts (26.2% against 7.7%). A considerable number of buyers trusted imports from certain countries to be RoHS compliant (57.3%).

An EEI survey in 2006 found that respondents produced 1 to 6 products in total but mostly 1 product. Production and development was mostly organised in relation to customer needs and R&D. Other production developments were organised by company working standards, TQM, Kaizen, Lean and six sigma approaches. The engineering methods utilised in production development reported by respondents were six sigma, Kaizen, Lean, and PDCA (Plan, Do, Check, Act); tools used were quality control (QC) tool, XRF, and EDX – among them, fish-bone diagrams were the most frequently used. In production development, engineers were primarily involved followed by production technicians and R&D engineers. Other staff engaged included design engineers, QC personnel, CNC engineers, managers, supervisors, and machine operators. Personnel involvement in production including survey and development were ranked highest, others were designing, checking defects from inappropriate product design, process and tool adjustment.

Product development was also surveyed. The respondents reported that most companies had their own product development that was mostly organised by QC and Kaizen production methods. Value engineering and ISO 9001:2000 were also employed. The three factors that had the most influence on product development were as follows:

- 1 customer specifications
- 2 customer complaints
- 3 customer surveys.

Responses showed that OEMs were leaders in product development. Development occurred in response to competition, specification changes, and R&D results. The process was unanimously formal and defined, and it was structured by engineering procedures, company standards, customer requirements, and quality procedures. Six sigma and design analysis were the methods most used for product development, and the tools utilised were SPC, EDX, and testing equipment.

Computer assisted design methods were utilised in engineering design processes and the tools used were mostly computers. The reason these tools and methods were used was because they were appropriate for products needing rapid design and development. Computers were also used for cost reduction purposes, accuracy, efficiency and quality control. Customers and superiors were those who required the methods and tools for convenience, quality, and cost reduction. Personnel involved were in engineering, quality, R&D, design, and QC technicians and R&D.



Engineering designers had complete freedom to select methods and tools in the engineering design process. However, the costs associated with the increased utilisation of methods and tools, was seen as an obstacle.

For eco-design, customers' main environmental requirements were RoHS and the ISO 14000 series. The respondents replied that internal environmental-related requirements were mostly relating to the ISO 14000 series, followed by RoHS and green procurement procedures. In handling environmental issues and requirements, the respondents mostly implemented the ISO 14000 series, RoHS, and the ISO 9000 series. They had experience in RoHS compliance and were trained in product and system checking.

In terms of eco-design, only some respondents had implemented RoHS compliant re-designs.

#### **Incentives for recycling/reuse and associated costs/benefits**

In September 2005 (DIW Memorandum, 2005), manufacturers of EU exports claimed that they were ready to comply with WEEE and RoHS and had no concerns with WEEE treatment. Treatment surcharges were planned to be paid in the EU without the need of return for local treatment due to the high logistical costs. Local reuse and recycling factories need upgrading for WEEE treatment. A proposal related to customs taxes of recyclable and valuable waste needs to be discussed among related offices to support manufacturers and recycling factories.

### **3.2 Implications on competitiveness vis-à-vis other Asian suppliers**

Japan's Ministry of Economy and Trade and Industry (METI) initiated cooperation under the Green Aid Plan (GAP) in 1992. The aim was to utilise Japanese expertise and knowledge for environmental improvements in developing countries. The principal policy of this plan was to support the self-help efforts of developing countries in relation to energy and environmental improvements. The host countries for GAP included Thailand, China, Indonesia, the Philippines, Malaysia, India and Vietnam.

On 1 May 2002, China announced that EEE products required the China Compulsory Certification (CCC) mark for 132 items with a 1 year adjustment period (1 May 2002 to 1 May 2003), in order to guarantee the safety and health of humans, plants, the environment, and natural conservation.

From 1 May 2003, Thai products exported to China need certification and inspection of quality standards and labeling with the CCC Mark.

The product coverage is very broad in EEE and includes the following: ([www.ccc-mark.com](http://www.ccc-mark.com))

- 1 Electrical Wires and Cables (5 categories)
- 2 Switches for Circuits, Installation Protective and Connection Devices (6 categories)
- 3 Low-voltage Electrical Apparatus (9 categories)
- 4 Small Power Motors (1 category)
- 5 Electric Tools (16 categories)
- 6 Welding Machines (15 categories)
- 7 Household and Similar Use Appliances (18 categories)
- 8 Audio and Video Apparatus (excluding acoustic apparatus for broadcasting services and automobiles) (16 categories)
- 9 Information Technology Equipment (12 categories)
- 10 Lighting Apparatus (excluding lighting apparatus with voltages lower than 36V) (2 categories)
- 11 Telecommunication Terminal Equipment (9 categories)
- 12 Motor Vehicles and Safety Parts (4 categories)
- 13 Agricultural Machinery (1 category)
- 14 Medical Devices (7 categories)
- 15 Fire Fighting Products (3 categories)
- 16 Detectors for Intruder Alarm Systems (1 category)

The Thai government is aware of the implications for industry competitiveness and sustainability, and has made efforts through international cooperation, especially with the Japanese government under the GAP.

In 2002, a project on the establishment of appropriate 'bring/buy back' of WEEE was proposed by the Pollution Control Department (PCD), the Department of Industrial Works, and the FTI. The project aimed to design and conduct an inventory programme of manufacturers and distributors of EEE as well as sources of WEEE. This was to establish and develop the appropriate programme/measure to 'bring/buy back' the EoL EEE from the consumers for 3R or final disposal, and develop Thai human resources for the preparation of the 'bring/buy back' system for WEEE and home appliances based on Japanese experiences.

In addition, the Green Manufacturing Technical Assistance Program (GMTAP) was created and led by the Cleaner Technology Advancement Program (CTAP) of MTEC under the GAP between 2002 and 2007. The GMTAP aim was to enhance Thai industry's ability to competitively, effectively produce environmentally-friendly products or processes using life cycle analysis (LCA) in tandem with eco-design. This is increasingly being demanded by the restrictions in environmental regulations. The project included human resource development in LCA and eco-design, development of case studies, technology transfer, networking and information dissemination.

In addition to the GAP assistance, the government sought cooperation through the Thai National Economic and Social Development Board (NESDB). The NESDB initiative on green productivity (GP) completed the following strategies and pilot projects in mid 2004:

- 1 GP strategy in target industries
  - 1.1 NESDB cooperated with the Ministry of Finance and DIW on tax incentives for industries that adjusted their production to be in accordance with GP.
  - 1.2 NESDB cooperated with financial institutions to support SMEs that wanted to adjust their production process to GP.
- 2 Strategy to support markets for eco-design products
  - 2.1 Thailand's green public procurement was initiated by the Office of National Economic and Social Development Board (NESDB), Thai Industrial Standards Institute (TISI) and Thailand Environment Institute (TEI).
- 3 Strategy on impact reduction of non-tariff barriers (NTB)
  - 3.1 NESDB cooperated with the Ministry of Foreign-Affairs (MFA), the Ministry of Commerce (MOC), and the Ministry of Natural Resources and Environment (MNRE) to estimate NTB impacts related to natural resources and environmental reasons.
- 4 Pilot projects for foreign *green* requirements EEE industry. Factory consultation on GP and LCA, and eco-design knowledge training was suggested to prepare for compliance with requirements of the imported countries.
- 5 A project related to market driven expansion of eco-designed products: TISI was to study the plan, regulations, and implementation procedures, creating eco-designed products where the government drove the market.
- 6 NESDB cooperated with EEI to acquire knowledge of existing and upcoming impacts on EEE industry resulting from measures and requirements of the importing countries.
- 7 NESDB studied the implementation procedures of government green procurement to promote GP in industry (Japan, Taiwan, and Germany) compared to the Thai preparations and proposed an appropriate procedure for Thailand.

The NESDB and EEI proposed a *green* pilot project to support SMEs exporting to the EU, to the National Committee on Competitiveness Development in September 2004. The committee approved the so-called 'green camp' project and proposed sharing the cost with industry.

The 'green camp' project achieved the following:

- 1 Recruited 200 SME production and factory managers that produce for EU export and trainers to participate in a train-the-trainers activity. 15 experts were also trained in Japan to be trainers.
- 2 SME suppliers conducted in-house training and the government and education office representatives were trained (a total of 1,000 people).
- 3 10 SMEs exporting to the EU were consulted to reduce factory pollution.
- 4 2 factories demonstrated projects and were advised by foreign experts.
- 5 The Thai life cycle inventory, the Thai LCA software, and the SME Service Network were developed.

In 2005, the Thai Ministry of Industry has appointed the Committee on Measure Determination underlying the EU Directives, consisting of inter-ministerial members to determine integrated policies, measures, action plans, underlying the EU policies and directives. Sub-committees were subsequently appointed on the making of related environmental measures and regulations and determination of guidelines on WEEE recycling and management, the creation of a knowledge-base and development of EU regulations and environmental databases, and the development of manufacturers and testing laboratories. As a result, a number of short and long term projects were proposed and funded by the Thai government, some of which are listed below.

- Development of production management system (long term)
- Human resource development (long term)
- Green productivity integration (short term)
- Development of logistics management system (short term)
- Business network linkage (short term)
- Development of environment and energy regulation databases
- Development of chemical databases
- Development of life cycle inventory and life cycle assessment databases
- Enhancement of the Thai RoHS network potential
- Development of knowledge and understanding of the EU technical requirements
- Service enhancement of the green label certification for industrial products to increase the local green product quantities
- Development of laboratory potential for RoHS certification
- Potential development and preparation of manufacturers to be CE mark certified.

Another project was conducted related to capacity building under the EU-Thailand Economic Cooperation Small Project Facilities between 2005 and 2006. The project, organised by EEI, contributed to the following objectives:

- 1 Promote LCA and eco-design among Thai manufacturers of EEE products.
- 2 Reduce the amount of waste from EEE products in Thailand and Europe.
- 3 Reduce the amounts of dangerous chemical substances contained in EEE products manufactured in Thailand.
- 4 Increase the potential of Thai manufacturers of EEE products to access EU markets.

The activities included LCA and eco-design training in Denmark and internal knowledge transfer meetings amongst EEI experts. The European experts followed up the progress on knowledge transfer and provided complementary assistance to the technicians initially trained by EEI. 12 technicians from EEI collaborated in the preparation of a manual including detailed procedures for the implementation of LCA and eco-design in Thai industries manufacturing EEE. Furthermore, 12 technicians will be divided into 4 teams with each team responsible for applying LCA and eco-design in one factory. The European experts undertook a second visit to ensure that the work was carried out correctly. Knowledge and information was ultimately disseminated to the factory workers, government and non-governmental representatives.

Due to competitiveness concerns among Asian countries and to enhance the learning experience for EU requirements, the Thai WEEE strategic plan was drafted by all related parties, eg. ministries, industry associations, NGOs, university faculties etc. The plan incorporates several aspects: administration, law, technology, economic, and investment. The administration aspect included database and information systems, R&D networking programmes, education and awareness programmes, a segregation and collection system, and designating a responsible agency. The legal aspects included amendment of existing laws, EEE standards, fee collection, control on the disposal, segregation, collection for the reduction, reuse, and recycling (3Rs), code of conduct for WEEE facilities and other specific issues related to the WEEE laws. The technical aspect included capacity building of manufacturers, researchers, and workers. The economic and investment aspects included budget allocation, setting up of specific funds for WEEE management, financial incentives, tax reductions or exemptions etc. The draft strategic plan was approved by the National Environment Board and agreed by the Thai Cabinet. Working groups on funding and regulating are looking into further details for putting into practices. Ministerial regulations will be subsequently drafted as a framework of up-coming specific regulations, e.g. enforcement of payments for waste collecting and recycling, management of waste and financial funding, etc.

## 4.0 Gaps and future needs

### 4.1 Management needs

Between the September 2005 survey (123 companies) and the March 2006 survey (103 companies) (Ramunkul, 2006), most respondents' companies were certified as working towards ISO 9001 and ISO 14001. This has been the main reason why the Thai respondents have a management system in place. Details of the standards that the companies have been certified to are detailed below:

**Table 7: Standards the company certified**

Standard	2005 (%)	2006 (%)
ISO 9001	73.2	78.6
ISO 14001	48.8	55.3
QS 9000	1.6	9.7
Energy Star	4.9	3.9
TISI	17.9	4.9
CE	21.1	–
CCC	8.9	6.8
UL	21.1	15.6
Eco-label	0.8	1.0
EMAS	1.6	0
Others	9.8	17.5

The Thai data, as at the end of March 2006, surveyed by MTEC revealed that most producers have a management system (47.6%) or plan to have (30%) or are working on having (12.6%) a system.

In 2006 EEI surveyed EEE producers and also found that the companies mostly have the ISO 9000 and ISO 14000 in place. Other management systems implemented include ISO/TS 16949 for part makers of automotive industry. Quality was the no. 1 customer requirement about the products offered was quality (ranked highest), followed by just in time (JIT) delivery, and then low pricing. Other customer requirements were service, precision, RoHS compliance and durability etc.

In a typical RoHS adjustment process in Thailand (Ramunkul, 2006), product manufacturers (1st tier) receive a management policy from the mother company overseas. The mother company then requires subsidiary companies to carry out internal inspections. Internal adjustment requires an internal review, adjustment plan, and new management systems to comply with the regulations or the company's environmental requirements.

After the internal adjustment, the supply chain also needs to be adjusted. Suppliers will be reviewed by the buyer eg. document review of certificates or compliance. A material datasheet will be required to monitor performance of the manufacturing audit. In so doing, the agents in the supply chain are inevitably forced to change.

Supply chain re-alignment is the next step in adjusting suppliers who do not comply with regulations. Some suppliers may be excluded from the value chain as has been the case in some countries.

Thailand is presently in the monitoring phase. A number of companies have been re-aligned in the supply chain with the products exported to the EU mostly RoHS compliant. The monitoring begins when the 1st tier receives orders and sends messages to the 2nd tier to comply with the orders. Assistance will be provided in terms of knowledge transfer, internet sourcing preparation, information dissemination etc. The orders received by the 2nd tier will be conveyed to the 3rd tier from whom parts and materials are purchased. The 3rd tier will receive more information on rules and compliance rather than policy and assistance. Information is then sent back to the 2nd tier, and information from the 2nd tiers to the 1st tiers relates to material declarations and proofs of compliance.

**Table 8: Issues in EuP that might affect the company**

Issues	2005 (%)	2006 (%)
Determination of environmental performance	26.0	15.5
Eco-design	24.4	15.5
Readiness of supply chain	30.1	41.6
Environmental management system	17.9	15.5
Certification (CE mark and/or Eco-label)	28.5	17.5
Need to know more	–	31.1
Others	2.4	1.0

Factors that could assist the supply chain to improve the products (Ramunkul, 2006), include provision of information, knowledge or assistance (83.5%), training courses (49.8%), forums for news, information or knowledge or opinion exchange (43.7%), handbooks or tools for adjustment (36%), financial support (26.2%), and reliable sources of materials or parts (2.9%). A one-stop service and forums for news or information or knowledge or opinion exchange or discussion forums was also felt to be useful.

**Table 9: Environmental aspects of the products that have been considered and/or improved**

Aspects	Yes (%)	Never (%)	Need to know more (%)
Material usage	50.4	9.8	23.6
Energy efficiency	40.7	17.0	24.4
Consumables and batteries	22.8	31.7	21.0
Emissions (from products)	31.7	30.1	17.1
Products' useful life	30.1	18.7	26.0
End of Life (EoL) management	35.6	26.8	22.8
Uses of toxic and hazardous substances	55.3	12.2	17.1
Packaging	43.1	16.3	17.9

Respondents also indicated that the EuP is not new to the Thais. Many aspects considered in EuP have been experienced in WEEE and RoHS. However, products' useful life, energy efficiency, and material usage were among the top aspects that manufacturers wanted to know more about. Details are shown in Table 8.

## 4.2 Technical needs

Survey responses (EEI, 2006) showed that most companies were trained in the ISO 14000 series and RoHS, and WEEE. For eco-design methods, they mostly used material examination and used EDX as a tool. The respondents believed that the products produced would be environmental friendly, reliable to customer and business, and qualified by international standards.

In relation to technologies, the survey conducted in 2004 by MTEC indicated that the respondents were mostly interested in analysis of hazardous substances in materials (74.2%), technological management of hazardous waste (63.5%), lead free technology for parts and materials (56.7%), recycling technology (53.9%), lead free soldering (48.9%), material

qualification/reliability tests (48.3%), clean technology (46.1%), material property tests (41.6%), fundamental knowledge of hazardous substance in product (41.0%), lead free finishing (38.2%), life cycle engineering (36.5%), calibration (34.3%), basic metal surface hardening and coating (30.9%), analysis technique and process control of metal hardening (30.9%), flame retardants in IC packaging compounds (23%), flame retardants in PCB (21.9%), flame retardants in cable and connector (20.2%), general flame retardants (20.2%), and chromium hardening (16.9%). 34.8% also indicated an interest in eco-design.

In 2004 a voluntary network 'ThaiRoHS' or 'Thai RoHS Alliance' was established – the aim being to organise efforts to help one another, reduce repeat or redundant implementation, leverage minimum requirements, provide guidelines for SMEs, and promote compliant producers.

Technical Committee on Environmental Standards of Electrical and Electronics Products was appointed in 2006 to propose a draft of the Thai Environmental Standards of Electrical and Electronics Products to the Thai Industrial Product Standards Committee. The Thai RoHS regulations are the focus. The draft has undergone a public hearing process among stakeholders.

## 5.0 Capacity building plans

The strategic development of capacity building in EEE industry rests on the availability of trained personnel working and the rapid development of technology. EEI and the Ministry of Labour expect to achieve the following strategies within the next four years:

- 1 Development of Thailand's EEE curricula
- 2 Development of a national EEE skill certification system and medium wages
- 3 Industrial manpower preparation
- 4 Promotion of personnel development at industrial trainer level
- 5 Construction of effective database system in wages, skills, and technologies.

To achieve the above target, the following plans and activities need to be implemented in a short-term plan (1–2 years) and a medium/longer term plan (3 or more years):

### 1 Curriculum development (2 years)

- 1.1 Development of a technological curriculum in the EEE industry
- 1.2 Development of standard curricula for personnel, engineers, technicians and supervisors in the EEE industry
- 1.3 Development of administration curricula for manufacturers.

### 2 Development of a National Labour Skill Certification and Wages in the EEE industry (2 years)

- 2.1 Development of a national EEE skill testing and certification
- 2.2 Determination of national wages following the labour skill certification system.

### 3 Training for unskilled labour

- 3.1 Technician training (4 years)
- 3.2 Graduate training (2 years)
- 3.3 Training of labourers from other industries (2 years).

### 4 Development of trainers and EEE manufacturers

- 4.5 Workshops for trainers in EEE technology (4 years)
- 4.6 Workshops for EEE manufacturers on best practice (4 years).

### 5 National EEE labour database

- 5.1 System development of software and hardware for EEE labour hub
- 5.2 Conducting a EEE labour census and wages.

The following plans have been also proposed to the government for the long-term (3 years) and the short-term (1–2 years) in capacity building plans for the environment.

### Establishment of the Centre of Excellence (CoE) for knowledge creation and transfer to consultants/trainers

- 1 CoE in eco-design, LCA, and clean technology
  - 1.1 Establishment of a supporting office in design technology and product development (eco-design) for SMEs (3 years)
  - 1.2 CoE in LCA (3 years)
  - 1.3 Establishment of Centre of Research and Technology Transfer in Clean Technology (3 years).
- 2 CoE in eco-materials
  - 2.1 Establishment of an eco-materials centre (3 years)
  - 2.2 Follow-up of progress in compliance practices and advancement of eco-materials technologies (3 years)
  - 2.3 Human resource development underlying adjustment in RoHS, WEEE, and EuP (3 years).

### Training led by consultants (TLC)

- 1 TLC in eco-design, LCA, EuP, CT for EE industry
  - 1.1 TLC for EEE industry in the ISO 14000 series, eco-design, LCA, clean technology (CT), recycling (3 years).
- 2 Train the trainers in EuP (2 years).
- 3 Eco-products promotion project in green electronic cluster development (3 years).

### R&D projects

- Establishment of recycling factory prototypes (2 years)
- Research and develop eco-products (3 years).

### Producer preparation

- 1 Promotion of producers to be certified by CE
  - 1.1 Promotion of EE producers to be certified by CE for 2 years.

### Build/increase potential/coordination including conference/networking forum

- 1 Green procurement software service network
  - 1.1 Build/install a server (1 year)
  - 1.2 Build/allocate a service network for EEE industry (3 years)
  - 1.3 Green procurement software laboratory testing (1 year).
- 2 Increase voluntary network potential of Thai RoHS (3 years)
  - 2.1 Registration centre
  - 2.2 Increase members
  - 2.3 Meeting to present reports.
- 3 CT training network (3 years).
- 4 Organise a forum to exchange knowledge/experiences in eco-materials technology and adjustment to cope with RoHS, WEEE, and EuP (3 years)



- 4.1 Organise a national conference on eco-materials
- 4.2 Organise an international conference in eco-materials
- 4.3 Organise a technical workshop/adjustment guideline to cope with WEEE, RoHS and EuP
- 4.4 Organise an exchange forum on the internet.

#### **Study/research/develop substituted substances and others**

- 1 Develop eco-materials technology
  - 1.1 Study materials technology for production (2 years)
  - 1.2 Develop tools for production adjustment (3 years).

The curriculum used to train in the 'Green Camp' project may be outlined as follows.

#### **Training curriculum for train-the-trainer on LCA**

- What is LCA?
- Goal and scope, system boundary, allocation, etc.
- Application
- How to do LCA:
  - Inventory Analysis
  - Impact Analysis
  - Interpretation
- Eco-efficiency
- Life cycle costing
- Chemical management
- Evaluation of infrastructure with LCA.

#### **Training curriculum for train-the-trainer programmes on eco-design**

- Scope
- Quality Function Deployment for Environment
- Definition
- Goal and potential benefits
- Strategic consideration
- Management consideration
- Product consideration
- Product design and development process
- Recycling plant visit.

#### **Training curriculum for train-the-trainer on clean technology (CT)**

- Definition and principle of CT
- What is CT?
- Principle of environmental management using CT
- Methods of CT
- Pollution reduction at source
- Reuse and recycling
- Usefulness of CT
- Procedure of CT implementation

- Planning and organising
- Pre-assessment
- Detailed audit
- Feasibility study
- Implementation and evaluation.

#### **Training curriculum for industrial workers and related personnel from government and non-government offices on LCA**

- What is LCA?
- Goal and scope, system boundary, allocation, etc.
- Application
- How to do LCA
- Inventory analysis
- Impact analysis
- Interpretation.

#### **Training curriculum for industrial workers and related personnel from government and non-government offices on eco-design**

- Scope
- Quality function deployment for environment
- Definition
- Goal and potential benefits
- Strategic consideration
- Management consideration
- Product consideration
- Product design and development process
- Recycling plant visits.

#### **Training curriculum for industrial workers and related personnel from government and non-governmental offices on clean technology (CT)**

- Definition and principle of CT
- What is CT?
- Principles of environmental management using CT
- Methods of CT
- Pollution reduction at source
- Reuse and recycling
- Usefulness of CT.

In addition to training, EEI planned to launch an international conference, the so-called Thailand Electrical and Electronic Green Society 2007 held between 14 and 15 September 2007. The conference expected to disseminate information to the public towards development of EE green society, exchange knowledge and experience at local and international levels, and build up individual co-operation and assistance in academic research and skills from various organisations; public and private.

## 6.0 Conclusions and recommendations

The EEE industry has played an important role in Thailand's economy. In 2006, the export value was US\$ 41 billion, an 17% increase compared to the 2005 value; 15% exported to the EU.

The WEEE Directive has resulted in increased importing of WEEE, particularly used televisions and air conditioners, at the beginning of the 5 year transitional period when producers are collectively responsible for the costs of historical WEEE. WEEE has increased also as a result of decreasing product life-cycles and increasing demand in developing countries, its value enhanced by the rising prices of precious metal.

Repair shops, recycling and incineration plants are scattered around Thailand and vary in size and the level of process technology.

Amongst the 1st tier suppliers it is estimated that more than 80% are expected to have adjusted systematically to *green* requirements eg. RoHS due to market-driven forces requiring them to be competitive. This is largely due to existence of management systems that have been designed to cope with RoHS and upcoming environmental requirements, allocation of resources, good planning, investment in equipment and infrastructure and knowledgeable personnel.

In the 2nd tier, it is estimated that 50% of companies that were informed of RoHS, etc. are aware of what ought to be adjusted and have adjusted systematically. The adjustment has included dedicated planning, learning, and assisting 3rd tier suppliers. It is thought that the remaining 50% of the 2nd tier are in the fire-fighting category and have adjusted in an ad hoc manner.

SMEs have been facing uneven burdens relative to large companies. The burdens include management costs, product re-evaluation costs, and capital costs including investment in new processes and new quality control schemes and lower yields.

Thailand has concentrated on promoting management capability, i.e. information gathering on new legislation, document preparation for proof of compliance e.g. process examination and test reports, quality and composition controls, and parallel production lines that need both a materials and products inventory, rather than product redesign. Design for recycling for example, has not been used very actively as a tool to meet the requirements of RoHS and WEEE.

Local reuse and recycling factories need upgrading for WEEE treatment. A proposal related to customs taxes of recyclable and valuable waste needs to be discussed among related offices to support manufacturers and recycling factories.

There is some development of WEEE inventory data and some collection/take-back projects exist, but further detailed study is needed to confirm the availability of a continuous/appropriate WEEE supply to recycling plants.

More detailed studies of WEEE inventory data, collection and take-back systems and appropriate separating and recycling technologies will be needed. The Pollution Control Department of the Thai Ministry of Natural Resources and Environment, should consider setting up working groups to work out practical regulation of a WEEE system; fees, funding, collection and take-back and recycling facilities/technology.

Information on becoming RoHS compliant manufacturers should be promoted more strongly. Manufacturers need guidelines, tools, advisors, training courses, a data centre(s), pilot companies and an active role in international development. Assistance from trainers, consultants, and auditors is needed. Analytical capacity needs to be built up to include verification of test results and capacity build-up.

Eco-design – although based on life cycle thinking – can provide guidelines for RoHS and potential EuP compliance. Although it is not new for Thai SMEs it is not easily implemented. Eco-design infrastructure needs to be established eg. databases, technology and environmental management systems. The 1st tier usually redesigns the product and this is one reason why the Thai 2nd tier and 3rd tier have not done much in eco(re)design.

Centres of excellence for knowledge collection/development need to be established to help build SME capacity. Training led by consultants in LCA, eco-design and clean technology will need to be accelerated. Supplier networks also need to be built for exchanging opinions and information through both software technology and forums. Therefore, cooperation is needed to include all stakeholders eg. industry and government both domestic and international.



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