



# GEF-6 REQUEST FOR PROJECT ENDORSEMENT/APPROVAL

PROJECT TYPE: Full-sized Project

TYPE OF TRUST FUND: GEF Trust Fund

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## PART I: PROJECT INFORMATION

Project Title: Application of industry-urban symbiosis and green chemistry for low emission and persistent organic pollutants free industrial development in Thailand			
Country(ies):	Thailand	GEF Project ID: <sup>1</sup>	9219
GEF Agency(ies):	UNIDO (select) (select)	GEF Agency Project ID:	150036
Other Executing Partner(s):	- Department of Industrial Works under the Ministry of Industry; - Pollution Control Department under the Ministry of Natural Resources and Environment; - Industrial Estate Authority of Thailand under the Ministry of Industry; - The Federation of Thai Industries; and, - Kasetsart University	Submission Date:	09/26/2018
GEF Focal Area (s):	Multi-focal Areas	Project Duration (Months)	60
Integrated Approach Pilot	IAP-Cities <input type="checkbox"/> IAP-Commodities <input type="checkbox"/> IAP-Food Security <input type="checkbox"/>	Corporate Program: SGP <input type="checkbox"/>	
Name of Parent Program	[if applicable]	Agency Fee (\$)	851,770

### A. FOCAL AREA STRATEGY FRAMEWORK AND OTHER PROGRAM STRATEGIES<sup>2</sup>

Focal Area Objectives/Programs	Focal Area Outcomes	TRUST FUND	(IN \$)	
			GEF PROJECT FINANCING	CO-FINANCING
(select) CCM-1 Program 1 (select)	Outcome A. Accelerated adoption of innovative technologies and management practices for GHG emission reduction and carbon sequestration	GEFTF	3,560,133	87,650,600
(select) CW-1 Program 1 (select)	Outcome 1.2: Innovative technologies are successfully demonstrated, deployed and transferred	GEFTF	980,234	1,442,400
(select) CW-2 Program 3 (select)	Outcome 3.1: Quantifiable and verifiable tonnes of POPs eliminated or reduced	GEFTF	4,425,633	30,969,700
<b>Total project costs</b>			8,966,000	120,062,700

<sup>1</sup> Project ID number remains the same as the assigned PIF number.

<sup>2</sup> When completing Table A, refer to the excerpts on [GEF 6 Results Frameworks for GETF, LDCF and SCCF](#) and [CBIT programming directions](#).  
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## B. PROJECT DESCRIPTION SUMMARY

<b>Project Objective: To reduce greenhouse gas emissions, as well as releases of persistent organic pollutants and other harmful chemicals from industries and urban centers through the application of industry-urban symbiosis and green chemistry technology.</b>						
Project Components/ Programs	Financing Type <sup>3</sup>	Project Outcomes	Project Outputs	TRUST FUND	(IN \$)	
					GEF PROJECT FINANCING	CONFIRMED Co- FINANCING
1. Policy development	TA	Outcome A: GHG emissions and releases of POPs reduced through industry-urban symbiosis by transferring low carbon and green chemistry	Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced	GEFTF	402,700	1,357,000
2. National capacity building and awareness raising on industry-urban symbiosis and POPs	TA	technologies, improving capacity, enhancing infrastructure, promoting innovative business models and raising awareness	Output 2.1 Inventory of new POPs and intervention plan developed for the three selected provinces  Output 2.2 Opportunities for industry-urban symbiosis elaborated through material and waste stream analysis  Output 2.3 Increased capacity and awareness on risks of new POPs and the benefits of (i) resource efficient and cleaner production, (ii) green chemistry, (iii) industry-urban symbiosis	GEFTF	3,465,700	9,233,135
3. Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis	TA		Output 3.1 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises, industrial zones and neighboring urban settlements	GEFTF	3,770,100	4,226,000
	Inv			(select)		102,112,951

<sup>3</sup> Financing type can be either investment or technical assistance.  
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4. Development of National Eco-Industrial Town Framework and its supporting system	TA		Output 4.1 Continuous improvement and sustaining the industry-urban symbiosis	GEFTF	621,500	2,101,000
5. Monitoring and evaluation	TA	Outcome B: Project achieves objective on time through effective monitoring and evaluation	Output 5.1 Periodic monitoring and evaluation of project implementation completed	GEFTF	280,000	368,614
Subtotal					8,540,000	119,398,700
Project Management Cost (PMC) <sup>4</sup>				(select)	426,000	664,000
<b>Total project costs</b>					<b>8,966,000</b>	<b>120,062,700</b>

### C. CONFIRMED SOURCES OF CO-FINANCING FOR THE PROJECT BY NAME AND BY TYPE

Please include evidence for co-financing for the project with this form.

Sources of Co-financing	Name of Co-financier	Type of Cofinancing	Amount (\$)
Recipient Government	Department of Industrial Works	In-kind	7,800,000
Recipient Government	Ministry of Natural Resources and Environment	In-kind	1,000,000
Recipient Government	Industrial Estate Authority of Thailand	In-kind	1,300,000
Private Sector	The Federation of Thai Industries and its Water and Environment Institute for Sustainability	In-kind	2,000,000
Private Sector	Kasetsart University	In-kind	100,000
GEF Agency	UNIDO	Grants	100,000
GEF Agency	UNIDO	In-kind	100,000
Private Sector	PTT	Equity	53,057,000
Private Sector	PTT	In-kind	5,305,700
Private Sector	PTT LNG	Equity	6,000,000
Private Sector	PTT LNG	In-kind	60,000
Private Sector	PTT Global Chemical (CG)	Equity	18,590,000
Private Sector	Saha Pathana Inter-holding	Equity	23,500,000
Private Sector	Saha Pathana Inter-holding	In-kind	1,150,000
<b>Total Co-financing</b>			<b>120,062,700</b>

<sup>4</sup> For GEF Project Financing up to \$2 million, PMC could be up to 10% of the subtotal; above \$2 million, PMC could be up to 5% of the subtotal. PMC should be charged proportionately to focal areas based on focal area project financing amount in Table D below.

**D. TRUST FUND RESOURCES REQUESTED BY AGENCY(IES), COUNTRY(IES), FOCAL AREA AND THE PROGRAMMING OF FUNDS**

GEF Agency	Trust Fund	Country Name/Global	Focal Area	Programming of Funds	(in \$)		
					GEF Project Financing (a)	Agency Fee <sup>a)</sup> (b) <sup>2</sup>	Total (c)=a+b
UNIDO	GEF TF	Thailand	Climate Change	(select as applicable)	3,560,133	338,213	3,898,346
UNIDO	GEF TF	Thailand	Chemicals and Wastes	POPS	4,725,633	448,935	5,174,568
UNIDO	GEF TF	Thailand	Chemicals and Wastes	SAICM	680,234	64,622	744,856
<b>Total Grant Resources</b>					<b>8,966,000</b>	<b>851,770</b>	<b>9,817,770</b>

a ) Refer to the [Fee Policy for GEF Partner Agencies](#)

**E. PROJECT'S TARGET CONTRIBUTIONS TO GLOBAL ENVIRONMENTAL BENEFITS<sup>5</sup>**

Provide the expected project targets as appropriate.

Corporate Results	Replenishment Targets	Project Targets
1. Maintain globally significant biodiversity and the ecosystem goods and services that it provides to society	Improved management of landscapes and seascapes covering 300 million hectares	<i>hectares</i>
2. Sustainable land management in production systems (agriculture, rangelands, and forest landscapes)	120 million hectares under sustainable land management	<i>hectares</i>
3. Promotion of collective management of transboundary water systems and implementation of the full range of policy, legal, and institutional reforms and investments contributing to sustainable use and maintenance of ecosystem services	Water-food-ecosystems security and conjunctive management of surface and groundwater in at least 10 freshwater basins;	<i>Number of freshwater basins</i>
	20% of globally over-exploited fisheries (by volume) moved to more sustainable levels	<i>Percent of fisheries, by volume</i>
4. Support to transformational shifts towards a low-emission and resilient development path	750 million tons of CO <sub>2e</sub> mitigated (include both direct and indirect)	<i>Direct GHG reduction 1,305,761 metric tons  Indirect GHG reduction (bottom up) 2,611,522 metric tons  Indirect GHG reduction (top-down) 3,153,904 metric tons</i>
5. Increase in phase-out, disposal and reduction of releases of POPs, ODS, mercury and other chemicals of global concern	Disposal of 80,000 tons of POPs (PCB, obsolete pesticides)	<i>620 metric tons</i>
	Reduction of 1000 tons of Mercury	<i>metric tons</i>
	Phase-out of 303.44 tons of ODP (HCFC)	<i>ODP tons</i>

<sup>5</sup> Update the applicable indicators provided at PIF stage. Progress in programming against these targets for the projects per the *Corporate Results Framework* in the [GEF-6 Programming Directions](#), will be aggregated and reported during mid-term and at the conclusion of the replenishment period.

6. Enhance capacity of countries to implement MEAs (multilateral environmental agreements) and mainstream into national and sub-national policy, planning financial and legal frameworks	Development and sectoral planning frameworks integrate measurable targets drawn from the MEAs in at least 10 countries	<i>Number of Countries:</i>
	Functional environmental information systems are established to support decision-making in at least 10 countries	<i>Number of Countries:</i>

**F. DOES THE PROJECT INCLUDE A “NON-GRANT” INSTRUMENT? No**

(If non-grant instruments are used, provide an indicative calendar of expected reflows to your Agency and to the GEF/LDCF/SCCF/CBIT Trust Fund) in Annex D.

## **PART II: PROJECT JUSTIFICATION**

### **A. DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN WITH THE ORIGINAL PIF<sup>6</sup>**

There are slightly changes on the project framework by adding one more output and component as shown in Table 1. The number of Outcome 1 and Outcome 2 are changed to Outcome A and Outcome B respectively. The number of output is adjusted for better understanding.

During the PPG phase, a new Component 4, Development of National Eco-Industrial Town Framework and its supporting system, is added to establish a mechanism to sustain the resource efficiency, low carbon technology application and green chemistry implementation as well as the industry-urban symbiosis. Based on a series of stakeholder consultation meetings, the lessons learned of previous implementation of cleaner technology and other resource efficiency approaches in Thailand showed that a lack of system to support continuous improvement was one of the constraints to sustain the implementation of the innovative approaches introduced to the country. Therefore, the development of national eco-industrial town framework and its supporting system will be a tool and mechanism for the responsible agencies and industry to identify the gap as well as improvement opportunity as described in Component 4.

**Table 1** Detailed changes of project framework

<b>Components and outputs at PIF stage</b>		<b>Components and outputs at CEO endorsement stage</b>	
<b>Project Component</b>	<b>Expected Outputs</b>	<b>Project Component</b>	<b>Expected Outputs</b>
Component 1: Policy development	Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced	Component 1: Policy development	Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced
Component 2: National capacity and awareness raising on industry-urban symbiosis and POPs	Output 1.2 Textile and electronic sectors confirmed based on inventory of new POPs and intervention plan developed	Component 2: National capacity building and awareness raising on industry-urban symbiosis and POPs	Output 2.1 Inventory of new POPs and intervention plan developed for the three selected provinces
	Output 1.3 Opportunities for industrial-urban symbiosis elaborated through material and waste stream analysis		Output 2.2 Opportunities for industry-urban symbiosis elaborated through material and waste stream analysis
	Output 1.4 Increased capacity and awareness on risks of new POPs and the benefits of (i) industrial-urban symbiosis, (ii) resource efficient and cleaner production, (iii) green chemistry		Output 2.3 Increased capacity and awareness on risks of new POPs and the benefits of (i) resource efficient and cleaner production, (ii) green chemistry, (iii) industry-urban symbiosis

<sup>6</sup> For questions A.1 –A.7 in Part II, if there are no changes since PIF , no need to respond, please enter “NA” after the respective question.

Components and outputs at PIF stage		Components and outputs at CEO endorsement stage	
Project Component	Expected Outputs	Project Component	Expected Outputs
Component 3: Pilot demonstration on industry-urban symbiosis	Output 1.5 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises, industrial zones and neighbouring urban settlements	Component 3: Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis	Output 3.1 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises, industrial zones and neighboring urban settlements
Component 4: Monitoring and evaluation	Output 2.1 Periodic monitoring and evaluation of project implementation completed	Component 4: Development of National Eco-Industrial Town Framework and its supporting system	Output 4.1 Continuous improvement and sustaining the industry-urban symbiosis
		Component 5: Monitoring and evaluation	Output 5.1 Periodic monitoring and evaluation of project implementation completed

The three selected provinces for industry-urban symbiosis demonstration are Samut Prakarn, Chonburi and Rayong. The previous selected provinces namely Ayutthaya and Samut Sakorn were replaced due to their high sensitivity to climate change impact and the recently announcement of government policy on Eastern Economic Corridor (EEC).

Due to the detailed assessment made during the preparatory phase of the project, the target of GHG emission reduction was changed from 1,300,000 ton CO<sub>2</sub>eq to 1,305,761 ton CO<sub>2</sub>eq. Moreover, the initial findings from the on-going GEF-UNIDO's enabling project, Enabling activities to review and update the national implementation plan for the Stockholm Convention on Persistent Organic Pollutants, are incorporated into the project design causing some changes on Output 2.1 and its activities.

A.1. *Project Description*. Elaborate on: 1) the global environmental and/or adaptation problems, root causes and barriers that need to be addressed; 2) the baseline scenario or any associated baseline projects, 3) the proposed alternative scenario, GEF focal area<sup>7</sup> strategies, with a brief description of expected outcomes and components of the project, 4) [incremental/additional cost reasoning](#) and expected contributions from the baseline, the GEFTF, LDCF, SCCF, CBIT and [co-financing](#); 5) [global environmental benefits](#) (GEFTF) and/or [adaptation benefits](#) (LDCF/SCCF); and 6) innovativeness, sustainability and potential for scaling up.

*1) The global environmental and/or adaptation problems, root causes and barriers that need to be addressed*

Despite the efforts made to reduce greenhouse gas (GHG) emissions, Thailand is the world's 19<sup>th</sup> largest emitter of carbon dioxide (CO<sub>2</sub>). Based on the second biennial update report of Thailand, during 2000 - 2013, total emissions (excluding those from the LULUCF sector) increased from 226.1 million tons of carbon dioxide equivalent (CO<sub>2</sub>eq) in

<sup>7</sup> For biodiversity projects, in addition to explaining the project's consistency with the biodiversity focal area strategy, objectives and programs, please also describe which [Aichi Target\(s\)](#) the project will directly contribute to achieving..

2000 to 318.7 million tons of CO<sub>2</sub>eq in 2013. The major source of GHG emissions was the energy sector, which released 236.9 million tons of CO<sub>2</sub>.

In terms of the release of persistent organic pollutants (POPs), a report from Greenpeace International on the industrial releases of POPs and other harmful chemicals in the Chao Phraya Basin underlined the seriousness of the current situation. This is confirmed by a study that collected a total of 300 surface water samples in 31 locations along the Chao Phraya River and concluded that higher PFOS concentrations were measured in more industrialized and more densely populated areas. The field survey of PFOS in rivers around the world during 2004 to 2010 with total 539 samples collected from the rivers in 41 cities including 8 cities in Thailand<sup>8</sup> showed that PFOS were detected in all 41 cities both in developed and developing countries. Although PFOS and its salts were listed in the Stockholm Convention Annex B, some industrial activities are still using PFOS in their process. Following the washing of textile and electronic equipment after the coating process, the wastewater is cleaned in internal factory treatment plants equipped with activated sludge anaerobic digestion processes. However, even POPs are partially removed from wastewater, they remain in the sludge, presenting a hazard.

Additionally, increasing environmental and health problems are related to issues of collection, disposal and recycling of hazardous substances, especially e-waste, as POPs and other chemicals are released at the industry and household levels when disposed in landfills or open burnt. Storage of industrial waste on site is widespread leading to high contamination risks, which can be attributed to lacking infrastructure, high pick-up costs and logistical challenges.

The speedy change of technology enables the increasing number of users and shorten the replacement cycles of mobile phone and computer. It was estimated that the generation of e-waste has grown to 44.7 tons annually with Asia as the biggest generator<sup>9</sup>. For Thailand, as a consequence of rapid urbanization and industrialization combined with unsustainable industrial development patterns and insufficient e-waste management, pollution increased and contributed to the intensification of climate change, degradation of human health and the environment.

### Root causes

The root causes of the identified major environmental issues regarding GHG emissions and POPs releases are summarized below. These root causes are systemic problems and therefore need to be addressed at the (i) national and provincial; (ii) industrial zone; and (iii) factory levels.

- Insufficient policy incentives and market-based instruments to encourage resource efficient production processes;
- Limited access to affordable financial schemes to invest in clean and low carbon technology;
- Lack of systematic linkages related to shared infrastructure resulting in incomplete material value chains, such as non-integrated and poor waste management practices encouraging unauthorized dumping by industries and municipalities;
- Suboptimal industrial process efficiency and lack of technical knowledge resulting in low resource productivity and excessive GHG emissions;
- Improper management of hazardous chemicals resulting in water and soil contamination.
- Poor e-waste management system based on informal dismantling and disposal; and,
- Inappropriate worker protection leading to human exposure to hazardous substances.

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<sup>8</sup> Kunacheva, C. et al. (2012). Worldwide surveys of Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) in water environment in recent years. *Water Science and Technology*, 66 (12), 2764-71.

<sup>9</sup> Balde, C.P., Forti V., Gray, V., Kuehr, R., Tegmann, P., The Global E-Waste Monitor – 2017, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna.  
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## Barriers

Despite the political and economic efforts made by the government and its agencies to reduce the environmental impact of industries, Thailand will not be able to achieve its goals if the following barriers are not addressed.

- Policy: gaps in political and legislative frameworks (i) to support inclusive and sustainable industrial development through industry-urban symbiosis, which refers to the collaboration, exchange of resources and sharing of infrastructure between companies and their use of by-products (wastes) from urban areas as alternative raw materials and energy sources in industrial operations, (ii) to provide policy incentives such as market-based instruments to encourage investment in resource efficient and cleaner production (RECP), and (iii) to implement the Stockholm Convention;
- Awareness: low awareness on the principles and benefits of sustainable development and industry-urban symbiosis, as well as on the risks of new POPs and other chemicals to human health and the environment. In terms of sustainable production, there is a wide gap in awareness between academia/large industrial conglomerates and the vast majority of SMEs;
- Capacity: there is a lack of institutional capacity to implement the concept of industry-urban symbiosis and resource (energy, water and raw material) efficiency principles, as well as a lack of inventory and data on sources and emissions of new POPs;
- Technology: environmentally sound technologies are present in Thailand, but only within the largest industrial groups that benefit from well-financed R&D departments or have the capacity to contract external expert organizations. There is a general lack of knowledge and financial means regarding green chemistry and RECP impeding their adoption; and,
- Economy: lack of investment incentive mechanisms and difficulties in accessing financial resources from commercial banks due to insufficient information and cumbersome processes in loan applications for SMEs. As such only 40% of SMEs gained access to credit in 2011. This results in inadequate financial resources for investments in clean and low carbon technology.

### *2) The baseline scenario or any associated baseline projects;*

#### *2a) Baseline scenario*

#### Relevant national policy, plan and legislation

Currently, Thai Government give a priority to the 20-Year National Strategy highlighting 6 strategies, namely Security, Competitive enhancement, Development and empowerment human capital, Broadening opportunity and equality in society, Environmentally-friendly growth, and Reforming government administration. The support to eco-industrial town development is explicitly stated in the strategy. It is expected that the eco-industrial town development will be achieved by providing the close-loop management of raw material, wastes, toxic substances, and hazardous wastes, enhancing the efficiency of sharing resources, having the mechanism to handle the development of eco-industrial town, and amending the rules and regulations to support such development.

The 12<sup>th</sup> National Economic and Social Development Plan 2017 - 2021 (NESDP) is a 5-year national development plan, which is drafted to correspond with the 20-Year National Strategy. There are 10 development strategies consisting of (1) Strengthening and realizing the potential of human capital, (2) Creating a just society and reducing inequality, (3) Strengthening the economy, and underpinning sustainable competitiveness, (4) Environmentally-friendly growth for sustainable development, (5) Reinforcing national security for the country's progress towards prosperity and

sustainability, (6) Public administration, corruption prevention, and good governance in Thai society, (7) Advancing infrastructure and logistics, (8) The development of science, technology, research, and innovation, (9) Regional, urban, and economic zone development, and (10) International cooperation for development. The eco-industrial town development is under strategy 3, while the resource efficiency, low carbon technology application, sound chemical management is highlighted under strategy 4.

The 20-Year National Strategy and the 12<sup>th</sup> NESDP are the key national policy and plan shaping the development direction of Thailand. The focuses on eco-industrial town development and resource efficiency including the low carbon technology reflect the Government's priority on such issues.

There are also the sectoral and cross-cutting issue master plans such as the National Climate Change Master Plan and the National Waste Management B.E. 2559 – 2564 (2016 – 2021), which are briefly discussed in the following subsection and Section B of this document.

There are four major legislations that directly relevant to the project as described below.

- Factory Act B.E. 2535: The factory act covers all aspects of factory including safety and environmental performance. It allows the Ministry of Industry to issue the ministerial announcements and regulations to control the factory's operation for example the industrial waste management.
- Hazardous Substance Act B.E. 2535: The act covers various hazardous substances including the industrial hazardous substance. The hazardous substances are classified into four categories, 1 to 4. The hazardous substances under category 1 to 3 are allowed to import, sell, use and have in possession under the specific conditions. The hazardous substances under category 4 are prohibited and required to be properly disposed.
- Enhancement and Conservation of Environmental Quality Act B.E. 2535: The act aims to protect and enhance the environmental quality by executing some important environmental management instruments for example Environmental Impact Assessment (EIA), emission standards, treatment fee and Environmental Quality Management Plan.
- Energy Conservation Promotion Act B.E. 2535: This act established the fund for promoting energy conservation, which provide grant and loan to the industry through various energy efficiency and renewable energy programs such as the revolving fund. The Act also classify the energy intensive user as the designated factory or designated building requiring them to submit the annual energy management report to the responsible agency.

There is another major legislation, Act on the Management of Waste Electrical and Electronic Equipment and Other End-of-Life Products, which is under preparation. This act will support the call back system and authorize the relevant agencies and officers to take actions on the proper management of waste electrical and electronic equipment.

Department of Industrial Works (DIW) and Pollution Control Department (PCD) are directly involve in most of these policy, plan and legislation except the Energy Conservation Promotion Act.

### Mitigation of GHG emissions in Thailand

Recognizing the global impacts of climate change and the need to take part in the global community that collectively take actions to reduce GHG emissions, Thailand signed the United Nations Framework Convention on Climate Change (UNFCCC), on 12 June 1992, and ratified the convention on 28 March 1995.

On 1 October 2015, Thailand's Intended National Determined Contribution (INDC) was communicated to the UNFCCC secretariat. Thailand intends to reduce its GHG emissions by 20 percent from the projected business-as-usual

(BAU) level, which is approximately 555 Mt CO<sub>2</sub>eq by 2030. The level of contribution could increase up to 25 percent, subject to adequate and enhanced access to technology development and transfer, financial resources and capacity building support through a balanced and ambitious global agreement under the UNFCCC<sup>10</sup>.

To achieve the INDC's target, Thai Government have approved several climate change related plans for example the National Climate Change Master Plan (NCCMP) 2015-2050. The NCCMP is currently implemented with the linkage to the 12<sup>th</sup> National Economic and Social Development Plan (NESDP) 2017-2021. The climate change mitigation measures have been included in all major sectors for example energy, industry and transportation.

Ministry of Energy and Ministry of Industry have launched the projects to promote energy efficiency and renewable energy in the industrial sectors. One of the important measures is to obligate the designated factories<sup>11</sup> to submit the annual energy management report.

#### Activities under Stockholm Convention

As a signatory to the Stockholm Convention, Thailand developed a National Implementation Plan (NIP) with GEF resources that included an inventory on the initial twelve POPs in 2007. Currently, with GEF's support, PCD and UNIDO is working on the NIP update including the inventory update of 12 initial POPs and new inventory for new POPs.

Efforts of the Thai government to track some of the new POPs were made by including PFOS under the Department of Customs Act in 2012, requiring a declaration for the import of 16 chemicals. Moreover, in January 2018 PFOS and its salts, c-OctaBDE and c-PentaBDE have been listed as the hazardous substance category 3 under the Hazardous Substance Act B.E. 2535, requiring permission for import, use, export and having in possession. For HBCD, it is under consideration process for registering as hazardous substance under the Act. However, up to mid of June 2018, no factory reported their usage and/or possession of PFOS and its salts, c-OctaBDE and c-PentaBDE.

#### Industrial waste management in Thailand

In Thailand, industrial waste is controlled under the Factory Act B.E. 2535, which the storage, treatment, transport and disposal of industrial waste is required the approval from DIW. The hazardous waste from industry have to be collected and transported by the company with a specific permission. The treatment and disposal of hazardous waste from industry have to be carried out by the specific facilitates with the registration of factory category 101, 105 and 106.

In 2014, 17,384 factories (about 25% of all factories) had already registered with DIW's industrial waste online system and only 7% of them had sent their waste to treat or dispose properly<sup>12</sup>. Since 2015, DIW has undertaken a project to encourage the factories to register with this online system. An ambitious target of at least 12,000 factories newly registered with the system per year for 5 consecutive years was set by DIW.

In 2016, DIW reported that the industrial wastes was approximately 37.4 million tons with 2.8 million tons of hazardous waste accounted for 7.5% of total industrial wastes. Only 15.2 million tons of non-hazardous waste and 1.12 million tons of hazardous waste were treated. The problem of illegal disposal by dumping the industrial waste with the

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<sup>10</sup> Thailand's INDC on 10 October 2015 (last access in July 2018)

[http://www4.unfccc.int/ndcregistry/PublishedDocuments/Thailand%20First/Thailand\\_INDC.pdf](http://www4.unfccc.int/ndcregistry/PublishedDocuments/Thailand%20First/Thailand_INDC.pdf)

<sup>11</sup> Factories with meter more than 3,000 kW or transformer(s) more than 3,530 kVA or energy usage more than 60M MJ/year

<sup>12</sup> DIW's Industrial Waste Management Plan B.E. 2558-2562 (2015-2019)

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municipal waste and in the public or private space, which could create the negative impacts to human health and environment, was found across Thailand.

According to the DIW's Industrial Waste Management Plan (2015 – 2019), the 3Rs principle with the focus on reuse of waste is promoted. However, one of the barriers of using industrial waste by other parties - for example other factories and community - is the limitation of legislation, which restricts the receipt of industrial waste. This can hinder the symbiosis among industries and between industry and community.

### Solid waste management in Thailand

Solid waste is one of the pressing environmental problems in Thailand with increasing severity. In 2014, it is estimated that only 30% of solid waste was treated correctly. Thai Government announced that the solid waste issue was a national agenda required the cooperation of and actions taken by the whole nation.

In 2016<sup>13</sup>, there were 27.06 million tons of solid waste generated with 35% of solid waste treated correctly and another 21% of solid waste used for other purposes. There were 2,810 facilities for solid waste disposal with only 330 facilities offering the proper disposal/treatment consisting of sanitary landfill, engineer landfill, controlled dump site, waste-to-energy, compost site, and mechanical and biological waste treatment. There were 23 facilities that completed their construction phase, but could not provide the service because of the objection from the communities and/or the limited capacity of local authority to operate the facility.

To increase the financial capacity of the local authority, the Thai government amended the Act on the Maintenance of the Cleanliness and Orderliness of the Country B.E. 2560 to allow the local authority to collect the solid waste collection fee at 150 Baht/month (~4.50 USD) with the additional charge of solid waste treatment fee up to 200 Baht/month (~6.00 USD).

For the disposal and treatment, in addition to landfill disposal, the Thai government promoted the production of Refuse Derived Fuel (RDF) from solid waste and the waste-to-energy plant. The Public Private Partnership (PPP) between the local authority and private sector to co-invest in the waste-to-energy plant is allowed. The government also give the EIA exemption for a waste-to-energy plant with capacity more than 10 MW. The exemption of EIA requirement and using of Code of Practice for waste-to-energy plant, which includes a detailed environmental practice to prevent and minimize the negative impacts, is expected to accelerate the number of waste-to-energy plants in Thailand. Currently, there are 53 projects with total capacity of 300 MW under the approval process by Ministry of Interior.

### E-waste management in Thailand

The issue of sound e-waste collection, disposal and recycling is very pressing in Thailand. According to the Pollution Control Department (PCD), around 401,387 tons of waste electrical and electronic equipment were disposed of in 2017 with the average increasing rate of more than 2% per year over the last 5 years, while only 148 permitted factories related to e-waste collection and recycling existed. Based on the survey, PCD found that approximately 25% of waste electrical and electronic equipment would be disposed as typical solid waste<sup>14</sup>. Currently, the informal sector plays a vital role in the business of collecting and recycling e-waste.

Apart from domestic e-waste, about 53,000 tons of e-waste per year were legally imported by 7 registered factories to be recycled, treated and disposed of in Thailand. However, in 2018 more than 10 facilities were shut down and charged

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<sup>13</sup> PCD's Situation of Solid Waste in Thailand B.E. 2559 (2016)

<sup>14</sup> PCD's Strategy of Waste Electrical and Electronic Equipment Management B.E. 2557-2564 (2014-2021)  
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with illegally importing and recycling e-waste causing negative impacts to the environment. Most of the e-waste found in these cases were illegally imported from other countries in Asia. The destination of these illegal e-waste is Chachoengsao, Chonburi and Rayong. The incident became a wake-up call for Thai society on the issue of e-waste and its negative impacts sequencing from improper management.

The Thai Government have realized an importance of e-waste issue and taken several measures to solve the problem including of controlling the e-waste from industrial sector and the preparation of the Act on the Management of Waste Electrical and Electronic Equipment and Other End-of-Life Products. However, the public has low awareness of the negative impacts of e-waste to environment and human health, especially the impacts from POPs contamination. The survey by Department of Disease Control in 2014 reported that there were more than 100 communities in 17 provinces working informally on e-waste sorting and dismantling. The sorting and dismantling practice was done manually without using the proper PPE (Personal Protective Equipment).

#### Financial sources for energy efficiency, renewable energy and chemical management in Thailand

In addition to the industry's internal funding source, there are several financial sources available for the industry to use for their energy efficiency, renewable energy and chemical substitution projects as described below.

- Ordinary Bank loan: The industry can submit the application to the bank for the typical corporate loan. The interest rate is varied based on various factors such as the amount of loan, payback duration and the company's credit.
- Specific bank loan program: Some banks offer the specific bank loan programs for energy efficiency, renewable energy application and chemical management. Kasikorn Bank is one of the leading banks in Thailand providing various specific loan programs for example solar rooftop loan program, energy efficiency loan program and lighting system loan program. Although the programs are specifically designed for energy saving, there is no special interest rate offered.
- Soft loan provided by government through some specific banks: Ministry of Energy by the Department of Alternative Energy Development and Efficiency (DEDE) has offered the Revolving Fund through the participated banks since 2003. Currently, the phase 6 of revolving fund (2015 – 2019) is active with the total amount of 4,489,000,000 Baht. The fund has been used up with the remaining limit of 1,400,000,000 Baht. The eligible project has to have a payback period less than 7 years and conform to section 7 and 17 under the Energy Conservation Promotion Act B.E. 2535 for example the improvement of combustion efficiency. The industry can submit the application through eight banks participating in the project. The loan limit is 50,000,000 Baht/project with the maximum interest rate at 3.5%.
- Government subsidy program: DEDE regularly subsidizes the energy efficiency and renewable energy project. Different schemes are offered such as the subsidy of 20% to 30% of total cost for the energy efficiency equipment and the subsidy for actual energy savings. These programs may vary year-by-year depended on the available budget.

It should be noted that the soft loan provided by government and the subsidy programs have their own set of criteria, which require the industry to carry out the technical and financial assessment before submitting proposal.

Some key findings and observations from the study of energy efficiency financial source under the UNIDO-GEF's Industrial Energy Efficiency Project are shown below.

- Most of the banks do not usually consider financing of energy efficiency projects as project finance. It is commonly considered as corporate finance, which increases the bank's transaction cost and require more information from the projects' owner.

- Most of the banks pay attention to the Ability to Repay Ratio especially DSCR (Debt Service Coverage Ratio), which is calculated from a corporate cash flow, not a project cash flow.
- Net Present Value (NPV) and Internal Rate of Return (IRR), which are frequently used to evaluate the energy efficiency project at the plant level, are not used by banks as a direct consideration of repayment capacity.

It was also found that SMEs have a higher difficulty to access the bank loan due to their credit condition and the lack of solid technical and financial proposal.

### Scope of the project

During the preparatory phase, the consultation meeting with all project partners was carried out to confirm the target provinces for project demonstration. The updated situation, government policy in a next 5-year, project partner's experiences of working with the provinces and the relevant risks were taken into account along with knowledge sharing and scaling-up opportunities, and a balance between recent industrial estates/parks and older industrial zones. Three selected provinces, namely Samut Prakarn, Chonburi and Rayong, were confirmed as the target areas of the project. The three selected provinces house a high number of relevant industries for example chemical, electronic and auto-part industries as well as plastic manufacturers and textile factories. According to the national eco-industrial town plans, in all three provinces waste management and illegal contaminated dumping sites as well as water and air pollution are key challenges that need to be addressed. Chonburi and Rayong are two out of three provinces in the Eastern Economic Corridor (EEC) Development Plan under scheme of Thailand 4.0, which is a flagship program of Thai Government. More information on these provinces are shown in the further sections. The details reports of these three eco-industrial towns are in Annex J, K and L.

During the consultation meeting in August 2017, the project partners by the lead of PCD, a National Focal Point of Stockholm Convention, agreed to focus on three new industrial POPs consisting of Perfluorooctane sulfonic acid (PFOS) and its salts, Polybrominated diphenyl ethers (PBDEs) and Hexabromocyclododecane (HBCD). The baseline information of these new POPs are shown in the further sections. A detail report of an initial material flow analysis of these three new POPs is in Annex M.

However, during the stakeholder meeting under the UNIDO-GEF's Enabling activities to review and update the national implementation plan for the Stockholm Convention on Persistent Organic Pollutants in June 2018, the industries raised their concerns about the emerging new POPs including Short Chain Chlorinated Paraffin (SCCP) and deca-BDE. After consulting with the key project partners, it was agreed that this proposed project should design the activities to support Thailand on managing these emerging new POPs including the preparatory of baseline information for the country to take a proper actions on legislative perspective.

Based on the physical dimension, the project implementation can be classified as a provincial dimension and a national dimension.

- Provincial dimension: The limited boundary will allow the project to focus and optimize the resource usage for maximizing the project impacts. Therefore, the project will primarily focus on three pilot provinces of the project, namely Samut Prakarn, Chonburi and Rayong as shown in Figure 1. To strengthen the impacts and increase the visibility of the project, the priority of capacity building activities as well as the assessment and implementation of RECP, low carbon technology and green chemistry will be given to these three selected provinces. The demonstration sites for waste-to-energy and e-waste management will be preferably selected from the potential sites in these three provinces.
- National dimension: The lessons learned and good practices from the project will be shared nation-wide through the awareness raising and training activities. The online learning and information sharing platform developed

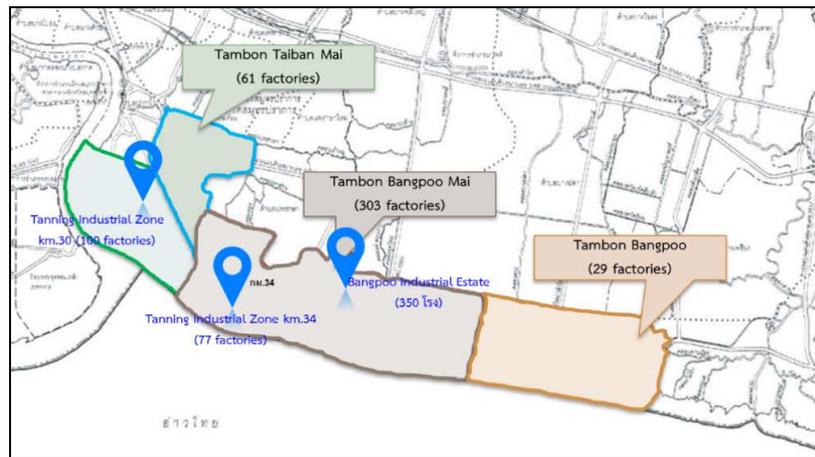
under the project will be freely accessible. During the implementation phase, the project will evaluate the opportunities for replicating some project activities at national scale and prepare the necessary resources to enhance the execution.



**Figure 1** Three selected provinces and project office location

#### Baseline information of Samut Prakarn's eco-industrial town

Samut Prakarn Province is next to Bangkok, the capital of Thailand. Due to the strategic location, the industrial development in Samut Prakarn has been promoted since many decades when the environmental management in Thailand was not restricted. The factories are scattered and mixed with other land uses such as community, which make the environmental management more complicated. In the project, the target area is scoped by the DIW's Eco-industrial Town Master Plan with the area of 63.5 sq.km., covering 4 Tambons (subdistricts) including Bangpoo, Bangpoo Mai, Taiban, and Taiban Mai under the administration of Bangpoo Municipality. Because of a part of Bangpoo Industrial Estate area is in the DIW's Eco-industrial Town area, so the target area of this project is extended to include all area of Bangpoo Industrial Estate in Phraek Sa. The map of target area is shown in Figure 2.



**Figure 2** Boundary of Samut Prakarn's Eco-industrial Town

There are around 7,500 registered factories in Samut Prakarn, 661 factories located in Samut Prakarn Eco-industrial Town area outside the Bangpoo Industrial Estate and 475 factories located in Bangpoo Industrial Estate.

Apart from the Bangpoo Industrial Estate, there is a Tanning Industrial Zone with 138 tanneries, which are members of Thai Tanning Industry Association (TTIA). The wastewater from the tanning process is collected and sent for treatment at a central wastewater treatment plant, which has been invested by the association. Due to the combined sewage system, the wastewater is diluted and treated with an aerobic treatment process. There is the possibility to generate energy from the biogas collected from the wastewater treatment plant. However, the investment of a new separate sewage system and new wastewater treatment plant is required. In 2016, the 9,278 tons of leather scrap were disposed into a secured landfill or an incinerator. Some of these leather scraps are considered as raw materials for the household industry such as leather accessories.

In 2016, the energy consumption of the industries in the target areas was approximately 86,000 TJ. The five industrial sectors with the highest energy consumption in the target area are 1) electricity, gas, steam and air conditioning supply, 2) textiles, 3) food products, 4) basic metals, and 5) chemicals and chemical products. The detail of energy consumption by industrial sector is shown in Table 2.

**Table 2** Total Energy Consumption in Samut Prakarn's Eco-industrial Town in 2016

2-digits ISIC	Industrial Sector	Energy Consumption (TJ)
10	Manufacture of food products	1,890.98
13	Manufacture of textiles	4,378.06
14	Manufacture of wearing apparel	57.32
15	Manufacture of leather and related products	185.76
17	Manufacture of paper and paper product	749.96
20	Manufacture of chemicals and chemical products	1,681.00
21	Manufacture of pharmaceuticals, medicinal chemical and botanical products	185.53

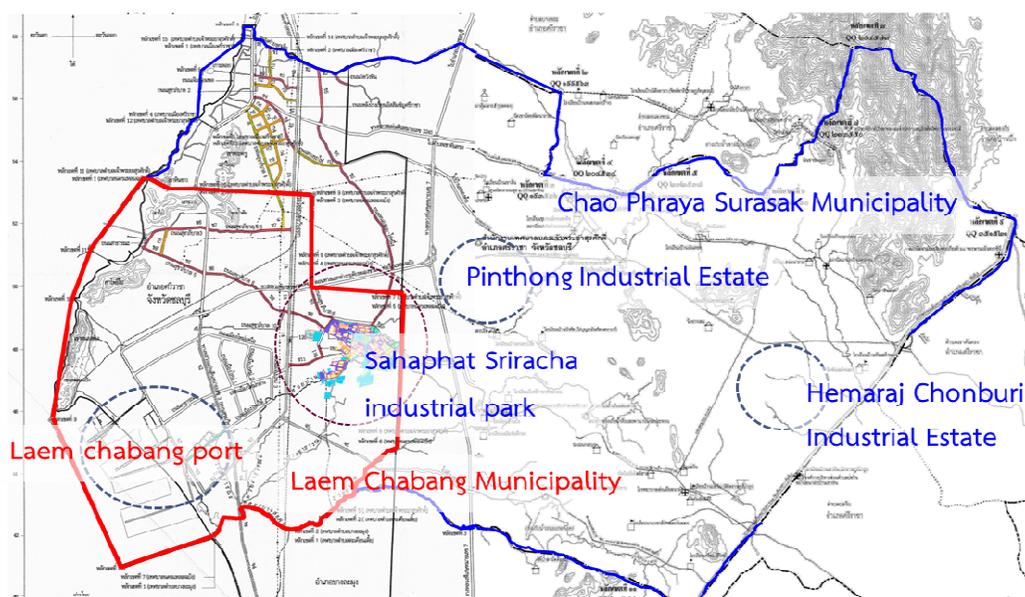
2-digits ISIC	Industrial Sector	Energy Consumption (TJ)
22	Manufacture of rubber and plastic products	1,192.58
23	Manufacture of other non-metallic mineral products	1,254.12
24	Manufacture of basic metals	1,825.54
25	Manufacture of fabricated metal products, except machinery and equipment	446.99
26	Manufacture of computer, electronic and optical products	822.33
27	Manufacture of electrical equipment	983.07
28	Manufacture of machinery and equipment not elsewhere classified	74.44
29	Manufacture of motor vehicles, trailers and semi-trailers	677.30
30	Manufacture of other transport equipment	34.75
32	Other manufacturing	294.24
33	Repair and installation of machinery and equipment	8.31
35	Electricity, gas, steam and air conditioning supply	68,786.85
38	Waste collection, treatment and disposal activities; materials recovery	295.46
52	Warehousing and support activities for transportation	55.81
	<b>Total</b>	<b>85,880.40</b>

In 2016, the estimated amount of solid waste in Samut Prakarn was 862,218 tons<sup>15</sup>. The solid waste in Samut Prakarn is collected and transported to a controlled dump site in Tambon Phraek Sa Mai, which is equipped with a waste sorter to separate the plastic in order to reduce the waste volume going to landfill. A Refuse Derived Fuel (RDF) plant with a capacity of 500 tons/day is operating to feed RDF to a waste-to-energy plant, which can generate electricity up to 9.9 MW.

#### Baseline information of Chonburi's eco-industrial town

Chonburi province is one of the new economic development areas called Eastern Economic Corridor (EEC) including Chonburi, Rayong and Chachoengsao. The target area for the project is scoped by the DIW's Eco-industrial Town Master Plan with the area of 386.63 sq.km. as shown in Figure 3, covering 7 Tambons in Amphur Sriracha including Tambon Khao Khan Shong, Tambon Bueng, Tambon Sriracha, Tambon Surasak, Tambon Thung Sukha, Tambon Borwin and Tambon Nong Kham. These areas are under the administration of Laem Chabang Municipality and Chao Phraya Surasak Municipality.

<sup>15</sup> PCD's Thailand Solid Waste Situation Report B.E. 2559 (2016)  
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**Figure 3** Boundary of Chonburi's Eco-industrial Town

There are 1,374 factories located in Chonburi's Eco-industrial Town with 119 factories located in Hemaraj Chonburi Industrial Estate, 196 factories located in Laem Chabang Industrial Estate, 284 factories located in Pinthong Industrial Estate, 71 factories located in Sahapattana Sriracha Industrial park and 704 factories scattered throughout the Chonburi eco-industrial town area.

In 2016, the energy consumption of the industries in the target areas was approximately 108,000 TJ. The five industrial sectors with the highest energy consumption in the target area are 1) electricity and gas, 2) coke and refined petroleum products, 3) chemical and chemical products, 4) basic metal, and 5) rubber and plastic products. The detail of energy consumption by industrial sector is shown in Table 3.

**Table 3** Total Energy Consumption in Chonburi's Eco-industrial Town in 2016

2-digits ISIC	Industrial sector	Energy consumption (TJ)
10	Manufacture of food products	970.81
13	Manufacture of textiles	977.77
14	Manufacture of wearing apparel	88.58
15	Manufacture of leather and related products	0.21
17	Manufacture of paper and paper products	55.02
19	Manufacture of coke and refined petroleum products	34,208.12
20	Manufacture of chemicals and chemical products	10,492.54
22	Manufacture of rubber and plastic product	2,996.32
23	Manufacture of other non-metallic mineral products	863.44
24	Manufacture of basic metals	5,358.16

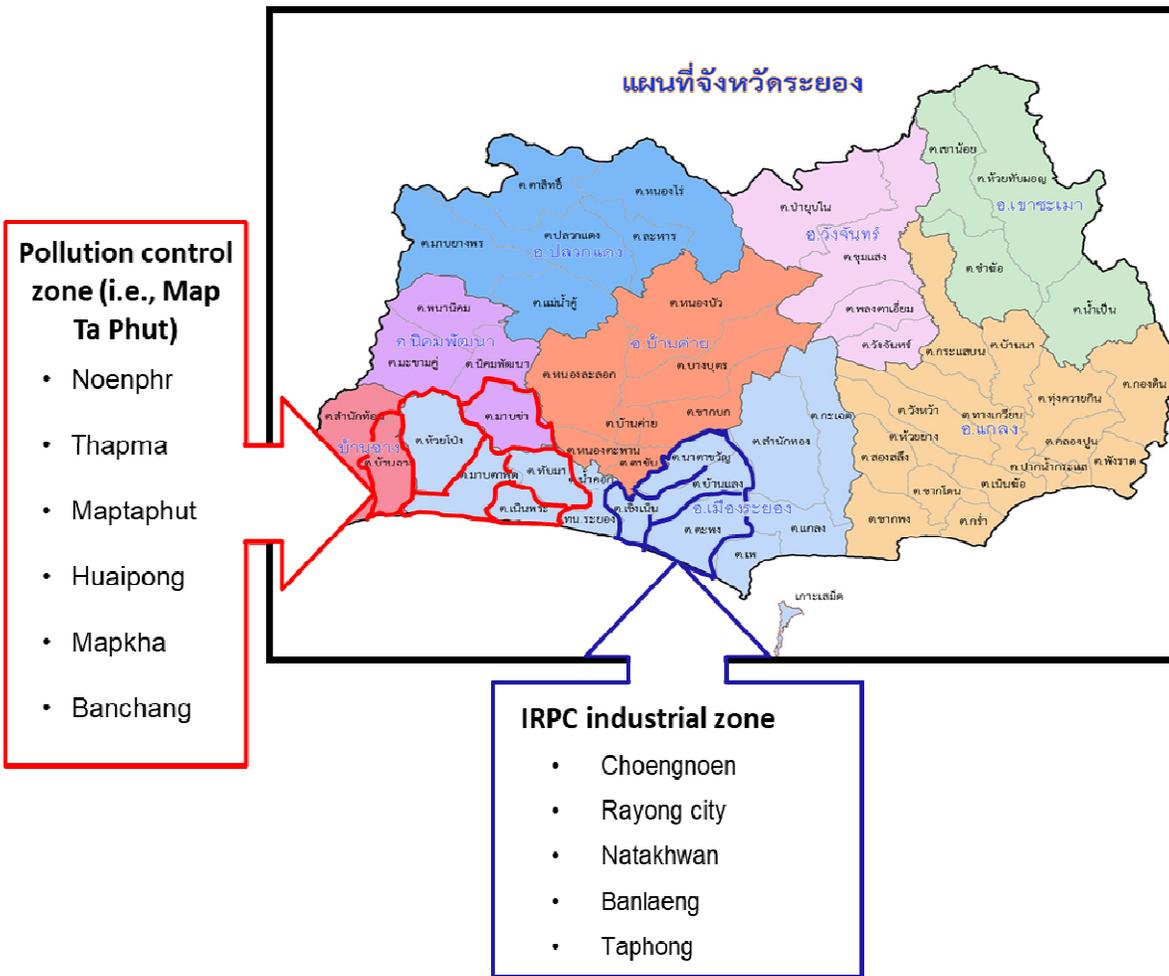
2-digits ISIC	Industrial sector	Energy consumption (TJ)
25	Manufacture of fabricated metal products, except machinery and equipment	931.45
26	Manufacture of computer, electronic and optical products	520.56
27	Manufacture of electrical equipment	658.93
28	Manufacture of machinery and equipment not elsewhere classified	570.60
29	Manufacture of motor vehicles, trailers and semi-trailers	2,233.63
30	Manufacture of other transport equipment	92.95
32	Other manufacturing	59.11
33	Repair and installation of machinery and equipment	15.09
35	Electricity, gas, steam and air conditioning supply	50,892.59
38	Waste collection, treatment and disposal activities; materials recovery	22.51
Total		112,008.39

In 2016, the estimated amount of solid waste in Chonburi was 956,196 tons<sup>16</sup>. The solid waste in the eco-industrial town area is collected and transported to a sanitary landfill located in Chao Phraya Surasak Municipality.

#### Baseline information of Rayong's eco-industrial town

Rayong is one of the most important industrial areas in Thailand. It is a home of Petrochemical and downstream industries of that Petrochemical industry. The target area for the project is scoped by the DIW's Eco-industrial Town Master Plan with the area of 426.21 sq.km., covering three districts (Muang district of Rayong Province; Nikhom Phatthana District; and Ban Chang District) that include Map Ta Phut Pollution Control Zone and the IRPC industrial zone. As shown in the map of target area in Figure 4, Map Ta Phut Pollution Control Zone includes 6 Tambons, namely Noenphra, Thapma, Maptaphut, Huaipong, Mapkha, and Banchang. The IRPC industrial zone includes 5 Tambons, namely Choengnoen, Rayong city, Natakhwan, Banlaeng, and Taphong.

<sup>16</sup> PCD's Thailand Solid Waste Situation Report B.E. 2559 (2016)  
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**Figure 4** Boundary of Rayong’s Eco-industrial Town

There are six industrial estates in the pollution control zone, namely Map Ta Phut Industrial Estate; Hemaraj Eastern Industrial Estate - Map Ta Phut; Rayong Industrial Estate; Asia Terminal Industrial Estate; RIL Industrial Estate; and Phadaeng Industrial Estate. In the IRPC industrial zone there is only the IRPC Industrial Estate.

There are 2,620 factories in total, located in Rayong Province, which can be categorized into 29 industrial sectors identified by the 2-digit code according to Thailand Standard Industrial Classification (TSIC). Only 719 of 2,620 factories are located in the target area, accounting for 27.44% of Rayong province. These 719 factories can be further classified into 27 industrial sectors, or 96 TSIC numbers. Out of 719, the 336 factories are the designated factories.

In 2015, the energy consumption of the industries in the target areas was approximately 127,500 TJ. The five industrial sectors with the highest energy consumption in the target area are 1) coke and refined petroleum products, 2) electricity and energy supply, 3) chemical and chemical products, 4) basic metals and rubber, and 5) plastic products. The detail of energy consumption by industrial sector is shown in Table 4.

**Table 4** Total Energy Consumption in Rayong’s Eco-industrial Town in 2015

2-digits ISIC	Industrial Sector	Energy Consumption (TJ)
8	Other mining and quarrying	11.89
17	Manufacture of paper and paper product	1.25
19	Manufacture of coke and refined petroleum products	69,603.19
20	Manufacture of chemicals and chemical products	9,544.21
22	Manufacture of rubber and plastic products	397.31
23	Manufacture of other non-metallic mineral products	372.42
24	Manufacture of basic metals	1,913.40
25	Manufacture of fabricated metal products, except machinery and equipment	93.07
26	Manufacture of computer, electronic and optical products	0.09
27	Manufacture of electrical equipment	1.96
28	Manufacture of machinery and equipment not elsewhere classified	15.39
29	Manufacture of motor vehicles, trailers and semi-trailers	6.75
30	Manufacture of other transport equipment	26.49
31	Manufacture of furniture	0.86
35	Electricity, gas, steam and air conditioning supply	45,526.73
36	Water collection, treatment and supply	4.26
	Total	127,519.27

Currently, there are a few practices of industrial symbiosis among factories for example sending waste gas and off-gas from polymer/aromatic plants to be used as feed stocks of the olefin plants. For industry-urban symbiosis, there is one pilot activity attempting to transform the sludge from WWTP to fertilizer by earthworms. There are also some CSR/CSV projects supported by the factories that still need to develop into the concrete industry-urban symbiosis.

In 2016, the estimated amount of solid waste in Rayong was 327,361 tons<sup>17</sup>. Rayong Provincial Administrative Organization (Rayong PAO) has started the construction of an integrated waste disposal center in 2016. Currently, Rayong PAO together with the Global Power Synergy Public Company Limited (GPSC) has formed a joint venture to invest in a project of the integrated waste-to-energy plant consisting of an RDF production plant and a 9 MW power plant. However, due to some legislation and technical problems, the construction has not been started yet.

#### New POPs

Thai industries are not the producers of POPs chemical. They import POPs chemical and/or articles to use in their production process. The finished goods are either used domestically or exported to other countries. For the export to EU, US, Japan, Korea and China, the industries are controlled and regularly checked for conformation with their client’s

<sup>17</sup> PCD’s Thailand Solid Waste Situation Report B.E. 2559 (2016)  
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specific chemical requirements and regulations such as RoHS, ELV and REACH, which include most of the industrial POPs.

Based on the series of stakeholder consultation with the potential users of new POPs in the three selected provinces and the survey of chemical usage list of some major chemical and polymer producers, it was found that there is no usage of PFOS, c-PentaBDE, c-OctaBDE and HBCD in those industries. However, it should be noted that some participants expressed their concern about the tradename of such new POPs that maybe lead to the unintentional use. Some participants confirmed that the factories have used the alternatives of those new POPs for a few years to comply with their client's requirements such as RoHS and REACH.

The project cannot prove that there is no new POPs used in the production process. However, to come up with the baseline scenario, the project made the following assumptions based on the results of stakeholder consultation and survey of industries in the target areas.

- Assume that the production for export may have a little or no new POPs usage.
- Assume that the production for domestic use has a possibility of new POPs usage, especially PFOS, which the import data in 2017 was identified.
- Assume that the imported articles related to PFOS for example chromium plating may contain PFOS.
- Assume that the imported articles related to c-PentaBDE and c-OctaBDE may not contain such substances due to their production ended in 2004
- Assume that there is a possibility of new POPs stockpile in the factories because there is no information of disposal reported to DIW, which required the transportation and disposal of industrial waste to be reported.
- Assume that some specific articles produced or imported before 2005 such as PUR foam and ABS and HIP in electrical and electronic equipment contained c-PentaBDE and c-OctaBDE.

#### i) PFOS

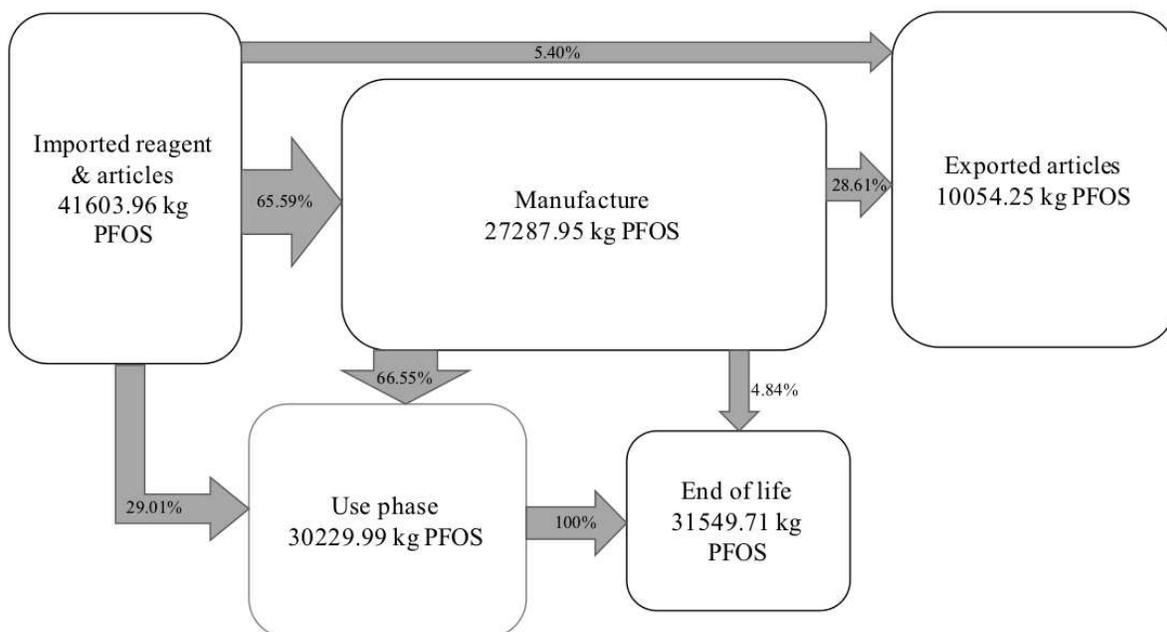
Based on the above assumptions, the baseline scenario of PFOS took into account the import of PFOS and its salts and the articles with possibility of PFOS consumption. The distribution of each phase, namely manufacture, usage, export and end-of-life is based on the available literatures and Thai statistics. The number of PFOS in the baseline indicates the average-to-high figure since the detail clarification could not be done in this stage for example the disaggregated number of chromium plating used for closed system, which PFOS usage is exempted.

In 2017, Thailand imported PFOS and its salts around 1,722 kg that consisted of 42 kg of potassium perfluorooctane sulphonate, 380 kg of Tetraethylammonium perfluorooctane sulphonate, and 1,300 kg of containing PFOS and its salts<sup>18</sup>. Additionally, major articles that potentially contain PFOS and its salts imported to Thailand are listed as follows; chromium plating, floor polishes, insulation materials, hydraulic brake fluid, polystyrene, textile, and firefighting foams. The potential amount of PFOS contained in all imported goods was approximately 39,882 kg and hence the total imported PFOS (chemicals and articles) was around 41,604 kg.

The summary of the amount of PFOS imported, used, stocked and exported is shown in Figure 5.

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<sup>18</sup> Thai Customs Department 2017  
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**Figure 5** Summary of PFOS at national level under the assumption that the imported articles possibly containing PFOS (Study report, 2017)

For end of life, the sector breakdown for PFOS is as follows (per year):

- In the electronic industries, the semiconductor industries and the metal plating industries PFOS in wastewater<sup>19</sup> was approximately 1.32 tons (4.18% of total PFOS in the end of life phase).
- For vehicles, machinery products, x-ray film, housewares equipment and building materials, reused and recycled materials contained PFOS of around 17.04 tons (54% of total PFOS in the end of life phase)
- Solid waste from households and offices, and construction sites contained PFOS of approximately 13.19 tons (41.82% of total PFOS in the end of life)<sup>20</sup>.

## ii) PBDEs

In 2017, Thailand imported 98 kg of PBDEs that consisted of tetra-, penta-, hexa-, hepta- or octabromodiphenyl ethers<sup>21</sup>. However, it could not confirm whether the registration with the Thai Custom Department was made by mistake or not.

The baseline scenario of PBDEs will assume that only 98 kg PBDEs and articles possibly containing c-DecaBDE imported. However, the 98 kg of PBDEs was not included in the analysis since it is minute when compare to those contained in the commercial articles. There are no articles containing c-PentaBDE and c-OctaBDE imported into Thailand. The most likely scenario of c-PentaBDE and c-OctaBDE is that the contaminated articles are partly in-use and circulated in the recycling business. Based on these assumptions, both c-PentaBDE and c-OctaBDE are existing only in the use phase.

<sup>19</sup> UNEP. 2017. Guidance on best available techniques and best environmental practices for the use of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention. Switzerland: UNEP.

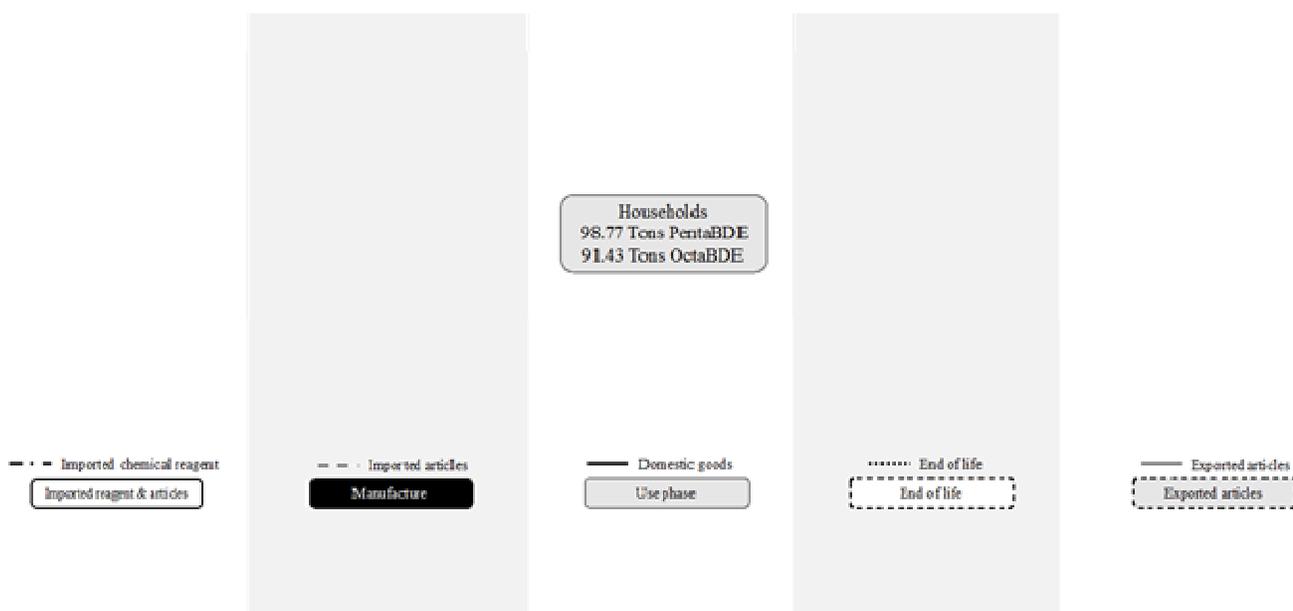
<sup>20</sup> Waste and Hazardous Substances Management Bureau 2017

<sup>21</sup> Thai Customs Department 2017

It is assumed that both PBDEs still exist in the remaining commercial articles that have been previously imported and are still being used in the nation. It is supposed that only the remaining of the previously imported textile and vehicle seats during 2001 to 2005 contained c-PentaBDE and also only the remaining of the previously imported ABS in the computer and TV casings (CRT) in 2005 contained c-OctaBDE.

For c-PentaBDE, vehicle seats in the country for the vehicles registered during 2001 to 2005 was estimated to be around 46,065.67 tons (Department of Land Transport 2018). All textile and vehicle seats used in the automotive industries could contain c-PentaBDE up to 98.77 tons (Thai Customs Department 2017, Department of Land Transport 2018). For c-OctaBDE, all ABS polymer the total were used in the electronic industry and consumed c-OctaBDE around 91.43 tons (Thai Customs Department 2017). For end of life, the information of waste management was unavailable. Therefore, it was assumed that all products were still used in households.

The summary of the amount of c-PentaBDEs and c-OctaBDEs in imported, used, stocked and exported use phase is shown in Figure 6.



**Figure 6** Summary of c-PentaBDEs and c-OctaBDE at national level under the assumption that these contaminated articles are in use phase only (Study report, 2017)

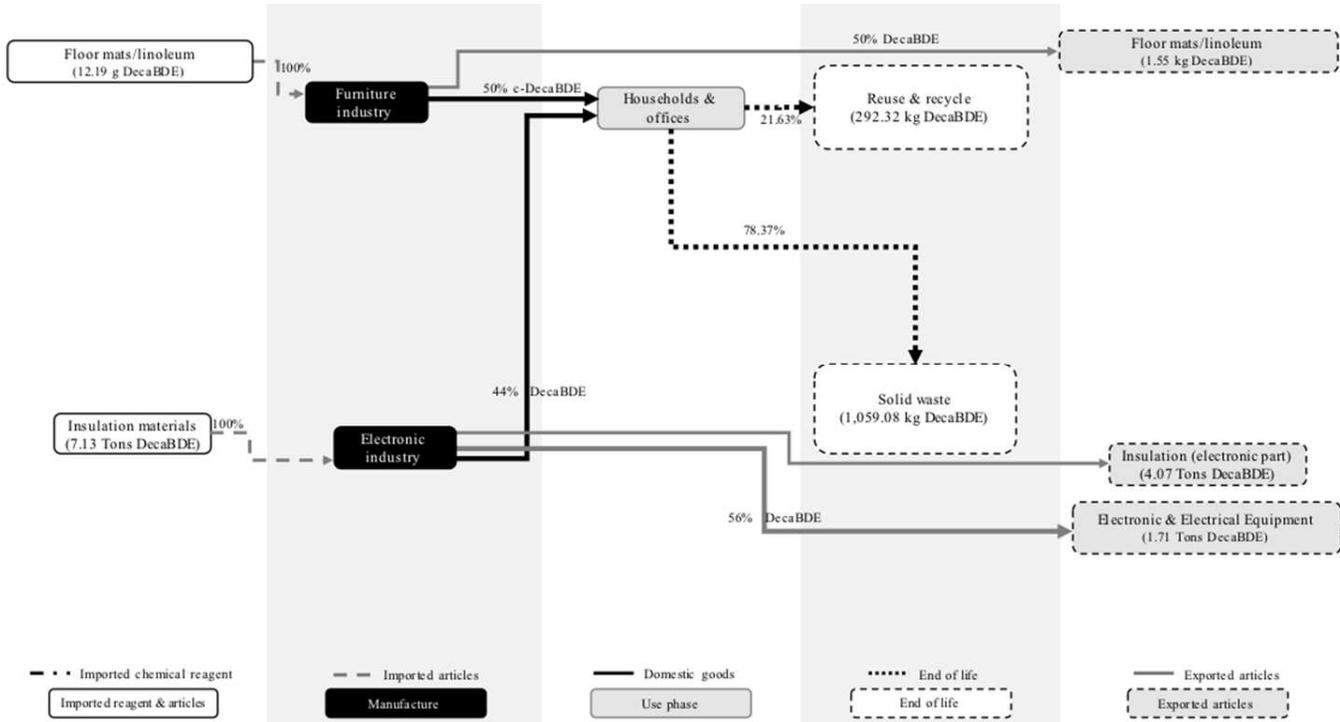
Imported items possibly contained c-DecaBDE composed of floor mats and linoleum, and insulation materials that was approximated to be 4271.28 tons, and 146,280.46 tons, respectively.

For manufacturing phase, the furniture industries used polyurethane foam and floor mats and linoleums that contained 1.55 kg c-DecaBDE. For furniture factories, floor mats and linoleums exported 1.55 kg c-DecaBDE. Finally, the electronic industries used imported articles (i.e. PVC, HIPS, ABS, epoxy resins and insulation materials) and domestic polymers (i.e. PVC, HIPS, ABS and epoxy resins) that totally comprised 7.13 tons c-DecaBDE. Besides, the exported electronic and electrical equipment contained c-DecaBDE of about 1.71 tons.

For use phase, goods from the textile industries, the furniture industries, the automotive industries and the electronic industries were consumed by households and offices and they contained c-DecaBDE approximately 1.35 tons.

For end of life, households reused and recycled materials, and generated solid waste around 21.63% and 78.37%, respectively. Reuse and recycle materials contained c-DecaBDE of about 0.292 tons, while solid waste contained c-DecaBDE approximately 1.06 tons. However, the inventory of articles containing c-PentaBDE and c-OctaBDE was initially calculated following the inventory guidance.

The summary of the amount of c-DecaBDE imported, used, stocked and exported is shown in Figure 7.



**Figure 7** Summary of c-DecaBDEs at national level under the assumption that the imported articles possibly containing c-DecaBDEs (Study report, 2017)

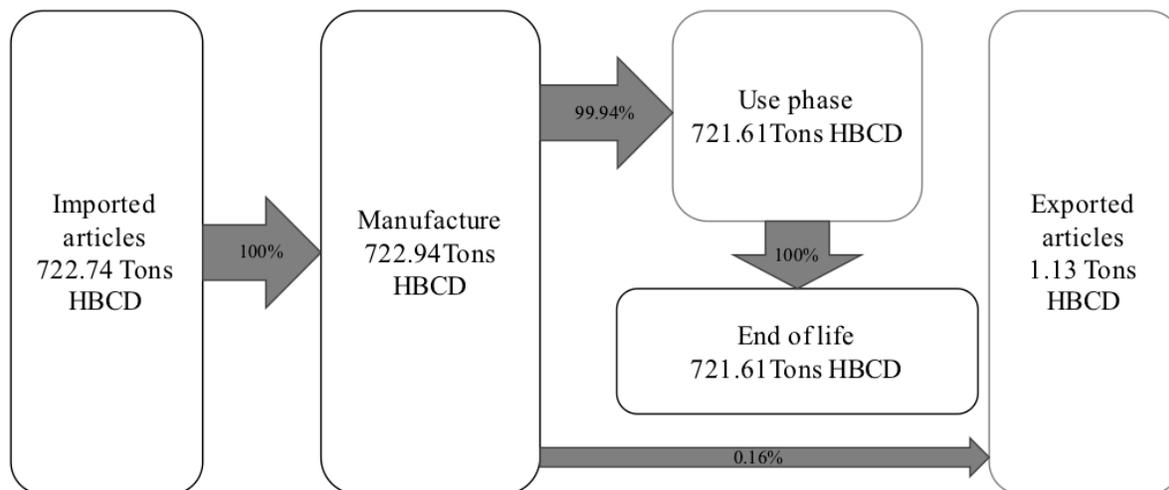
### iii) HBCD

In 2017 the information of imported HBCD to Thailand was not available, whereas articles that potentially contain HBCD were imported to Thailand as follows; HIPs, polystyrene, and back-coating textile. HBCD potentially contained in all imported goods was approximately 733 Tons.

It should be noted that in Thailand the typical house, residential building and commercial building is constructed by brick and mortar and/or reinforced concrete, for which the use of EPS and XPS is not usual unless the specific requirement is stated. There is a possibility of using EPS and XPS in some specific facilities for example cold storage industry. During the NIP update stakeholder meeting, some key players in the polymer manufacture for example IRPC and SCG-DOW Chemicals confirmed that no HBCD was used in their process. Therefore, the number of HBCD in the baseline indicates the average-to-high figure since the detail clarification could not be done at this stage for example the proof that the EPS and XPS imported contained HBCD.

With the assumption that there is no HBCD chemical imported to Thailand, all domestic and export goods were not contaminated with HBCD, and only the imported goods have a potential to contain HBCD.

The summary of the amount of HBCD imported, used, stocked and exported is shown in Figure 8.



**Figure 8** Summary of HBCD at national level under the assumption that the imported articles possibly containing HBCD (Study report, 2017)

For end of life, households and construction sectors reused and recycled materials, and generated solid waste that contained HBCD about 21.32% and 78.68%, respectively<sup>22</sup>.

iv) Sampling and test results of new POPs

Four samples of incoming waste from a secure landfill in Rayong and sludge waste from Samaedum were collected as shown in Figure 9. In addition, the samples from a municipal landfill in Chonburi and Samut Prakarn were also collected as shown in Figure 10.



**Figure 9** Secure landfill in Rayong

<sup>22</sup> Waste and Hazardous Substances Management Bureau 2017  
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**Figure 10** Solid waste from a municipal landfill in a) Chonburi b) Samut Prakarn

The analytical results of these samples showed that it was unable to detect the concentrations of PFOS, PBDEs or HBCD from all ten samples from incoming waste collected from the secure landfill in Rayong province and the municipal landfill from Chonburi and Samut Prakarn.

PFOS was detected in the textile waste sludge collected from Samaedum disposal center. PFOS was found in 4 out of 10 sludge samples with the concentration range of 2.624 to 3.483  $\mu\text{g}/\text{kg}$ . This PFOS concentration is quite low. However, it is still very interesting that PFOS can be detected from the textile sludge. Unfortunately, it is not possible to identify the sources of this sludge. In addition, HBCD can be determined from one sludge sample (together with PFOS detected) with the concentration of 36.747  $\mu\text{g}/\text{kg}$ .

PFOS was detected in the metal plating waste sludge collected from Samaedum disposal center. PFOS was found in 5 out of 10 sludge samples with the concentration range of 1.935 to 2.545  $\mu\text{g}/\text{kg}$ . In addition, HBCD can be determined from one sludge sample (together with PFOS detected) with the concentration of 36.378  $\mu\text{g}/\text{kg}$ .

In conclusion, it was found that PFOS could be detected from the waste samples from the textile and metal plating industries. However, the concentrations of PFOS are at low level. In addition, HBCD can be detected from some samples in those sludge. In the study, it was not possible to detect PBDEs from any of the samples.

## *2b) Baseline projects*

### *(i) International organization initiatives*

The International Finance Cooperation (IFC) has been active in Thailand in providing financing services for renewable energy in rural infrastructure projects. This has involved programs that are designed to strengthen the financial sector and to provide investment opportunities for SMEs. As such, IFC creates investment schemes and mobilizes partner banks to ensure increased access to affordable clean and renewable energy projects.

### *(ii) Global initiatives:*

Thailand is a member of the Strategic Approach to International Chemicals Management (SAICM), a policy framework to promote sound chemicals management, i.e. chemicals produced and used in order to minimize adverse impacts on the environment and human health. Among other chemicals, PFOS and its salts are also targeted by SAICM.

The project will benefit from UNIDO's vast experience in resource efficient and cleaner production (RECP). This approach aims to improve resources, reduce environmental pollution and contribute to sustainable industrial development within and beyond enterprise levels by applying clean and low carbon principles. UNIDO has been committed in implementing initiatives on RECP and working with both eco-cities and eco-industrial estates/parks. A project entitled "Promote the Development of an Ecological Cities (Eco-Cities) Network in Southeast Asia" funded by the government of Japan was recently completed with phase II underway. The objective of the project was to set up a network and build capacity of selected eco-cities in five countries, including China (city of Pingtan), Viet Nam (Da Nang), Thailand (Map Ta Put), Malaysia (Iskandar) and the Philippines (Cebu).

In 2014, UNIDO launched a project in Viet Nam entitled "Implementation of Eco-industrial Park Initiative for Sustainable Industrial Zones" funded by the GEF and the government of Switzerland. This project aims to increase the resource efficiency of industries and to promote industrial ecology, thus shifting from industrial zones to eco-industrial estates/parks.

Finally, UNIDO is cooperating with the city of Kitakyushu, Japan, in the field of environmental technology and waste recycling services.

(iii) Regional initiatives:

The following two projects developed by UNIDO in the area of POPs have just completed:

- Regional Plan for Introduction of BAT/BEP Strategies to Industrial Source Categories of Stockholm Convention Annex C of Article 5 in ESEA Region, and
- Demonstration of BAT and BEP in Fossil Fuel-fired Utility and Industrial Boilers in Response to the Stockholm Convention on POP.

The project manager has already consulted with the implementation team of both projects to avoid duplication.

(iv) National initiatives:

The Thai government has been very active in moving towards cleaner production and a more sustainable approach on industrial development. The Green Growth Strategy (2014 – 2018) was introduced to promote sustainable production and services as well as to increase the scope of industry-urban symbiosis, intensifying the collaboration among companies and exchange of by-products with urban areas.

In 2013, the Ministries of Industry, Interior, as well as Natural Resources and Environment formed a committee to study the model of eco-industries introduced in the existing industrial zones of Thailand. Since 2014, the Department of Industrial Works (DIW) has promoted the eco-industrial town development under the cooperation of relevant stakeholders including the provincial office, local authority and community. As of today, the eco-industrial town master plans of 15 provinces including Samut Prakarn, Chonburi and Rayong have been developed and started implementing. The incentive scheme of the eco-industrial town is in the process of announcement. However, the interactions between industries and towns remain limited not reaching the full potential of industry-urban symbiosis. To address this issue, the 12<sup>th</sup> national economic and social development plan (NESDP) 2017-2021 seeks to create awareness on the co-existence between industries and communities and to further transform eco-industrial towns. The implementation of eco-industrial town master plans in 15 provinces is set as a target under the 12<sup>th</sup> NESDP.

In addition to DIW's initiative, the Industrial Estate Authority of Thailand (IEAT) has mobilized their resources to support the eco-industrial estate/park development. A set of Indicators for Eco-industrial Estate, which later was changed to Eco-industrial Town, was formulated in 2012. These two sets of indicators developed by DIW and IEAT have somewhat overlapped. The difference between the definition of eco-industrial town under DIW's and IEAT's initiative is the implementation boundary. The scope of IEAT's eco-industrial town is the eco-industrial estate/park and its community within the boundary of 5 kilometers from the estate/park, and the industrial estate/park manager will lead the master plan implementation. The scope of DIW's eco-industrial town is wider with one or more industrial estates/parks and several communities in the boundary indicated in the eco-industrial town master plan, and the provincial governor will lead the master plan implementation.

Another government led initiative, to support a shift towards more sustainable industrial development, is the introduction of an eco-industry certification system. The Government and the Federation of Thai Industries (FTI) developed two certification mechanisms namely the Green Industry (GI) Mark and the Eco Factory using a combination of incentives and benefits for accredited factories. The former is divided in five levels: (1) green commitment; (2) green activities; (3) green system (ISO certification required); (4) green culture and (5) green network. The latter focuses on enhancing environmental, economic and social performances. Additionally, the Department of Industrial Works (DIW) is currently putting in place an incentive scheme for enterprises with GI-Mark level 5, which will exempt them from the annual factory license fee in Thailand.

In the past two decades, several initiatives have been undertaken to promote the application of cleaner production (CP) in Thai industries. The sectoral guidelines and code of practices were produced as the outputs of the projects funded by DIW and other agencies.

In the textile sector, these efforts include:

- (i) the introduction of a carbon footprint manual by the Thailand Textile Institute (THTI);
- (ii) the issuance of the REACH manual (Registration, Evaluation, Authorization and Restriction of Chemicals) co-funded by the EU-Thailand Small Projects Facility; and
- (iii) the currently under development scheme for pollutant release and transfer register (PRTR) system with the support of JICA, Japan.

In the electric and electronic sector, the Electrical and Electronics Institute (EEI) has supported a number of initiatives related to CP, such as Green Camp with the aim to share technical and practical knowledge with SMEs in life cycle assessment, eco-design and CP and to provide expertise and consultancy in cleaner technology.

### *3) The proposed alternative scenario, with a brief description of expected outcomes and components of the project*

As decided by the project partners, the project will use the area-based approach to demonstrate the industry-urban symbiosis by selecting Samut Prakarn, Chonburi and Rayong provinces, while the nation-wide intervention will be carried out for the disposal of new POPs focusing on PFOS, PBDEs, and HBCD. The incorporation of emerging POPs for example SCCP into the project activities will be decided by the Project Steering Committee (PSC) during the inception phase of project implementation.

In order to meet the objectives stated in Table E, the following methodologies and tools will be implemented in an integrated manner under the principles of industry-urban symbiosis:

- (i) RECP with low carbon technologies,
- (ii) Green chemistry with the substitution of POPs by less harmful substances; and

(iii) BAT/BEP for the use/recycling and disposal of new POPs.

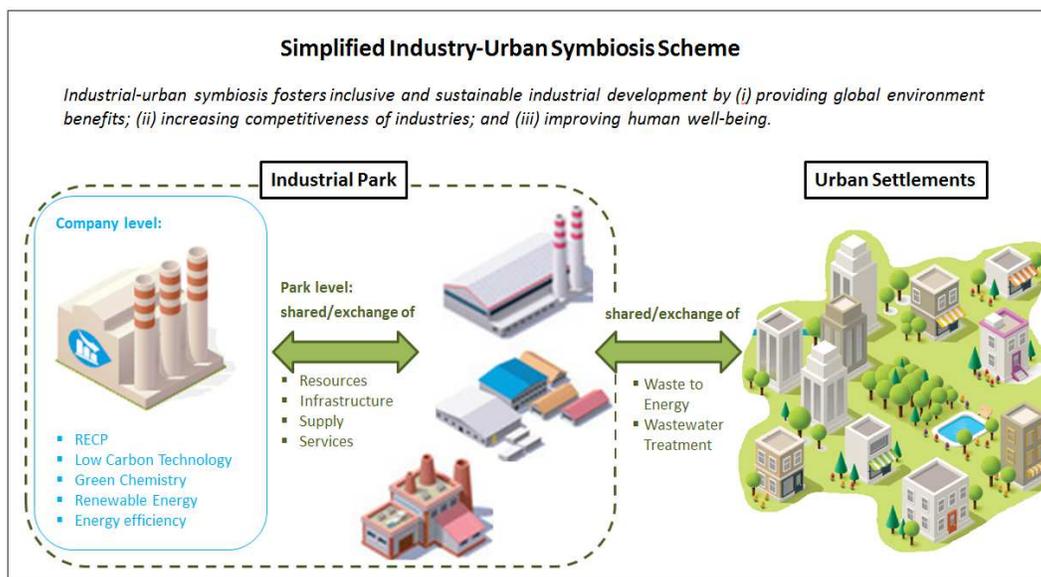
The demonstration projects of RECP, low carbon technology, industrial symbiosis and industry-urban symbiosis in the selected provinces will accelerate the adoption of innovative technologies and management practices for GHG emission reduction. The implementation of green chemistry and BAT/BEP for new POPs management will lead to the introduction of innovative technologies with an opportunity for scaling up across the country to properly manage and dispose of new POPs. It is expected that the lessons learned from technology transfer and the increasing capacity of relevant stakeholders will enhance the nation-wide replication and eventually contribute to the higher reduction of POPs and GHG emission.

Under RECP, renewable energy (solar and waste-to-energy) and energy efficiency measures will be promoted to reduce GHG emissions. The proposed project will combine policy strengthening, capacity-building, awareness raising, pilot demonstration, and national standard establishment in an integrated manner. The combination of these approaches intends to change behavior towards more inclusive and sustainable industrial development. In parallel, the project will demonstrate that industry-urban symbiosis is an economically sound business model that will provide benefits to the enterprises, the society and the environment at large.

The proposed project offers a holistic approach to reduce releases of GHG emissions and POPs at their source at factory, industrial zone and urban area level. The combination of proposed methodologies will encourage investment in technological solutions at three levels by applying a step-by-step approach:

- (i) within factories;
- (ii) among factories (eco-industrial zones); and
- (iii) between industry and urban centers (eco-industrial town).

The Figure 11 below illustrates the principles of industry-urban symbiosis.



**Figure 11** Industry-Urban Symbiosis Scheme

To apply the above-mentioned methodologies and tools and to meet the project targets, the project’s components and outputs are presented in more details hereafter.

## Component 1: Policy development

### *Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced*

The main objective of this component is to put in place the necessary policies, which will promote the development and adoption of RECP, green chemistry and industry-urban symbiosis through the implementation of environmentally sound technologies in Thailand. The policies will include components on:

- (i) low carbon and clean technologies as tools to reduce raw material usage, GHG emissions and untreated wastewater discharges;
- (ii) sound chemicals management, including chemical pollution prevention; and
- (iii) waste minimization through the reduction, reuse and recycling of raw materials, energy and water.

To tackle the major constraints of symbiosis among industries and between industry and urban, the legislative framework and system of industrial waste management in Thailand will be studied. The policy recommendation and suitable tools will be proposed to the responsible agencies to facilitate the symbiosis through resource, energy and waste exchange.

In addition to waste and hazardous substance related policies, market-based instruments (MBIs) will be assessed and adopted. MBIs are policy instruments that use market, price and other economic variables as incentives for companies. Within this project, the purpose of MBIs will be to incentivize polluters to reduce or eliminate negative environmental externalities and to support the establishment of eco-system of industry-urban symbiosis. The project will thus assess some of the innovative market-based instruments to price pollutants and test them at pilot scale. Some examples of potential MBIs include environmental taxes and charges, environmental subsidies, environmental certifications, liability and compensation schemes, and tradable permits.

DIW and PCD will play an active role to lead the activities under this output. DIW has a direct mandate to facilitate and control the industrial waste management, which is one of the identified barrier for implementing industry-urban symbiosis. PCD as a national focal point of Stockholm Convention have to mobilize the implementation plan to manage new POPs.

To achieve Output 1.1, the following activities are planned:

- Activity 1.1.1 Review current legal, regulatory, policy and institutional frameworks on waste- and chemical management of new POPs including their BAT/BEP and industry-urban symbiosis mechanisms (in relation to waste value chains and urban planning);
- Activity 1.1.2 Identify needed policy reforms, potential tools and system required to ensure large-scale implementation of RECP, green chemistry and industry-urban symbiosis;
- Activity 1.1.3 Develop and submit a draft policy to the legislative authority for formal appraisal based on the need to manage new POPs and to promote and implement industry-urban symbiosis within the existing eco-industrial town development strategy of the Ministry of Industry;
- Activity 1.1.4 Support the development of other related policies in order to channelize the collection and recycling of POPs containing end-of-life products; and

- Activity 1.1.5 Assess existing MBIs and if needed develop and introduce the most appropriate incentives to support the implementation of RECP, green chemistry, POPs management including its contaminated wastes, and industry-urban symbiosis.

## **Component 2: National capacity building and awareness raising on industry-urban symbiosis and POPs**

### *Output 2.1 Inventory of new POPs and intervention plan developed for the three selected provinces*

The updating of National Implementation Plans is currently going on under GEF's support. The process of preparing a national inventory of new POPs is included and used to support the national policy and plan to manage such new POPs. This information will be reviewed under this component to support the policy development detailed under Component 1. However, the data at national level is inadequate to support the intervention plan in the three selected provinces. The data collected on POPs value chains focused on the target areas will be collected and analyzed to facilitate the implementation of RECP, BAT/BEP and industry-urban symbiosis activities. Based on the gathered information, the main tools and instruments to be used in an intervention plan will be identified via participative approaches.

PCD will take a lead for the activities under this output. The capacity building of relevant stakeholders and the availability of provincial intervention plan will supplement PCD's role to help Thailand properly manage new POPs.

The main activities are described below:

- Activity 2.1.1 Conduct training sessions on new POPs analysis especially sampling, transport and storage of samples and inventory methods for the inventory of new POPs using material/substance flow analysis of new POPs at the provincial level for the three selected provinces. During this activity, all industrial sectors will be covered. At least 30 researchers and representatives of the project partners will attend the trainings;
- Activity 2.1.2 Draft an inventory report for new POPs in use and in waste streams in the three selected provinces (The initial list of new POPs consists of PFOS, PBDEs and HBCD. The emerging new POPs like SCCP may be added based on the decision of PSC upon the changed context and the availability of budget);
- Activity 2.1.3 A material/substance flow analysis (MFA/SFA) on new POPs including the e-waste, will be carried out in the three targeted provinces. The use of MFA and SFA combined with the inventories will provide quantitative information on stocks within and flows between certain industrial processes;
- Activity 2.1.4 Under the consultation with the project partners and the responsible agencies including the local authorities, draft the intervention plan at provincial level to implement in the three selected provinces; and
- Activity 2.1.5 Identify the monitoring points and monitoring new POPs for tracking the new POPs contamination in environment and update the database annually to assess the impacts of intervention plan developed in Activity 2.1.4.

### *Output 2.2 Opportunities for industry-urban symbiosis elaborated through material and waste stream analysis*

This output is intended to identify and clarify the potentials for industry-urban symbiosis in the three selected provinces. The objective hereby is to select concrete solutions and processes on how low carbon and green chemistry technologies, through symbiotic collaboration among companies and with communities, can be implemented. In this process, companies are encouraged to actively participate in the identification process of suitable technologies for pilot

demonstration under component 3. A material/substance flow analysis on energy, industrial wastes and municipal wastes will be also carried out in the specific industrial zones/estates and nearby communities to identify the symbiosis opportunities among the industries as well as the industry-urban symbiosis. The purpose is to identify stakeholders, location of related activities, material and energy use and releases to the environment. The mass balance obtained allows the (i) identification of flows and losses/emissions (ii) elaboration of alternative scenarios (iii) calculation of performance indicators to quantify savings and monitor improvement measures. The results of the MFA/SFA will highlight points of releases to the environment as well as opportunities for industry-urban symbiosis.

All project partners including the private sector will actively participate in this output. DIW and IEAT will lead the activities under this output.

The main activities to achieve this output are described below. They will contribute to the GHG emissions reduction target.

- Activity 2.2.1 Collect field information and build the material flow model to highlight material paths for energy, industrial wastes and municipal wastes as well as target (i) closed loop and (ii) industry-urban symbiosis opportunities. DIW, IEAT and the private sector participating in the project will share their database and information to support this project activity;
- Activity 2.2.2 Develop material flow and waste databases at industrial estate/park level using collected data to encourage entrepreneurship and information exchanges. Establish an online database with restricted access for authorized users as well as an open access area for replication and scaling up opportunities. The existing database maintained by DIW and IEAT will be reviewed for an opportunity to integrate or to share the resources. The project will select one industrial estate/park in the three target provinces to demonstrate the development and using this online database; and
- Activity 2.2.3 Based on the MFA and specific needs of each area and with stakeholder consultation and consideration of past experience and lessons learned in each area, develop business models for various types of industry-urban symbiosis including material, social and economic symbiosis.

*Output 2.3 Increased capacity and awareness on risks of new POPs and the benefits of (i) resource efficient and cleaner production, (ii) green chemistry, (iii) industry-urban symbiosis*

The study during preparatory phase of the project showed that the awareness and knowledge on new POPs is low among the industry. While the industry has practiced the cleaner production and energy efficiency for more than a decade, the huge gap of knowledge and capacity of factory personnel between large corporate and SMEs is addressed with the advantage of the corporate to access the resources at international level with no or less linguistic barriers. The existing information of RECP, low carbon technology and green chemistry is limited and scattered.

All project partners will actively participate in this output. DIW and PCD will lead the activities under this output. DIW, IEAT and FTI will help the project to reach their industrial network, while PCD and KU will provide the technical expertise to support the capacity building activities.

The first part of capacity building and awareness raising efforts will focus on national, industrial estate/park, and enterprise levels for the areas relevant to RECP, low carbon technologies, green industry, new POPs and their BAT/BEP, and industry-urban symbiosis. At the national level, the main target group will be DIW, PCD, IEAT, FTI and the relevant institutes under the Ministry of Industries, such as the Thailand Textile Institute, Plastic Institute of

Thailand and the Electrical and Electronics Institute, as well as supporting academic institutions, such as Kasetsart University. The other stakeholders will be included based on their relevance to the training topics. For the industrial estate/park and enterprise levels, the project will provide support to the management of the industrial estates/parks in the three selected provinces as well as to technicians and managers from the respective enterprises. The second part of the capacity building and awareness raising program will focus on local authority, community, wastes collector, recycle facility, and waste treatment and disposal facility to support their management of solid wastes, hazardous wastes and business model for industry-urban symbiosis.

The main activities to achieve Output 2.3, targeting at awareness raising, are described hereafter.

- Activity 2.3.1 Organize seminars and workshops on the principles and benefits of RECP, low carbon technologies, industry-urban symbiosis and wastes management as well as on the risks of new POPs to human health and the environment. To reach the target audience, company workers, governmental officials (e.g. urban planners and policy makers), communities, waste collectors, recycle facilities, civil society organizations (e.g. NGOs and local community associations), industry associations (private sector), consultants, suppliers and service providers will be involved. The seminars and workshops will be organized across Thailand with the priority given to the three selected provinces to cover at least 2,500 participants from factory, industrial estate/park and government agency, consultant, supplier and service provider, and other relevant stakeholders; and at least 500 participants from community, local authority, wastes collector, recycle facility, and waste treatment and disposal facility. The seminars and workshops for community and local authority will focus on the separation of wastes including the hazardous wastes and e-wastes, while for wastes collector, recycle facility, and waste treatment and disposal facility, the project will focus on the good practices of hazardous wastes and e-wastes management to minimize the risk of new POPs to human health and their contamination to environment.
- Activity 2.3.2 Disseminate the project information, lessons learned and best practices from component 3 (see below) through seminars, workshops, publications and outreach/educational materials for the replication and widespread adoption of RECP, low carbon technology, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis. The project will regularly provide the articles for the project partners to publish in their magazine, journal and booklet. All these materials will be available on the online learning and information sharing platform developed in Activity 2.3.8.
- Activity 2.3.3 Develop various awareness programs on the topics to suitably use in universities, technical colleges and schools. The awareness programs will be customized to suit these target audiences. At least the topics of the risks of new POPs to human health and the environment, waste separation and e-waste management will be covered.

To enhance the sustainability of the capacity building program, the project will have different levels of trainings, namely user training, intensive training, and expert training.

- User training: The user training is a beginner to intermediate training focusing on the application of RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis. The main target groups are factory personnel, operator in industrial zone/estate, environmental and energy auditor, consultant, and the officer of project partners. The classroom training with mixed of learning modalities will be mainly used for the user training.
- Intensive training: The intensive training is an intermediate to advance training providing the technical knowledge and practice of RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis. The main target groups are the engineer in factory and industrial zone/estate,

consultant, supplier and service provider. The classroom and on-line training will be used for the intensive training.

- Expert training: The expert training is an advance training providing the in-depth technical knowledge of RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis. The main target groups are the consultant/supplier/service provider, the senior engineer in factory and industrial zone/estate, and the officers of project partners. The classroom and on-line training with possibly the on-the-job training and individual assessment depended on the topic will be used for the expert training. A trainee who passes the exam will be qualified as the national expert. The pool of national experts will be a source to sustain the implementation of RECP, low carbon technology, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis in the future.

All training courses will be designed by the team of international expert with the support from either the national specialist or the qualified consulting firm/institute. Initially, the training courses will be delivered by the international expert and/or qualified national specialist. The English to Thai translation, if needed, will be made available to support the participants. After the expert training, some qualified national experts will be selected to join the team as the national trainers.

The main activities to achieve output 2.3, targeting at capacity building are described below.

- Activity 2.3.4 Review the current activities and infrastructure of project partners, relevant agencies and institutions. The review will also cover the program and contents of relevant trainings.
- Activity 2.3.5 Design training programs and adapt academic curricula on the challenges faced in implementing RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs and industry-urban symbiosis in Thailand. The training programs covering different levels of training will be designed with the consideration of Thai context. Some courses when suitable will be designed to meet the specific requirements of online training and delivered through the platform developed in activity 2.3.8.

Kasetsart University will be a key player to develop at least 3 courses for RECP, low carbon technologies, green chemistry and industry-urban symbiosis with the contribution from other universities. The courseware will be made available for other universities and colleges. The project will promote the integration of these courses to the university's curricula and provide the necessary support for example the train-the-trainer session.

- Activity 2.3.6 Train technical staff and experts from partner institutes, the respective industrial zones, beneficiary industries, consultants, suppliers and service providers on the topics mentioned under 2.3.5. The trainings will be organized across Thailand with the priority given to the three selected provinces to cover at least 3,000 participants for user trainings, 500 participants for intensive trainings and 100 qualified national experts.

To increase the outreach and access of the awareness raising and capacity building program, the online learning and information sharing platform will be developed and established. The project will design and implement the platform in various forms such as website and mobile application. The UX/UI (user experience / user interface) of the platform will be deliberately designed with the inputs from potential users such as the factory management and personnel, consultants, suppliers, government officers, and community. The platform's contents will be built up on the existing contents for example RECPnet's publication, UNIDO-GEF's dissemination materials, and the new materials developed under the project. Most of the contents will be provided in Thai language. The on-line training developed in Activity 2.3.5 will be hosted on this platform.

The main activities to achieve output 2.3, targeting at online learning and information sharing platform, are described hereafter:

- Activity 2.3.7 Review the existing online learning and information sharing practice at the international and national level for example Department of Industrial Promotion's e-learning system and Department of Environmental Quality Promotion's e-learning webpage.
- Activity 2.3.8 Develop the online learning and information sharing platform for the project. The user friendly and responsive website and application will be developed to share the technical knowledge and best practice on RECP, low carbon technology, BAT/BEP of new POPs, green chemistry, industry-urban symbiosis and e-waste management. The information will be developed in various formats for example pdf file, short video clip, live interview session, and on-line course. The project will regularly update the contents and increase the reach to the target audiences throughout the project implementation period. After the project termination, the online learning and information sharing platform will be maintained and updated by the project partners.

The project will dedicate one section of the online learning and information sharing platform for the financial sources and building up the capacity of the industry on financial evaluation of the project proposal. The information of available financial supporting schemes and loan will be collected and updated regularly. The project will coordinate with the financial institutes and relevant agencies to share the relevant training courses and materials on financial evaluation of the project proposal.

As a result of the second component, it is expected that behavior towards resource efficiency and management of hazardous wastes and e-wastes will change. In particular, management of household hazardous waste will be addressed by informing and involving multi-level forms of governance and the inclusion of local population.

### **Component 3: Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis**

Under this component, the innovative approaches promoted by this project will be demonstrated at pilot scale. Following the industry-urban symbiosis principles, the activities will focus initially on company level with the application of RECP and green chemistry to reduce resource consumption and switch to less hazardous chemicals together with the implementation of BAT/BEP of new POPs when applicable. In addition, the installation of solar PV panels on the roof of industries will be promoted. Energy management systems and heat system optimization will also be introduced as measures to increase energy efficiency and reduce GHG emissions.

Secondly, at the industrial estate/park level, exchanges between companies in terms of resources (supply chain, waste to raw material, heat, etc.), infrastructures (heat or power generation, wastewater treatment) or services elaborated under output 2.2 will be implemented.

Lastly, exchanges between the industrial estates/parks and the neighboring urban areas will be demonstrated with a specific emphasis on household waste management, with the underlying objective to shift from landfilling or open burning to waste-to-energy solutions. In order to maximize the benefits of waste-to-energy, initial recycling and recovering processes need to be strengthened and if absent implemented. Additionally, conventional burners will be replaced to allow for better recovery of metals and heightened elimination of contaminants. In this regard, air quality standards need to be ensured in order to avoid pollution and unintentionally releases of POPs. The project will benefit from the shared experiences and information via the ESEA Forum established by UNIDO and ensure the generation of positive impacts for the environment and human health.

When assessing suitable low carbon and clean technologies, priority will be given to the BAT/BEP solutions listed below.

GHG mitigation technologies:

- i. Waste heat boiler: utilizes the heat from waste gases stemming from combustions processes or from hot waste air streams. In this process, hot waste gas is passed through a tube bundle, where it transfers heat to the water located in the boiler body;
- ii. Efficiency monitoring systems: expose possibilities for saving energy of up to 10% including the following possible inputs: data burner capacity, fuel flow rate, fuel gas temperature and oxygen content;
- iii. Heat networks: allows the creation of symbiosis by using residue heat in plants for other companies situated in close proximity;
- iv. Thermal solar systems: may be used to provide process heat at a temperature of up to a maximum of 120 °C. Coupling solar-thermal energy directly to the process is suitable for cleaning, drying, evaporation, bleaching or boiling; and,
- v. Solar PV installation: depending on the rooftop system, solar PV installations can cover a large amount of the companies' annual energy requirements.

Practices to reduce POPs:

- i. Chemical leasing: international demonstration projects of chemical leasing in various industrial sectors have evidenced that it is possible to reduce the consumption of chemicals by an average of 20%. Such projects facilitate new service-oriented business model to be piloted and implemented in companies in the industrial zones that manufacture toxic substances of global significance, hereby focusing on the textile and electronics industries; and,
- ii. Fossil fuel combustion systems: coal combustion may be a source of HCB emissions and the potential of unintentionally produced POP emissions at a greater concentration from small and less well controlled fossil-fuel fired boilers. Hence, fuel quality and combustion control are the most important aspects in minimizing emissions of POPs. Parameters that can be controlled to reduce PCDD/F emissions in fossil fuel combustion systems are combustion quality, air pollution control temperatures, fuel parameters and operating parameters for air pollution control devices if installed.
- iii. A proper e-waste management approach based on life cycle considerations will be evaluated according to the BAT/BEP guidelines under the Stockholm Convention. Some of the most relevant processes for PBDEs containing material flow involve recycling, material/energy recovery or disposal. As such PBDEs wastes often have to be stored and handled prior to treatment or final disposal. Hereby a number of technical requirements according to the before mentioned guidelines have to be met, such as appropriate storage drainage infrastructure or proper loading and unloading management systems as well as fire safety measures required for storage of plastic wastes according to the Basel Convention.

Throughout this component, institutions offering financial mechanisms in Thailand for investments in low carbon and resource efficient technologies will be involved and their services made accessible to industries and SMEs in particular.

All project partners including the private sector will actively participate in this output. DIW, IEAT and PCD will lead the activities under this output. DIW, IEAT and FTI will promote the implementation of RECP, low carbon technologies, green chemistry and industry-urban symbiosis to their industrial network. FTI will support the certification if applied. PCD will help identify the demonstration sites for waste-to-energy and e-waste dismantling/recycling. KU together with the national experts will provide the technical expertise for the RECP assessment.

*Output 3.1 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises, industrial zones and neighboring urban settlements*

All pilot demonstration activities to be carried out in three selected provinces studied under activities 2.2.1, 2.2.2 and 2.2.3 are grouped under output 3.1. The planned activities are detailed hereafter:

- Activity 3.1.1 Conduct RECP assessments in 200 facilities and when appropriate introduce low carbon technologies, green chemistry application, energy management system and system optimization measures. The assessment will allow official certification (e.g. Green Industry Mark or Eco-factory certification) and also cover the opportunities for industrial symbiosis and industry-urban symbiosis. Out of 200, 100 facilities will be further supported by performing technical and financial feasibility studies to present bankable pilots on:
  - (i) potential low carbon and green chemistry technologies, including the PV installation on factory roof,
  - (ii) industrial ecology, and
  - (iii) interactions between industrial estates/parks and urban areas.

The selection criteria will be agreed by the project partners during the implementation phase. The level of technology proposed for the industry will be varied on their baseline condition and readiness to adopt technology. However, for SMEs there will be a strong focus on low hanging fruits.

The 50 facilities out of 100 will be expected to implement the proposed measures/projects to reduce GHG and POPs disposal. To support the company's investment, the project will coordinate with the banks and the government special loan program/subsidy program to facilitate the financial support requesting process including the preparation of bankable financial proposal.

After the proposed measures/projects implemented, the project will provide the verification assessment for the savings/reduction of some selected projects agreed by the project partners and the facilities.

The main outputs for the demonstration of industry-urban symbiosis at both industrial zone/estate and provincial scale are described in the following activities.

- Activity 3.1.2 Demonstrate industrial symbiosis between companies and establish partnerships between industries and urban areas. Based on the results of Output 2.2, the project will work further with the factories to demonstrate their industrial symbiosis opportunities. For the industry-urban symbiosis, the project will support the industrial zone/estate and the community to conceptualize the opportunities of by-product and industrial waste utilization by the community. Totally, there will be three demonstration projects. Technically and financially sound business models will be developed to demonstrate feasibility as well as economic, social and environmental benefits and to ensure the sustainability of the demonstration projects

The project will work with the local authority and waste management facility in the three selected provinces to demonstrate the waste-to-energy plant to dispose the household waste in an environmentally sound manner while offering alternative energy supply to the community and industrial estate/park and the e-waste management. One demonstration project will focus on waste management and waste-to-energy, while another demonstration project will focus on e-waste management and its dismantling and recycling plant. The demonstration projects will be carried out by using the local authority's or their concessionaire's or the waste facility's plant. The technical assistance provided by the project will focus on the logistics of waste/e-waste including the waste/e-waste separation and sorting system, good operation practices and BAT/BEP of waste-to-energy plant/dismantling and recycling plant and the potential MBIs to encourage the behavior change among the communities.

The project will facilitate the safe disposal of new POPs contaminated wastes including e-waste. The suitable MBIs and/or sound business model, which are outputs from the component 1 and 2, will be demonstrated to encourage the safe disposal as well as the implementation of BAT/BEP of safe disposal site. The lessons learned will be shared nation-wide for the opportunity of upscaling.

Regarding a concern of U-POPs emission from the waste-to-energy plant, the project will ensure that the BAT/BEP has been implemented in the demonstration project. The demonstration results and its practice of BAT/BEP will be promoted to other waste-to-energy facilities across Thailand via the published case study and the dedicated trainings for these topics.

To effectively support the capacity building activities under Component 2, the pilot demonstration under Component 3, the pilot implementation of National Eco-industrial Town Framework under Component 4 and the monitoring of project's results under Component 5, the project staffs are required to be in the field frequently to attend, supervise, visit the site, coordinate and solve any issues raised. Based on the workplan, the number of days in the field annually will be about half of the year. The three selected provinces are far from the project's office in Bangkok with the travel time ranging from 1 to 3 hours. By considering the frequency of travel and management perspective, the project's vehicle will be acquired to provide the flexibility and effectiveness.

It is expected that this component will demonstrate that investments in low carbon and resource efficient technologies have short payback periods and lead to increased profitability and competitiveness making them attractive to the private sector. Thus the goal is to provide a solid business model for industrial development in Thailand. This will in turn systematically change behavior at company level in utilizing the financing opportunities supporting in particular low carbon and RECP technology. The project will facilitate access to green financial schemes by disseminating information on available financial programs and their application processes. Subsequently, enterprises operating in numerous locations will be expected to replicate the project's success in other provinces and countries where they are operating.

#### **Component 4: Development of National Eco-Industrial Town Framework and its supporting system**

One of the barriers to upscale RECP and improve the environmental quality is a lack of continuity and supporting system to sustain the implementation. Thai government agencies and industrial associations realized this issue and tried to resolve by issuing the recognition schemes as an incentive for industry such as Green Industry Mark (GI Mark) and Eco Factory for individual factory and Eco-industrial Town criteria for the eco-industrial estate/park and nearby area. However, with the limited supporting system, the auditing and certification process of these standards heavily relies on the consultant's work not the actual capacity of the industry and the industrial estate/park.

Under this component, the national Eco-Industrial Town Framework will be developed by incorporating the innovative approaches promoted by the project and streamline the various standards relevant to eco-industrial town in Thailand, namely FTI's eco-factory, IEAT's eco-industrial town criteria and DIW's eco-industrial town criteria. The supporting system of the framework including the data collection and analysis system, monitoring procedure, and certification process will be designed to ensure that the responsible agencies and the industries themselves can continue using the framework to identify their status and the gap for improvement. By having the national eco-industrial town framework implemented, it is expected that all three levels, namely factory, industrial estate/park and industrial town will apply the RECP, low carbon technologies, green chemistry and industry-urban symbiosis together with other socio-economic elements of the framework to be more environmental-friendly and share the benefits among industries and communities.

DIW and IEAT will lead the activities under this output. They will share the relevant information on eco-industrial town criteria with the project, support the development of the supporting system, and co-host the National Eco-industrial Town Framework.

#### *Output 4.1 Continuous improvement and sustaining the industry-urban symbiosis*

The main activities are described below.

- Activity 4.1.1 Review the relevant Thai Eco-industrial standard and criteria as well as the international criteria for example an international framework for eco-industrial estates/parks
- Activity 4.1.2 Develop a national eco-industrial town framework and its supporting system. Various environmental related criteria for example resource efficiency, GHG reduction, chemical management, waste management will be incorporated into the framework to encourage the further implementation of RECP and other relevant approaches. The socio-economic elements related to industry-urban symbiosis will be emphasized in the framework as well. The national eco-industrial town framework should be applicable to both industrial estate/park and town with different ranking for continuous improvement. The national eco-industrial town framework should also allow the benchmarking with other international frameworks/standards on eco-industrial park/estate/town. The development process will be carried out under the close consultation with DIW and IEAT.

The project will identify the data/evidences required under the framework and the reporting systems, which are owned by the project partners and other agencies. The project will develop the supporting system for the national eco-industrial town framework to consolidate the data required for the framework auditing. Several approaches will be used to establish the supporting system by giving the priority to information sharing from the existing sources.

The national eco-industrial town framework will be approved and adopted by the responsible agencies, DIW and IEAT. Its supporting system will be co-hosted by both agencies to facilitate the certification process and to ensure its operation after the project termination.

- Activity 4.1.3 Promote and implement the national eco-industrial town framework and its supporting system. The pilot implementation of the national eco-industrial town framework will be carried out in the three selected provinces. The feedbacks from the implementation will be used to improve the framework, if needed.

To support the demonstration, the project will design the capacity building program for the participated industrial estates/parks and the relevant stakeholders such as the local authority, factories outside the industrial estate/park. The capacity building program will include the detail of framework, the data collection and analysis, and the use of its supporting system. The manager and key staffs of the industrial estates/parks in the target areas will also be trained under this capacity building program.

It is expected that this component will urge the industry to continuously improve their environmental performance. The accumulated results at the industrial estate/park and town level will improve the environmental quality and the quality of life of the community.

## **Component 5: Monitoring and evaluation**

### *Output 5.1 Periodic monitoring and evaluation of project implementation completed*

Project monitoring and evaluation will be conducted in accordance with UNIDO and GEF requirements and procedures. The Project Steering Committee (PSC) will be a main mechanism to track the overall progress of the project, solve the issues faced during project implementation, and approved the formal reports as a reference source for midterm and final evaluation.

The Project Management Unit (PMU) will be in charge for monitoring the project progress and preparing the reports submitted to PSC, GEF and UNIDO. The Project Results Framework in Annex A, which provides the indicators and targets at project and activity level as well as the means of verification, will be a guideline for the PMU to track the progress and achievements. The project reports as a formal document to record the workplan, project activities, progress against targets, problems/constraints, and lessons learned will consist of Inception report, Project Implementation Report (PIR), Annual reports, Technical reports, and Project terminal report.

More details on the monitoring, reporting and evaluation are in Section C: Describe the budgeted M&E Plan.

### *4) Incremental/additional cost reasoning and expected contributions from the baseline, the GEFTF, LDCF, SCCF, and co-financing*

GEF intervention is needed to remove the policy, regulatory, capacity, technology and other barriers that hinder the industry to apply the industry-urban symbiosis approach reduce GHG emission and properly manage new POPs. In the absence of GEF support, this could potentially occur but in a fragmented manner, less coordinated, at a slow speed, with limited beneficial group by excluding some marginal groups and without the substantial benefit of international experience that GEF and UNIDO bring.

#### *Cost Effectiveness*

The Project will strengthen industrial companies and areas' ability to reduce GHG emissions through both energy efficiency and renewable energy utilization, while at the same time improving chemical management – resulting in green chemistry systems in a number of enterprises – thus reducing the negative impact on the environment. Additionally, the project will have an impact on the policy level dealing with both energy and POPs. The combination of these approaches will allow for a highly cost-effective project. Without the project it is unlikely that the symbiotic development of industries would be possible due to the barriers described in previous sections.

#### *Co-financing*

During project formulation phase, commitments were received for investment, grant, and in-kind contributions from the key national stakeholders, industrial investors, and UNIDO. These co-financing letters are included in Annex I – Co-Financing Letters and Agreements. All stakeholders have included sufficient co-finance to support the proposed activities in which they are involved. Additionally, the project expects to mobilize co-finance of at least USD 102 million for investment in EE and chemical management activities throughout the project implementation period. This would result in a co-financing ratio of over 10-to-1 for the GEF investment. The comparison of baseline and alternative scenarios brought by the incremental investment from GEF and co-financing from the project partners is shown in Table 5.

**Table 5** Incremental cost led to the alternative scenarios

Baseline	Alternative Scenario (Incremental Activities)	GEF Grant (USD)	Co-financing Budget (USD)
<b>Outcome A:</b> GHG emissions and releases of POPs reduced through industry-urban symbiosis by transferring low carbon and green chemistry technologies, improving capacity, enhancing infrastructure, promoting innovative business models and raising awareness			
<b>Component 1: Policy development</b>			
<p>Some of new POPs were listed as the hazardous substances by law, however, there is no other actions taken since the new national intervention plan is under preparation.</p> <p>Currently, limited MBIs relevant to industry-urban symbiosis were implemented for example fee collection for operating waste-to-energy plant.</p>	<p>Potential tools and system required to ensure large scale implementation of RECP, green chemistry and industry-urban symbiosis available for relevant stakeholders to implement</p> <p>Proposed policy improvements/guidelines and market-based instruments available for relevant stakeholder to take action</p> <p>Waste exchange among industries and between industry and community facilitated</p>	402,700	1,357,000
<b>Component 2: National capacity building and awareness raising on industry-urban symbiosis and POPs</b>			
<p>There is no inventory and intervention plan of new POPs at the provincial level.</p> <p>Limited capacity of researchers and government officers to collect sampling and analyze the new POPs.</p> <p>There is no baseline information of some emerging POPs such as SCCP. Therefore, it is difficult for the responsible agency to take action.</p> <p>Limited industrial symbiosis and industry-urban symbiosis implemented in Thailand. Most of the industrial symbiosis were carried out by the companies under the same corporate.</p> <p>Some industry-urban symbiosis exist, but on ad-hoc basis as the CSR/CSV project. Most of the</p>	<p>Inventory and intervention plan of new POPs at the provincial level available</p> <p>Capacity of researchers and relevant government officers on sampling and analyzing the new POPs increased</p> <p>Opportunities for industrial symbiosis and industry-urban symbiosis identified</p> <p>Awareness and capacity of responsible officers and relevant stakeholders on new POPs, RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis increased</p> <p>New information, lessons learned and publication on new POPs, RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis disseminated</p>	3,465,700	9,233,135

Baseline	Alternative Scenario (Incremental Activities)	GEF Grant (USD)	Co-financing Budget (USD)
<p>industry-urban symbiosis emphasized on the product development instead of the whole value chain of the potential business.</p> <p>Lack of knowledge and understanding of new POPs among industries, government agencies and communities</p> <p>Limited knowledge sharing and trainings available on RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis.</p> <p>There is no mechanism to sustain the knowledge sharing on RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis.</p>	<p>Knowledge about RECP, low carbon technologies, green chemistry and industry-urban symbiosis institutionalized in the major universities in Thailand</p> <p>Online learning and information sharing platform available to be one of the key local resources on new POPs, RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis</p>		
<b>Component 3: Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis</b>			
<p>Limited case study to demonstrate the implementation of RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs, and industry-urban symbiosis. Some guidelines on energy audit and energy saving are available, but with limited case study.</p> <p>Increasing interest of waste-to-energy as a part of industry-urban symbiosis. Code of Practice is available. However, the community raise their concern about environmental issues, especially release of air pollution.</p> <p>Recently, E-waste became a pressing issue in Thailand. In addition to the domestic e-waste, the problem of illegally imported e-waste is increasing. The e-waste management</p>	<p>Application of RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis demonstrated</p> <p>Lessons learned on the demonstration of waste-to-energy and e-waste management shared and replicated</p>	3,770,100	106,338,951

<b>Baseline</b>	<b>Alternative Scenario (Incremental Activities)</b>	<b>GEF Grant (USD)</b>	<b>Co-financing Budget (USD)</b>
is dominated by informal sector without using the PPE. Their dismantling and recycling facilities are poorly managed with the high risk of environmental and health impacts.			
<b>Component 4: Development of National Eco-Industrial Town Framework and its supporting system</b>			
There is no national eco-industrial town framework available. There are two eco-industrial town criteria sets provided by DIW and IEAT.	National Eco-industrial Town Framework available and co-hosted by DIW and IEAT  Application of the framework promoted to other areas in Thailand	621,500	2,101,000
<b>Outcome B: Project achieves objective on time through effective monitoring and evaluation</b>			
<b>Component 5: Monitoring and evaluation</b>			
UNIDO and GEF monitoring and evaluation procedures are new for some of the project staffs and project partners.	Monitoring and evaluation of the project carried out systematically and effectively	280,000	368,614

*5) Global environmental benefits (GEFTF) and/or adaptation benefits (LDCF/SCCF)*

This proposed GEF project will facilitate and scale up the development of energy efficiency, renewable energy, and symbiotic relationships amongst industries to improve environmental management. Through an integrated approach the project will reduce the GHG and pollutants emission in industries and achieve global environmental benefits.

The cumulative direct GHG emission reduction from the Project is estimated to be 1,305,761 tons CO<sub>2</sub>eq over the lifetime of investments triggered by the project. The GEF contribution for the Project for mitigation is USD 3,560,133. This gives a direct CO<sub>2</sub> unit abatement cost (UAC) of USD 2.73 per ton of CO<sub>2</sub>eq. The estimated indirect emissions reductions range between 2.61 and 3.15 million, which would mean that a combination of direct and indirect emissions reductions would result in a UAC of under USD 1.00. The detailed analysis and methodologies for calculation are included in Annex G – Detailed CO<sub>2</sub> Emission Calculations.

Related to POPs reduction and destruction, it is estimated that the project will contribute to the reduction or destruction of at least 620 tons of POPs / POPs containing materials. Additionally, the business models established to reduce POPs could result in reductions of many times more than this amount, which will be tracked during project implementation.

## *6) Innovativeness, sustainability and potential for scaling up*

### Innovativeness

This is the second GEF project supporting a transition towards more sustainable industrial zones. The first one is currently being implemented by UNIDO in Viet Nam. The Thai project builds upon the Vietnamese initiative by adopting a multi-level governance approach on both RECP and green chemistry technology application, and waste management including electronic and industrial wastes. In addition, this project takes a step forward by targeting urban areas and their relations with industries.

The industry-urban symbiosis principles apply environmentally sound methods and practices in an innovative and holistic approach encompassing enterprises via the integration of RECP and industrial ecology. The proposed concept overcomes the virtual barriers that prevent companies to interact with one another and the nearby community and environment. Hence, the project proposes an innovative approach targeting the following three levels: (i) within industries; (ii) among industries within selected industrial zones/parks/estates; and (iii) among more resource efficient industrial zones/parks/estates and their neighboring communities.

Due to the innovative and integrated nature of this project, environmental targets, such as the reduction of emissions and energy consumption, can be reconciled with social and economic well-being. By working jointly, the group of businesses and the local community seek a collective benefit that is greater than the sum of the individual benefits that each company and the selected urban areas would enjoy if they only optimized their individual performances.

This project will be one of the first GEF projects to apply the green chemistry technology concept, an innovative approach that involves substituting and reducing the use of new POPs. In addition, the project will assess some options for innovative market-based instruments to price polluters. This is fully in line with GEF 6's Programmatic Strategy, to not only to emphasize the concrete reduction of GHG emissions and release of harmful chemicals, but also to establish innovative financial mechanisms that could leverage cost recovery from the private sector to clean up their environmental pollution.

### Sustainability

Sustainability will be achieved by strengthening the regulatory framework to incentivize the development of industry-urban symbiosis and sound management of chemicals and by creating institutional capacities in key public institutions. A series of training sessions will be conducted in selected industries and national institutions to ensure stakeholder ownership of technologies, tools and methods introduced by the project beyond its completion. During the trainings and workshops, awareness will be raised on national certification mechanisms and existent financial programmes in order to encourage companies to invest in clean and low carbon technologies. Financial investment schemes can serve as an incentive for the private sector to implement a more sustainable and inclusive business model.

The project partners will play a vital role on sustaining the project's impacts and knowledge sharing after the project termination. The selected partners will bring in the mixed of authority and expertise to strengthen and sustain the implementation of RECP, low carbon technology, sound chemical management, BAT/BEP of new POPs and industry-urban symbiosis through various mechanisms and tools developed under this project.

DIW and IEAT with their direct mandates to supervise the industries and support them to improve the environmental performance will co-host the National Eco-industrial Town Framework developed under Component 4. The framework will institutionalize the resource efficiency, sound chemical management and industry-urban symbiosis practice in

Thailand. It is expected that the framework will not only sustain the implementation but also encourage the continuous improvement to enhance more GHG emission reduction in the long term. Both DIW and IEAT have a strong commitment to pursue and apply the National Eco-industrial Town Framework across Thailand by using the lessons learned from the selected provinces in the project. DIW and IEAT have a full capacity in terms of resources, network and policy to maintain the compliance evaluation of such framework and encourage the continuous improvement of relevant industries and industrial estate/park to achieve more efficiency uses of resource together with the symbiosis among the industries and between the industry and urban area.

PCD as a national focal point of Stockholm Convention can upscale the achievement of the project's demonstration by using the practices and lessons learned from the project, especially the MFA/SFA of new POPs, monitoring of provincial intervention plans' effectiveness, BAT/BEP application, and sound business model to manage new POPs. Moreover, PCD will be benefit from the network with industry established during the project, which can support the national intervention of the emerging industrial POPs in the future.

FTI will host some awareness workshops and trainings after the project termination. As a center of industry network in Thailand, FTI is in the strong position to sustain the knowledge sharing activities. The selected courses and materials generated under the project will be incorporated in the existing training courses and/or add to the training program offered to FTI's members. The national trainers developed under the project will be a key resource to deliver those trainings for FTI to maintain the quality of the training.

The integration of the innovative concepts proposed in this project into the University's and technical college's curricula is one of the approaches to sustain and encourage the implementation of such concepts in the industry. KU as one of the project partners will adopt those courses into their regular curricula. KU's engineering department is one of the leading engineering schools in Thailand with a reputation of strong academic team who also provide the consulting services to the industry. Therefore, they will use their strength to support the industry by providing a qualified engineers equipped with RECP, low carbon technology, sound chemical management and industry-urban symbiosis knowledge and practice to the industry. Moreover, KU will promote those curricula to other Universities in Thailand.

The capacity building for local authority to use MBI in waste management, the separation and sorting of wastes, the logistic and its supporting system will increase the effectiveness and the viability of waste-to-energy. Moreover, the demonstration sites, waste-to-energy plant and e-waste dismantling/recycling facility, will be the learning hubs to encourage the replication of the good practices in managing solid waste and e-waste in Thailand.

#### Potential for scaling up

Enabled by the dedicated regulatory framework, the proposed project will serve as a model for replication and scaling up of industry-urban symbiosis in other provinces, supporting the Government of Thailand to achieve the goals of the 12<sup>th</sup> National Economic and Social Development Plan as well as other relevant National Strategy and Plans.

In addition to the sustainability perspective, the development of a curricula for universities and technical schools will also contribute to the scaling up potential. Lessons learned and experiences gained with the synergies among industries and selected urban areas will be shared on a national and international level. In addition, the environmental and socio-economic gains achieved in this project serve as a model for national and international companies, as well as manufacturing countries in Asia facing similar challenges and seeking to implement green growth strategies. The awareness of the financial sector on the potential economic gains that the proposed technologies can offer will also be raised, encouraging investments in companies and industrial estates/parks that are willing to increase their resource

efficiency, as well as to promote sustainable and inclusive industrial development. The pilot applications will also demonstrate the soundness of industry-urban symbiosis as a business model that should trigger further replication.

The awareness raising and capacity building program for an informal sector, dismantling and recycling facilities can be used by the national agencies and local authority to enhance the e-waste or WEEE (waste electrical and electronic equipment) management across Thailand. The demonstration of e-waste management can be replicated to other areas as well as other developing countries facing the e-waste problem.

The private sectors participating in the project, namely PTT and Saha Pathana Inter Holding, intend to replicate what they have learned from the project to the factories under their corporates and the industrial parks in other area.

*A.2. Child Project?* If this is a child project under a program, describe how the components contribute to the overall program impact.

Not applicable.

*A.3. Stakeholders.* Identify key stakeholders and elaborate on how the key stakeholders engagement is incorporated in the preparation and implementation of the project. Do they include civil society organizations (yes  /no )? and indigenous peoples (yes  /no )? <sup>23</sup>

During the preparatory phase of the project, several meetings with project partners were carried out to identify the potential stakeholders. The stakeholder meetings were also carried out to understand the possible role and contribution of each stakeholder. The potential role in the project of main stakeholders and secondary stakeholders were analyzed and identified as shown in Table 6 and 7, respectively.

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<sup>23</sup> As per the GEF-6 Corporate Results Framework in the GEF Programming Directions and GEF-6 Gender Core Indicators in the Gender Equality Action Plan, provide information on these specific indicators on stakeholders (including civil society organization and indigenous peoples) and gender.

**Table 6** Main stakeholders and their possible role in the project

No.	Stakeholders	Description/Mandate	Role in the Project
<b>Project Partners</b>			
1	Department of Industrial Works under the Ministry of Industry	<ul style="list-style-type: none"> <li>- Supervise the industry including hazardous waste, production, environmental and safety aspects</li> <li>- Support and provide knowledge related to machinery, production, environment, safety, hazardous waste, energy and CSR for industrial development</li> </ul>	DIW is the National Executing Agency of the project and will host the PMU and support its office's setup. DIW will chair the project steering committee and provide strategic guidance and direction to the project team. DIW will lead the activities relevant to policy and legislative framework study, RECP, low carbon technology transfer, industry-urban symbiosis, awareness raising, capacity building and project demonstration.
2	Pollution Control Department, under the Ministry of Natural Resources and Environment	<ul style="list-style-type: none"> <li>- Propose the comments related to pollution control for Environmental Quality Management Plan preparation</li> <li>- Develop the suitable systems, approaches, and methods to manage hazardous wastes, hazardous substances, water quality, air quality, and noise and vibration</li> </ul>	PCD will be the project steering committee co-chair and provide strategic guidance and direction to the project team on POPs related issues including the municipal wastes and e-waste management. PCD will lead the activities relevant to POPs and support the PMU for other project's activities.
3	Industrial Estate Authority of Thailand under the Ministry of Industry	<ul style="list-style-type: none"> <li>- Provide the system and management of environmental aspect for the industrial estate</li> <li>- Approve the operation of factory in the industrial estate</li> </ul>	IEAT will contribute to the project by being a focal point for the project to reach the industrial estates under their supervision as well as the factories located in these industrial estates and the nearby communities. IEAT will be part of the awareness raising and capacity building activities. They will also promote the adoption of RECP, low carbon technology, green chemistry application, and industry-urban symbiosis.
4	The Federation of Thai Industries	<ul style="list-style-type: none"> <li>- Act as a representative of industrial operators in the private sector and perform the task of coordinating all the matters related to policy and implementation of the private sector and the government</li> <li>- Promote and render support to the study and researches, trainings and dissemination of technical data and technological matters</li> </ul>	FTI will support the project by building collaboration with the private sector and reaching out to factories; thus facilitating data collection for industry-urban symbiosis and cleaner production. FTI will collaborate with government agencies on policy and industry-urban symbiosis development. FTI will support awareness raising activities and certification processes in industry.

No.	Stakeholders	Description/Mandate	Role in the Project
5	Department of Chemical Engineering and Department of Environmental Engineering under Kasetsart University	<ul style="list-style-type: none"> <li>- Produce professional engineers, who are recognized for their competence and technical knowledge as well as their ethical, moral and social responsibilities</li> <li>- Provide extensive and socially recognized academic and research services, which contribute towards the self-sustainable development of the country</li> </ul>	<p>Kasetsart University academic team in collaboration with other Universities will provide technical expertise on RECP, green chemistry, eco-factory and industry-urban symbiosis for stakeholders in the country, including government agencies, the private sector, communities, students and other organizations.</p> <p>Kasetsart will support the development of technology and knowledge transfer capacities in green chemistry, GHGs mitigation technologies, industrial symbiosis from international experts.</p>
<b>Industry</b>			
6	Participating factories	<p>The 1<sup>st</sup> target group: the factories in the three target areas and the factories with high potential of GHG and/or POPs reduction</p> <p>The 2<sup>nd</sup> target group: the factories outside the three target areas, but with high potential of GHG and/or POPs reduction.</p>	<p>The private sector will be a direct beneficiary of the project. The participating industries will invest and adopt low carbon/emission technologies, implement BAT/BEP, green chemistry and take part to urban-industry symbiosis depending on their production process and technical and financial feasibilities.</p>
7	Industrial estate/park/zone	The project will focus mainly the industrial estate/park/zone in the three target areas.	<p>Industrial estate/park/zone manager, both public and private, will be the beneficiaries of the project as in charge of the economic development and of equipment and infrastructure in industrial zones.</p> <p>The project will coordinate with the industrial estate/park/zone manager to facilitate the adoption of RECP, green chemistry and industry-urban symbiosis. The project will also seek support from the industrial estate/park/zone manager to promote the project activities and disseminate the project information and publication.</p>
8	Industrial waste treatment/disposal facility	All industrial wastes are required to be treated properly. The industrial waste treatment/disposal facility is required to register with DIW and to follow the specific regulations.	The project will provide a good practice to handle and manage the POPs contaminated wastes to the industrial waste treatment/disposal facility, especially the one with incinerator.

No.	Stakeholders	Description/Mandate	Role in the Project
9	Waste recycle/treatment/disposal facility	Legally, the waste recycle facility is required to register as the factory. However, there are still the dismantling and recycling activities in the informal facility, which is illegal. There are also the illegal treatment and disposal activities, which cause the negative impacts to the environment and pose the risk to human health.	The waste recycle facility, especially the e-waste recycle, has a high potential of POPs contamination. The project will provide a good practice to handle and manage the POPs contaminated wastes.
<b>Local Authority</b>			
10	Provincial Administration Organization (PAO)	<ul style="list-style-type: none"> <li>- Develop and improve the infrastructure</li> <li>- Manage the natural resources and environment</li> </ul>	According to the National Solid Wastes Management Master Plan B.E. 2559 – 2564, the local authority will take a critical and active role to collect and sort the hazardous wastes, which are the sources of POPs contaminated wasted products, from community. The project will collaborate with the PAO in the target areas to implement the relevant activities of POPs management and the industry-urban symbiosis including the waste-to-energy option.
11	Municipality/Subdistrict Administration Organization (SAO)	<ul style="list-style-type: none"> <li>- In charge for wastewater and solid wastes management</li> <li>- Manage the natural resources and environment</li> </ul>	According to the National Solid Wastes Management Master Plan B.E. 2559 – 2564, the local authority will take a critical and active role to collect and sort the hazardous wastes, which are the sources of POPs contaminated wasted products, from community. The project will collaborate with the municipality and SAO in the target areas to implement the relevant activities of POPs management and the industry-urban symbiosis including the waste-to-energy option.
<b>Community</b>			
12	Eco network, Green network and other networks	Eco network, green network and other networks are the established group of stakeholders including the community leaders. Each network has their own objectives and activities. For example, the eco network is set up to mobilize the eco-industrial town action plan.	To avoid the redundancy of network setup, the project will collaborate with the existing networks and share with them the relevant studies for feedback and comments. These network will be invited to attend the awareness activities and capacity building program.

No.	Stakeholders	Description/Mandate	Role in the Project
Other			
13	Waste picker and Waste collector	Most of the waste pickers collect the wastes from the trash bin in public area with no or minimum protection equipment for example mask and gloves. The more formal waste collector travel by the small truck and may offer the exchange of small items such as egg for the wasted electrical and electronic equipment (WEEE). The waste picker and waste collector will sell the wastes to the waste collection center. Some waste collector will dismantle the WEEE and/or extract the valuable minerals in their own premise before selling them to the waste recycle facility.	The waste picker and waste collector should be considered as an informal sector with a high risk to hazardous waste exposure. The project will aim to increase the awareness of this group regarding to harm of POPs.
14	Waste collection center	The waste collection center will buy the wastes from waste picker and waste collector. Some waste collection center will dismantle WEEE to separate the value substances and other parts such as plastic and/or extract the valuable minerals from the WEEE. According to the law, the waste collection center for WEEE has to register as a factory with DIW.	The project will try to identify the waste collection center with the WEEE dismantling activity, which poses the high risk of POPs contamination on the site and nearby area. The project will aim to increase the awareness of this group regarding to harm of POPs and the good practices to manage the contamination.
15	Waste-to-energy plant	In Thailand, the waste-to-energy plants are invested by either local authority or private sector. However, many of them are facing the operation problems, which generate the negative environmental impacts including the dioxin emission due to the quality of the waste and the limited capacity of their operators.	The project will help building the capacity of the plant's operators in the three selected provinces. The assessment of the waste quality and operational practices will be carried out to identify the improvement opportunities together with the support to the upstream of the wastes, which include the separation at source, logistics and sorting on site.

**Table 7** The secondary stakeholders and their possible role in the project

No.	Stakeholders	Description/Mandate	Role in the Project
<b>Central Government Agency</b>			
1	Department of Environmental Quality Promotion (DEQP), under the Ministry of Natural Resources and Environment	<ul style="list-style-type: none"> <li>- Raise awareness and public participation on environmental management</li> <li>- Increase capacity of related networks to environmental management</li> </ul>	The project will coordinate with DEQP to raise awareness on POPs and e-waste.
2	Thai Customs	<ul style="list-style-type: none"> <li>- Collect tax for import and export goods</li> <li>- Maintain database of import and export goods (for certain good)</li> <li>- Support other relevant agencies on collecting data for certain types of import and export goods</li> </ul>	Thai Customs owns the import and export database of POPs and related products. It will be a source for inventory update. Thai Customs is an authorized agency to control the import and export of goods and articles. The project will work with Thai Customs to strengthen their knowledge and system to prevent the illegal import of e-waste.
3	Department of Alternative Energy Development and Efficiency (DEDE), under the Ministry of Energy	<ul style="list-style-type: none"> <li>- Promote, support and regulate energy conservation activities</li> <li>- Enforce energy conservation regulation</li> <li>- Research, study and develop alternative energy</li> <li>- Prescribe rules, criteria and disseminate technology in relation to the generation, conversion, transmission, consumption and conservation of energy</li> <li>- Monitor and assess the outcomes of alternative energy development and energy conservation activities</li> </ul>	DEDE regularly promotes the energy efficiency and renewable energy projects through their regular budget. DEDE has a large collection of energy efficiency and renewable energy publications. The project will look for the opportunity to promote the energy efficiency and low carbon technology application with DEDE's projects. The project will ask for DEDE's permission to share their publications and use some contents to create the online training course.
<b>Institute/Public Organization</b>			
4	Thailand Greenhouse Gas Management (TGO)	<ul style="list-style-type: none"> <li>- be an information center for circumstances on greenhouse gas operations</li> <li>- disseminate and conduct public relations campaign on the greenhouse gas management</li> <li>- promote and support relevant climate change operations</li> </ul>	The project will look for an opportunity to work with TGO on providing the technical training for GHG reduction.

No.	Stakeholders	Description/Mandate	Role in the Project
5	Industrial institutes under Ministry of Industry such as Thailand Textile Institute, Plastic Institute of Thailand and Electrical and Electronics Institute	- promote and develop the industry together with environmental responsibility	The Institutes will act as subcontractor to implement some activities relating to their sector. Activities will include capacity building and awareness raising in the industry, and supporting to identify technologies and accompany change in the industry. The project will also collaborate with the institutes to promote the project and materials to their networks.
<b>Community</b>			
6	NGOs and non-profit organizations	The project will focus on the relevant NGOs and non-profit organizations.	Relevant Civil Society Organizations (CSOs) will be invited to participate during project implementation. Studies and assessments prepared throughout the project (e.g. review of policies) will be shared with interested organizations for feedback and comments. Also they will take part in Eco-industrial Town awareness rising activities.
<b>Academic and research institute</b>			
7	School	The school in the three target areas will be the primary focus of the project.	The project will aim to integrate the awareness raising campaign to the school activities.
8	Technical college	The technical colleges in the three target areas will be the primary focus of the project.	The project will design the awareness raising activities and the suitable short course to enhance their lecturers' and students' capacity.
9	University	The University plays an important role to produce the qualified personnel for the industry. However, most of the courses for undergraduate students are theory with limited real world exercise.	The lecturers and researchers from selected Universities will be invited to work with the Kasetsart University's academic team to develop the curricula relevant to RECP and green chemistry. The project will provide the curriculum on RECP and green chemistry, which comprise of both theory and its application, for the University.
10	The Thailand Research Fund (TRF)	TRF's main role is to assist in the development of researchers and research-based knowledge through making research grants and assisting with research management.	The project will seek for the cooperation with TRF to share the lessons learned from the project to their network and encourage their researchers to participate in the capacity building and awareness raising program. The potential collaboration is to upscale the relevant

No.	Stakeholders	Description/Mandate	Role in the Project
			research and implement it in the three selected provinces.
11	Researcher	The target of the project covers the independent researchers and the researchers working with the University and research institute.	The project will encourage the researchers to participate in the capacity building and awareness raising program.
<b>Other</b>			
12	Media	Newspaper, TV, Environmental/Energy/ Engineering Magazine, Partner's Newsletter etc.	The medias will be invited to attend some key project activities for example the inception workshop. The relevant articles will be published in the project partner's newsletters for promoting technical implementation of the project and awareness raising contents.

A.4. *Gender Equality and Women's Empowerment.* Elaborate on how gender equality and women's empowerment issues are mainstreamed into the project implementation and monitoring, taking into account the differences, needs, roles and priorities of women and men. In addition, 1) did the project conduct a gender analysis during project preparation (yes  /no )?; 2) did the project incorporate a gender responsive project results framework, including sex-disaggregated indicators (yes  /no )?; and 3) what is the share of women and men direct beneficiaries (women 30%, men 70%)? <sup>24</sup>

Gender and Development (GAD) considerations will be made an integral part of the project strategy in consideration of the Gender policies of the GEF, UNIDO and the Government of Thailand. During the preparatory phase of the project, a detailed gender analysis of the key stakeholders involving GHG emission reduction, new POPs and industry-urban symbiosis was carried out by focusing on the three selected provinces. A report of gender analysis is in Annex N. The specific context of each selected province and its target industries and communities was taken into account during the analysis to provide the recommendations on how gender can be mainstreamed in the project and the specific concerns that should be aware. Gender indicators were provided in the project results framework (Annex A).

It has been noted that one of the key actions undertaken by the GEF relative to gender mainstreaming was to incorporate gender responsive approaches and indicators in the GEF-6 focal area strategies. UNIDO, for its part, recognizes the significant positive impact on sustained economic growth and sustainable industrial development generated by gender equality and the empowerment of women. UNIDO adopted a policy on Gender Equality and the Empowerment of Women in 2009. As a consequence, the organization commits to engage all men and women equally in all of its organizational practices, policies, programs and projects. Gender dimensions are now a prerequisite in the design, implementation, monitoring and evaluation of programs, projects and activities with tools and guidelines on mainstreaming gender in the whole range of project management.

The project would like to demonstrate the success cases of resource efficiency and green chemistry application in the factory and the resource sharing/waste exchange among industries as well as between industry and community through the concept of industry-urban symbiosis. The project starts with the policy and legislation elements for facilitating and

<sup>24</sup> Same as footnote 8 above.

enabling the above mention practices, the awareness raising and capacity building for relevant stakeholders, the implementation to demonstrate the cases, then the system and framework to sustain what have been done and keep them improving. The communication about the risks of new POPs to environment and human's health is crucial, especially the vulnerable groups like women and children.

In the study, the potential industries are identified by province as indicated in Table 8.

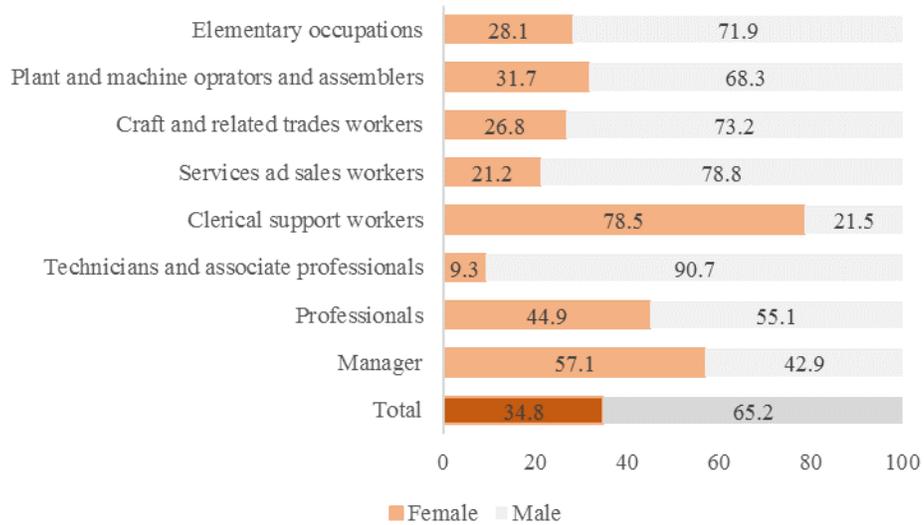
**Table 8** List of potential industries in three selected provinces\*

<b>Area</b>	<b>Energy consumption and engine capacity</b>	<b>New POPs</b>	<b>Industry-urban symbiosis</b>
Samut Prakarn	1310-1399 Textiles 1510-1520 Leather and related products 2010-2030 Chemicals and chemical products 2210-2220 Rubber and plastic product	1310-1399 Textiles 2210-2220 Rubber and plastic product 2910-2930 Motor vehicles, trailers and semi-trailers	Potentials among communities and industries/ firms 3820-3822 Treatment and disposal 3830 Materials recovery
Chonburi	1910-1920 Manufacture of coke and refined petroleum products 2592 Treatment and coating of metals; machining 2930 Manufacture of parts and accessories for motor vehicles	2220 Manufacture of plastics products 2592 Treatment and coating of metals; machining 2930 Manufacture of parts and accessories for motor vehicles	Potentials among communities and industries/ firms 2220 Manufacture of plastics products 3820-3822 Treatment and disposal 3830 Materials recovery
Rayong	1920 Petroleum refinery, lube base oil 2011 Basic chemical (inorganic) 2013 upstream petrochemical and plastic 3510 Power generation 3520 Gas separation process	No targeted industries	High potentials among industries/ firms. 3811-3822 Waste collection and Treatment and disposal

Note: The industrial code in this table is the four-digit classification under the International Standard Industrial Classification of All Economic Activities (ISIC) revision 3.

Source: Author, from the technical teams (Samut Prakarn and Chonburi province by FTI; Rayong province by Kasetsart University)

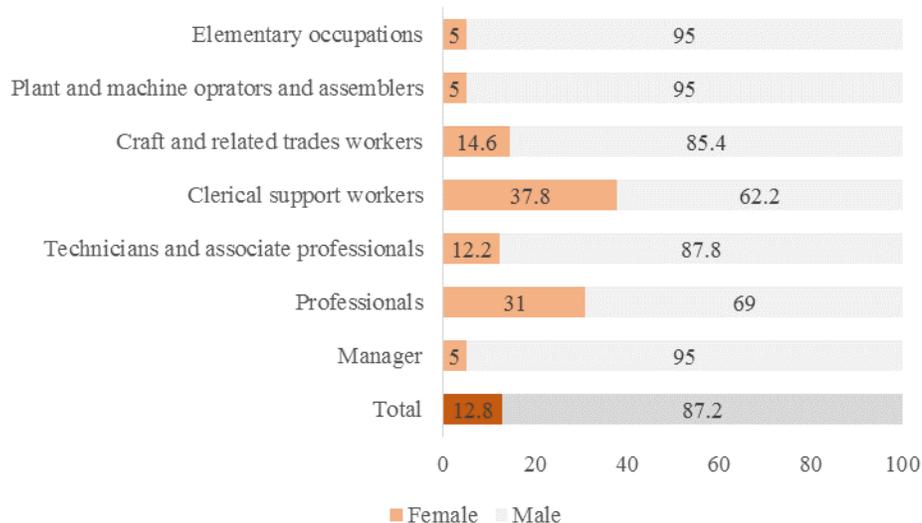
The labor force statistics (LFS) of Q3 2017 was used to generate the employment structure in the potential industries of each province as shown in Figure 12 to 14. The results showed that there is a higher number of men than that of women in the potential industries. The percentage of female managers of 57.1% in Samut Prakarn is the highest percentage among the three selected provinces. However, the total female employment in Chonburi is the highest among three selected provinces at 36.4%. For Rayong, the percentage of female employment in each category is quite low comparing to another two provinces with the total female employment of 12.8%. However, when comparing the list of potential industries in Table 8, the potential industries in Rayong are relatively high capital-intensive industries and relatively heavy industries, which explain the lowest female employment percentage among three provinces.



**Figure 12** Percentage of female and male employment in the potential sectors in Samut Prakarn  
57% of female manager is the highest percentage among three selected provinces



**Figure 13** Percentage of female and male employment in the potential sectors in Chonburi  
36.4% of female employment is the highest percentage among three selected provinces



**Figure 14** Percentage of female and male employment in the potential sectors in Rayong  
12.8% of female employment is the lowest percentage among three selected provinces

Based on the interview and analysis of data collected, some concerns of genders and social aspects were addressed as described below.

- Prevailing awareness on gender among government authorities and NGOs, yet no target on women. It was found that gender awareness has been raised among government authorities, while the NGOs have underlined the prevailing gender concerns. However, most activities on gender are more active in light industries as these sectors employ a large number of women and are mostly informal.
- Limited empirical evidences and knowledge on new POPs in Thailand creating barriers in developing policies. Thai government has committed to promote sound management of chemicals and waste. However, there is little empirical evidences of new POPs because of a non-mandatory regulation to monitor new POPs. There is a need to develop a database and inventory report with the regular updated basis.
- Lack of understanding and low awareness of new POPs in the manufacturing sector due to the lack of database especially on different impacts on men and women. The occupational health issue does not address new POPs in the workplace. Only a few officers have knowledge on POPs, especially new POPs. The impact of chemical waste at work becomes the second priority and is monitored at the minimum required by law. Only few NGOs are actively raising concerns on new POPs, for example EARTH (Ecological Alert and Recovery - Thailand). Some community representatives/ ecological network in the targeted provinces addressed concerns on visible, wastewater, air, and odor pollution. However, the knowledge about chemical pollution is limited.
- Lack of understanding of the industry-urban symbiosis. The private sector and the CSO/NGO/Eco network/communities should be encouraged to visualize possibility of the industry-urban symbiosis. This finding is reflected from the interviews, which only the factory-to-community activities in terms of employment creation was mostly mentioned by the interviewees.
- The on-going developed indicators of Eco-industrial Town and other Eco-related indicators have not yet included the gender issues/gender segregated data.

A gender analysis matrix as shown in Table 9 has been developed to understand the gender issues that maybe addressed by the project for the stakeholders affected by them. The four levels included in the analysis include women, men, household and community while the four categories of analysis include labor, time, resources and socio-cultural criteria.

**Table 9** Gender analysis matrix

	Labor	Time	Resources	Culture
Women (Direct beneficiary)	+ Acquire new/ advance skills in BAT/BEP (particularly with those directly impacted.)	+ In the long term, reduce the possibility of sickness, particularly the women that expose to new POPs.	+ Reduce GHG emissions, and new POPs in the environment  ? Access to income generation and social activities (In case of the employment is increasing.)  + Training, and maintenance take more time.	+ Awareness on GHG emissions, new POPs, industry-urban symbiosis increase and change the environmental and gender concerns.  + Change working attitude toward environmental friendly.  + Create a friendly industry-community environment, promoting a sustainable development.
Men (Direct beneficiary)	+ Acquire new/ advance skills in BAT/BEP (particular with those directly impacted.)	+ In the long term, reduce the possibility of sickness, particularly the men that expose to new POPs.	+ Reduce GHG emissions, and new POPs in the environment  + Better health (reduce the negative impact caused by GHG emission, and new POPs.)  + Training, and maintenance take more time.	+ Awareness on GHG emissions, new POPs, industry-urban symbiosis increase and change the environmental concerns with a gender concern.  + Change working attitude toward environmental friendly.  + Create a friendly industry-community environment, promoting a sustainable development.
Household	+ Skills improved	+ In the long term, reduce the possibility of sickness of household members.	+ Better health (reduce the negative impact caused by GHG emissions and new POPs.)  ? Possibility to increase income	+ Raise the concern on GHG emissions and new POPs with a gender concern.  + Promote attitude toward environmental friendly.

	Labor	Time	Resources	Culture
Community	+ Increase in employment	+ In the long term, reduce the possibility of sickness of community members.	+ Better health (reduce the negative impact caused by GHG emissions and new POPs.)  ? Possibility to increase for the community activities	+ Reduce the negative impact due to possible symptoms caused by GHG emissions and new POPs.  + Create a friendly industry-community environment, promoting a sustainable development with a gender concern.

Note: + positive impact; - negative impact, ? either positive or negative?

During the project implementation, the following suggestions should be carried out to integrate gender dimension in the whole scope of project management. These steps may be distinct activities or may be incorporated in the different activity components of the project.

- Collection and analysis of sex-disaggregated data and qualitative information to understand roles and needs of women and men in the project. This will be done both at the project team level and project implementation level. Identification of the number of female and male project team members, determinations of the roles and responsibilities in the project and ensure that in the documentation of the various project activities, contribution of female and male participants are documented through attendance sheet and other project document as well as in the analysis of online users.
- The project must ensure that the project activities meet the specific needs of women and men. Capacity building activities will ensure that training design and tools will take into account the different education/skill levels, and responsibility that may exist between women and men.
- Mechanisms to ensure gender balanced representation and participation in project activities and decision-making process will be established along with the gender-specific targets or indicators that track gender results and impact. The detail of initial target of women and men in each activity for different stakeholders is in Annex N.
- Any adverse impacts or risks that may affect the equal access to, equal participation in and/or equal benefit from project activities among women and men will be taken into account.
- Equal opportunity for women and men in the management and implementation arrangements of project will be ensured.
- Sufficient financial resources for gender equality and women's empowerment activities will be allocated. The PMU will ensure that the adequate effort have been provided and gender relevant activities have been included during the detail planning of each annual plan and budget. During the PSC meeting to approve a yearly plan, the gender inclusiveness will be presented.
- Capacity within project team and among stakeholders to ensure gender-responsiveness implementation and the continued integration of a gender perspective within the sectors/areas of intervention after the project ends will be endeavored.
- Access, participation and benefits among women and men and incorporate remedial action that redresses any gender inequalities in project implementations will be monitored. Report on how gender is mainstreamed will be generated and mid-term reviews, assessments, audits, etc. will include gender as a specific criteria/component.

A set of recommendations that identify opportunities and entry points for mainstreaming gender into the project are developed and presented in Table 10. For the detail of indicators for each component, please refer to Annex N.

**Table 10** Preliminary recommendations on gender mainstreaming by components of the project

Expected component	Expected outputs	Recommendations
Component 1: Policy development	Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced	A set of gender-related indicators has to be systematically developed with consultation and discussion with relevant stakeholders to ensure the functional application in working group meetings/discussions.
Component 2: National capacity building and awareness raising on industry-urban symbiosis and POPs	Output 2.1 Inventory of new POPs and intervention plan developed for the three selected provinces	The information about gender-related issues to be addressed in the technical information must comply with the work culture of the industry. The information about gender-related issues to be addressed to various groups must reflect their specific concerns/ needs.
	Output 2.2 Opportunities for industry-urban symbiosis elaborated through material and waste stream analysis	The information about gender-related issues to be addressed in the technical information. It must comply with the work culture, and communities' nature of each area, taking gender issues and sustainability into account.
	Output 2.3 Increased capacity and awareness on risks of new POPs and the benefits of (i) resource efficient and cleaner production, (ii) green chemistry, (iii) industry-urban symbiosis	Identify key persons and encourage their continuous participation, ensuring the gender participation in the project. The training programs, covering different levels of training, must be designed with the consideration of targets' group characteristics, area context, and social & gender issues.
Component 3: Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis	Output 3.1 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises, industrial zones and neighboring urban settlements	The gender-related issues to be addressed in the process must comply with the work culture of each establishment. Quality of translation and quality content for dissemination materials that fit the target group's interest. A strong network among schools & vocational schools & universities & ecological networks should be established for a sustainable knowledge management. The publication has to be easy to read and target to various groups of people.
Component 4: Development of National Eco-Industrial Town Framework and its supporting system	Output 4.1 Continuous improvement and sustaining the industry-urban symbiosis	The database must be regularly updated and accessible by various groups of people.

Expected component	Expected outputs	Recommendations
Component 5: Monitoring and evaluation	Output 5.1 Periodic monitoring and evaluation of project implementation completed	Gender issues have to be included throughout the activities. Monitoring of gender indicators to be made an integral part of project management.

A.5 Risk. Elaborate on indicated risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, the proposed measures that address these risks at the time of project implementation.(table format acceptable):

The project's scope is broad covering many major areas of environmental management for example climate change, sound chemical management, solid waste and e-waste. Therefore, a large number of stakeholders with different interest and agenda have to be involved during the project implementation phase. Although the project has been designed by taking into account the major concerns and interest of key stakeholders to minimize risk of project failure, there are also other factors affecting the success of the project implementation. The project has prepared the mitigation measures for the potential risks as described in Table 11.

**Table 11** Project's risk analysis and proposed mitigation measures

No.	Risk	Rating	Mitigation
1	Technical risk:		
1.1	Lack of awareness on technical opportunities for adopting environmentally sound technologies	Low-medium	Encourage a participatory approach and provide adequate information and training on planning and implementation of clean and low carbon technologies.  The online training course, which provide an on demand learning will be another alternative for the participants who could not attend the in-class training.
1.2	Reluctance of private sectors (factory's personnel, owner and staff of recycling facilities, etc.) to actively participating in the capacity building component.	Low	FTI will be the focal access to the industrial sectors through their established network. The relevant institutes and associations for example Plastic Institute of Thailand will be involved to use their expertise and networks to attract the participants in those specific industries.  Training needs will be assessed and pre-and post-training analysis will be undertaken.
1.3	Low participation and interest from the communities, school and the general public in the awareness raising program.	Medium	Awareness raising activities will be carefully designed by taking into account the different needs and background of the target audiences. The mixed media will be used, for example infographic and short video clips, to generate their interest and participation.
1.4	Inadequate RECP, low carbon technology, green chemistry, BAT/BEP, and industry-urban symbiosis implementation, which lead to the lower	Medium	During the implementation phase, the potential demonstration projects will be carefully assessed of their technical and financial feasibility as well as the socio-economic impact. The selection criteria of the

No.	Risk	Rating	Mitigation
	quantified figure of the expected reduction target.		demonstration project will be carefully set by the expert team under the close consultation with the project partners and key stakeholders. The training for calculating GHG and POPs reduction will be provided to ensure that the results reported will be on the same standard.
2	Socio-economic risk:		
2.1	Reluctance of industries to change towards climate resilient development, considering it as a burden instead of an opportunity. Besides cultural resistance, SMEs are often unable to undertake large investments, even though in the long run these generally pay off.	Low-medium	Awareness raising and capacity building initiatives will reinforce the environmental and socio-economic advantages of eco-industrial towns and the adoption of environmentally sound technologies. Examples of best practices and successful projects implemented by UNIDO will be presented to stakeholders based on results and indicators.  Technical and financial feasibility studies will be offered by the project and investment plans will be developed for the companies, if needed. As awareness will be raised on national certification mechanisms and financial schemes available in the country, facilitating access to these schemes will also serve as an incentive for companies to participate in the project.
3	Institutional risk:		
3.1	Developing industry-urban symbiosis is a complex undertaking and demands integration across many fields of planning and decision-making. Lack of collaboration and engagement among ministries, companies, local communities and other stakeholders may hinder the success of the project.	Medium	The Project Steering Committee (PSC) will establish the institutional linkages among the stakeholders. The Project Management Unit will consult with executing partners and stakeholders to ensure their commitment to and ownership of the project. Meetings and workshops to strengthen the collaboration among main stakeholders will be organized on a regular basis to identify potential issues and develop adequate mitigation measures.  During the preparatory phase of the project, DIW and IEAT showed a strong commitment to co-host the national eco-industrial town framework with elements to enhance the industry-urban symbiosis. Moreover, the initial discussion with key stakeholders in the targeted areas have been carried out several times to raising their awareness of industry-urban symbiosis.
4	Regulatory risk:		
4.1	The proposed regulatory framework is not adopted and enforced.	Medium	Decision makers will be engaged early on in the project preparation and implementation to ensure their long-standing commitment.

No.	Risk	Rating	Mitigation
			The key institutional stakeholders will be represented in the PSC in order to express their ideas and concerns with respect to roles and responsibilities of their own institution and to participate in the development process.
5	Political risk:		
5.1	Political instability due to a military coup, violent protests and political division of society between different factions may affect the project's development.  Change of government policy and its priority of environmental issues caused by the industrial development	Medium	Members of the PSC and UNIDO Regional Office in Thailand will monitor the political situation. Potential changes or adaptation of project activities will be discussed and endorsed by the PSC.
6	Climate risk:		
6.1	Natural disasters in the form of prolonged droughts and severe floods may interrupt the project's progress.	Low-medium	Sensitivity to climate risks will be taken into account when selecting the industrial estates/parks where the project will have demonstrations.  During the preparatory phase of the project, the reselection of the three targeted provinces have taken this climate risk into account. Ayutthaya was removed due to its high risk of flooding.

*A.6. Institutional Arrangement and Coordination.* Describe the institutional arrangement for project implementation. Elaborate on the planned coordination with other relevant GEF-financed projects and other initiatives.

#### *A.6.1 Institutional Arrangement*

##### GEF Implementing agency

As a GEF implementing agency, UNIDO will maintain the oversight on the project implementation, manage the overall project budget and supervise the project execution.

In addition, as agreed with national counterparts, UNIDO will provide execution support for the procurement of goods and services, as well as recruitment of technical experts. Full or partial title and ownership of equipment purchased under the project may be transferred to national counterparts and/or project beneficiaries during the project implementation as deemed appropriate by the UNIDO Project Manager in consultation with project stakeholders.

##### Executing partners

The Department of Industrial Works (DIW) is a lead executing partner. The project office will be hosted in DIW's premises. The management of DIW will chair the Project Steering Committee and provide the strategic guidance and

direction to the Project Management Unit (PMU). As the lead executing partner, DIW will provide support to the PMU for their day-to-day operation and act as a focal point to coordinate with other co-executing partners, which include the:

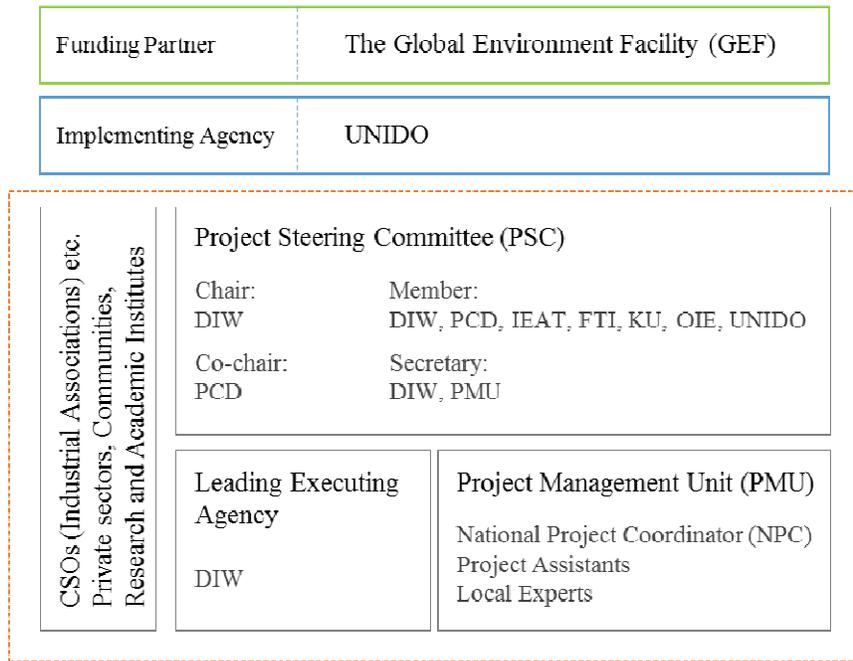
- Pollution Control Department (PCD) under the Ministry of Natural Resources and Environment: PCD's management will co-chair the PSC and provide strategic guidance and direction to the PMU on POPs related issues. As a Stockholm Convention's national focal point, PCD will help sustain the project's impacts on POPs after the project termination;
- Industrial Estate Authority of Thailand under the Ministry of Industry: IEAT will help the project to reach their industrial estates and the industries located in those industrial estates. To ensure the sustainability of the resource efficiency, low carbon technology application and sound chemical management, the National Eco-industrial town framework developed by the project will be co-hosted by DIW and IEAT after the project termination;
- The Federation of Thai Industries: FTI will support the project by building collaboration with the private sector and reaching out to factories; and
- Kasetsart University (KU): Kasetsart University academic team in collaboration with other Universities will provide technical expertise on green chemistry, cleaner production, eco-factory and industry-urban symbiosis for stakeholders in the country.

FTI and KU will also act as the subcontractors. FTI will promote and raise awareness of their members and industrial network on the issues related to RECP, low carbon technology application, green chemistry, BAT/BEP of new POPs, industry-urban symbiosis, and national eco-industrial town framework. They will intensively contribute to output 2.3 and 4.1. FTI will organize the awareness workshops and trainings across Thailand on behalf of the project.

KU will provide technical expertise to the project, especially for output 2.2, 2.3, 3.1 and 4.1. KU will support the knowledge transfer from international experts to the local experts and Thai industries. KU will lead the collaboration with other universities and academic institutes for the development of curricula addressing the RECP, low carbon technologies, green chemistry and industry-urban symbiosis. KU will initiate the internship program to support the implementation of RECP, low carbon technologies, green chemistry and industry-urban symbiosis under the supervision of KU's academic team. KU will also provide their technical expertise in the RECP and industry-urban symbiosis opportunity assessment, the pilot demonstration of some identified opportunities and the implementation of national eco-industrial town framework.

UNIDO will supervise FIT's and KU's works to ensure that the quality of their works will be met with the project's expectation and the results will fulfill the project's indicators/outputs/outcomes and lead to the project's achievement.

The implementation and execution structure of the project is shown in Figure 15.



**Figure 15** Institutional arrangement of the project

Project Steering Committee (PSC)

The Project Steering Committee (PSC) will be set up to supervise and provide guidance to the project’s operation and implementation to ensure the good performance of the project and the achievement of project’s targets and indicators. The management of Department of Industrial Works (DIW), which is the National Executing Agency, will chair the PSC, while the management of Pollution Control Department (PCD) will co-chair the PSC. The high level representatives from DIW, PCD, IEAT (Industrial Estate Authority of Thailand), FTI (The Federation of Thai Industries), KU (Kasetsart University), OIE (Office of Industrial Economics), and UNIDO will be the PSC’s members. The representatives from DIW and PMU will be the member and secretary of the PSC. The final composition of the PSC will be decided during the project inception phase.

The PSC will assign the working groups to coordinate between the project partners and PMU, and between other relevant organizations and PMU, to mobilize the necessary resources to support the project implementation, and to follow up the PMU’s operation according to PSC’s decisions. The structure and members of the working groups will be decided during the 1<sup>st</sup> PSC meeting.

The PSC will meet at least once a year to approve work plan for the subsequent year, monitor implementation progress, discuss and outline the execution activities, and provide strategic guidance to the PMU on project execution. In case that project amendment is required due to change of context and/or situation, project amendment will be done in accordance with the GEF Council Document GEF/C.39/Inf.03.

Project Management Unit (PMU)

UNIDO with the support from DIW will set up the Project Management Unit (PMU). The PMU’s office will be based in the premises of the DIW. The PMU will also be responsible for liaising with project partners and other relevant

government agencies. The PSC will oversee the work of the PMU and general execution of the project in regular interventions.

UNIDO will authorize required expenses for the PMU for execution of project activities. The PMU will report to the UNIDO project manager on a regular basis.

The PMU office will at least comprise of a National Project Coordinator (NPC), Project Assistant and local experts. The NPC will be supported by a team of professionals to manage the entire scope of work. UNIDO in consultation with DIW and PCD will recruit the NPC. The NPC will be under ISA contract issued by UNIDO. The key tasks of the PMU include of drafting terms of reference, coordinating with UNIDO RO to issue the request for proposals, evaluating and negotiating tenders, and implementing and monitoring project activities. All these activities will be done in close coordination with relevant partners and UNIDO, and according to UNIDO/GEF regulations.

#### *A.6.2 Coordination with other relevant GEF-financed projects and other initiatives*

The proposed project will closely liaise with other GEF initiated projects under GEF-TF and SCCF in the area of energy and water efficiency, as well as waste and chemicals management. It will be ensured that there is no duplication, and that all related projects can benefit from the exchange of experience and best practices. Synergies and complementarities will be created with the following ongoing projects:

GEF funded:

- Industrial Energy Efficiency in Thailand (IEE), UNIDO. As this project will be completed by the time the proposed initiative starts, lessons learned in the country and knowledge gained in the energy sector will be used as a reference. The IEE Project produced 25 case studies about the Energy Management System and system optimization implementation, which can be an initial resource for the online learning and information sharing platform. Moreover, the project has trained a large number of national experts on energy efficiency and management. Consequently, the experts who participated in these trainings will be preferably recruited for energy related assignments under the industry-urban symbiosis project;
- CleanTech in Thailand, UNIDO. The proposed project can also utilize the awareness that has been raised by the Cleantech Program on clean technology and climate change issues. Another key opportunity in terms of knowledge sharing on clean technology innovations and SME business models presents the National Cleantech Platform for SME associations and national agencies. Particularly valuable hereby are the identification of effective business models and the connections with potential investors for the mobilizing of investments to implement the respective technologies;
- Greening Industry through Low Carbon Technology Application for SMEs in Thailand (GI), UNIDO. The GI project has started in April 2018. The target group of GI project is SMEs in various sectors, especially the automotive parts industry, which is a potential industry using new POPs in the production. The proposed project will coordinate with the GI's PMU to share the knowledge management materials on low carbon technology application and energy management system for SMEs;
- Greening the scrap metal value chain through Promotion of BAT/BEP to Reduce U-POPs Releases from Recycling Facilities, UNIDO. Although the scrap metal project focuses on U-POPs reduction, the lessons learned from the BAT/BEP implementation in the pilot factories will be useful for other factories in the basic metal industry;

- Enabling Activities to Review and Update the National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants, UNIDO. During this project document preparation, the regularly updating with the study team of the enabling activities have been carried out. The exchange information on new POPs inventory in Thailand, especially PFOS, PBDEs and HBCD, is beneficial for both projects; and,
- Eco-industrial estate/park initiative in Vietnam, UNIDO. Taking advantage of the similarities between the proposed project and the eco-industrial initiative in Vietnam, an international workshop will be organized to strengthen south-south cooperation and exchange lessons learned.

Additional Information not well elaborated at PIF Stage:

*A.7 Benefits.* Describe the socioeconomic benefits to be delivered by the project at the national and local levels. How do these benefits translate in supporting the achievement of global environment benefits (GEF Trust Fund) or adaptation benefits (LDCF/SCCF)?

The following socioeconomic benefits are expected to be delivered by the project, which translate to the support of the achievement of global environmental benefits:

1. Improved capabilities for industries to conduct business sustainably – thus resulting in job creation and improved economic security. Improving energy efficiency can deliver benefits economy, directly and indirectly. These benefits include employment, trade balance and energy prices. There is no study on the impacts of energy efficiency improvement in Thailand. However, IEA reports that in general, GDP changes due to large-scale energy efficiency policies show positive outcomes with economic growth ranging from 0.25% to 1.1% per year. The potential for job creation ranges from 8 to 27 job years per EUR 1 million invested in energy efficiency measures.
2. Higher long term profitability due to lower cost of production. Energy cost accounts for approximately 16-25% of total production cost and energy savings will have a direct impact on the bottom line of industrial players.
3. Reduced reliance on fossil fuels. The main fuels for electricity generation in Thailand are fossil fuels (in 2015, 64% natural gas, 9% imported coal, and 10% lignite). It was reported that every unit of electricity reduced will result in a CO<sub>2</sub> reduction of approximately 0.5-0.6 kg. Therefore, by reducing energy consumption, the industry can help lowering Thailand's dependence on fossil fuel and reduce impact on the environment.
4. The project is expected to reduce utilization of POPs which would result in reduction of water and soil pollution. Additionally, the project would result in crucial data updates as the POPs inventory is expected to be updated and the flow of materials investigated and elaborated upon.
5. Demonstration projects can lead to a high level of replicability, which would increase amount of RECP mainstreamed in a broad range of Thai industries.
6. The project envisaged significant and comprehensive capacity building activities. This is expected to result in raised awareness on low carbon technologies, BAT/BEP technologies intended to reduce POPs, and advantages of industrial estate/park-urban symbiosis systems. Furthermore, comprehensive courses envisaged by this project would increase number of personnel capable of conducting implementation of RECP technologies.

*A.8 Knowledge Management.* Elaborate on the knowledge management approach for the project, including, if any, plans for the project to learn from other relevant projects and initiatives (e.g. participate in trainings, conferences, stakeholder exchanges, virtual networks, project twinning) and plans for the project to assess and document in a user-friendly form (e.g. lessons learned briefs, engaging websites, guidebooks based on experience) and share these experiences and

expertise (e.g. participate in community of practices, organize seminars, trainings and conferences) with relevant stakeholders.

Knowledge management is inherent to UNIDO's operating modality by sharing experiences across its interventions worldwide. This has been demonstrated through many publications, events, webinars, and more. Moreover, a dedicated Knowledge Management Plan will be designed during the inception phase and implemented under the proposed project, which will function as the basis for gathering and distributing of information and lessons learned. The plan will also include the development of an online learning and information sharing platform, which will be a main channel to disseminate data, increase the accessibility, and act as a knowledge management system itself. There will be a strong commitment towards transparency and communication to ensure the involvement of all project stakeholders.

The online learning and information sharing platform will contain of its website, relevant mobile applications and other various social-media platforms for example facebook page. The website will provide the access to various contents for example the online training courses with the possibility of earning certificate of completion, training material, interview session with key stakeholders, demonstration clip of best practice, fact sheet, case study, guideline, calculation tool, and infographic. The project activities and news will be shared on the website as well. The main language of these contents will be Thai, while the English version of some selected materials will be made available to share the results and successful approaches to other regions.

During the implementation phase, the data will be systematically collected and analyzed to generate insights for example factors motivating behavior change of using resource more efficiently. It is expected that the useful information, lessons learned and knowledge will be collected in parallel with the implementation of project activities. The contents, format, and design of the disseminated materials will be carefully designed by analyzing the target audiences, their background and perception to suit the different target groups. This will be done by the PMU with the close consultation with UNIDO and the project partners.

To avoid reinvent the wheel for the basic information, the project will seek to adapt or build on the existing information and knowledge owned by the project partners. The sharing information and publication of other projects or agencies will be considered when appropriate.

Moreover, this project will benefit from the current expansion of the knowledge platform for the UNIDO/UNEP global resource efficient and cleaner production network (RECPnet). This knowledge exchange enables the dissemination of lessons learned and experiences particularly from other similar projects in the region and the world. The information available will also be used for this project. Some selected materials will be translated to Thai.

The project plans to share some contents with the GEF-UNIDO's project, Greening Industry through Low Carbon Technology Application for SMEs in Thailand (GI). Some disseminated materials on low carbon technology and its success cases will be useful for the industry.

## **B. DESCRIPTION OF THE CONSISTENCY OF THE PROJECT WITH:**

*B.1 Consistency with National Priorities.* Describe the consistency of the project with national strategies and plans or reports and assessments under relevant conventions such as NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.:

The project will contribute to specific SDG targets as follows:

SDG 7 Ensure access to affordable, reliable, sustainable and modern energy for all  
SDG 7.3: By 2030, double the global rate of improvement in energy efficiency.

SDG 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

SDG 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

SDG 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

SDG 12: Ensure sustainable consumption and production patterns

SDG 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

By working with Thai industries to implement RECP including green chemistry and BAT/BEP, this project will reinforce Thailand's commitment to achieve the four targets (SDG 7.3, SDG 8.4, SDG 9.4 and SDG 12.4). Most importantly, these four targets are listed in the top 30 prioritized targets announced by the National Committee on Sustainable Development on 16 December 2016. In addition, the project will supplement to Thailand's effort in fulfilling its commitment to both United Nations Framework on Climate Change Convention (UNFCCC) and Stockholm Convention on Persistent Organic Pollutants. Lastly, acknowledging the importance of these targets to the country development pathway, Thailand's framework with the United Nations family- United Nations Partnership Framework 2017-2020 (UNPAF) places them at the core of the UN's work to help Thailand achieving the SDG 7, 8, 9 and 12 at large. UNIDO is among key UN agencies coordinating with UN family to work with the country to achieve these targets by being a part of three inter-agency working groups namely, i) Planet, ii) Prosperity and iii) Partnership on Data for SDGs.

This project is highly consistent with the commitments and strategies of Thailand to address climate change, GHG emission and chemicals management. The country is party to the UNFCCC, Paris Agreement and Stockholm Convention on POPs. Under the UNFCCC, Thailand submitted its Initial National Communication in November 2000 and the Second National Communication in March 2011. The GEF has endorsed a combined project, submitted by the UNDP in 2013, to develop the Third National Communication and a Biennial Update Report. Currently, two Biennial Update Reports have already been published.

The country has also conducted the National Portfolio Formulation Exercise (NPFE) for the GEF-6 replenishment period. As indicated in the NPFE, the Thai Government has given high priority to this proposal, which is ranked in second place on the list of projects, after the Sixth Operational Phase of the GEF Small Grants Programme.

Under the Stockholm Convention, Thailand has developed the first National Implementation Plan (NIP) and also assessed the legal aspects related to the newly listed POPs under the Stockholm Convention with government funding. Currently, PCD is in the process of NIP review and update to take into account the chemical added from 2009 to 2015 by using GEF's enabling activity and UNIDO's technical assistance. During the preparatory phase of the project, the proposed project has regularly communicated with the NIP updating project to exchange information and concerned issues. It is expected that the NIP review and update will be completed by the time of this proposed project starting its implementation. The updated national inventory and implementation plan related to new POPs will be reviewed and taken into account when preparing the detail work plan at the inception period.

In 2015, Thailand submitted an Intended Nationally Determined Contribution (INDC) to the UNFCCC Secretariat stated that Thailand intends to reduce its GHG emissions by 20% from the projected BAU (reference year 2005) level by 2030 with the possibility to increase up to 25%. The strong commitment to achieve the target stated in INDC has been illustrated through the government policy, national long term strategy, national development plan and other relevant national master plans. The 20-Year National Strategy has addressed climate change in various strategies, especially in Strategy No. 5 Environmental-Friendly Growth. Thailand has developed two overarching national plans on climate change and GHG mitigation: the 12<sup>th</sup> National Economic and Social Development Plan (NESDP) 2017-2021, and the National Climate Change Master Plan (NCCMP) 2015-2050. The key concept of the NESDP is to shift the development paradigm and redirect the country towards a low carbon and environmentally friendly economy. In order to set a long-term strategy and integrate policies related to climate change, Thailand developed the NCCMP.

The 12<sup>th</sup> NESDP encourage the resource efficiency measures in line with the Sustainable Consumption and Production (SCP) concept. Although there is no direct measure to support the industry-urban symbiosis, the DIW and IEAT has included the industry-urban symbiosis as a part of eco-industrial town development. Eco-industrial town itself is a key mechanism used by Thai Government for driving the development of local economies, quality of life and environment that will bring about sustainable co-existence between industry and community. Eco-industrial town has been addressed as the key measures to support more environmental-friendly industrial development, reduce GHG emission and increase quality of life in the 20-Year National Strategy, the 12<sup>th</sup> NESDP, the NCCMP 2105–2050, Thailand Industry 4.0 Development Strategy 20 years 2017–2036 and the Environmental Quality Management Plan 2017-2021.

The National Waste Management B.E. 2559 – 2564 (2016 – 2021) is a comprehensive plan consisting of the holistic measures to reduce the solid wastes and hazardous wastes at source, increase capacity of waste management and enhance the solid wastes and hazardous wastes management. The waste exchange system for industrial sector and waste-to-energy plant as an alternative for solid wastes management are the measures highlighted in the master plan. The government has taken several actions as stated in the master plan to facilitate the waste management for example the replacement EIA for the waste-to-energy plant with the code of practices, which will shorten the approval process but still reinforce the environmental protection, and incensement of waste collection fee's ceiling, which reflected the government's strong intention to solve the problem.

The draft Act on the Management of Waste Electrical and Electronic Equipment and Other End-of-Life Products is in the consideration process by the Senate. The Act aims to reduce the negative environmental impacts of and provide the proper measures to handle the e-waste and End-of-Life products. The e-waste is a primary source of the PBDEs and HBCD contaminated products for example CRT. The draft Act also reflects the priority given by Thai Government to the POPs contaminated wastes.

### **C. DESCRIBE THE BUDGETED M & E PLAN:**

Monitoring and evaluation (M&E) of the project implementation is one of the key elements taken into account in the project design phase. The M&E of the project's activity, output and outcome will be carried out to track the achievement of its targets and project performance including the underperformed activities. It will also act as the corrective measures to identify and correct the issues or problems, if any. The results of the regular M&E of the project will also be used to improve the project activity and to cope with any changes of project's environment.

M&E will be conducted in accordance with established UNIDO and GEF procedures. The M&E activities are defined by Project Component 5 and the concrete activities for M&E that are specified and budgeted in the M&E plan. Monitoring will be based on indicators defined in the strategic results framework (which details the means of verification), and the annual work plans. Monitoring and Evaluation will make use of the GEF Tracking Tool, which will be submitted to the GEF Secretariat three times during the duration of the project: at CEO Endorsement, at mid-term review, and at project closure.

UNIDO as the Implementing Agency will involve the GEF Operational Focal Point and project stakeholders at all stages of the project monitoring and evaluation activities in order to ensure the use of the evaluation results for further planning and implementation.

According to the Monitoring and Evaluation policy of the GEF and UNIDO, follow-up studies like Country portfolio evaluations and thematic evaluations can be initiated and conducted. All project partners and contractors are obligated to (i) make available studies, provide reports or other documentation related to the project and (ii) facilitate interviews with staff involved in the project activities.

#### Monitoring

During the inception phase, the PMU in collaboration with project partners will develop a detailed monitoring plan, which will be updated at least annually. The monitoring plan will at least include the tracking of progress, performance and accomplishments in relation to:

- implementation of project activities;
- effectiveness of awareness raising and capacity building program including their impacts and usefulness;
- initiatives of project partners to support the industry-urban symbiosis, GHG reduction and POPs disposal;
- CO<sub>2</sub> emission reduction due to the implementation of RECP, low carbon technology and industry-urban symbiosis;
- POPs disposal due to the implementation of RECP, green chemistry, BAT/BEP, e-waste management and industry-urban symbiosis;
- performance of the demonstration projects;
- potential replication of the demonstration projects; and
- effectiveness and usefulness of the dissemination materials and the online learning and information sharing platform

## Reporting

The PMU will prepare the following reports and present to UNIDO and the PSC.

- Inception report: After the inception workshop, the PMU will prepare the inception report to submit to UNIDO and circulate to the project partners. The inception report will include: (i) a description of the institutional roles, responsibilities, communication and coordinating actions, and feedback mechanisms of project-related partners; (ii) the structure of PSC; (iii) finalization of project design and approval of the overall workplan including its work breakdown structure; (iv) a monitoring and evaluation plan; (v) a detailed workplan for the 1<sup>st</sup> year of implementation; (iv) a detailed project budget for the 1<sup>st</sup> year of implementation.
- Project Implementation Report (PIR): The PIR is an annual monitoring process mandated by the GEF. It is an essential management and monitoring tool for project managers and offers the main vehicle for extracting lessons from the ongoing project. Once the project has been under implementation for a year, the PMU and the project team at UNIDO HQ is responsible for completing the PIR. The PIR should then be circulated to the project partners so that the result is a PIR that has been agreed upon by the project staff, the project partners and UNIDO.
- Annual reports: At the end of calendar year, the PMU will prepare the annual report describing the project activities implemented during the year, the progress in terms of project indicators and targets, and lessons learned.
- Periodic thematic reports: As and when called for by UNIDO, the PMU will prepare specific thematic reports, focusing on specific issues or areas of activity. The request for a thematic report will be provided to the PMU in written form by UNIDO and will clearly state the issue or activities that need to be reported on. These reports will be used as a form of a lessons learned exercise, specific oversight in key areas, or as trouble shooting exercises to evaluate and overcome obstacles and difficulties encountered.
- Technical reports: Technical reports are detail, comprehensive documents covering specific areas of research within the framework of the overall project. The key areas where technical reports are expected to be prepared during the course of the project will be listed during annual PSC meetings. In consultation with the project partners, the PMU will be in charge to prepare the technical reports with the support by external consultants.
- Project terminal report: The project terminal report will summarize all activities, achievements and outputs of the project, lessons learned, objective met (or not met), budget and co-financing spent, and recommendation for follow-up activities (if any). The PMU will prepare the project terminal report within six months after the project implementation completed. The draft project terminal report will be sent to UNIDO and the independent evaluator as a reference for the final evaluation. The feedbacks from the final evaluation will be incorporated to the final version of project terminal report.

## Evaluation

The project will be subjected to two independent external evaluations, a midterm evaluation and a final evaluation. The independent midterm evaluation will be carried out between the second and the third year of the project implementation by an independent consultant. The objectives of the midterm review are to review the progress of each project activities and to assess effectiveness of implementation according to the project's indicators presented in the project results framework. The findings from midterm evaluation could propose recommendations and remedial actions to be incorporated as improvement in the implementation strategy and executing for the remainder of the project's duration, if necessary. The term of reference for the midterm evaluation will be prepared by UNIDO in accordance with the generic TORs developed by the Independent Evaluation Division. The midterm evaluation report will be cleared by UNIDO and approved by the PSC.

The independent final evaluation will start within six months after the project implementation completed and at least two months before the project termination. The final evaluation will look at the impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefit goals. Since the sustainability of results will be one of the key evaluation topics, the effectiveness of capacity building program, the dissemination and usage of lessons learned, and the replicability of project results will be focused. The term of reference for the final evaluation will be prepared by UNIDO in accordance with the generic TORs developed by the Independent Evaluation Division. The term of reference for the final evaluation will be prepared by UNIDO and will be circulated to all project partners.

### Budgeting

The budget estimation of M&E activities is shown in Table 12.

**Table 12** Estimation of the budget for M&E activities

Type of M&E activity	Engaged Parties	Budget in USD (Excluding PMU staff time)	Time Frame
Project inception workshop and report	PMU, UNIDO, consultants	30,000	Within first three months after the 1 <sup>st</sup> PSC meeting
Monitoring and verification of project progress and performance	PMU, UNIDO, consultants	160,000	In line with the annual project monitoring and evaluation plan, which will be prepared by PMU in consultation with other project partners
Project reports	PMU in consultation with other project partners	20,000	Annual report and project terminal report
Independent midterm evaluation (external)	UNIDO, PSC, PMU, independent external evaluators	30,000	Midpoint of project implementation
Independent final evaluation (external)	UNIDO, PSC, PMU, independent external evaluators	40,000	Within 6 months after the project implementation completed and at least two months before the project termination
Total indicative cost		280,000	

### Legal Context

“The Kingdom of Thailand agrees to apply to the present project, mutatis mutandis, the provisions of the Revised Standard Agreement between the United Nations, the International Telecommunication Union, the World Meteorological Organization, the International Labour Organization, the Food and Agriculture Organization of the United Nations, the United Nations Educational, Scientific and Cultural Organization, the International Civil Aviation Organization, the World Health Organization and the International Atomic Energy Agency and the Government of Thailand concluded on 4 June 1960”

**PART III: CERTIFICATION BY GEF PARTNER AGENCY(IES)**

**A. GEF Agency(ies) certification**

This request has been prepared in accordance with GEF policies<sup>25</sup> and procedures and meets the GEF criteria for CEO endorsement under GEF-6.

<b>Agency Coordinator, Agency Name</b>	<b>Signature</b>	<b>Date (MM/dd/yyyy)</b>	<b>Project Contact Person</b>	<b>Telephone</b>	<b>Email Address</b>
Mr. Philippe R. Scholtès  Managing Director Programme Development and Technical Cooperation  UNIDO-GEF Focal Point		09/26/2018	Mr. Smail Alhilali  	+43 1 26026 3363	s.alhilali@unido.org

<sup>25</sup> GEF policies encompass all managed trust funds, namely: GEFTF, LDCF, SCCF and CBIT  
GEF6 CEO Endorsement /Approval Template-August2016

**ANNEX A: PROJECT RESULTS FRAMEWORK (either copy and paste here the framework from the Agency document, or provide reference to the page in the project document where the framework could be found).**

<b>Project Narrative</b>	<b>Indicator</b>	<b>Baseline</b>	<b>Target</b>	<b>Source of Verification</b>	<b>Assumptions/Risks</b>
<p><b>Project Objective</b> To reduce greenhouse gas emissions, as well as releases of persistent organic pollutants and other harmful chemicals from industries and urban centers through the application of industry-urban symbiosis and green chemistry technology.</p>	<p>GHG emission reductions due to implementation of RECP, low carbon technology, and industry-urban symbiosis.</p> <p>Quantified reduction in POPs released by the industrial sector, and the improper treatment and disposal of wasted products with POPs contamination.</p>	<p>Limited direct and indirect energy savings by industry</p> <p>Limited data on new POPs inventory</p> <p>Lack of knowledge and understanding of new POPs among industries, government agencies and communities</p> <p>No mechanism and system to encourage the industry-urban symbiosis</p>	<p>Direct GHG reduction: 1,305,761tons of CO<sub>2</sub>eq for 10-year projection</p> <p>Disposal of 620 tons of POPs</p>	<p>Project’s annual reports</p> <p>Project’s final report</p> <p>Project midterm and terminal evaluation reports</p>	<p>Assumptions:</p> <p>Continuous support from government bodies, national institutions, local authority and private sectors.</p> <p>Commitments of the private sector in ensuring the co-financing for 1) RECP, low carbon technology application, and green chemistry operation in their processes; 2) industry-urban symbiosis; and 3) waste-to-energy plant.</p> <p>Risks:</p> <p>Change of government policy and its priority of environmental issues caused by the industrial development</p> <p>Community actions against the waste-to-energy plant</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
<p><b>Outcome A:</b> GHG emissions and releases of POPs reduced through industry-urban symbiosis by transferring low carbon and green chemistry technologies, improving capacity, enhancing infrastructure, promoting innovative business models and raising awareness</p>	<p>Development of awareness campaign for industry-urban symbiosis and POPs relevant issues including their risks and management approaches</p> <p>Number of participants that increased their capacity and knowledge of RECP, low carbon technologies, green chemistry application, BAT/BEP and industry-urban symbiosis.</p> <p>Number of assessment and feasibility study to support the GHG reduction and POPs disposal through the application of RECP, low carbon technology, green chemistry, BAT/BET, and industry-urban symbiosis</p> <p>Number of RECP, low carbon technology, green chemistry, BAT/BET, and</p>	<p>Limited direct and indirect energy savings by industry</p> <p>Energy management by law exists, but concern is on reporting not the energy savings.</p> <p>Policies and plans related to climate change mitigation exist, but limited MBI exercised to enhance the GHG emission reduction.</p> <p>Lack of MBI to support the new POPs management</p> <p>Limited data on new POPs inventory</p> <p>Lack of knowledge and understanding of new POPs among industries, government agencies and communities</p> <p>Limited knowledge sharing and trainings available on RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis.</p> <p>Some industry-urban symbiosis exist, but on ad-hoc</p>	<p>Awareness raising campaign is available for stakeholders.</p> <p>3,600 participants increase their capacity and knowledge of RECP, low carbon technologies, green chemistry application, BAT/BEP and industry-urban symbiosis</p> <p>Online training and information sharing platform is available for stakeholders with regularly updating</p> <p>200 assessment are conducted with the further study for technical and financial feasibility in 100 facilities</p> <p>50 implementation projects related to the application of RECP, low carbon technologies, green chemistry or BAT/BEP carried out</p>	<p>Awareness raising materials</p> <p>Training materials</p> <p>Seminar/workshop/training reports</p> <p>Assessment reports</p> <p>Feasibility study reports</p> <p>Project implementation reports</p> <p>Project demonstration reports</p> <p>National eco-industrial town framework</p>	<p>Assumptions:</p> <p>Willingness of key stakeholders for example industry representatives, local experts, local authority's officers, and community representatives to attend awareness and training activities.</p> <p>Willingness of key stakeholders to co-financing through their infrastructure to reduce the GHG emission and POPs disposal.</p> <p>Willingness of key stakeholders to adopt the proposed business model.</p> <p>Risks:</p> <p>Change of government policy and its priority of environmental issues caused by the industrial development</p> <p>Community actions</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
	<p>industry-urban symbiosis projects implemented with support from the project.</p> <p>Institutionalized the Industry-urban symbiosis practice through the implementation of national eco-industrial town framework</p>	<p>basis as the CSR/CSV project.</p> <p>No mechanism and system to encourage the industry-urban symbiosis</p>	<p>3 demonstration projects on industrial symbiosis between the companies/estate and industry-urban symbiosis carried out</p> <p>1 demonstration project for waste management and waste-to-energy</p> <p>1 demonstration project for e-waste management and its dismantling and recycling plant</p> <p>A national eco-industrial town framework endorsed by the stakeholders with at least one industrial estate/zone in each selected province and the three selected provinces assessed by using the national eco-industrial town framework</p>		<p>against the waste-to-energy plant</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
<b>Component 1: Policy development</b>					
<i>Output 1.1 Necessary legislative and policy measures on industry-urban symbiosis principles, management of new POPs and market-based instruments enhanced</i>	Number of policy measures/guidelines and market-based instruments endorsed by stakeholders	Some of new POPs were listed as the hazardous substances by law, however, there is no other actions taken since the new national implementation plan is under preparation.  Currently, limited MBIs relevant to industry-urban symbiosis were implemented for example fee collection for operating waste-to-energy plant.	Proposed policy improvements/guidelines and market-based instruments endorsed by the stakeholders	Official document	Assumptions: National authorities are willing to endorse, specific policy documents.  Risks: Change of government policy and its priority of environmental issues caused by the industrial development
<b>Component 2: National capacity building and awareness raising on industry-urban symbiosis and POPs</b>					
<i>Output 2.1 Inventory of new POPs and intervention plan developed for the three selected provinces</i>	Number of participants attending the new POPs inventory and MFA/SFA trainings  Availability of MFA/SFA of new POPs in three selected provinces  Availability of provincial intervention plan for three selected provinces  Monitoring results showing the performance of the intervention plan implemented	There is no inventory and intervention plan of new POPs at the provincial level.  Limited capacity of researchers and government officers to collect sampling and analyze the new POPs.  There is no baseline information of some emerging POPs such as SCCP. Therefore, it is difficult for the responsible agency to take action.	At least 30 researchers and representatives of the project partners attend the trainings  MFA/SFA reports of new POPs in three selected provinces  Provincial Intervention plans for the three selected provinces adopted by PCD and relevant stakeholders  Monitoring reports of new POPs contamination in three selected provinces	Training Materials  Training reports  MFA/SFA report of new POPs in the three selected provinces  Provincial Intervention Plan  Monitoring Reports of new POPs contamination	Assumptions:  Willingness of researchers and representatives of the project partners to attend training activities.  Willingness of private sector to share data  Willingness of responsible agencies to implement the intervention plan

<b>Project Narrative</b>	<b>Indicator</b>	<b>Baseline</b>	<b>Target</b>	<b>Source of Verification</b>	<b>Assumptions/Risks</b>
<i>Output 2.2 Opportunities for industry-urban symbiosis elaborated through material and waste stream analysis</i>	<p>Number of industrial symbiosis or industry-urban symbiosis identified</p> <p>Number of online waste database</p>	<p>Limited industrial symbiosis and industry-urban symbiosis implemented in Thailand. Most of the industrial symbiosis were carried out by the companies under the same corporate.</p> <p>Some industry-urban symbiosis exist, but on ad-hoc basis as the CSR/CSV project. Most of the industry-urban symbiosis emphasized on the product development instead of the whole value chain of the potential business.</p>	<p>At least 3 industrial symbiosis or industry-urban symbiosis opportunities and their business model identified and ready for implement in Output 3.1</p> <p>One pilot online waste database for one industrial estate/park</p>	<p>MFA/SFA report of potential resource/waste exchange opportunities among industries and between industry and community</p> <p>Online waste database</p>	<p>Assumptions:</p> <p>Willingness of private sector to share data</p> <p>Willingness of key stakeholders to adopt the proposed business model.</p> <p>Risks:</p> <p>Change of government policy and its priority of municipal wastes management</p> <p>Community actions against the waste-to-energy plant</p>
<i>Output 2.3 Increased capacity and awareness on risks of new POPs and the benefits of (i) resource efficient and cleaner production, (ii) green chemistry, (iii) industry-urban symbiosis</i>	<p>Development of awareness programs and materials</p> <p>Number of participants attending the project organized awareness raising events (disaggregated by gender)</p> <p>Number of participants attending technical</p>	<p>Lack of knowledge and understanding of new POPs among industries, government agencies and communities</p> <p>Limited knowledge sharing and trainings available on RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis.</p> <p>There is no mechanism to</p>	<p>At least 10 leaflets and factsheets developed to promote RECP, low carbon technology, green chemistry, BAT/BET, and industry-urban symbiosis including the waste separation and POPs contaminated wastes management</p> <p>2,500 participants from factory, industrial</p>	<p>Awareness raising materials</p> <p>Training materials</p> <p>Seminar/workshop/training reports</p> <p>Online learning and information sharing platform and its analytic report</p>	<p>Assumptions:</p> <p>Willingness of key stakeholders for example industry representatives, local experts, local authority's officers, and community representatives to attend awareness and training activities.</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
	<p>training (disaggregated by gender)</p> <p>Number of curricula and course materials developed for RECP, low-carbon technologies, green chemistry and industry-urban symbiosis.</p> <p>Development of online learning and information sharing platform</p> <p>Number of online contents for the online learning and information sharing platform</p>	<p>sustain the knowledge sharing on RECP, low carbon technologies, green chemistry, BAT/BEP and industry-urban symbiosis.</p>	<p>zone/estate and government agency, consultant, supplier and service provider, and other relevant stakeholders attend the awareness raising seminar (equal access to seminar for men and women ensure, with average of 30% female participants – aggregate ratio by area and stakeholder is in Annex N)</p> <p>500 participants from community, local authority, wastes collector and recycle facility attend the awareness raising event/seminar/workshop (equal access to event/seminar/workshop for men and women ensure, with average of 30% female participants – aggregate ratio by area and stakeholder is in Annex N)</p> <p>At least 3,000 participants attend user trainings, 500 participants attend intensive trainings and 100 candidates are qualified as national experts (equal access to training for men and women ensure, with average of 30%</p>		<p>Accessibility of internet and digital technology supporting the access of online learning and information sharing platform</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
			<p>female participants – aggregate ratio by area and stakeholder is in Annex N)</p> <p>Three academic courses developed for RECP, low-carbon technologies, green chemistry and industry-urban symbiosis</p> <p>At least one online training course for each topic covering RECP, low carbon technology, new POPs, green chemistry, industry-urban symbiosis produced and available for stakeholders</p> <p>At least one new information material in various formats for example pdf file, short video clip, live interview session updated monthly</p>		
<b>Component 3: Pilot demonstration of cleaner production, new POPs management and industry-urban symbiosis</b>					
<i>Output 3.1 Industry-urban symbiosis implemented through the demonstration of low carbon and green chemistry systems in selected enterprises,</i>	Number of assessment and feasibility study to support the GHG reduction and POPs disposal through the application of RECP, low carbon technology,	Limited case study to demonstrate the implementation of RECP, low carbon technologies, green chemistry, BAT/BEP of new POPs, and industry-urban symbiosis. Some guidelines on	200 RECP assessment conducted, when appropriate including the application of low carbon technologies, green chemistry implication, energy management system and system optimization	Assessment reports Feasibility study reports Project demonstration reports	Assumptions: Willingness of private sector to partially support the assessment cost

<b>Project Narrative</b>	<b>Indicator</b>	<b>Baseline</b>	<b>Target</b>	<b>Source of Verification</b>	<b>Assumptions/Risks</b>
<i>industrial zones and neighboring urban settlements</i>	<p>green chemistry, BAT/BET, and industry-urban symbiosis</p> <p>Number of RECP, low carbon technology, green chemistry, BAT/BET, and industry-urban symbiosis projects implemented with support from the project.</p>	<p>energy audit and energy saving are available, but with limited case study.</p> <p>Increasing interest of waste-to-energy as a part of industry-urban symbiosis. Code of Practice is available. However, the community raise their concern about environmental issues, especially release of air pollution.</p> <p>Recently, E-waste became a pressing issue in Thailand. In addition to the domestic e-waste, the problem of illegally imported e-waste is increasing. The e-waste management is dominated by informal sector without using the PPE. Their dismantling and recycling facilities are poorly managed with the high risk of environmental and health impacts.</p>	<p>measures</p> <p>Technical and financial feasibility study report for 100 facilities</p> <p>50 implementation projects related to the application of RECP, low carbon technologies, green chemistry or BAT/BEP carried out</p> <p>3 demonstration projects on industrial symbiosis between the companies/estate and communities carried out</p> <p>1 demonstration project for waste management and waste-to-energy</p> <p>1 demonstration project for e-waste management and its dismantling and recycling plant</p>	<p>Project implementation reports</p>	<p>Willingness of key stakeholders to co-financing through their infrastructure to reduce the GHG emission and POPs disposal.</p> <p>Risks:</p> <p>Community actions against the waste-to-energy plant</p>
<b>Component 4: Development of National Eco-Industrial Town Framework and its supporting system</b>					
<i>Output 4.1 Continuous improvement and sustaining the industry-urban symbiosis</i>	<p>Development of national eco-industrial town framework</p> <p>Demonstration of</p>	<p>There is no national eco-industrial town framework available. There are two eco-industrial town criteria sets provided by DIW and IEAT.</p>	<p>A national eco-industrial town framework endorsed by the stakeholders</p> <p>At least one industrial</p>	<p>National eco-industrial town framework</p> <p>Assessment reports</p>	<p>Assumptions:</p> <p>National authorities are willing to endorse national eco-industrial</p>

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
	national eco-industrial town framework		estate/zone in each selected province assessed by using the national eco-industrial town framework  3 selected provinces assessed by using the national eco-industrial town framework		town framework.  Key stakeholders are willing to adopt a national eco-industrial town framework.  Risks:  Change of government policy and its priority of environmental issues caused by the industrial development
<b>Outcome B:</b> Project achieves objective on time through effective monitoring and evaluation	Existence of project management structure  Timely availability of reports	UNIDO and GEF monitoring and evaluation procedures are new for some of the project staffs and project partners.	Monitoring and evaluation activities implemented and project implementation monitored and evaluated to achieve project objectives	Various monitoring and evaluation, and other reports e.g. progress and terminal reports, mid-term review and terminal evaluation reports.	Assumptions:  Efficient monitoring and evaluation to facilitate timely achievement of project outcomes and objectives
<b>Component 5: Monitoring and evaluation</b>					
<i>Output 5.1 Periodic monitoring and evaluation of project implementation completed</i>	Monitoring and evaluation adequately conducted according to UNIDO and GEF standard  Timely availability of inception, annual and evaluation project reports	The project result framework with outcome and output indicators and targets will be used for track the progress and achievement of the project.  The detail annual work plan will be presented to PSC at the annual meeting.	PSC officially established and met annually  Training on monitoring procedures including gender and administrative processes held during inception period.  Progress reports available	PSC establishment order  Project inception workshop report  Annual Project Implementation Reports (PIRs)	Assumptions:  Project steering committee set up in the timely manner  Monitoring and evaluation, and project reporting mechanisms agreed and adopted by

Project Narrative	Indicator	Baseline	Target	Source of Verification	Assumptions/Risks
		UNIDO and GEF monitoring and evaluation procedures are new for some of the project staffs and project partners.	<p>annually</p> <p>Mid-term evaluation delivered within 3 years after the clearance from Thai Government</p> <p>Terminal evaluation report delivered within 3 months from project closure.</p>	<p>Annual Progress Reports</p> <p>Mid-term evaluation report</p> <p>Terminal evaluation report</p> <p>Terminal report</p>	<p>all the relevant project partners</p> <p>Project stakeholders actively cooperating in all monitoring and evaluation activities</p> <p>All deliverables submitted in time</p> <p>Risks:</p> <p>Election and change of government may delay the setup of PSC.</p>

**ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF).**

**ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS<sup>26</sup>**

A. Provide detailed funding amount of the PPG activities financing status in the table below:

PPG Grant Approved at PIF: USD 200,000			
<i>Project Preparation Activities Implemented</i>	<i>GETF/LDCF/SCCF/CBIT Amount (\$)</i>		
	<i>Budgeted Amount</i>	<i>Amount Spent To date</i>	<i>Amount Committed</i>
Meeting and workshops (stakeholder meeting, consultation meeting, validation workshop)	20,000	4,697.48	15,302.52
Baseline data collection and analysis (desk study, visit to facilities, preliminary analysis of PFOS, PBDEs and HBCD), GHG emission reduction calculation and POP's disposal	100,000	90,755.93	9,244.07
Development of the project document and the gender study	80,000	70,026.89	9,973.11
<b>Total</b>	200,000	165,480.2	34,519.8

The PPG phase included various activities to ensure the commitment of stakeholders, assessment of the baseline, analysis of gender mainstreaming, detailed project design, and the potential and target GHG emission reduction and POPs disposal.

The balance of USD 34,519.8 from the PPG phase will be used for preparation activities to be carried out under the implementation phase of the proposed project.

The detailed PPG activities are shown in the table below:

A. Workshops

Date	Description	Objectives	Outputs
29 Aug 2017	Project partner inception workshop at DIW meeting room	To identify the roles and responsibilities of the project partners To agree on the activities during the PPG phase To confirm the three selected provinces and the list of new POPs to be focused in the project activities	The project partners agreed to invite IEAT as a new project partner. The three selected provinces are Samut Prakarn, Chonburi and Rayong. The list of new POPs to be focused in the project activities consists of PFOS, PBDEs and HBCD.

<sup>26</sup> If at CEO Endorsement, the PPG activities have not been completed and there is a balance of unspent fund, Agencies can continue to undertake the activities up to one year of project start. No later than one year from start of project implementation, Agencies should report this table to the GEF Secretariat on the completion of PPG activities and the amount spent for the activities. Agencies should also report closing of PPG to Trustee in its Quarterly Report.

Date	Description	Objectives	Outputs
16 Feb 2018	Project partner meeting at DIW meeting room	To follow up the progress of PPG phase	The baseline study team reported the progress to the project partners.
6 Jun 2018	Project partner meeting at DIW meeting room	To summarize the baseline information To agree on the proposed project activities during the implementation phase To agree on the indicators and targets of project outputs To confirm the co-financing items and amount.	The baseline study team reported the findings. The results of gender analysis and mainstreaming were presented to the project partners. The project partners reviewed, revised and approved the project activities. The indicators and targets of project outputs were agreed and approved by the project partners. The project partners confirmed their co-financing.
21 Jun 2018	Validation workshop at Centara Grand at Central World	To present and validate the baseline study, results of gender analysis and project activities	There are 55 participants including project partner, UNIDO, government agency, academic, research institute, industrial association and institute, and private sector. The participants provided the feedbacks on baseline study. The feedbacks were verified and incorporated to the baseline information in the project document.

## B. Stakeholder meeting

Date	Description	Objectives	Outputs
16 Mar 2018	Stakeholder meeting – Samut Prakarn at Provincial Industrial Office, Samut Prakarn	To describe the project framework to the relevant stakeholders To gather feedback about the proposed activities to achieve the targets of GHG emission reduction and POPs disposal	There are 17 participants including project partner, UNIDO, local authority, industrial association and private sector. Information about the industries participating in the meeting and their practices on energy savings received. The participants provided the feedbacks on baseline study.
3 Apr 2018	Stakeholder meeting – Chonburi at Saha group industrial park, Chonburi	To describe the project framework to the relevant stakeholders To gather feedback about the proposed activities to achieve the targets of GHG emission reduction	There are 28 participants including project partner, UNIDO, local authority, industrial association and private sector. Information about the industries

Date	Description	Objectives	Outputs
		and POPs disposal	participating in the meeting and their practices on energy savings received. The participants provided the feedbacks on baseline study.
23 May 2018	Stakeholder meeting – Rayong at Cameo Classic Hotel, Rayong	To describe the project framework to the relevant stakeholders To gather feedback about the proposed activities to achieve the targets of GHG emission reduction and POPs disposal	There are 44 participants including project partner, UNIDO, local authority, industrial association and private sector. Information about the industries participating in the meeting and their practices on energy savings received. The participants provided the feedbacks on project activity and gender mainstreaming.
25 May 2018	Stakeholder meeting at Maple Hotel, Samut Prakarn	To describe the project framework to the relevant stakeholders To gather feedback about the proposed activities to achieve the targets of GHG emission reduction and POPs disposal	There are 29 participants including project partner, UNIDO, local authority, industrial association and private sector. Information about the industries participating in the meeting and their practices on energy savings received. The participants provided the feedbacks on project activity and gender mainstreaming.
1 Jun 2018	Stakeholder meeting at Top View Hotel, Chonburi	To describe the project framework to the relevant stakeholders To gather feedback about the proposed activities to achieve the targets of GHG emission reduction and POPs disposal	There are 22 participants including project partner, UNIDO, local authority, industrial association and private sector. Information about the industries participating in the meeting and their practices on energy savings received. The participants provided the feedbacks on project activity and gender mainstreaming.

### C. Consultative meeting

Date	Description	Objectives	Outputs
22 Aug 2017 11 May 2018	Consultative meeting with DIW	Project consultation	Updating information for the project document development
22 Aug 2018 18 May 2018	Consultative meeting with PCD	Project consultation	Updating information for the project document development

Date	Description	Objectives	Outputs
22 Jun 2018			
29 Aug 2017 24 Jan 2018 5 Apr 2018 30 Apr 2018 11 May 2018	Consultative meeting with FTI	Project consultation and progress tracking of baseline study	Updating information for the project document development Progress of data collection and analysis
24 Aug 2017 5 Oct 2017 19 Jan 2018 9 Apr 2018 14 May 2018 15 May 2018	Consultative meeting with Kasetsart University	Project consultation and progress tracking of baseline study	Updating information for the project document development. Progress of data collection and analysis
24 Apr 2018 3 May 2018	Consultative meeting with IEAT	Invitation to be a project partner Project consultation	IEAT accepted to be a project partner. Updating information for the project document development.
11 Apr 2018 21 May 2018 8 Jun 2018	Consultative meeting with expert on gender analysis	Progress tracking of gender and stakeholder analysis Verify the gender mainstreaming in project activities	Updating information for the project document development Progress of data collection and analysis

#### D. Other meetings for networking and baseline data collection

Date	Description	Objectives	Outputs
9 Jan 2018	Meet with Environmental officer of Bangpoo Industrial Estate	To share the project information and asking for advice about the chemical using database of factories in Bangpoo Industrial Estate	Updating information for the baseline scenario
11 Jan 2018	Meet with Information and Communication Technology Center, DIW	To share the project information and asking for advice about the chemical using database of factories	Updating information for the baseline scenario
16 Jan 2018	Meet with Sahapattana Inter Holding	To share the project information and discuss the future cooperation	Sahapattana Inter Holding showed their interest to participate in the project activities.
1 Feb 2018	Meet with The Federation of Thai Industries (FTI)	To share methodology and source of data collection of project	Finalizing the agreed methodology and data collection of three selected provinces
2 Feb 2018	Meet with director of Samut Prakarn provincial industrial office	To share the project information and asking for advice about the chemical using database of factories	Updating information for the baseline scenario
12-13 Feb 2018	Saha Group industrial park tour	To collect the data about chemical using, process and waste management	Updating information for the baseline scenario

Date	Description	Objectives	Outputs
16 Feb 2018	Meet with PTT	To share the project information and discuss the future cooperation	PTT showed their interest to participate in the project activities.
23 Feb 2018	Site visit to tanning factories and textile factories	To collect the data about chemical using, process and waste management.	Updating information for the baseline scenario
2 Mar 2018	Meet with PTTGC	To share the project information and discuss the future cooperation	PTTGC showed their interest to participate in the project activities.
5 Mar 2018	Meet with director of Chonburi provincial industrial office	To share the project information and asking for advice about the chemical using database of factories	Updating information for the baseline scenario
6 Mar 2018	Meet with Thai Tanning Industrial Association	To share the project information and discuss the future cooperation	Thai Tanning Industrial Association showed their interest to participate in the project activities.
15 Mar 2018	Meet with PTTLNG	To share the project information and discuss the future cooperation	PTTLNG showed their interest to participate in the project activities.
	Meet with Puen Chum Chon (CSO)	To share the project information and gather data on their activity	Updating information for the baseline scenario
19 Mar 2018	Meet with SCG Chemical	to share the project information and discuss the future cooperation	SCG Chemical showed their interest to participate in the project activities.
23 Mar 2018	Site visit to tanning factories and textile factories	To collect the data about chemical using, process and waste management.	Updating information for the baseline scenario
29 Mar 2018	Collect samples	To collect samples for new POPs contaminated analysis	Samples for the baseline scenario
25 – 26 Apr 2018	Eco-industrial town audit at Samut Prakarn	To observe the audit process of DIW's Eco-industrial Town criteria	Updating information for the baseline scenario
8 – 10 May 2018	NIP Update training and meeting	To participate in the NIP update meeting	Updating information for the baseline scenario
10 May 2018	Rayong survey	To survey the communities' opinions on pollution, environment, and health associated with industries	Updating information for the baseline scenario
16 May 2018	Eco-industrial town audit at Chonburi	To observe the audit process of DIW's Eco-industrial Town criteria	Updating information for the baseline scenario
24 May 2018	Eco-industrial town master plan meeting	To observe the eco-industrial town master plan development meeting at Pinthong Industrial Estate in Chonburi (under IEAT)	Updating information for the baseline scenario
4 Jun 2018	Meet with Dr. Chanathip Pharino, Chulalongkorn University, author of Challenges for	To interview about the current situation, issues and challenges of solid waste management and e-waste in Thailand	Updating information for the baseline scenario

Date	Description	Objectives	Outputs
	Sustainable Solid Waste Management: Lessons from Thailand (SpringerBriefs on Case Studies of Sustainable Development)		
7 Jun 2018	Meet with Dr. Kriengsak Wongpromrat, Executive Director of Plastics Institute of Thailand	To interview about the current situation, issues and challenges of POPs contaminated plastics (usage, waste management and recycle)	Updating information for the baseline scenario
11 Jun 2018	Meet with Executive Director of Electrical and Electronics Institute	To interview about the current situation, issues and challenges of POPs contaminated products (usage, waste management and recycle)	Updating information for the baseline scenario
15 Jun 2018	NIP Update consultative meeting	To participate in the NIP update meeting	Updating information for the baseline scenario
19 Jun 2018	Visit the integrated solid waste management center in Rayong	To visit the landfill and to interview the officers about the current situation, issues and challenges of solid waste management in Rayong	Updating information for the baseline scenario
20 Jun 2018	Meet with Thai Tanning Industry Association	To discuss about the opportunity to reduce GHG emission by improving the WWTPs in the Tanning Industrial Zones	Updating information for the baseline scenario
22 Jun 2018	Meet with Waste Management Siam	to discuss about the current situation, issues and challenges of e-waste and other POPs contaminated wastes in Thailand	Updating information for the baseline scenario