(Draft) Thailand's Updated National Implementation Plan under the Stockholm Convention on Persistent Organic Pollutants

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Abbreviations and Acronyms

3Rs	Reduce, Reuse, Recycle
ABS	Acrylonitrile Butadiene Styrene
ACFS	National Bureau of Agricultural Commodity and Food Standards
AFFF	Aqueous Film Forming Foam
AIDS	Acquired Immune Deficiency Syndrome
ASEAN	The Association of Southeast Asian Nations
BAT	Best Available Technology
BDEs	Brominated diphenylethers
B.E.	Buddhist Era
BEP	Best Environmental Practices
BFR	Brominated Flame Retardant
BMA	Bangkok Metropolitan Administration
CAS	Chemical Abstracts Service
CiP	Chemical substances in Products
COP	Conference of Parties
CoP	Code of Practices
CRT	Cathode Rays Tube
CS	Capsule Suspension
Customs	The Customs Department
DALY	Disability-Adjusted Life Years
DDPM	Department of Disaster Prevention and Mitigation, Ministry of Interior
DDT	Dichlorodiphenyltrichloroethane
DEDE	Department of Alternative Energy Development and Efficiency, Ministry of Energy
DEQP	Department of Environment Quality Promotion, Ministry of Natural Resources and Environment
DIW	Department of Industrial Works, Ministry of Industry
DfE	Design for Environment
DOLA	Department of Local Administration, Ministry of Interior
DM	Diabetes Mellitus
DMS	Department of Medical Sciences, Ministry of Public Health
DNA	Designated National Authority (Rotterdam Convention)
DNP	Department of Natural Parks, Wildlife, and Plant Conservation
DOA	Department of Agriculture, Ministry of Agriculture and Cooperatives
DOAE	Department of Agricultural Extension, Ministry of Agriculture and Cooperatives
DOH	Department of Health, Ministry of Public Health
DOLA	Department of Local Administration, Ministry of Interior
DPA	Department of Provincial Administration, Ministry of Interior
EEC	Eastern Economic Corridor
EEDP	Energy Efficiency Development Plan
EEE	Electrical and Electronic Equipment
EF	Emission Factors
EGAT	The Electricity Generating Authority of Thailand
E-HIA	Environmental-Health Impact Assessment

EI	Energy Intensity
EIA	Environmental Impact Assessment
EMRL	Extraneous Maximum Residue Limits
EOL	End-of-Life
EPPO	Energy Policy and Planning Office
EPR	Extended Producer Responsibility
EPS	Expanded Polystyrene
ERTC	Economic Research and Training Center, Thammasat University
ESEA	Eastern and Southeast Asia
FCPF	Forest Carbon Partnership Facility
FDA	Food and Drugs Administration
FTI	The Federation of Thai Industries
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHS	Global Harmonize System
GMS	Greater Mekong Subregion
GPP	Green Public Procurement
HALE	Health-Adjusted Life Expectancy
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCH	Hexachlorocyclohexane
HIV	Human Immunodeficiency Viruses
HS	Hazardous Substance
HSA	Hazardous Substance Act
HT	Hypertension
HW	Hazardous Waste
ICSCs	International Chemical Safety Cards
I-EA-T	The Industrial Estate Authority of Thailand
IEE	Initial Environmental Examination
ISO	International Standards Organization
kg	kilogram
km	kilometer
ktoe	thousand tonnes oil equivalent
LAOs	Local Administrative Organizations
LE	Life Expectancy at birth
LGBTQI	Lesbian, Gay, Bisexual, Transgender, Queer, and Intersex
MAC	Maximum Allowable Concentrations
MB	Million THB
MEA	The Metropolitan Electricity Authority
MHESI	Ministry of Higher Education, Science, Research and Innovation
M-Industry	Ministry of Industry
MNRE	Ministry of Natural Resources and Environment
MOAC	Ministry of Agriculture and Cooperatives
MOC	Ministry of Commerce

MOD	Ministry of Defence
MOE	Ministry of Education
MoEN	Ministry of Energy
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOI	Ministry of Interior
MOL	Ministry of Labour
MOPH	Ministry of Public Health
MOT	Ministry of Transport
MRL	Maximum Residue Limits
MSDHS	Ministry of Social Development and Human Security
MSW	Municipal Solid Waste
MTEC	National Metal and Materials Technology Center, National Science and Technology Development Agency
MWA	The Metropolitan Waterworks Authority
NCDs	Non-Communicable Diseases
NEB	National Environmental Board
NESDC	Office of the National Economic and Social Development Council
NGOs	Non-governmental Organization
NHCO	National Health Commission Office
NHES	Thai National Health Examination Survey
NIP	National Implementation Plan
NOB	National Office of Buddhism
NRCT	The National Research Council of Thailand
OSH	Occupational Safety, Health and Environment
PBBs	Polybrominated biphenyls
PBDEs	Polybronated diphenylethers
PCBs	Polychlorinated biphenyls
PCD	Pollution Control Department
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PCNs	Polychlorinated napthalenes
PCPs	Pentachlorophenols
PEA	The Provincial Electricity Authority
PeCB	Pentachlorobenzene
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
PM	Particulate Matters
POPs	Persistent Organic Pollutants
PPP	Polluter Pay Principle
PRTR	Pollutant Release and Transfer Registers
PS	Polystyrene
PWA	The Provincial Waterworks Authority
QSP	Quick Start Program (SAICM)
R&D	Research and Development
REDD+	Reducing Emissions from Deforestation and Forest Degradation

RTG	Royal Thai Government
SAICM	Strategic Approach to International Chemicals Management
SC	Stockholm Convention
SCP	Sustainable Consumption and Production
SCCP	Short-chain Chlorinated Paraffins
SCWRM	Strategic Committee for Water Resource Management
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessments
SEP	Sufficiency Economy Philosophy
SOP	Standard Operating Procedure
sq. km.	square kilometer
TAO	Tambon Administrative Organizations
TBBPA	Tetrabromo bisphenol-A
TEQ	Toxic Equivalence
gTEQ/a	gram toxic equivalence per year
THB	Thai Baht
TISI	Thai Industrial Standards Institute, Ministry of Industry
toe	ton oil equivalent
TSRI	Thailand Science Research and Innovation
TV	Television Sets
UNEP, UN Environment	The United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
uPOPs	unintentionally produced Persistent Organic Pollutants
USA	United States of America
VOC	Volatile Organic Compounds
WEEE	Waste of Electrical and Electronic Equipment
WHO	World Health Organization
WG	Working Group
WWTP	Wastewater Treatment Plant

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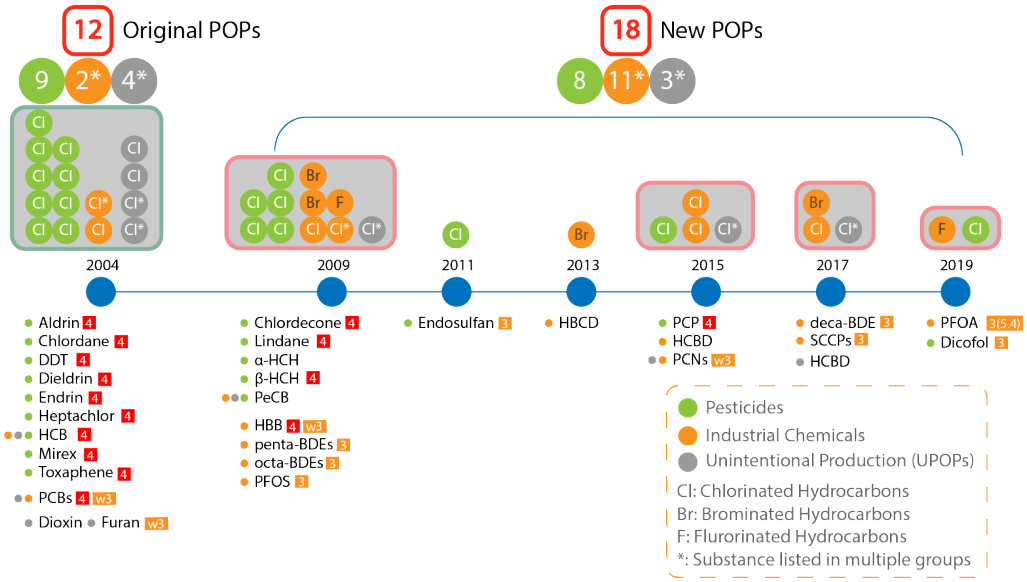
Executive summary



Numbers in square brackets indicate the substances are listed as hazardous substances in Thailand

The Stockholm Convention on Persistent Organic Pollutants is a global treaty with the objective to protect human health and the environment from persistent organic pollutants (POPs) by eliminating or reducing the releases of POPs. POPs are chemical substances with characteristics of environmental persistency and bioaccumulation, posing a risk that may lead to adverse health effects. These pollutants also transport in long range across international boundaries. The Stockholm Convention on POPs commits governments to take measures to protect human health and the environment from POPs.

Thailand ratified the Stockholm Convention (SC) on POPs on 31 January 2005. The national sub-committee on the SC was established, with the Pollution Control Department (PCD) under the Ministry of Natural Resources and Environment (MNRE) assigned as the country's focal point. As a Party to the Convention, Thailand has developed and submitted its first National Implementation Plan (NIP) in 2008. Thailand's first NIP addressed 12 chemical substances or groups of substances listed in 3 Annexes; Annex A for elimination, Annex B for restriction, and Annex C for the reduction of the unintentional production. The first NIP outlined strategies and action plans for the management of POPs pesticides, PCBs, unintentional production of POPs as well as action plans on social and economic management due to long-term use of POPs.

The Conference of Parties (COPs) of the SC has gradually added new POPs into the lists of substances under the SC. According to Article 7 of the Convention, each party has obligations to review and update the NIP periodically and when any amendment occurs in the SC. In this regard, POPs inventory assessment was carried out to provide current baseline information on sources, consumptions, disposal and the fate of the 12 initial POPs and new information on the 15 new POPs listed in Annexes A, B and C of the Convention. This preliminary POPs inventory assessment forms a basis for this updated NIP for Thailand.

Under the first NIP, legal measures were implemented to prohibit the use of the 12 initial POP substances. These substances are controlled under the Hazardous Substance Act B.E. 2535

(HSA) by being classified as Hazardous Substance (HS) Category 4, meaning the production, import, export or possession is prohibited. Waste from devices or components containing Polychlorinated Biphenyls (PCBs), transformers and capacitors are classified as chemical waste and as HS Category 3. The production, import, export, transit or possession of HS Category 3 must be done under license from the Department of Industrial Works (DIW), Ministry of Industry (M-Industry). Those who possess waste containing PCBs are responsible for hazardous waste handling in accordance with the law. A notification was issued in 2008 requiring those in possession of PCBs to plan for using other alternatives and disposal of PCBs by 2012. In case of the need to relocate appliances or tools containing PCBs, notification must be submitted to the DIW beforehand.

Most of the newly listed POPs are classified as HS Category 4 and Category 3. For substances classified under Category 4, their production, import, export, transit or possession are prohibited. For HS Category 3, the producer, importer, exporter, transporter or those in possession must request for registration of the Hazardous Substances and obtain the permission and license from responsible authorities.

For reduction and elimination of the release of unintentional production of POPs, Thailand has set a standard for the release of dioxins/furans from 5 sources, namely, (1) solid waste incinerator (2) industrial waste incinerator (3) medical waste incinerator (4) industry that uses waste oil (which has passed quality adjustment process) and synthetic fuel and (5) cement plants that utilize waste as fuel or raw materials for their production. A project for using the best available techniques and best environmental practices (BAT/BEP) to reduce or eliminate the release of dioxins/furans from point sources (electricity and thermal energy production, crematoria and metal production) was implemented.

As set out by the first NIP, Thailand has monitored POPs in living organisms and the environment through national and international cooperation projects. This includes the “Environmental Monitoring of Persistent Organic Pollutants (POPs) in East Asian Countries (2004 to present)” project with technical and financial supports from the Japanese government, which aims to monitor 9 types of POPs pesticides in the atmosphere of East Asian countries. Another international project, funded by the Global Environment Facility (GEF), is “Implementation of POPs Monitoring Plan in Asian Region (2018-2020)”; this project monitored POPs in various types of samples such as atmospheric air samples in clean areas, breast milk and some national samples (such as sediments, chicken eggs, duck eggs, fish and beef). For capacity-building of laboratories in Thailand, there are ongoing efforts to strengthen the capabilities of relevant laboratories to be able to efficiently support the country’s POPs monitoring activities in the long term.

Under this updated NIP, the action plans can be categorized into three groups which are human health and environment protection, capacity building of relevant agencies, and raising public awareness and understanding.

1) Activities related to producing safe food, ensuring healthy life, and clean environment

Activity	POPs			Implementing Body
	P	I	U	
a) Strengthening existing regulations, for example, setting environmental quality standards covering POPs, listing as Category 4 HS, declaring and collecting data of POPs chemical substances in products (CiP) on products manufactured in Thailand and imported from other countries, controlling open burning, etc.		•	•	M-Industry
b) Considering controlling newly listed industrial POPs substances that are not yet classified as Hazardous Substances		•		MNRE
c) Establishing additional standard limits for POPs in environmental media and in food and drinking water	•	•	•	MNRE/MOAC/ MOPH
d) Establishing a monitoring and assessment system for products containing POPs in all kinds of recycling processes		•	•	MHESI
e) Supporting safe agriculture practice or organic farming or biological cultivation or integrated pesticide management	•			MOAC
f) Setting up measures to reduce uPOPs release for major uPOPs sources			•	MNRE/M-Industry/ MOI

Note: P: POPs pesticides, I: industrial POPs and U: unintentional POPs

2) Activities relating to capacity building of government agencies and local authority organizations in monitoring small and medium industrial firms that are related to products containing POPs, monitoring activities that release unintentionally produced POPs (uPOPs), and monitoring quality of the environment as well as emission standards at point sources of POPs

Activity	**POPs**			**Implementing Body**
	P	**I**	**U**	
a) Empowering staffs of local authority organizations, together with providing budgets for operating and maintenance the waste incinerators under their supervision			•	MNRE/MOI
b) Improving laboratories in terms of equipment and personnel, at the national, local, and the private sector levels. A guideline for managing recycle activities that prevent POPs contamination is also suggested, as well as research of new technologies for analyzing POPs	•	•	•	MHESI/MNRE/ MOAC/MOPH

Activity	POPs			Implementing Body
	P	I	U	
c) Establishing an accomplished data management system, which consists of data from various government and private agencies, for evaluating the incidents or surveillance of POPs related activities which is accessible by all stakeholders	•	•	•	MHESI/MNRE

Note: P: POPs pesticides, I: industrial POPs and U: unintentional POPs

3) Activities relating to raising awareness and understanding for concerned sectors, including private entrepreneurs and local administrative organizations, with focuses on wastes containing POPs and unintentional production of POPs

Activity	POPs			Implementing Body
	P	I	U	
a) Raising awareness and understanding among staffs of local authority organizations, especially on identification and separation of POPs containing products and separate waste collection		•	•	MNRE/MOI
b) Raising awareness and understanding among people in all stakeholder groups at the local level, especially small and medium private firms, children, women, elderly, and disadvantage people	•	•	•	MNRE/M-Industry/ MOI/MOL
c) Monitoring POPs in the environment (including surface water, ground water, sea water, soil, sediments, air) especially at locations with high risk of POPs contamination and locations that are sources for tap water	•	•	•	MHESI/MNRE
d) Establishing marking system or declaring information on materials/products containing industrial POPs, to facilitate separators to manage these materials/products discretely from other materials.		•		M-Industry
e) Establishing a tracing system for products containing POPs, and data on stocks of POPs. POPs identification system should cover all the supply chain and consumer network (especially raw materials and substances used in the production process and in products) for the advantage of tracking POPs data	•	•	•	MHESI/MOAC/ MNRE/MOPH

Note: P: POPs pesticides, I: industrial POPs and U: unintentional POPs

To achieve the goals outlined in the strategies and action plans, it requires both necessary budget and continuous co-operation from all relevant parties in the government, industrial sector, private sector, local administrations and the general public.

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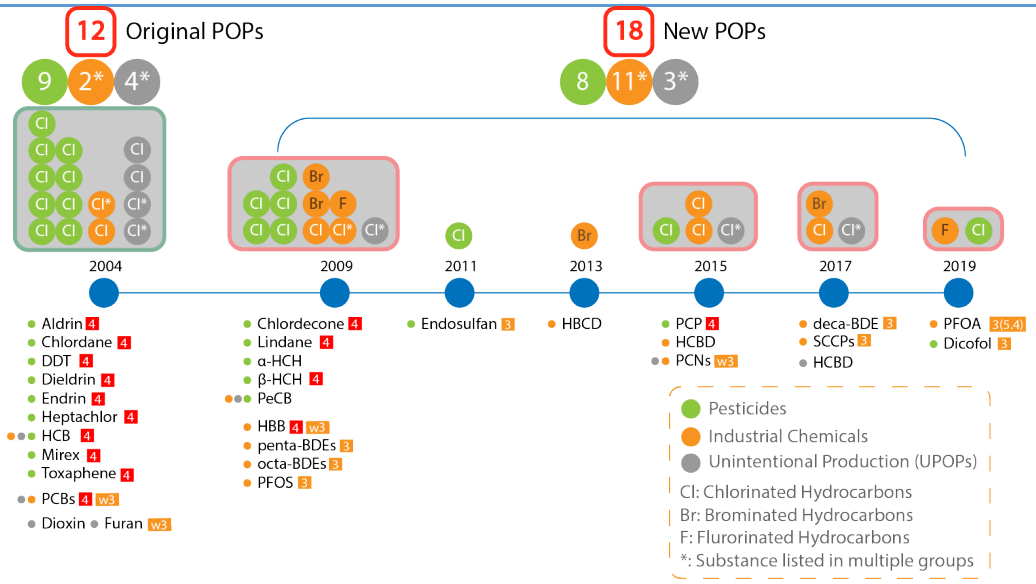
1 Introduction

Thailand ratified the Stockholm Convention on Persistent Organic Pollutants (POPs) on 31 January 2005. The cabinet has assigned the Pollution Control Department (PCD), Ministry of Natural Resources and Environment (MNRE) as the National Contact Point for the Stockholm Convention (SC). The Convention aims to protect human health and the environment from POPs substances, which possess specific traits – high toxicity, persistence to degradation in the environment, long-range transport across international boundary, and bioaccumulation in the food-web and in the environment - for which global action is needed. The Stockholm Convention aims to reduce and eliminate the production, use and release of POPs into the environment. The Convention initially included 12 chemical substances or groups of substances (also known as initial POPs) listed in 3 Annexes; Annex A for elimination, Annex B for restriction, and Annex C for reduction of unintentional production. Initially, there were 9 substances listed in Annex A, one substance (DDT) in Annex B, and 4 substances listed in Annex C. The Conference of Parties (COPs) of the SC has gradually added new POPs substances into the lists. As of 2019, the SC has added 18 more POPs substances; 17 substances to Annex A, 1 substance to Annex B, and 3 substances to Annex C, as visually summarized in Figure 1 and detailed in Table 1.

Figure 1: Overview of the listing of POPs substances under the Stockholm Convention from 2004 to 2019



Numbers in square brackets indicate the substances are listed as hazardous substances in Thailand

Annexes A and B to the Convention also set forth a number of specific exemptions for which Parties may register in accordance with Articles 3 and 4 of the Convention. If at any time there are no Parties registered for a given specific exemption, no new registrations may be made in respect of that exemption. As of the end of December 2019, there are acceptable purposes and/or specific exemptions for 11 substances for which Parties may register, as summarized in Table 2.

When new chemical substances are added in the Annexes, each Party has obligations under Article 7 to review and update its National Implementation Plan (NIP) and transmit it to the COP within two years of the entry into force of the amendment for it.

Table 1: List of POPs substances under the Stockholm Convention (Up to May 2019)

Substance name and CAS No.	Pesticide	Industrial Chemicals	Unintentional production
Initial POPs			
1. Aldrin (CAS No. 309-00-2 9)	A		
2. Chlordane (CAS No. 57-74-9)	A		
3. DDT (CAS No 50-29-3).	B		
4. Dieldrin (CAS No. 60-57-1)	A		
5. Endrin	A		
6. Heptachlor (CAS No. 76-44-8)	A		
7. Hexachlorobenzene: HCB (CAS No. 118-74-1)	A	A	C
8. Mirex	A		
9. Toxaphene (CAS No. 8001-35-2)	A		
10. Polychlorinated Biphenyls: PCBs (CAS No. 1336-36-3)		A (x)	C
11. Polychlorinated dibenzo-p-dioxins: PCDD			C
12. Polychlorinated dibenzofurans: PCDF			C
Newly listed POPs			
1) alpha hexachlorocyclohexane: α-HCH (CAS No. 319-84-6)	A (SC 4/10)		
2) beta hexachlorocyclohexane: β-HCH (CAS No. 319-85-7)	A (SC 4/11)		
3) Chlordecone (CAS No. 143-50-0)	A (SC 4/12)		
4) Hexabromobiphenyl: HBB (CAS No. 36355-01-8)		A (SC 4/13)	
5) Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octabromodiphenyl ether or c-octaBDE)(CAS No. 68631-49-2, 207122-15-4, 446255-22-7, 207122-16-5)		A (x) (SC 4/14)	
6) Lindane or gamma-HCH: γ-HCH (CAS No. 58-89-9)	A (x) (SC 4/15)		
7) Pentachlorobenzene: PeCB (CAS No. 608-93-5)	A (SC 4/16)	A (SC 4/16)	C (SC 4/16)
8) Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F) (CAS No: for example, 1763-23-1, 2795-39-3, 70225-14-8, 29081-56-9, 29457-72-5		B (x) (SC 4/17)	
9) Tetrabromodiphenyl ether and pentabromodiphenyl ether (or c-pentaBDE) (CAS No. 5436-43-1)		A (x) (SC 4/18)	
10) Technical Endosulfan and its related isomers (CAS No. 959-98-8, 33213-65-9)	A (x) (SC 5/3)		
11) Hexabromocyclododecane: HBCD (CAS No. 25637-99-4, 3194-55-6)		A (x) (SC 6/13)	
12) Hexachlorobutadiene: HCBD CAS No. 87-68-3		A (SC 7/12)	C (SC 8/12)
13) Pentachlorophenol and its salts and esters (PCP) (CAS No. 87-86-5, 131-52-2, 27735-64-4, 3772-94-9, 1825-21-4)	A (x) (SC 7/13)		
14) Polychlorinated naphthalenes: PCNs (CAS No. 70776-03-3		A (x) (SC 7/14)	C (SC 7/14)
15) Decabromodiphenyl ether (commercial mixture, c-decaBDE), (CAS No. 1163-19-5)		A (x) (SC 8/10)	
16) Short-chained chlorinated paraffins: SCCPs (CAS No. (for example) 85535-84-8, 68920-70-7, 71011-12-6, 85536-22-7, 85681-73-8, 108171-26-2)		A (x) (SC 8/11)	
17) Dicofol (CAS No. 115-32-2)		A (SC 9/11)	

Substance name and CAS No.	Pesticide	Industrial Chemicals	Unintentional production
18) Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds		A (x) (SC 9/12)	

Note:

1. A=Substance listed in Annex A: Elimination (Parties must take measures to eliminate the production and use of the chemicals listed under Annex A. Specific exemptions for use or production are listed in the Annex and apply only to Parties that register for them),
   B= Substance listed in Annex B: Restriction (Parties must take measures to restrict the production and use of the chemicals listed under Annex B in light of any applicable acceptable purposes and/or specific exemptions listed in the Annex),
   C= Substance listed in Annex C: Unintentional production (Parties must take measures to reduce the unintentional releases of chemicals listed under Annex C with the goal of continuing minimization and, where feasible, ultimate elimination.),
2. (x)= with specific exemption and/or Acceptable purposes
3. SC n/ii = SC decision number

Table 2: Existing specific exemptions for POPs substances listed in Annex A and B

	POPs Substances	Activity	Specific exemptions
1	Decabromodiphenyl ether (BDE-209)	Production	As allowed for the Parties listed in the Register of Specific Exemptions
		Use	In accordance with the provisions of Part IX of Annex A
2	Hexabromocyclododecane (HBCD)	Production	As allowed for the Parties listed in the Register of Specific Exemptions in accordance with the provisions of Part VII of Annex A of the Convention
		Use	Expanded polystyrene and extruded polystyrene in buildings in accordance with the provisions of Part VII of Annex A
3	Hexabromo- and heptabromodiphenyl ether	Use	Articles in accordance with provisions of Part IV of Annex A
4	Pentachlorophenol and its salts and esters	Production	As allowed for the Parties listed in the Register of Specific Exemptions in accordance with the provisions of Part VIII of Annex A
		Use	Pentachlorophenol for utility poles and cross-arms in accordance with the provisions of Part VII of Annex A
5	Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds	Production	Fire-fighting foam: None. For other production, as allowed for the Parties listed in the Register in accordance with the provisions of Part X of Annex A
		Use	In accordance with the provisions of Part X of Annex A
6	Polychlorinated biphenyls (PCBs)	Use	Articles in use in accordance with the provisions of Part II of Annex A
7	Polychlorinated naphthalenes, including dichlorinated naphthalenes, trichlorinated naphthalenes, tetrachlorinated naphthalenes, pentachlorinated naphthalenes, hexachlorinated naphthalenes, heptachlorinated naphthalenes, octachlorinated naphthalene	Production	Intermediates in production of polyfluorinated naphthalenes, including octafluoronaphthalene
		Use	Production of polyfluorinated naphthalenes, including octafluoronaphthalene

	POPs Substances	Activity	Specific exemptions
8	Short-chain chlorinated paraffins (Alkanes, C10-13, chloro)	Production	As allowed for the Parties listed in the Register
		Use	• Additives in the production of transmission belts in the natural and synthetic rubber industry • Spare parts of rubber conveyor belts in the mining and forestry industries • Leather industry, in particular fat-liquoring in leather • Lubricant additives, in particular for engines of automobiles, electric generators and wind power facilities, and for drilling in oil and gas exploration, petroleum refinery to produce diesel oil • Tubes for outdoor decoration bulbs • Waterproofing and fire-retardant paints • Adhesives • Metal processing • Secondary plasticizers in flexible polyvinyl chloride, except in toys and children's products
9	Technical endosulfan and its related isomers	Production	As allowed for the Parties listed in the Register of Specific Exemptions
		Use	Crop-pest complexes as listed in accordance with the provisions of Part VI of Annex A
10	Tetra- and penta-bromodiphenyl ether	Use	Articles in accordance with the provisions of Part V of Annex A
11	Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)[SC 4/17 & SC 9/4]	Production	None
		Use	• Metal plating (hard-metal plating) only in closed-loop systems • Fire-fighting foam for liquid fuel vapour suppression and liquid fuel fires (Class B fires) in installed systems, including both mobile and fixed systems, in accordance with paragraph 10 of part III of Annex B

Thailand has compiled its first NIP that covers plans to reduce and/or eliminate emissions and discharges of the 12 initial POPs. Thailand also established the Stockholm Convention Sub-committee under the National Environmental Board to be in charge with SC-related matters including i) set Thailand's positions for SC-related negotiations during COP, POPRC, and other SC-related meetings, ii) support and observation for the implementation of the NIP, and iii) providing comments/suggestions on SC-related activities – including collaboration with the SC secretariat.

Accordingly, under Article 7 Thailand is of the obligation to review and update the NIP to ensure required updating for SC management of the added POPs for approval by the cabinet, prior to submission at the COP. In 2016 the MNRE was supported by the Global Environment Facility (GEF) for NIP development and to develop inventory data of 26 POPs under the project "Enabling Activities to Review and Update the National Implementation plan for the Stockholm Convention on Persistent Organic Pollutants (POPs)", in collaboration with the United Nations Industrial Development Organization (UNIDO). After its completion the SC Sub-committee and the National Environment Committee shall review it for further approval by the cabinet prior to submission to the COP.

1.1 The review and update of the National Implementation Plan

The process to review and update the NIP consists of four key components:

Component 1: Coordination mechanism and awareness-raising

This component aims to strengthen the existing national coordination mechanism to address the new POPs added to the SC Annexes during 2009 to 2017, as well as to review the outcome and the effectiveness of the initial NIP. This component also includes awareness raising and information exchange activities to ensure active participations from relevant stakeholders.

Component 2: Inventories of new POPs and review of initial 12 POPs

The objectives of this component are to gather baseline information for the 15[1] new POPs and to obtain updated information on the initial 12 POPs. The key outcomes from this stage are the validated national inventory for the 27 listed POPs and Thailand inventory assessment reports for POPs pesticides, POPs industrial chemicals, and unintentionally produced POPs (uPOPs).

Component 3: National capacities assessment and priority setting for management of new POPs

The objectives of this component are to assess new POPs-related human health and environmental issues of concern and to assess existing national capacities to manage the identified risks; to review the inventories and the assessment to identify priority areas for attention; and to develop criteria for prioritizing health and environmental impacts of new POPs. At the end of this stage, areas that need national actions are identified and prioritized according to the established criteria.

Component 4: NIP formulation, endorsement and submissions

This component has three consecutive subcomponents, namely the formulation of NIP for the new POPs and the update of NIP for original POPs; the endorsement of the final updated NIP through an endorsement workshop and the government's endorsement of the final NIP; and the submission of the endorsed NIP document to the SC COP by the government.

1.1.1 Establishment of working groups

The SC Sub-committee under the National Environmental Board established five working groups (WGs) as follows:

Working Group 1 (WG1): Working group on project supervision and coordination; consists of 14 members from 12 organizations with the PCD's Director General or representative as the chairperson;

Working Group 2 (WG2): Working group on the review and update of the national implementation plan and POPs pesticides inventory; consists of 12 members from 9 organizations with the DOA's Director General or representative as the chairperson;

Working Group 3 (WG3): Working group on the review and update of the national implementation plan and POPs industrial chemicals inventory; consists of 14 members from 11 organizations with the DIW's Director General or representative as the chairperson;

[1] At the time of this report, there are 18 new POPs, 4 of which (decaBDE, SCCPs, PFOA, and Dicofol) were listed after this project has launched. Three of these recently listed POPs (SCCPs, PFOA, and Dicofol) are not covered in this NIP update.

Working Group 4 (WG4): Working group on the review and update of the national implementation plan and unintentional POPs inventory; consists of 13 members from 9 organizations with the PCD's Director General or representative as the chairperson; and

Working Group 5 (WG5): Working group on socio-economic implications of POPs uses; consists of 12 members from 10 organizations with the Director of Office for the Promotion of Health Risks Controls, Thai Health Promotion Foundation or representative as the chairperson.

1.1.2 Inventory of new POPs and review of initial POPs

A POPs inventory is a compilation of information regarding sources, consumptions, disposal and the fate of POPs of interest with in the country. It aims to provide decision makers with reliable baseline information on the current POPs situation as well as key areas that need attention. It provides necessary information for relevant parties for their priority setting and choosing cost-effective risk reduction plans.

In 2018-2019, Thailand launched its second POPs inventory assessment study to provide updated information on the 12 initial POPs and new information on the 15 new POPs listed in Annexes A, B and C of the Stockholm Convention during 2009 to 2017[2]. This inventory study forms a basis for the update of the NIP, as obligated by Article 7 of the Convention.

The Stockholm Convention addresses POPs throughout their life-cycle. Applicable POPs inventory, therefore, cannot be limited to the release at the end-of-pipe. The second inventory assessment endeavors to gather available information deemed necessary for the country's preliminary risk assessment and development of mitigation plans. Particularly, given the time and resource constraints, it tries to collect and analyze relevant national data to gain information on the following issues:

- Past and current uses/production/emissions of each POP substance at the national level;
- Pattern of uses, flows, and amount of POPs historically or currently used to produce articles that were made available on the consumer market;
- Presence of materials and articles containing relevant POPs in the recycling streams;
- Disposal practices for POPs substances and articles containing POPs when they become wastes, including recycling situation;
- Amount of POPs substances in stockpiles and situation of the stockpiles;
- Potential contaminated sites.

Due to time and resource constraints, the inventory study does not aim to provide precise figures for each POPs, but rather to provide a general idea on the current situation, identify areas that might be at risk, and areas where critical data might be lagging and, hence, need to be addressed in the action plan of the updated NIP.

In this POPs inventory assessment, POPs substances were classified into 3 groups based on their intended purposes: POPs pesticides, POPs industrial chemicals, and unintentionally produced POPs or uPOPs. As of 2019, there are 17 POPs pesticides, 13 POPs industrial chemicals, and 7 uPOPs. The inventory assessment covers all of the POPs listed before 2017.

[2] Excluding SCCPs

Unfortunately, due to constraint on budget and timeframe, this assessment does not address three newly listed POPs (PFOA, SCCPs, and Dicofol).

Questionnaires, interviews and place visits are approaches for data collection required for assessment and reviews to ensure information completeness by each concerned working team prior to the public presentation to each POPs National Inventory Validation Workshop.

Information provided by stakeholders and certain reviews by experts including from the public hearing workshops has been firstly assessed prior to the draft of the second POPs Inventory required for reviewing by WG 1 prior to further submission to UNIDO for the international expert reviews.

1.1.3 Formulation of the updated NIP

The processes to prepare drafts of action plans for the updated NIP mainly followed the Guidance for Developing a NIP for the Stockholm Convention on POPs (2017)[3]. Inputs for the formulation of this NIP comprise the baseline information from POPs inventory assessments (including existing national capacities, gaps and areas for attention), areas that need national actions, and policy recommendations from public, private, and civil sectors policy recommendation workshops, and the WG1-approved NIP outline.

Particularly, after obtaining the validated inventory, validated priority issues and objectives, and the approval of the outline of the upcoming NIP by WG1, the task team (PCD, MTEC and ERTC) reviewed and updated 16 relevant action plans and strategies on the initial POPs and new POPs. These updated action plans and strategies were built on lessons learned from the development and implementation of the first NIP and findings from activities under Components 1 to 3.

The first draft of the action plan was circulated to all relevant governmental bodies for their input/comments during 19th to 29th November 2019. Then, the PCD arranged four working group meetings (WGs 2 to 5, one for each WG) during 17th to 19th December 2019 to discuss the first draft and all the comments received during the NIP (1st draft) circulation.

Decisions made by the four WGs were used to compile the 2nd draft of the updated NIP. These versions of the draft action plans and the NIP report were circulated to relevant stakeholders with an invitation to participate in the NIP endorsement workshop on 24th January 2020 at the Century Park Hotel, Bangkok. This event was arranged in 4 sessions; 1) Thailand's actions during the first NIPs, 2) Thailand's 2017 POPs inventory assessment findings, 3) Draft Thailand's updated NIPs and Action Plans, and 4) Comments, feedback and information exchanges by the audiences.

The 2nd draft of the updated NIP and action plans were revised according to the proposed action as agreed during the endorsement workshop's feedback session. The resulting final draft version was submitted to and approved by WG1 on 4th March 2020.

1.2 Outline of the updated NIP

This updated NIP comprises 3 chapters:

[3] The Secretariat of the Stockholm Convention, the United Nations Environment Programme, the United Nations Industrial Development Organization, the United Nations Institute for Training and Research, the United Nations, (Draft) Guidance for developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants, January 2017

The 1st chapter focusses on objectives, goals, SC obligations for Thailand; including the obligation to review and update the NIP, the compilation of Thailand's 2017 POPs inventory assessment study report and the processes taken to update the NIP.

The 2nd chapter comprises of the national baseline information, legal frameworks and national mechanism relating to the SC, and the assessment of the POPs issues in Thailand.

Finally, the 3rd chapter outlines Thailand's strategies to manage NIPs and plans to manage POPs and meet its obligations.

□□□

2 Country baseline

2.1 Country profile

2.1.1 Geographical location

The Kingdom of Thailand is located in a tropical region (5°37′ N to 20°27′ N and 97°22′ E to 105°37′ E). It has a total land area of 513,115 sq. km. (51.3 million hectares). The country shares borders with the Republic of the Union of Myanmar to the north and west, the Lao People's Democratic Republic to the north and east, the Kingdom of Cambodia to the east, and Malaysia to the south. The Gulf of Thailand is situated on the east and southeast coasts, while the Andaman Sea is situated on the southwest coast (Figure 2).

Thailand has 77 provinces, 23 of which are coastal provinces. Seventeen provinces are situated on the Gulf of Thailand, with a coastline of 2,039.77 km, and six provinces border the Andaman Sea, with 1,111.36 km of coastline. Prachuap Khiri Khan Province has the longest coastline (251 km), while Bangkok has the shortest (5.81 km).

Thailand can be divided into 6 geographic regions, each with its own general topography. The northern region is hilly and mountainous. The northeastern region is a natural high plain. The central region is a large low plain adjacent to the western region which is hilly and mountainous. The eastern region is also a plain but has valleys with small hills. And, the south is a peninsula with the Andaman Sea to the west and the Gulf of Thailand to the east.

Figure 2: Map of the Kingdom of Thailand

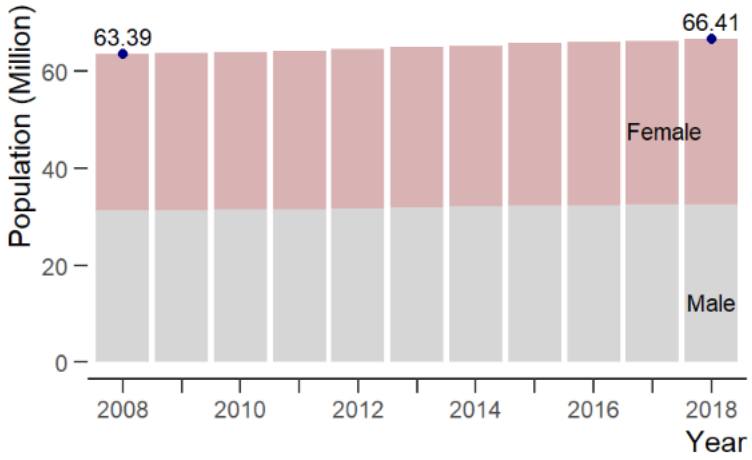
Source: Department of Field Support Cartographic Section UNITED NATIONS

2.1.2 Population

According to registration records from the Department of Provincial Administration, the total population of Thailand in 2018 was 66.41 million, with 32.56 million males and 33.86 million females (Figure 3).

An increase in life expectancy has shaped Thailand's population structure into an ageing society. Figure 4 shows that the projected ageing index will continue to rise at an increasing rate. In 2019, the number of people aged 60 and over had caught up with those under 15 years of age (i.e., ageing index started to exceed 100%). By 2040, the elderly population will be close to 2.5 times that of the youth. This demographic transition translates into challenges in the care and support for the ageing members of society. Pension spending, health care, and long-term care systems for the elderly will pose large financial burdens. Also, the shrinking labor force can impair Thailand's economy; thus, enhancing labor productivity will be required.

Figure 3: Thailand's number of population and sex ratio from 2008 to 2018

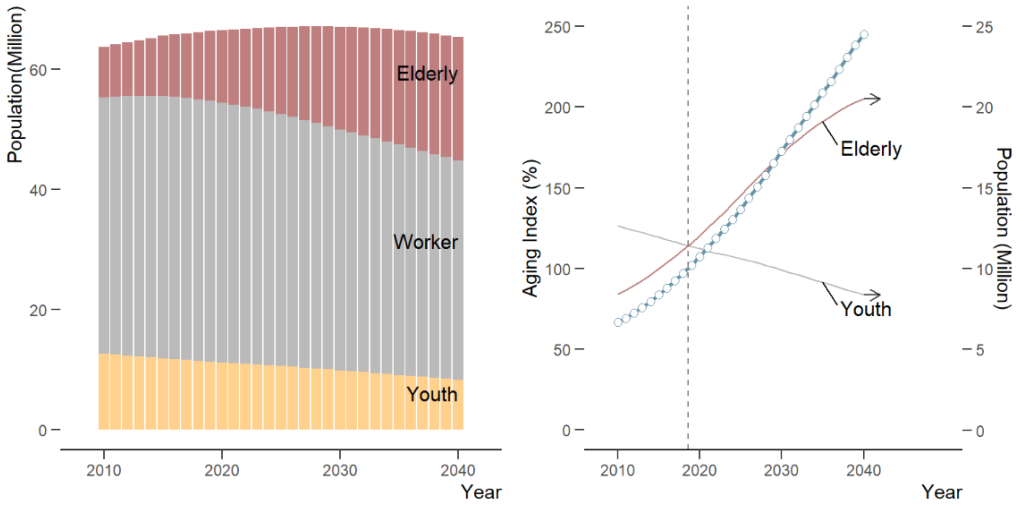


Data Source: Department of Provincial Administration, Ministry of Interior

2.1.3 Politics and government

Thailand went through a peaceful revolution in 1932 when sovereign power was passed on to the Thai people. The king is Thailand's head of state. He is above partisan politics and exercises his role in accordance with the national constitution. The prime minister forms the cabinet and carries out the country's administration. Thailand's public administration is divided into three tiers: central, provincial, and local administrations. Local authorities consist of provincial administrative organizations, district organizations, sub-district organizations or Tambon administrative organizations (TAO). The Ministry of the Interior (MOI) appoints governors for all 77 provinces. Bangkok, the capital of Thailand, is governed by the Bangkok Metropolitan Administration (BMA), for which a governor is elected. The Tambon Council and Tambon Administrative Authority Act, B.E. 2537 (1994) and the 1999 Local Administrations Decentralization Act state that it is the mandate and duty of local authorities to protect and maintain natural resources and the environment within their jurisdiction.

Figure 4: Population projection and ageing index (2010-2040)



Note: Ageing Index refers to the number of elderly persons (over 60 years old) per 100 persons younger than 15 years old, which indicates the change in the age structure of the population. The number over 100 means the number of elderly population exceeds the youth.

Source: Report of the Population Projections for Thailand 2010-2040 (Revision), Office of the National Economic and Social Development Council (NESDC)

2.1.4 Economic and social situations

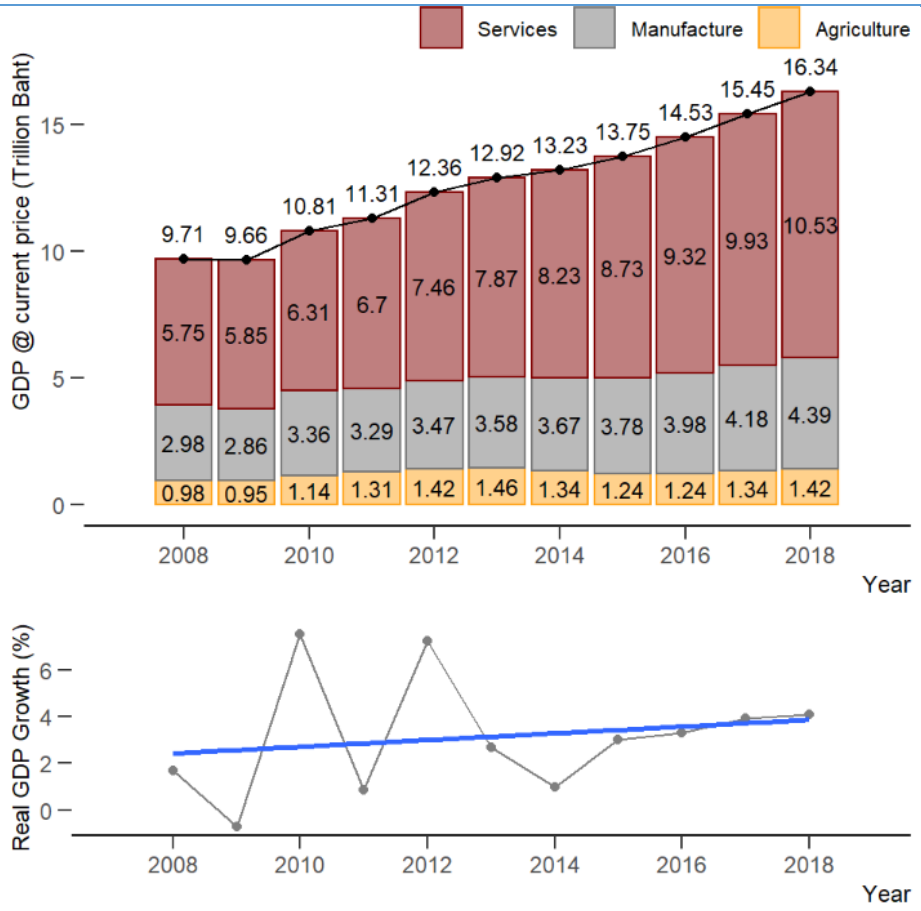
1) Economic Situation

Over the past decade, Thailand had a low GDP growth rate at the beginning due to the global financial crisis. Nevertheless, this was followed by a smoothly increasing rate later on, with significant contributions from the industrial and service sectors (Figure 5). One-third of Thailand's total labor force belongs to the agricultural sector, which generated only about 10% of the GDP in 2008 and declined to 8.6% in 2018. While the share of the industrial sector in GDP during 2008 – 2018 decreased from 30.7% to 26.8%, the share of the service sector increased from 59.2% to 64.4%. During 2015-2018, the growth rate of the non-agricultural sector was steady at around 4% per annum, while the growth rate of the agricultural sector was unstable (Table 3).

Thailand's economy has been highly dependent on the expansion of the export and import sectors. The export and import growth rates were small during 2008-2009, and became substantially higher during 2017-2018. The economic growth rates performed at the same trend as the export and import growth rates (Table 3). Still, the ratio of foreign debt to GDP increased over time. Nevertheless, Thailand's unemployment rate is at 1%, which is regarded as very low (Table 3).

Since 2017, all government policies are led by the 20-year National Strategy (2018- 2037). The Strategic Framework comprises six dimensions: (1) ensuring security, (2) enhancing competitiveness, (3) developing and empowering human capitals, (4) providing more opportunities and ensuring social equality, (5) economic growth with environmental sustainability, and (6) balancing and developing the administrative system of the public sector.

Figure 5: Gross domestic product and economic growth (2008-2018)



Source: Office of National Economic and Social Development Council

Table 3: Thailand economic and social indicators (2015-2018)

Economic and Social Indicators	2015	2016	2017	2018
GDP Growth Rate (CVM, %)	3.0	3.3	3.9	4.1
GDP per capita (current price) (THB/person)	204,406	215,767	228.398	240,545
GDP per capita (current price) (USD/person)	5,937	6,103.9	6,729.8	7,445.4
Growth of Agricultural GDP (%)	-6.5	-1.3	3.7	5.1
Growth of Non-Agricultural GDP (%)	4.2	3.8	4.1	4.0
Export Growth (%)	-1.2	4.5	9.5	7.5
Import Growth (%)	-6.7	-0.3	13.2	13.7
Current Account (Billion THB)	954.07	1,534.62	1,494.49	1,039.53
Net Capital Inflow (Billion THB)	-586.26	-733.52	-421.88	-671.27
Balance of Payment (Billion THB)	190.83	456.58	882.99	225.51
Foreign Debt to GDP (%)	31.98	32.48	36.69	35.18
Total Labor Force (Millions)	38.55	38.27	38.09	38.43
Unemployment Rate (%)	0.9	1.0	1.2	1.1
Income from Tourism (Billion THB)	1,457.15	1,633.16	1,831.11	2,003.84

Economic and Social Indicators	2015	2016	2017	2018
Growth of Income from Tourism (%)	6.9	1.9	3.2	9.4
Ratio of SSF insured persons to total labor force (%) [1)]	35.77	36.69	38.44	41.62
Mortality Rates of Malignant Neoplasm, all kinds (per 100,000 population)	113.7	119.3	120.5	123.3
Poverty Line (THB/person/month)	2,644	2,667	2,686	2.710
Poor Population Ratio (%) [2)]	7.21	8.61	7.87	9.75
Gini Coefficient (consumption expenditure)	0.359	0.367	0.364	0.362

Note:

๑) Number of persons insured under Articles ๓๓, ๓๙, and ๔๐ of the Social Security Act B.E. ๒๕๓๓ (๑๙๙๐) to total labor force

๒) Poor Population Ratio is calculated from the number of population whose consumption expenses are lower than the poverty line divided by the total number of the population.

Data Source: Office of National Economic and Social Development Council (NESDC), and National Statistics Office (NSO)

In addition to the 20-year National Strategy, one of the government initiatives known as the "Thailand 4.0" policy aims to achieve the fourth industrial revolution in Thailand. The policy promotes five existing industrial sectors ("First S-Curve" industries) and establishes five new industries that are expected to have high probability to succeed ("New S-Curve" industries). The First S-Curve industries are automobiles, electronics, high-income tourism and health tourism, agriculture and biotechnology, and food processing. The New S-Curve industries include automation and robotics, aviation and logistics, biofuels and biochemistry, digital technology, and medical hub. The 12th National Economic and Social Development Plan (2017-2021), the country's main development plan, was also formed within the framework of the National Strategy.

In promoting the targeted industries mentioned above, the Eastern Economic Corridor (EEC) Development Project was established in three provinces (Chon Buri, Cha Choeng Sao, and Rayong) with an area of 13,000 sq. km. The EEC Project comprises three zones: industrial zone, infrastructure development zone, and urban development zone. In addition, the Eastern Economic Corridor Act of 2018 also provides several investment incentives such as corporate income tax exemption for 15 years, rights to lease the land for 50 years with the right to extend for another 49 years, and fast track for reviewing the environmental impact assessment (EIA) report. The EEC project also includes high-speed trains connecting the EEC zones and three international airports (Suvarnnabhumi, Don Muang, and U-Tapao). The project also aims to become an ASEAN marine transportation center by connecting the Dawei Seaport in Myanmar, the Sihanoukville Seaport in Cambodia, and the Vung Tau Seaport in Vietnam.

2) Tourism Sector

The tourism industry is one of the core sectors contributing to Thailand's economic growth. Incomes obtained from inbound foreign tourists were substantial at 1,400 – 2,000 billion THB or 11% of the GDP during 2015-2018. The average annual income growth rate for the tourism industry ranges between 2% to 9% (Table 3), due mainly to the global economic situation and the haze pollution situation in Thailand.

3) Transportation Sector

Road transport networks had been expanded to all regions of Thailand. Around 98.5% of the total road length are concrete and asphalt roads. Road networks in the economic zone of the Greater Mekong Subregion (GMS) connect the North-South Economic Corridor, the East-West

Economic Corridor, and other neighboring countries in ASEAN. Moreover, there are five expressway projects with a total distance of 770 km. These express tollways also complement the East-West Economic Corridor to connect the South China Sea with Bengal Bay, and join the North-South Economic Corridor to connect Singapore and Kunming City in Yunnan, China.

4) Labour

In 2019, the total labour force in Thailand was estimated at 37.96 million persons with 37.49 million, 0.39 million and 78 thousand employed, unemployed, and seasonally inactive labour force, respectively. The total number of formal employment and informal employment were 17.14 million (45.7%) and 20.34 million (54.3%), respectively [NSO (2019)[4]].

Most of the employments in 2019 were concentrated in the following 6 sectors - with combined employment of over 80% of total labour forces: i) agriculture (33.5%), ii) wholesale and retail trade (16.0%), iii) manufacturing (excl. construction) (15.6%), iv) accommodation and food service (7.7%), v) construction (5.4%), and vi) public administration and defence (4.2%). The manufacturing sector (excl. construction), the wholesale and retail trade, and the public administration and defence were the top 3 sectors with the highest number of formal employment (27%, 15.8%, and 8.9% of total formal employment, respectively). On the other hand, the informal works were mostly (>80%) in agriculture, wholesale and retail trade, and accommodation and food service (56%, 16%, and 9% of total informal employment, respectively).

The shares of employment in the Bangkok, Central, Northern, North Eastern, and Southern regions were 14%, 31.2%, 16.3%, 25.2%, and 13.3%, respectively. However, the employment in the Northeast, the North and the South was largely informal employment, with the share of informal employment of 75.1%, 69.7% and 56.8%, respectively.

In terms of occupation, 5 occupations constituted over 80% of all workers, namely skilled agricultural and fishery workers, service workers and shop sales workers, craft and related trades workers, elementary occupations, and plant and machine operators (31.5%, 20.1%, 10.6%, 10.4%, and 9.4%, respectively). Interestingly, the first 3 occupations were largely informal employment, with the share of informal employment of 92.7%, 60.9%, and 42.7%, respectively.

Due to the lack of business status of the employers, these informal employees may not be adequately protected from workplace hazards. The government has constantly revised relevant laws to ensure all workers, including informal and self-employed workers, have access to welfare protection and compensations in case of sickness and/or mishap from work. Particularly, in 2017 the definition of an “employee” under the Social Security Act was amended to broaden the scope of the protection.

5) Public Health Sector

Thailand’s Universal health care system is provided through 3 main schemes: i) civil servant medical benefits scheme (CSMBS), ii) social security/worker compensated fund (SSF), and iii) universal coverage scheme (UC) which was initiated in 2002. Thai people who meet certain criteria are eligible to obtain the universal coverage card, also known as “gold card”, ensuring equal rights to access public health services in their hometowns and at public hospitals. As of 2017, 99.15% of the population has health protection coverage through at least one of the

[4] National Statistical Office (NSO), The Informal Employment Survey 2019, Labor Statistics Group, Social Statistics Division, Statistical Forecasting Division, National Statistical Office

schemes [NSO (2020)[5]]. In addition, the proportion of labor force insured under the Social Security Act B.E. 2533 (SSF) to the total labor force has increased continuously and reached 41.6% in 2018. Thailand's health care expenditures are growing, from 3.10% GDP in 2000 to 3.75% of GDP in 2017 [WHO (2020)[6]].

According to its Twenty-Year National Strategic Plan for Public Health (2017-2036), Thailand's overall public health status has been improving, as evidenced by several indicative indices, such as the increasing life expectancy at birth (LE) and the health-adjusted life expectancy (HALE) of the Thai population, which in 2015 reached 74.9 and 66.8 years, respectively. Other figures that also reflect this generally improving trend in the Thai public health status include the relatively low rates of maternal mortality (24.6 per 100,000 live births), infant mortality (6.2 per 1,000 live births), and child (under-5 years old) mortality (8.6 per 1,000 live births).

Nevertheless, deaths due to non-communicable diseases (NCDs); primarily cancers, cerebrovascular diseases, pneumonia, ischemic heart diseases, and diabetes, are on the rise, reaching 71% of all deaths in Thailand in 2014 [WHO (2014)[7]]. This is in line with the growing DALY (disability-adjusted life years) due to NCDs and chronic conditions, including diabetes, ischemic heart diseases, cancers, dementia, etc., as shown in Table 4 [MOPH (2018)[8]]. In addition, according to the Thai National Health Examination Survey (NHES) IV-V, during 2009 to 2014, the prevalence of diabetes and hypertension rose from 6.9% to 8.9% and from 21.4% to 24.7%, respectively. The annual averages of new cases of diabetes and hypertension were 200,000 and 400,000 during 2015-2017, respectively, according to MOPH's Health Data Center.

Table 4: Ten leading causes for Thai Disability-adjusted life years (DALY) in 2014

Male	Female
1) Road Accidents (10.1%)	1) Diabetes (8.4%)
2) Cerebrovascular diseases (6.6%)	2) Cerebrovascular diseases (7.3%)
3) HIV/AIDS diseases (5.1%)	3) Ischemic heart disease (4.3%)
4) Ischemic heart disease (4.9%)	4) Osteoarthritis (3.9%)
5) Alcoholic Abuse (4.5%)	5) HIV/AIDS diseases (3.6%)
6) Liver cancer (4.4%)	6) Road Accidents (3.6%)
7) Diabetes (3.9%)	7) Dementia (3.1%)
8) Cirrhosis (3.6)	8) Liver Cancer (2.5%)
9) Chronic obstructive pulmonary disease (3.4%)	9) Nephritis (2.2%)
10) Tracheal and Lung Cancer (2.3%)	10) Breast Cancer (2.0%)

Source: MOPH (2018)[8]

Toxic effects of the various POPs substances to humans have been shown to include endocrine disruption, carcinogenesis, and damage to the immune, neurological, and reproductive

[5] National Statistical Office (NSO),Table 5.21: Number of Population by Type of Health Insurance: 2009, 2011, 2013, 2015 and 2017, http://statbbi.nso.go.th/staticreport/Page/sector/EN/report/sector_05_21_EN_.xlsx, last accessed: April 14, 2020

[6] World Health Organization, Global Health Expenditure Database, https://apps.who.int/nha/database/ViewData/Indicators/en, last accessed: April 14, 2020

[7] World Health Organization, Noncommunicable diseases country profiles 2014, Geneva, 2014, http://apps.who.int/iris/bitstream/10665/128038/1/9789241507509_eng.pdf?ua=1, last accessed: April 14,2020

[8] Ministry of Public Health (MOPH), Twenty-Year National Strategic Plan for Public Health (2017-2036), First Revision 2018, Strategy and Planning Division (SPD), Office of the Permanent Secretary (OPS), Ministry of Public Health

systems, among others [please see, for examples, WHO (2003)[9] and McComb (2019)[10]]. Examples of the associated diseases are cancer of various organs, diabetes, cardiovascular diseases (including hypertension), inflammatory diseases, dementia, birth defects, learning disability, and obesity [please see, for examples, Ruzzin (2012)[11],Wahlang (2018)[12], Alharbi (2018)[13], Rylander (2005)[14] and Fry and Power (2017)[15]]. Though less well known when compared to other risk factors such as physical inactivity and unhealthy diet, several of these POPs-related diseases coincide with or are closely related to the aforementioned growing NCDs observed in Thailand.

6) Energy Sector

The energy intensity (EI) reached its peak at 9.71 tonnes of oil equivalent (toe) per million THB in 1997, and continued to decline to 8.41 toe/million THB in 2018 (Figure 6). Thailand has launched the 20-year Energy Efficiency Development Plan (EEDP) targeting to reduce energy intensity by 30% by 2036 compared with that in 2010 or amounting to 56,142 ktoe.

Table 5 shows the trend of final energy consumption classified by types of fuel. Final energy consumption in 2015 was 84,831 ktoe and increased to 89,235 ktoe in 2019. Renewable energy consumption (solar, firewood, husk, bagasse, other farm wastes, waste and biogas) also augmented during 2016-2018, but its share declined. The share of energy from solid fossil fuel (coal/lignite) remained at 10%. These situations are the results of the 2015 enactment of the Alternative Energy Development Plan (AEDP), which aims to promote alternative energy and reduce dependency on imported energy (crude oil and natural gas). The target of the AEDP is to increase the share of renewable energy to 30% by 2030.

[9] World Health Organization, Health risks of persistent organic pollutants from long-range transboundary air pollution, 2003

[10] J. McComb, et.al., Human blood-based exposure levels of persistent organic pollutant (POP) mixtures antagonise androgen receptor transactivation and translocation, Environment International 132 (2019) 105083

[11] Jérôme Ruzzin, Public health concern behind the exposure to persistent organic pollutants and the risk of metabolic diseases, BMC Public Health 2012, 12:298

[12] Banrida Wahlang, Exposure to persistent organic pollutants: impact on women's health, Rev Environ Health 2018; 33(4): 331–348

[13] Omar M.L. Alharbi, et.al., Health and environmental effects of persistent organic pollutants, Journal of Molecular Liquids 263 (2018) 442–453

[14] Lars Rylander, et.al., A cross-sectional study of the association between persistent organochlorine pollutants and diabetes, Environmental Health: A Global Access Science Source 2005, 4:28

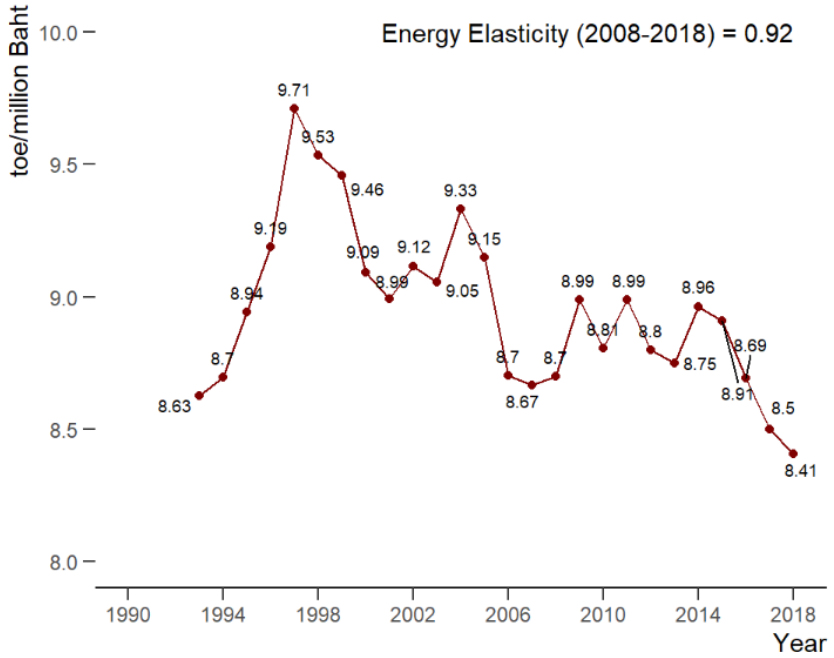
[15] K.Fry and M.C.Power, Persistent organic pollutants and mortality in the United States, NHANES 1999–2011, Environmental Health (2017) 16:105

Table 5: Final energy consumption in Thailand, classified by types of fuel (2015-2019)

Final Energy Consumption					Quantity (ktoe)
	2015	2016	2017	2018	2019
Commercial Energy					
• Petroleum Products	38,100	39,828	40,681	41,473	42,168
• Electricity	15,065	15,783	16,036	16,131	16,158
• Solid Fossil Fuel (Coal & Lignite)	8,836	8,603	9,129	10,265	8,622
• Natural Gas	8,793	8,763	8,628	8,725	8,452
Renewable Energy	14,037	12,633	12,608	13,130	13,835
Final Energy Consumption	84,831	85,610	87,082	89,724	89,235

Data Source: Energy Policy and Planning Office (2020)[16] (Table 1.2-3: Final Modern Energy Consumption (KTOE) and Table 10.1-2: Final Energy Consumption)

Figure 6: Thailand's Energy Intensity (1993-2018)



Data Source: Energy Policy and Planning Office (2020)[16] (Table 10.2-3: Energy Intensity)

7) Poverty and Inequality

Thailand's poverty line has increased from 1,555 to 2,710 THB/person/month during 2000-2018. The percentage of people under the poverty line was 42.33% of total population in 2000 and reduced to 9.85% in 2018. However, inequality still exists between people living in urban and

[16] Energy Policy and Planning Office, Ministry of Energy, Energy Statistics, http://www.eppo.go.th/index.php/en/en-energystatistics/summary-statistic?category_id=846&isc=1&orders[publishUp]=publishUp&issearch=1, last accessed: April 2020

those in rural areas, where the poor mostly live [NSO (2018)[17]]. The Thai government has designed policies to eradicate income inequality. As a result, the Gini coefficient of consumption expenditure has declined over time from 0.428 in 2000 to 0.362 in 2018 [NESDC (2019)[18]].

2.1.5 State of the environment

1) Air Quality

The overall air quality in Thailand improved in 2018 as compared to 2015. However, some air pollutants exceeded the standard limits, such as PM2.5, ozone, PM10, and benzene. Especially, statistics showed concentrations of PM2.5 and PM10 in certain areas consistently exceed standard limits for ambient air (Figure 7 and Figure 8).

Sources of pollution varied from area to area. In general, the main sources of air pollutants were activities that involve incomplete combustion, including open burning of agricultural residues and waste, and road transport. Based on Thailand's state of pollution 2018[19], sulphur dioxide emission in Bangkok and its vicinity was mainly resulted from industrial activities while volatile organic compounds (VOCs) resulted from gas stations and usages of chemicals and solvents (Figure 9). In Bangkok and large urban areas, high levels of PM2.5 were reportedly contributed by heavy traffic, open burning of agricultural residues, and industrial activities while the sources of PM10 were constructions of roads and buildings.

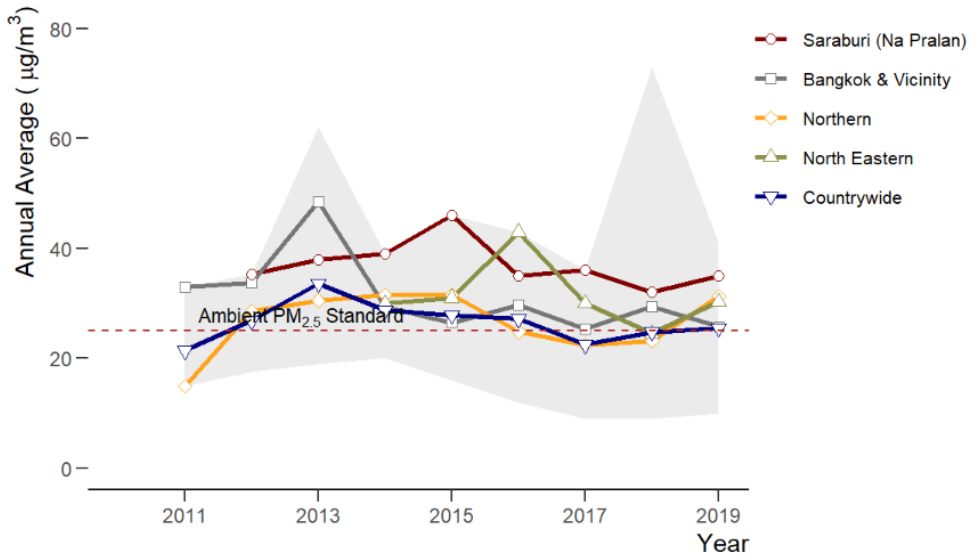
In the northern region, open burnings and forest fires were the main causes of haze. The Ministry of Interior, using the Public Disaster Prevention and Mitigation Act of 2007, has led the collaborative efforts to solve this ongoing problem. Thailand is also adversely affected by transboundary haze pollution from wildfire and agricultural burning in neighboring countries. This has become a critical problem requiring cooperation among ASEAN members under the ASEAN Agreement on Transboundary Haze Pollution.

[17] National Statistical Office, The 2018 Household Socio-Economic Survey, 2018, http://www.nso.go.th/sites/2014en/Survey/social/household/household/2018/Sum_EcoSocio61.pdf, last accessed: April 14, 2020

[18] Office of the National Economic and Social Development Council (NESDC), Table 9.1 Gini Coefficient of spending by Region 1988 – 2018, 2019, Office of the Prime Minister, https://www.nesdc.go.th/ewt_dl_link.php?nid=3518, last accessed: May 22, 2020

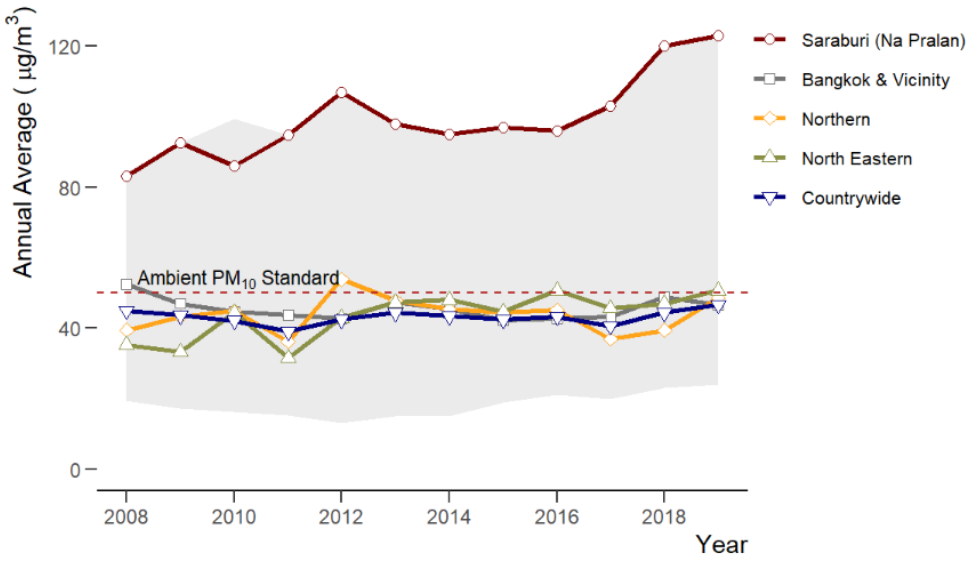
[19] Thailand's state of the pollution report 2018, Pollution Control Department (PCD), Ministry of Natural Resources and Environment, 2018

Figure 7: Annual Average of $PM_{2.5}$ (2011-2019)



Data source: Air4Thai[20]

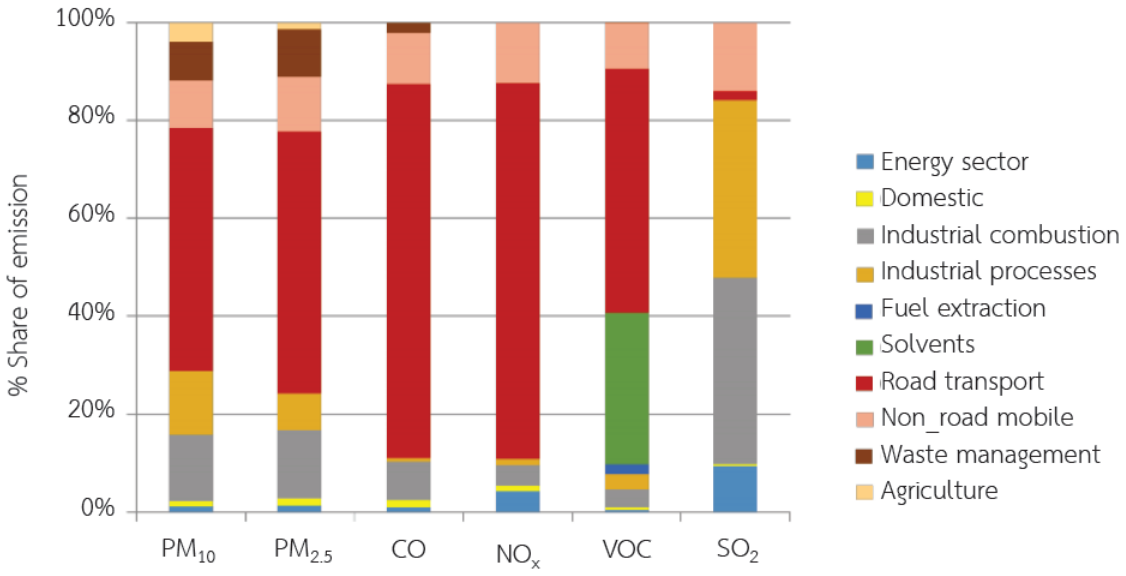
Figure 8: Annual average of PM_{10} (2008-2019)



Data source: Air4Thai[20]

[20] Air4Thai, Thailand's air quality and situation reports, Air quality and noise management bureau, Pollution Control Department, http://air4thai.pcd.go.th/webV2/index.php, last accessed: April 14, 2020

Figure 9: Air pollution sources in Bangkok and vicinity



Source: PCD (2018) [21]

2) Water Quality

The overall surface water quality has improved. The percentage of surface water sources with fair or good water quality increased to 88% while the percentage of sources with poor quality dropped to 12% (Figure 10). Areas with the worst surface water quality were estuaries in the central region that received effluents from urban, industrial, and agricultural activities whereas the northeastern region was the area with the largest number of water sources in good quality. Similarly, coastal waters were mostly good or fair, except for some locations that received wastewater discharged from urban, industrial, and agricultural (aqua-culture and paddy fields) areas where water quality was poor or very poor (Figure 11).

When the total volume of wastewater discharge exceeds the carrying capacity of water sources, water quality deteriorates. The main causes for poor surface water and coastal water quality were the high population and the illegal discharge of effluents from sources with poor wastewater treatment systems to natural water sources.

While waste generating activities, such as coastal businesses, local/community factories, seaport activities, tourism, aquacultures and agriculture, were increasing, Local Administrative Organizations (LAOs) operated wastewater treatment plants had limited capacity, and hence, were unable to cope with the growing amount of wastewater. The direct discharges to coastal areas have contributed to coastal water deterioration. In 2018, there were 22 reported red tide blooms on the Andaman Coast and the Gulf of Thailand [PCD (2018)[21]].

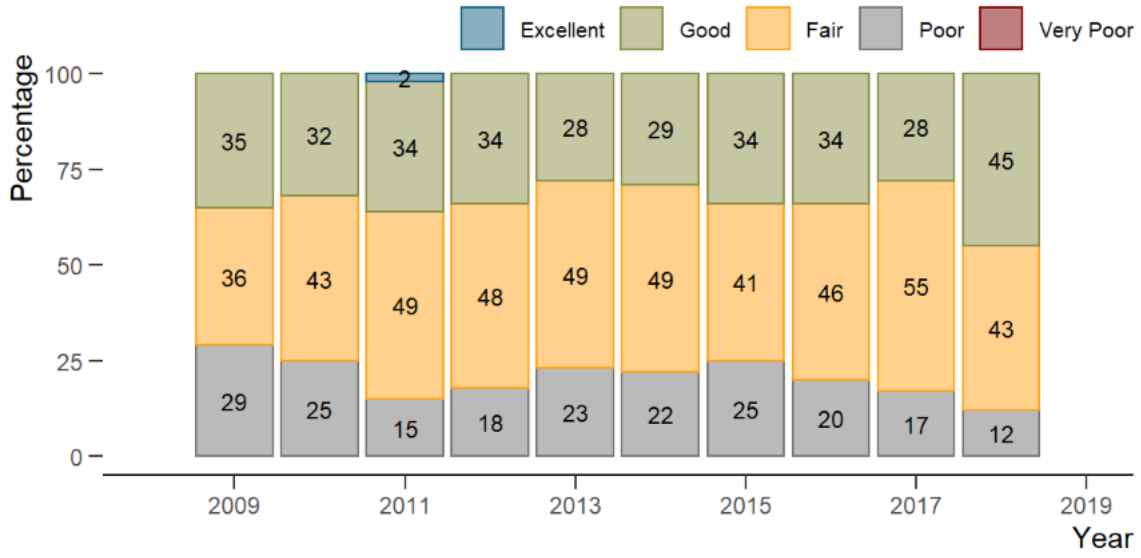
To manage water quality, Thailand assembled the 20-year National Water Quality Management Plan (2018-2037) using several principles such as (a) balancing economic, social and environmental aspects toward sustainable development, (b) precautionary principle and

[21] Pollution Control Department, Thailand State of Pollution report 2018, Pollution Control Department, Ministry of Natural Resources and Environment

limiting wastewater discharge according to carrying capacity of the water sources, (c) applying an emission permit system and polluter pay principle (PPP), (d) applying sustainable production and consumption principles in household, industrial and agricultural sectors to reduce both the amount of water consumption and the level of contamination, and (e) setting up and operating wastewater management systems in problematic areas and key economic areas using funds from the water conservation and wastewater treatment fees that are to be implemented [PCD (2018)[21]].

It is important to note that water quality mentioned here refers to surface water quality as described by Thailand's 1994 surface water quality standard which includes limits for 28 'conventional' water qualities[22]. Issues related to contamination of emerging water pollutants; such as pharmaceuticals and personal care products, per- and polyfluoroalkyl compounds (PFOS and PFOA and PFHxS), chlorinated paraffins (such as SCCPs), brominated flame retardants, and antiseptics are yet to be addressed at the national level. Toxic substances that are also water soluble, bioaccumulate and persistent (such as PFHxS which is currently under review at the POPRC [POPRC.14/6/Add.1 (2018)[23], POPRC-15/1(2019)[24]]) can be anticipated to be of great challenge as they have high potential to contaminate groundwater and drinking water.

Figure 10: State of surface water source quality (2009-2018)



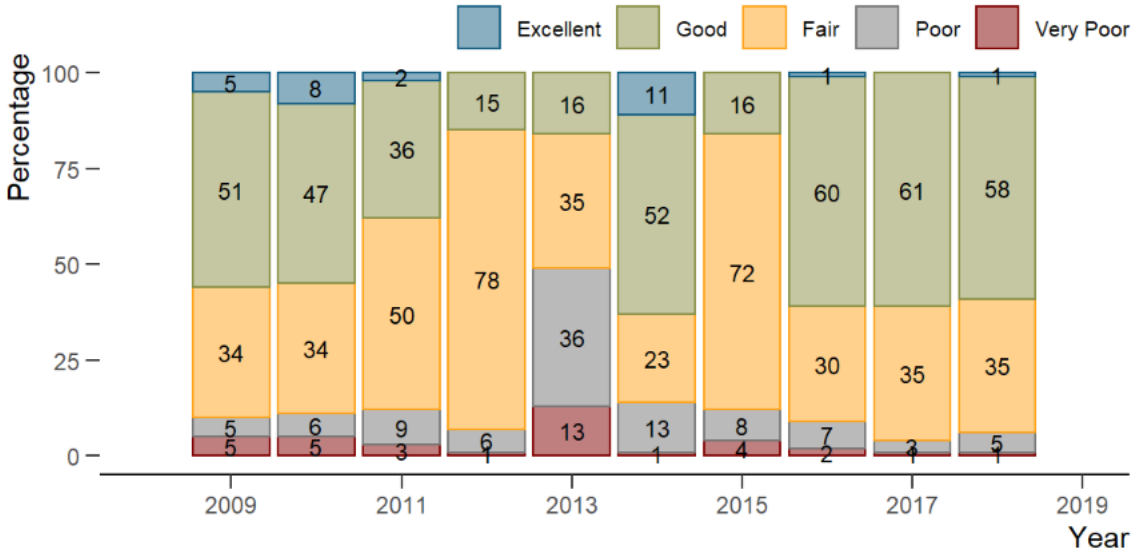
Source: PCD (2018)[21]

[22] Including physical appearance (color, odor, taste), temperature, pH, DO, BOD, total coliform bacteria (TCB), fecal coliform bacteria (FCB), nitrate, ammonia, phenols, 9 metallic ions, cyanide, radioactivity, total organochlorine pesticides, and 6 initial POPs pesticides (DDT, α-HCH, Dieldrin, Aldrin, Heptachor, and Endrin).

[23] Persistent Organic Pollutants Review Committee, Report of the Persistent Organic Pollutants Review Committee on the work of its fourteenth meeting, UNEP, 2018, UNEP/POPS/POPRC.14/6/Add.1

[24] Persistent Organic Pollutants Review Committee Decision 15/1, Risk Management Evaluation: Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds, UNEP, 2019

Figure 11: State of coastal water quality (2009-2018)



Source: PCD (2018)[21]

3) Solid Waste and Hazardous Waste

During 2009-2018, the amount of municipal solid waste (MSW) had increased (Figure 12) due to higher population, higher consumption rates, and life-style changes from rural society to urbanization. Out of 7,775 LAOs, about 37% of LAOs had no MSW collection system, so local residents had to manage their wastes by themselves.

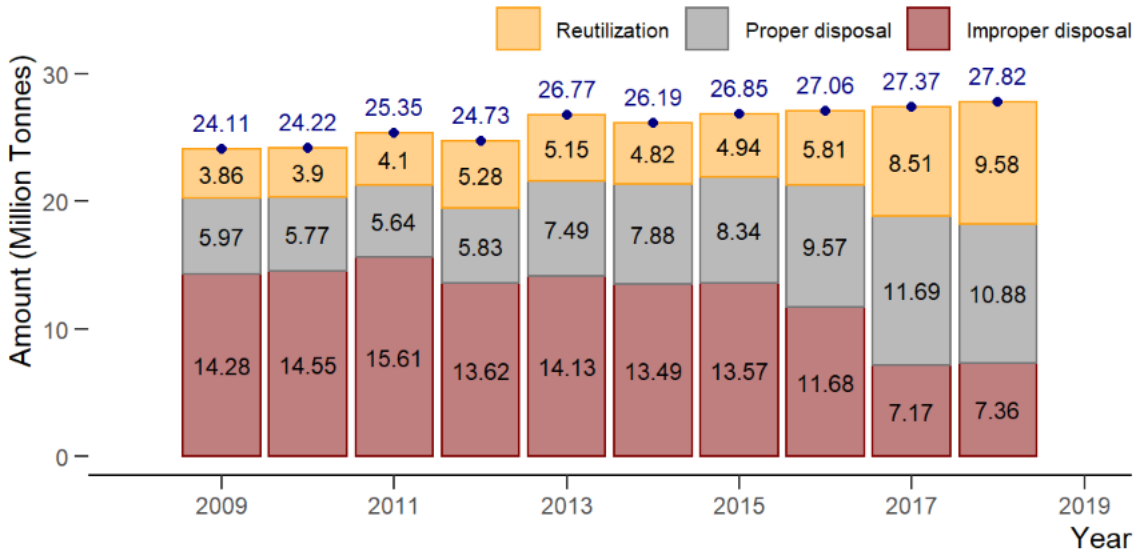
In 2018, there were 27.8 million tonnes of solid waste, slightly higher than in 2017. However, the overall solid waste management practices had improved. More MSW were separated at its sources and re-utilized (9.58 million tonnes or 34%), about 1 million tonnes higher than 2017. Most of the re-utilization was for recycle and compost.

Some of the remained MSW (10.88 million tonnes or 39%) were disposed of appropriately, while the rest (7.36 million tonnes or 27%) was still improperly managed (open dumping, open burning, illegal dumping in public areas, discard into waterbody, etc.). This improving trend was a result of the "Zero Waste Society" policy which was based on the 3Rs approach focusing on waste management at the sources and the public-private participation [PCD (2018)[21]].

In 2018, there were 3,205 waste disposal and transfer sites, 2,786 of which were in operation (2,764 disposal sites and 22 transferred sites), with only 647 of these sites operating appropriately. Another 419 sites were inactive either because they were full or due to LAOs' policies to divert MSW to nearby regional clusters [Ibid[21]].

Some of the inappropriately disposed MSW resulted in the spilling of inland wastes into the sea, including solid waste directly thrown to the sea. If allowed to reach the ocean, plastic wastes can cause adverse impact on the marine ecology [Ibid[21]].

Figure 12: The proportion of solid wastes disposal (2009-2018)



Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Generation Rate (kg/person/day)	1.04	1.04	1.08	1.05	1.15	1.11	1.13	1.14	1.13	1.15

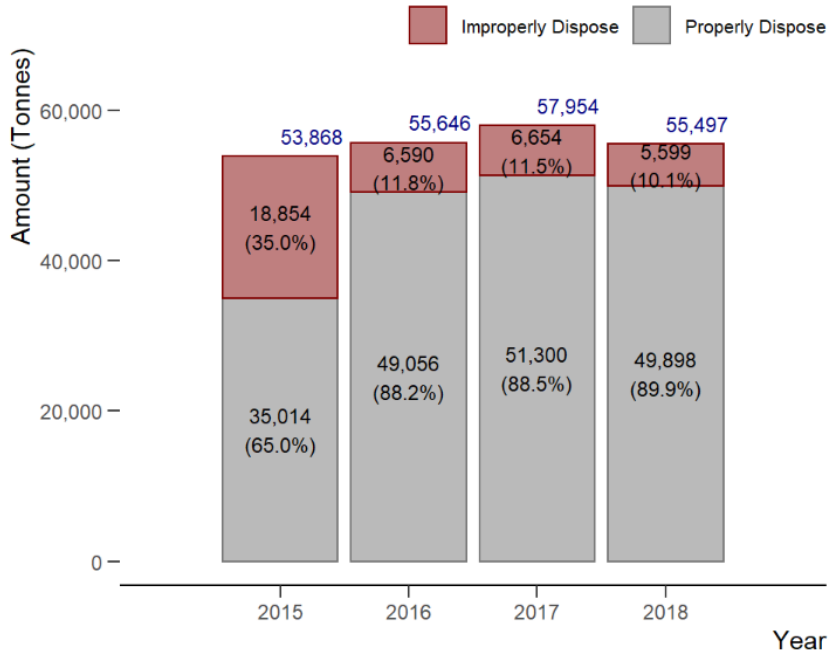
Source: PCD (2018) [21]

The amount of industrial wastes that entered the management system in 2018 was 22.02 million tonnes, 33% lower than the previous year. These industrial wastes included 20.82 million tonnes of non-hazardous industrial wastes, of which 7.2 million tonnes were converted to electricity. Hazardous industrial wastes amounted to 1.2 million tonnes [Ibid[21]].

The amount of medical wastes in 2018 was 55,497.22 tonnes (Figure 13), which originated from more than 38,235 public hospitals, private hospitals, private clinics, veterinary clinics and laboratories. About half of the wastes were generated by public hospitals under the Ministry of Public Health (MOPH), and 24% was generated by private hospitals and clinics [Ibid[21]].

Medical waste management in large hospitals has been improved. However, private medical clinics, veterinary clinics and pet hospitals, still lack an adequate reporting manifest system. Most of the medical wastes were disposed of by infectious waste incinerators or on-site autoclaves. Infectious wastes from smaller sites were collected and transferred to regional hospitals which acted as hubs for further disposals.

Figure 13: The amount of medical waste generated and disposed in 2015-2018



Source: PCD (2018) [21]

The Thai government has assembled the Solid Waste and Hazardous Waste Management Plan (2018-2037) to serve as the master plan for the prevention and management of pollution caused by solid and hazardous wastes. The plan, which covers 4 types of wastes (MSW, municipal hazardous waste, medical waste, and industrial hazardous waste), is based on the following principles: a) 3Rs principle, b) Circular Economy/waste to resources, c) Polluter Pays Principle (PPP), d) promoting Public Private Partnership, e) Extended Producer Responsibility (EPR). Relevant measures include:

- supporting products and packaging designs for the environment (Design for Environment: DfE)
- control, restrict, and ban single use plastic
- rehabilitate or upgrade waste management sites toward proper operation
- encourage clustering of LAOs' MSW management
- enact WEEE law
- strict control of imports of electronic waste (e-waste) and plastic wastes
- study the impact of pollutants from MSW and wastes from new or emerging products/technologies (emerging waste) and
- issue generic waste management regulations that apply to all types of waste

4) Land Use and Forest

Thailand has a total land area of 513,115 km^2 (51.3 million hectares). As of 2015, 47% of the nation's total land area (or 24 million hectares) was allocated to agricultural uses. Non-

agricultural land use and forested land accounted for 21% and 32% of the total area, respectively. Paddy fields accounted for about half of the agricultural land use, amounting to about 11 million hectares or 22% of Thailand's total land area.

Slash-and-burn farming, shifting cultivation, land resettlement, and dam and road construction have encroached on forested areas. The Thai government imposed a nation-wide logging ban by a Royal Decree in January 1989. In 1973, the total forested area of Thailand covered over 43% of the country, but that number declined to 25% in 1998. One of the threats facing Thailand's forests was illegal logging, which was destroying Thailand's remaining forests. To reduce deforestation, several actions had been taken such as improving forest law enforcement, declaring national conserved forests, rehabilitating degraded forests, and promoting community forest management. These implementations had reduced the deforestation rate, and in 2015 the estimated forested area was 16.36 million hectares (102.24 million rais) or about 31.8% of total land area.

The 20-Year National Strategic Plan sets a target to increase forest land to 40% of by 2036 and increase national conserved forest areas up to 25% of total land within 10 years, together with the "forest recovery operation" during 2014-2017. In addition, in 2016 the Department of Natural Parks, Wildlife, and Plant Conservation (DNP) under the MNRE received support for the REDD+ (Reducing Emissions from Deforestation and Forest Degradation) preparation project during 2016-2019 from Forest Carbon Partnership Facility (FCPF).

5) Water Resources

Based on geographical characteristics, Thailand can be divided into 22 river basins, with the Chao Phraya River as the main river basin running through the center of the country. Thailand's average annual rainfall is approximately 1,455 mm, while the average annual runoff is 33,123 million cubic meters. In the northern section of the basin, the total storage capacity is estimated at 25,773 million cubic meters, while the central area can store only 2,124 million cubic meters. Due to the lack of a fully developed water infrastructure, deforestation, and climate change during the last decade, Thailand has become particularly vulnerable to drought and flooding. This has resulted in several recent extreme climate events. In 2011, Thailand faced major flooding that affected over 13 million people and cost more than 1.43 trillion THB in economic losses [World Bank (2012)[25]].

Soon after, in 2015-2018, Thailand faced severe droughts throughout the country. Particularly, in 2015, Thailand experienced one of the worst droughts in decades, leading to critically low levels of water in reservoirs countrywide. Rapid economic growth has also increased water demand in the main economic sectors of agriculture, industry, and tourism. The construction of dams and reservoirs, however, were often delayed due to concerns over adverse environmental impacts. In response to the threat of flooding, drought, and increased water demand, the government set up the Strategic Committee for Water Resource Management (SCWRM) to formulate a Master Plan on Sustainable Water Resource Management. The plan addressed both urgent and long-term issues to ensure continuous development, even under the threats of future drought and flooding.

[25] The World Bank, Thai Flood 2011: Overview - Rapid Assessment for Resilient Recovery and Reconstruction Planning, 2012, http://documents.worldbank.org/curated/en/677841468335414861/pdf/698220WP0v10P106011020120Box370022B.pdf

The government has revised the 12-year Strategic Plan for Water Resource Management (2015-2026) to be in line with the 20-year National Strategy, government policies and the Sustainable Development Goals. In 2018, the Water Resource Act was enacted, with the Office of National Water Resource, Office of the Prime Minister, in charge of consolidating management and budget.

6) Coastal and Marine Resources

During 2012-2015, amounts of natural marine fishery captures and coastal aquaculture declined, while the amount of freshwater aquaculture increased [ONEP (2017)[26]]. Thailand has 4.54 million hectares (2.84 million rais) of mangrove forest, which are classified as remaining intact mangrove forest of 2.45 million hectares (1.53 million rais), and land-use change of 2.09 million hectare (1.31 million rais, including aquaculture 0.44 million rais, agricultural areas 0.34 million rais, salt farming 0.16 million rais, and others 0.37 million rais).

In general, during 2012-2016 it was found that seagrass beds in the Andaman Sea were healthier than those in the Gulf of Thailand, whereas the abundance of coral reefs was mostly classified as moderate (coral reefs were healthy in some areas, and damaged in others). The causes of coral reef deterioration were coral bleaching, tourism, fishing, and anchor dropping.

The government implemented the "forest recovery operation" targeting deteriorating and encroached mangrove forests, with the aim of forest reforestation, and protection of marine and coastal ecosystems from encroachment.

In addition, the Royal Ordinance on Fisheries (No.2) B.E. 2560 (2017) was enacted in 2017 to strictly control fishing practices. Since Thailand has over 3,000 km of coastline and is facing the problem of coastal erosion, programs and measures for preventing coastal erosion from encroachment of buildings into rivers and seas have implemented [Ibid[26]].

7) Biological Diversity

According to (Section VII of) its Sixth National Report on the Implementation of the Convention on Biological Diversity (6NR)[27], Thailand belongs to 2 biogeographic regions (Indo-Chinese to the north, and Sundaic to the south), and is one of the richest countries in Southeast Asia in terms of biodiversity. As of 2016, Thailand recorded 4,731 vertebrate species. A 2016 status assessment of 2,276 vertebrate species found that 569 species were threatened (vulnerable, endangered, or critically endangered). The country is also home to over 10,500 species of plants (about 3% of the world's plant species), with new species continuing to be discovered. However, a status assessment in 2015 revealed that 964 Thai plant species (or 8.76% of the total plant species classified in Thailand) were under threat.

Thailand's biodiversity continues to be deteriorated by utilization without adequate consideration of its limits and recovery potential. The loss of native fauna and flora is contributed by a wide variety of factors, such as: the expansion of urban areas and community settlements, increasing industrial development, land use change, illegal logging and deforestation, illegal forest invasion (including wildlife poaching), wetland reclamation, coastal erosion, illegal

[26] Office of the Natural Resources and Environment Policy and Planning, Thailand State of Environment 2017, Ministry of Natural Resources and Environment

[27] Office of the Natural Resources and Environment Policy and Planning , Thailand's Sixth National Report on the Implementation of the Convention on Biological Diversity, June 2019, https://www.cbd.int/doc/nr/nr-06/th-nr-06-en.pdf, last accessed: May 28, 2020

fisheries, the spread of invasive alien species, tourism, climate change, as well as pollution from waste and chemical substances.

2.2 Institutional, Policy and Regulatory Framework

2.2.1 National policies and plans for chemicals management

Policies, national plans and supporting mechanisms for chemical handlings in Thailand are as follows:

1) The Constitution of the Kingdom of Thailand (B.E. 2560 (2017))

The Constitution grants individuals and communities the right to preserve, manage, and benefit from natural resources, the environment and biological diversity as long as that is balanced and sustainable. The highest law requires that citizens contribute to the preservation and protection of the environment, natural resources, biological diversity as well as cultural heritage. Above all, with sustainability in mind, the State must conserve, protect, maintain, rehabilitate, manage, utilize as well as facilitate utilization of the natural resources, the environment and biological diversity. To achieve those ends, citizen and local communities must be allowed to participate and see benefits for doing so, all in a lawful manner. If a project, by the State or else, may greatly affect the natural resources, environmental well-being, health, hygiene, life quality and/or any other interest of the public, it then becomes the State's duties to study and assess possible and potential impact. The State must hold public hearings for all stakeholders to enable further consideration or permit as required by laws.

2) State Policies (announced to Parliament on 24th Day of July 2019)

With a vision of turning Thailand into a developed country by 2037, the government announced 12 main policies and 12 urgent ones. The main policies represent the directions of governmental activities planned for the next 4 years while urgent policies aim to reduce or alleviate impacts from urgent problems at hands. Those concerning chemical handlings are:

- Main Policy:
    - No. 5: Thailand's economic and competitiveness (No.5.2) to develop Thai industry toward a Bio-Circular-Green (BCG) economy while emphasizing the importance of national and international environmental regulations, (No. 5.3.4) promote value creation to agricultural produces by reduce or eliminate the use of (synthetic) pesticides and promote high quality and safe agricultural products and (No. 5.9) develop new ecosystem to support novel economy such as sharing economy, bio-economy, circular economy, and green economy.
    - No. 9: Public health and social security: (No. 9.2) to promote measures to prevent and control health risk factors which include establishment of an integrated system to cope with emerging and recurring diseases.
    - No. 10: Rehabilitation of natural resources and caring for the environment with the goal of sustainable growth, (No. 10.3) to support for proper management of water resources, (No. 10.6) To develop a system under the concept of the circular economy for the optimal use of natural resources without compromising the environment and people's well-being. Advanced technology and innovation must be introduced in the handling of environmental issues such as garbage and waste which can be put into re-utilization processes to ensure maximum benefits,

(No. 10.8) to systematically tackle waste by raising awareness in people and businesses, and by recycling. Waste must be separated at source, which will help municipals and cities save costs and recycle more effectively. Facilities must also be up to the required standard.

- Urgent Policy
    - No. 4: Provide (technical and financial) assistance to farmers, support the conversion of agricultural outputs to energy, and provide access to agricultural tools and innovation to help reduce production costs, and control chemical fertilizer and pesticide uses with an ultimate goal to eventually eliminate their usages. This will be possible by supporting viable alternatives to the farmers.
    - No. 6: Laydown system for future economy – by extending target industries and laydown developmental infrastructure toward the BCG economy

3) The 20-Year National Strategic Plan (2017-2036)

The grand plan's aim is for "national stability, economic prosperity and sustainable growth of a country having achieved a developed status, all propelled by the philosophy of self-sufficient economy". By sustainability, one means 1) Development that generates economic growth without depleting resources, the environment is allowed to self-heal, and the ecological systems to continue functioning naturally; 2) Production and consumption without harming the environment that is in line with international regulations and consensus, and the natural resources remain abundant whilst the environment continues to improve in quality; 3) Emphasis upon common interests and contribution from all sectors; and 4) Self-sufficient economy philosophy conducted by the society.

The plan is of 6 strategies for which chemicals management is mainly addressed by the National Strategy on Competitive Enhancement and The Strategy on Eco-friendly Development and Growth:

- National Strategy on Competitive Enhancement focuses on three main concepts; namely, "Learning from the past for further development", "Adjusting the present", and "Creating new future values". One of the main focuses, exploring higher value-added agriculture, calls for safe farming that emphasizes the importance of food safety management system standards; incentives designed to influence farmers and producers to produce agricultural products in accordance with acceptable standards; information and knowledge regarding agricultural productions that conform with international standards, aiming for chemical use reduction; expansions of organic agricultural products; and quality certification systems and standards for Thai organic products.
- The Strategy on Eco-friendly Development and Growth: The ideology of this strategy has been formulated based on the King Rama IX Philosophy towards sustainable development by upholding three principles which are "Moderation, Reasonableness and Prudence"[Chaipattana Foundation (2020) [28], MOF (2017)[29]], together with seventeen goals

[28]The Chaipattana Foundation, Philosophy of Sufficiency Economy, https://www.chaipat.or.th/eng/concepts-theories/sufficiency-economy-new-theory.html, last accessed: April 22, 2020

[29]Ministry of Foreign Affair, Sufficiency Economy Philosophy: Thailand's Path towards Sustainable Development Goals, second edition, Ministry of Foreign Affairs, Kingdom of Thailand,

of the Sustainable Development Goals (SDGs), in order to achieve all development aspects, namely social, economic and environmental, as well as good governance, and domestic and international cooperative partnerships. Recommended measures in this area include 1) promoting green growth and sustainable development, 2) promoting sustainable maritime based economic growth, 3) promoting sustainable climate-friendly based society growth, 4) developing urban, rural, agricultural, and industrial areas with a key focus on a sustainable growth, 5) creating eco-friendly water, energy, and agricultural security, and 6) improving the paradigm for determining the country's future by promoting a sense of environmental stewardship among Thai people; developing effective tools and mechanisms to manage natural resources and the environment for quality future growth; establishing and improving the justice process related to natural resource and environmental management; promoting environmental democracy as a way to solve problems and reduce disputes; and implementing projects of developing the paradigms to guide the future country.

4) The 12th National Economic and Social Development Plan (2017-2021)

The 12th National Economic and Social Development Plan is the strategy to advance the 20-Year National Strategic Plan by 10 established strategies. Strategies relating to POPs and chemical management are:

- Strategy for Strengthening the Economy, and Underpinning Sustainable Competitiveness with following chemicals safety - related development
    - Enhance competitiveness in agricultural production and services by several means such as (1) Supporting and replicating agricultural practices based on the Sufficiency Economy Philosophy (SEP)[28,29]. For instance, these are (a) strict control the use of agricultural chemicals that are a danger to health and the environment, particularly pesticides, (b) promoting bio-products for continual substitution of agricultural chemicals including proper use of agricultural chemicals to reduce health and environment impact, and (c) introducing the financial and fiscal measures to control production importation and utilization. (2) Developing enabling factors in agriculture and supporting new generation farmers. Amending related laws and regulations to keep them up-to-date; including laws concerning chemicals and standards of agricultural products, is among the priority action.
    - Enhance competitiveness in industrial sector by (1) promoting the application of technology and creativity and the development of innovation, based on environmentally-friendly production, (2) establishing a sound foundation for future industries which includes revamping and renewing laws and regulations to reduce negative social and environmental impact in order to generate investor confidence and support the balancing of the economic-social-environmental development of the country.

    Several flagship projects had been proposed including (1) Project on the collection of environmental taxes and fees that aim for a) enforcement of environmental tax and fee collection from products and materials that create pollution; and b) encouraging Local Administrative Organizations (LAOs) to collect taxes or fees from polluters in their areas; (2) Project for developing the standards of agricultural

http://www.mfa.go.th/dvifa/contents/files/articles-20170626-142701-203959.pdf, last accessed: April 22, 2020

products that includes a) Developing the standards of targeted agricultural products to meet international standards, b) Developing standards for the certification of food and agricultural products to create reliability and provide safety to individual customers and the country's traders; (3) Eco-industrial Town Project - focuses on developing and upgrading industries to be a key mechanism for driving the development of local economies, quality of life and environment that will bring about sustainable co-existence between industry and community.

- Strategy for Environmentally-Friendly Growth for Sustainable Development - aimed to simultaneously address following challenges 1) to build security in the stock of natural resources and leverage environmental quality in order to support green growth; 2) solving the environmental crisis to reduce pollution from production and consumption; 3) setting up a transparent and fair environmental management system; 4) accelerating readiness for greenhouse gas reduction while enhancing capacity for climate change adaptation and management in order to reduce risks from natural disasters.

  Relevant measures include 1) Solving problems of environmental crisis by speed up the control of air pollution, wastewater, solid and hazardous wastes caused by production and consumption; 2) Promoting sustainable production and consumption (SCP); 3) Develop management systems and conflict resolution mechanisms regarding natural resources and environmental issues, including for instance, advocate Strategic Environmental Assessments (SEA) to be legally required as a significant tool for government decision making on certain policies; and 4) Create international partnerships for the environment, including measures such as a) advocate the formulation of an ASEAN master plan on natural resources and environmental management, b) develop guidelines for cooperation between ASEAN and the Greater Mekong Subregion (GMS) in terms of transboundary transport, energy and natural resource management, and transboundary haze pollution, c) regularly review and follow updates of international laws and agreements on trade and the environment, and d) support detailed studies and research on the country's commitments resulting from endorsing any international environmental agreements.

- Strategy for Regional, Urban, and Economic Zone Development with several measures that are related to chemicals uses and management:
  - Strategy for regional development with measures such as a) strengthen the agricultural sectors to be fully capable of developing the value chain while continuously and sustainably contributing to regional revenue, b) to prevent and mitigate the degradation of natural resources and the environment in order to maintain a balanced ecosystem and create sustainable watershed areas, c) improve agricultural productivity, value-added products, safe and organic agriculture under Good Agricultural Practice (GAP), b) improve water resource management for sustainable development, d) rehabilitating natural resources and environmental fertility for a balanced ecosystem to cope with climate change, and e) strengthen the competitiveness of the existing industrial bases and promoting future industrial development as a new income source by upgrading the industrial economic base of Central Region to become the leading green industrial center of Southeast Asia.

- Strategy for Urban development: Develop for provincial city centers to become livable cities for all groups of people in the society and endorse integrated urban environmental management with inclusive participatory approaches
- Strategy for key economic areas development - taking a balanced development approach and executing an efficient area revival program based on participatory processes. Particularly, measures designed to a) expedite the problem-solving process regarding pollution and environmental problems in key economic areas, b) support the development of eco-friendly high-technology industries consistent with an area's capacity, c) upgrade economic, social, and environmental infrastructure in order to improve the standard of living and be set for the development of the Eastern Economic Corridor (EEC), and d) distribute the benefits from development to local populations, are encouraged.

5) The 20-Year National Strategic Plan for Public Health 2017-2036

The 20-Year National Strategic Plan for Public Health 2017-2036 is intended to provide guidance for public health agencies to develop and implement a health system which is in line with the national policy, as well as the national reform and health system reform agenda toward Thailand 4.0. It ensures alignment and linkage with the 20-Year National Strategic Plan 2017-2036, the 12th National Economic and Social Development Plan (2017-2021), Thailand 4.0 Agenda, and the United Nations Sustainable Development Goals (SDGs).

This National strategic plan comprises 4 excellences; 1) PP&P Excellence – Proactive health promotion, disease Prevention, and consumer and environmental Protection, 2) Service Excellence – system to provide fair and equal healthcare service, 3) People Excellence - Development of a health workforce management system, and 4) Governance Excellence - Development of a good governance system and quality organization and development of a health informatics system. The plan includes an implementation plan which is divided into four five-year phases with each respective focus; System Reform, System Strengthening Efforts, Moving toward Sustainability and Becoming one of the top three countries in Asia, respectively.

In its work plan on disease prevention and control and reduction of health risk factors, the MOPH will implement measures for 1) Prevention and control of non-communicable diseases (NCDs) and health threats, including hypertension (HT) and diabetes mellitus (DM) (these diseases, among many others, have been shown, worldwide, to be associated with POPs), and 2) Promoting and developing food safety standards. Moreover, the work plan on environmental management will make sure that 1) all hospitals under the MOPH have in place an infectious waste management program using a Digital Infectious Control System by 2021, and 2) Thai people are provided with protection against health risk factors associated with environmental pollution. The work plan on the healthcare system will address Non-Communicable Diseases (NCDs), including DM and HT, and healthcare systems on heart disease, cancers, kidney disease, will be developed. Finally, a project on the development of designated special areas will address environmental and occupational diseases in the industrial sector and environmental health issues.

6) The Environment Quality Plan (B.E. 2560-2564 (2017-2021))

The Environment Quality Plan has been established as guidelines to enhance effective national management for natural resources and the environment with objective goals toward sustainable national development. This plan adopted Sufficiency Economy Philosophy as the guiding

principle while applying 10 natural resources and environmental management principles[30] to setup measures so that natural resources and environmental issues are addressed in an efficient and timely manner, and in line with the changes in economic, social and environmental policies at the national and international level. The plan recognizes the roles and rights of the community in natural resources and environmental management, in line with the development concepts in the 12th National Economic and Social Development Plan (2017-2021).

This Environment Quality Plan comprises 4 strategies all of which are related to POPs and chemical management

- Strategy for the balanced and fair management of natural capital addresses the importance of the conservation and restoration of natural resources, and the balance between conservation and sustainable utilization, with measures to ensure that natural resources utilizations are within the limits of its carrying capacity and resilience, while securing the natural resource base.
- Strategy for effective environment management with required prevention, remedy and rehabilitation. This strategy focuses on prevention of pollution at the sources, mitigation of wastes at all stages of production, and promotion for reuse. The strategic goal is to ensure appropriate environmental management (including prevention, remedy and rehabilitation) and transferring a healthy environment to the next generation.
- Strategy for efficient and sustainable utilization of natural resources emphasizes the promotion of sustainable consumption and production (SCP) and the development of sustainable bio-based economy.
- Strategy to prepare for climate change and natural disasters while promoting international collaboration. This strategy focuses on raising awareness, reducing greenhouse gas emission, developing plans for greenhouse gas mitigation, raising adaptive capacity, and developing international collaboration on natural resources and the environment.

7) The 20-Year Pollution Management Strategy (B.E. 2560-2579 (2017-2036))and the Pollution Management Plan (B.E. 2560-2564 (2017-2021))

The 20-Year Pollution Management Strategy aims to propel Thailand toward a low carbon and zero waste society, in line with the 20-Year National Strategic Plan. The Pollution Management Strategy comprises 4 phases. The first phase, detailed in the Pollution Management Plan (B.E. 2560-2564 (2017-2021)), focuses on improving the nationwide pollution management system via 3 strategic measures:

1) Prevent and reduce the generation of pollution at the sources;
2) Enhance efficiency for waste abatement and disposal, and control of the release of pollution from the sources with the intention to reduce the release of pollutants to the environment; and
3) Improve the nationwide pollution management system through a) development of supporting tools that allow appropriate management from a countrywide perspective

[30] 1) Sustainable Development, 2) Ecosystem Approach, 3) Precautionary Principle, 4) Polluters Pay Principle: PPP, 5) Beneficiaries Pay Principle: BPP, 6) Public - Private Partnership: PPP, 7) Good Governance, 8) Extended Producer Responsibility: EPR, 9) Resource Decoupling/Resource Efficiency, and 10) Human Rights

(such as specifying carrying capacity of the area; mandating the use of Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA), Environmental-Health Impact Assessment (E-HIA), or Code of Practices (CoP), etc.; increase environmental monitoring and prediction, etc.), b) introduction of a variety of economic and social tools to address different challenges in pollution management, c) strengthening of legal measures, d) promotion of participations and networking of all related parties to manage pollution problems, and e) institutional and human resources development to support Thailand's participation in international collaborations and agreements.

8) The Third National Environmental Health Strategic Plan (B.E. 2560-2564) (2017-2021)

The 3rd National Environmental Health Strategic Plan aims to protect people's health from environmental risks, to enhance cooperation among agencies responsible for the environment and health, and to develop the environmental health management system based on knowledge and evidence to support health risk factors' oversight and prevention.

This strategic plan composes of 4 strategies;

1) Preventing and reducing environmental health risks - focused on (a) monitoring and surveillance of environmental health risks in high-risk areas, (b) assessing risk and evaluating health impact from various environmental health risk factors, (c) developing a management system and a communication and alert system for issues that are of health concerns, public hazards and public disasters, especially for important health issues such as air pollution, drinking water, sanitation, foods, refuses and wastes, hazardous wastes, chemicals and climate changes;
2) Enhance participation from all sectors and LAOs in the form of "Pracharat" model in considering and planning activities to holistically prevent and solve environmental health risks problems, from controlling at source, preventing exposures, through monitoring and surveillance of the environmental health related impact;
3) Strengthening environmental health management systems through the update and enforcement of relevant laws as well as R&D to provide data both to support decision making and raise public awareness; and
4) Develop awareness amongst the public, environmental health personnel, and partners to become knowledgeable in environmental health risks through a) knowledge dissemination and social processes to ensure public access to environmental health related data and knowledge, b) capacity building program for public and environmental health related personnel, and c) continuously promote environmental health related human resources development and improve environmental health related courses and training program

9) The Fourth National Strategic Plan on Chemicals Management (B.E. 2555-2564 (2012-2021))

The Fourth National Strategic Plan on Chemicals Management (2012–2021) has a vision that within 2021 society and the environment will become safe by effective management of chemicals in accordance with national development and through participation from all sectors, in

line with the Strategic Approach to International Chemicals Management (SAICM)'s 2020 goals. Particularly, the plan aims to achieve 3 goals: 1) to have a national chemical management system and mechanism that protects human health and the environment, 2) all sectors have capacity to prevent and control health and environmental impacts from chemicals, and 3) to have a strong chemical management network.

The Fourth Plan comprises 3 strategies all of which are related to POPs management:

1) Develop a chemicals information system, database, tools and mechanisms to systematically manage chemicals throughout their life-cycle;
2) Improve stakeholders' capacity to manage chemicals and promote active participation from all sectors; and
3) Reduce risk from chemicals through measures to reduce risks in agriculture, industry, public and consumer health, and transportation; to monitor pollution and/or unsafe products caused by chemicals; and to improve preparedness for a chemical emergency.

10) The National Waste Management Master Plan B.E. 2559-2564 (2016-2021)

With a vision to be able to "systematically manage municipal solid waste and hazardous wastes with collaborations from all sectors", the National Waste Management Master Plan employs 3 measures to address national waste management; namely 1) reduce the amount of municipal solid waste (MSW) and hazardous waste (HW) at sources, 2) enhance local administration capacity to collectively manage MSW and HW, and 3) promote MSW and HW management; in line with the 12th National Economic and Social Development Plan.

The plan aims to achieve the following targets:

1) at least 75 percent of waste generated by communities is properly treated or reused by 2021,
2) all of the stockpiles of waste previously left untreated are appropriately managed by 2019,
3) at least 30 percent of municipal hazardous waste is collected and correctly disposed by 2021,
4) all infectious wastes are properly managed by 2020,
5) all industrial wastes are properly managed by 2020, and
6) at least 50% of the LAOs implement separate municipal and hazardous waste collection systems by 2021

11) The Action Plan for the National Agenda of "Solving Particle Pollution" (B.E. 2562-2567 (2019-2024))

In February 2019, the Cabinet designated "Solving Particle Pollution" a National Agenda and assigned the National Environment Board (NEB) to be the main mechanism to tackle the problem in collaboration with MNRE and other relevant agencies. Later in August 2019, the NEB approved The Action Plan for the National Agenda of "Solving Particle Pollution" B.E. 2562-2567 (2019-2024).

The action plan aims to "Provide healthy Air for Thai people and Visitors" through 3 measures: (1) increase efficiency in area-based management (for high-risk areas), (2) prevent and

reduce the generation of the particle pollution at sources as well as reduce the number of pollution sources, and (3) enhance (air) pollution management efficiency through, among several measures, expansion of tools and monitoring network, and development of a particulate matters forecasting system, etc.

2.2.2 Roles of related government agencies

Government agencies with roles and responsibility relating to POPs and chemicals management are as followings:

Ministry of Natural Resources and Environment (MNRE) roles include the development and mobilization of national strategies and measures to conserve, protect, rehabilitate, and properly use of natural resources and the environment. MNRE responsibilities also include integration and collaboration with all relevant sectors to manage natural resources and the environment at both national and international levels as well as setting up the environmental quality standards, standards for emission and effluents from pollution sources to control pollution and hazardous chemicals.

The office under MNRE responsible for chemicals and POPs including all operations under the international convention on chemicals management is the Pollution Control Department (PCD). The PCD serves as the national focal points to the Stockholm Convention on POPs, and the Rotterdam Convention on the prior informed consent (PIC) procedure for certain hazardous chemicals and pesticides in international trade, the Basel Convention on controlling transboundary movements of hazardous wastes and their disposals, and the Minamata Convention on Mercury.

Ministry of Industry (M-Industry) is responsible for promotion and development of industry, investment promotion and entrepreneurship development by promoting, supporting and overseeing the industrial business operations in technology, production, environment, safety, energy conservation, hazardous substances and chemicals. The ministry has a role to encourage the potential of industrial business for sustainable development that is in line with laws and obligations under international agreements. M-Industry is responsible for monitoring the industrial business operations related to hazardous substances and chemicals, which includes industrial waste management according to the Factory Act and its amendments, hazardous chemical waste management according to the Hazardous Substance Act B.E. 2535 (1992) and its amendments, and hazardous waste management according to the obligations under international agreements and managing used materials according to the Factory Act B.E. 2535 (1992) and its amendments.

Ministry of Agriculture and Cooperatives (MOAC) has role and responsibility relating to agriculture, water resources and irrigation development, agriculturist promotion and development, and cooperative systems including the agricultural production process and agricultural commodities. The Department of Agriculture (DOA), Department of Fisheries, Department of Livestock Development (DLD), Department of Agricultural Extension (DOAE), and Office of Agricultural Economics (OAE) have roles for managing and controlling production, import, export, and possession of chemicals in agriculture (pesticides) under the Hazardous Substance Act B.E. 2535 (1992) and its amendments as well as controlling operations harmful to health and municipal waste management according to the Public Health Act B.E. 2535 (1992).

Ministry of Public Health (MOPH) has role and responsibility to develop a quality healthcare system and to provide effective and equitable healthcare services by engaging people, community and all stakeholders toward health conscious society for healthy Thais. MOPH also has responsibility to manage and control import, export, and having in possession hazardous substances for consumers and public health purpose under List 4 of the Hazardous Substance Act B.E. 2535 (1992) and its amendments (HSA).

Ministry of Finance (MOF) has role and responsibility to control customs duties and the collection of taxes on imported and exported goods on behalf of other government agencies, such as value added tax, excise tax and municipal tax. The Customs Department is responsible for prevention and control smuggling of goods and other illegal products including import, export and re-export of hazardous substances, chemical products and hazardous wastes according to the Customs Act B.E. 2469 (1926), the Hazardous Substances Act B.E. 2535 (1992) and its amendments.

Ministry of Commerce (MOC) has role and responsibility to regulate agricultural products prices under the legislative framework of the MOC. It is also promoting and developing trade of goods and services, insurance business and IP protection, international trade negotiations, regulating and managing import and export of goods, resolving trade issues and protection of trade interests as well as trade promotion. In addition, the MOC has mandate to designate banned items from export or import, and define any items of goods requiring import/export permits, define categories, quality, quantity, volume, size, weight, price, trade name, logo, trademark, country of origin for export and import items, or regulate relevant source or destination countries under the Export and Import of Goods Act B.E.2522 (1979).

Ministry of Transportation (MOT) has role and responsibility to manage and control vehicles registration on the road, river, sea and ocean, mass transit and train. MOT is also responsible for license plate taxation. All license plates are required annual renewal to ascertain that all vehicles are in safe condition for transportation under the Land Transport Act B.E.2522 (1979) and the exhaust not exceed the emission standard according to the Vehicle Act B.E. 2552 (1979) and additional amendments.

Ministry of Higher Education, Science, Research and Innovation (MHESI) has role and responsibility to promote, support and regulate higher education affairs, sciences, researches and innovation for country development to cope with global changes, including research and development to reduce pollutions and environmental issues for sustainable development.

Ministry of Foreign Affairs (MOFA) has role and responsibility to protect, preserve and promote status and national interests and representing the government in international negotiations or providing consultation, strategic recommendations, policy and international strategies as well as international instruments, including providing knowledge and understanding on proactive international measures beneficial to national interests, and create correct understanding about Thailand in the world community by different departments.

Ministry of Interior (MOI) has role and responsibility for management and control of local and provincial administration. Department of Local Administration (DOLA) and Department of Provincial Administration (DPA) have authority for local and provincial administration. MOI also has significant roles and responsibility relevant to municipal waste management, municipal waste and hazardous waste incineration and crematorium (all of which are major sources of unintentional POPs according to the Public Health Act B.E. 2535 (1992) and the Act on the

Maintenance of the Cleanliness and Orderliness of the Country B.E. 2535 (1992) and amendments.

2.2.3 Relevant international agreements and their obligations

Thailand is a party in many international conventions and other international agreements. In addition to the Stockholm Convention, several of these conventions also aim to achieve environmentally sound management of chemicals, as follows:

1) Sustainable Development Goals (SDGs)

Thailand adopted the Agenda 2030 for Sustainable Development goals (SDGs) during the 70th session of the United Nations General Assembly on 25 September 2018 at the United Nations Headquarter in New York, USA. It becomes guidance for driving toward sustainable development on economic, social and environmental goals in order to eradicate all forms and dimensions of poverty and inequality during 2016-2030.

SDG comprises of 17 goals and 169 targets. Five of these goals are closely related to sound chemicals management throughout their life cycle as follows:

- Goal 3: Ensure healthy lives and promote well-being for all at all ages by (3.4) reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being by 2030 and (3.9) substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination by 2030.
- Goal 6: Ensure availability and sustainable management of water and sanitation for all with following chemical management related targets: (6.3) improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally by 2030, and (6.4) substantially increase water-use efficiency and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity by 2030.
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation with following chemical management related targets: (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.
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable by (11.6) reducing the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management by 2030
- Goal 12: Ensure sustainable consumption and production patterns with following chemical management related targets: (12.4) 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

2020, and (12.5) substantially reduce waste generation through prevention, reduction, recycling and reuse by 2030.

2) Basel Convention on the Controlling of Transboundary Movements of Hazardous Wastes and their Disposals

Thailand has ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal since 22 November 1997. The Cabinet has designated the DIW, Ministry of Industry to serve as the Competent Authority and the PCD to serve as the National Focal Point. The Basel Convention aims to protect human health and the environment against the adverse effects of hazardous wastes by reduction of hazardous waste generation in terms of quantities and hazards and the promotion of environmentally sound management of hazardous wastes, restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management, and a regulatory system applying to cases where transboundary movements are permissible.

Wastes regulated under the Basel Convention are as follows:

- Hazardous wastes, including: 1) 45 categories of hazardous wastes listed in Annex I (Y1-45) or wastes with hazard characteristics in Annex III (H1-13); 2) 62 categories of hazardous wastes in Annex VIII or List A; and 3) 63 categories of wastes exempted for transboundary movement for recycling or recovery in Annex IX or List B (as of October 2019).
- Wastes not defined as hazardous wastes under the convention but regulated by domestic legislation of each Party
- Other wastes, i.e., categories of wastes requiring special consideration as stated in Annex II and Y46: Wastes collected from households and Y47: Residues arising from the incineration of household wastes

3) Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

Thailand has accessed to the Rotterdam Convention since 19 February 2002. The Convention has entered into force since 24 February 2004. The Cabinet has designated the DOA (MOAC) to serve as Designated National Authority (DNA) for pesticides, the DIW (M-Industry), to serve as DNA for industrial chemicals and the PCD (MNRE), to serve as DNA for other chemicals and as the National Contact Point. The objective of this Convention is to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm and to contribute to their environmentally sound use, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

There are currently 52 chemicals regulated under the Rotterdam Convention, they are subjected to a strict ban or restriction of uses. These are 35 pesticides (including 3 severely hazardous pesticide formulations), 16 industrial chemicals, and 1 chemical in both the pesticide and the industrial chemical categories (as of September 2019.)

4) Minamata Convention on Mercury

Thailand has accessed to the Minamata Convention since 22 June 2017. The Convention has entered into force for Thailand since 20 September 2017, whereby the PCD, MNRE, has been designated by the Cabinet to serve as National Focal Point. The objective of the Minamata Convention is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.

There are 35 Articles and 5 Annexes in the Minamata Convention, with prescriptions focusing on controls and reductions of uses, emissions and releases of mercury from (1) mercury supply sources and trade (2) mercury-added products (3) manufacturing processes in which mercury and mercury compounds are used (4) artisanal and small-scale gold mining (5) emissions (6) releases (7) environmental sound interim storage of mercury other than waste mercury (8) mercury wastes, and (9) mercury contaminated sites. In addition, focusses are also made on raising awareness, researches, monitoring, information exchanges and support on funding, technical and technological assistance.

5) United Nations Framework Convention on Climate Change (UNFCCC)

Thailand has ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 28 December 1994, and it is in force in 28 March 1995. The ratification to the Kyoto-Protocol under UNFCCC was done in August 2003. The Convention objective is to stabilize greenhouse gas concentrations in the atmosphere at a safe level that would allow for ecosystem for adaptation and to ensure that there would be no impacts to food security and sustainable economic development. However, level or limit of emission is not defined clearly. Under Article 3 of the UNFCCC, there are five guiding principles, which are: 1) principles of equity and of common but differentiated responsibilities, 2) give full consideration to specific needs and special circumstances of developing country Parties and those Parties that would have to bear a disproportionate or abnormal burden, 3) precautionary principle, 4) parties have a right to, and should, promote sustainable development, 5) cooperation to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties.

6) ASEAN Agreement on Transboundary Haze Pollution

Thailand is a signatory to the ASEAN Agreement on Transboundary Haze Pollution on 10 June 2002 in Malaysia and ratified on 10 September 2003. The Agreement was entered into force on 25 November 2003. The Agreement objectives are to (1) enhance collaboration among ASEAN countries in prevention, monitoring and control of forest fire and open burning (2) increase mutual assistance channels in cases of crisis from transboundary haze or over control of fire in any country, and (3) provide connectivity and information exchanges for monitoring and control of fire in member countries.

7) The Strategic Approach to International Chemicals Management (SAICM)

The Strategic Approach to International Chemicals Management (SAICM) is a policy framework to foster the sound management of chemicals to achieve the Johannesburg Plan of Implementation goal that by 2020, chemicals will be produced and used in ways that minimize significant adverse impacts on human health and the environment.

SAICM comprises the Dubai Declaration on International Chemicals Management, expressing high-level political commitment to SAICM, and an Overarching Policy Strategy which sets out underlying principles and approaches, and implementation and review

arrangements. SAICM is a political agreement that focuses on risk management of chemicals throughout their life cycle.

The SAICM Overarching Policy Strategy sets out the functions and schedule of the International Conference on Chemicals Management (ICCM). One of the functions of the ICCM is to call for appropriate action on emerging policy issues as they arise and to forge consensus on priorities for cooperative action. So far ICCM has adopted resolutions on eight emerging policy issues; five of which are POPs relevant; namely, i) chemicals in products (CiP), ii) hazardous substance within the life cycle of electrical and electronic products, iii) endocrine-disrupting chemicals, iv) per-fluorinated chemicals and the transition to safer alternatives, and v) highly hazardous pesticides.

2.2.4 Laws and regulations related to POPs

1) Hazardous Substance Act B.E. 2535 (1992) and its Amendments

Hazardous Substance Act of 1992 (HSA) prescribes criteria and procedures for control of hazardous substances in regard to production, import, export, transport, uses, storage, disposal and possession of hazardous substances, including to establish the administrative system to promote coordination among various agencies involved in the supervision of said hazardous substances in order to prevent and mitigate harms to individuals, animals, plants, property and the environment.

Hazardous substances under the HSA are defined as explosives, flammable substances, oxidizing agents and peroxides, toxic substances, substances causing diseases, radioactive substances, mutation causing substances, corrosive substances, irritating substances and other substances either chemical or otherwise which may cause injury to persons, animals, plants, property or the environment. They are classified into four categories for necessary control, as follows:

- Category 1 Hazardous Substance is that of which the production, import, export, or having in possession must comply with the specified criteria and procedures.
- Category 2 Hazardous Substance is that of which the production, import, export, or having in possession must firstly be notified to the authority and must also comply with specified criteria and procedures.
- Category 3 Hazardous Substance is that of which the production, import, export, or having in possession must obtain a permit.
- Category 4 Hazardous Substance is that of which the production, import, export or having in possession is prohibited.

2) The Enhancement and Conservation of National Environment Quality Act B.E. 2535 (1992) and the 2nd Amendment B.E. 2561 (2018)

This Act provides a legal basis for the management and control of environmental quality and emission/effluent standards, monitoring, policy development and requirements for Environmental Impact Assessment (EIA) as well as pollution control. With respect to the hazardous wastes and chemicals related to POPs and in case of no specific law thereto, the MNRE shall, with the advice of the Pollution Control Committee, have the power to issue ministerial regulation specifying the types and categories of hazardous wastes generated from the

production and usage of chemicals or hazardous substances in the production process of industry, agriculture, sanitation and other activities which shall be brought under control. For this purpose, rules, regulations, measures and methods must also be prescribed for the control of collection, storage, safety measures, transportation, import into the Kingdom, export out of the Kingdom, and for proper and technically sound management, treatment and disposal of such hazardous wastes.

3) The Factory Act B.E. 2535 (1992) and its Amendment

The Factory Act B.E. 2535 (1992) prescribes criteria and standards to control factory operations related to legal permission, disposal of wastes or contamination created by factory operations (for instance, disposal of wastes, hazardous wastes, refuses or garbage, discharge of wastewater and exhausted air), waste treatment system, emission standards and emission control, as well as the procedure for officers to exercise administrative orders to enforce the law.

4) The Customs Act B.E. 2560 (2017)

It is the primary law governing the control of customs duties and the collection of taxes on imported and exported goods on behalf of other government agencies, such as value added tax, excise tax and municipal tax as well as the prevention and control of smuggling of goods and other illegal products including imported and exported chemical products and hazardous wastes.

5) Export and Import of Goods Act B.E.2522 (1979) and its second Amendment B.E. 2558 (2015)

This Act provides mandate to the MOC by the approval of the Cabinet to designate any goods as prohibited for export or import and designate any goods that require permit for export or import, including defining types, categories, quality, standard, quantity, volume, size, weight, price, trade name, logo, trade mark, country of origin for any goods exported or imported, including source or destination countries.

6) The Public Health Act B.E. 2535 (1992) and its Amendments

The Public Health Act B.E. 2535 (1992) relates to control and regulation of all matters concerning diseases prevention or threats, for instance, from possible pollutants considered harmful to health and by regulating wellness of business facilities, or housing environment covering household level, community, small- and large-scale business and any harmful activity to health. The aim is to decentralization to local administration involvement in regulation of business establishments or public health activities.

7) The Labour Protection Act B.E.2541 (1998) and its Amendments

This Act prescribes relevant rights and duties between employers and employees by defining minimum standards of work and remuneration payment in the workplace so that employees can work safely, be healthy and earn appropriate income and welfare. In order to maximize benefits to employers, employees and the country and to improve competitiveness of the country, the Act and subsequent Amendments ensures protections of employees' rights and well-being, in line with internationally recognized standards.

8) Occupational Safety, Health and Environment Act B.E. 2554 (2011)

"Occupational Safety, Health and Environment" according to the Occupational Safety, Health and Environment Act (OSH Act) means actions or working conditions which are safe from any cause resulting in danger to life, physique, mentality or health arising out of or related to work.

The OSH Act repeals Chapter 8 of the Labour Protection Act 1998 and subordinate legislations. The Act obligates employer to provide and keep the work place and the employees in safe and hygienic working conditions and environment. It also obligates employees to cooperate with the employer in operating and promoting such working conditions and environment. The law also requires the employers to provide an OSH management system in conformity with the Ministry prescribed standards and health check-up for the employees who work with risk factors. Specific hazards for which health check-up is required include work that involves hazardous chemical substances, toxic microbes, radioactivity, and hazardous environment such as heat, cold, vibration, atmospheric pressure, light, and noise, etc.

9) Notification of the Ministry of Industry on List of Hazardous Substance B.E.2556 (2013) and its Amendments

This Notification under the Hazardous Substance Act B.E. 2535 (1992) and its Amendments prescribes that the Minister of Industry, with the approval of the Hazardous Substance Committee, shall notify the list of hazardous substance, type, responsible agency and control criteria in the attached list of the Notification of Ministry of Industry on List of Hazardous Substance. The list of responsible agencies is as follows:

List 1: Substances for agricultural uses, controlled by the Department of Agriculture,

List 2: Substances for fishery uses, controlled by the Department of Fisheries,

List 3: Substances for livestock uses, controlled by the Department of Livestock Development,

List 4: Substances for public health uses, controlled by the Thailand Food and Drug Administration,

List 5: Substances for industrial uses, controlled by the Department of Industrial Works, and

List 6: Substances for energy production, controlled by the Department of Energy Business

10) Notification of the ministry of Industry on the Disposal of Waste or Unusable Materials B.E. 2548 (2005)

This notification sets out waste manifest system for industrial waste disposals. It defined waste codes and characteristic of hazardous waste, prescribed duties of waste generator and waste processor, and regulated the collection, transportation, and management of all industrial wastes, including industrial hazardous waste. The Notification came into force on 25 April 2005.

11) Notification of National Environment Board No.8 B.E.2537 (1994) under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992) on Water Resource Quality Standard

This Notification aims to control and maintain quality of water in various water resources for multi-purpose usage and for safety to public health, for natural resources and environment conservation. There are 28 parameters defined for water standards based on the following key criteria (1) appropriate to specific activities in case of multi-purpose water resources, key usage taken into account while there must be no conflicting standards for multi-purpose usage, (2) status of water quality in key national reservoirs and trends for changes to water quality due to future development (3) taking into account health and safety of humans and aquatic animals, and (4) public satisfaction and acceptance of water quality in different key watershed areas. In addition, the standards values for levels of POPs contamination in water resource are also defined.

12) Notification of National Environment Board No.25 B.E.2547 (2004) under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992) on Soil Quality Standard

This Notification aims to control and maintain soil quality suitable for residential, agricultural, and other purposes and to provide protection for public health and safety. Four categories of soil quality standards are defined, namely, Volatile Organic Compound, Heavy Metals, Pesticides and other chemicals including POPs.

13) Notification of the Ministry of Industry on Stack Emission Standard from Industrial Hazardous Waste Incinerators B.E. 2545 (2002)

This Notification, issued under the Factory Act B.E. 2535 (1992), limits concentration of 9 air pollutants in the stack air exhausted from industrial hazardous waste incinerators. Standard values for dioxin compounds (PCDD/PCDFs) and heavy metals are defined. The Notification came into force on 31 October 2002.

14) Notification of Ministry of Natural Resources and Environment on Emission Standard for Infectious Waste Incinerators B.E. 2546 (2003)

This Notification, issued under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992), prescribes emission standards for infectious waste incinerators. Standard values of dioxin compounds (PCDD/PCDFs) are defined. The Notification came into force on 26 December 2003.

15) Notification of Ministry of Industry on Air Emission Standard for Factory using Processed Used-oil and Synthetic Fuel as Fuel in Industrial Furnaces B.E. 2548 (2005)

This Notification, issued under the Factory Act B.E. 2535 (1992), limits concentration of 9 air pollutants in the air exhausted from factories that use processed used-oil and synthetic fuel as fuel in industrial furnaces. The standard values of dioxin compounds (PCDD/PCDFs), volatile compounds and heavy metals are defined. The Notification came into force on 15 July 2005.

16) Notification of Ministry of Natural Resources and Environment on Air Emission Standard for Cement Plant Using Waste as Fuel or Raw Materials for Production B.E. 2549 (2006)

This Notification, issued under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992), defines emission standards for cement plants that use wastes as fuel or as raw material for production. Standard values for stack air emissions of dioxin compounds (PCDD/PCDFs) are defined. The Notification came into force on 16 December 2006.

17) Notification of Ministry of Natural Resources and Environment on Emission Standard for Waste Incinerators B.E. 2553 (2010)

This Notification, issued under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992), defines emission standards for new waste incinerators or its extensions (approved after July 2010) and existing waste incinerators (in operation before July 2010). For each case, standard values of stack air emission dioxin compounds (PCDD/PCDFs) are defined. The Notification came into force on 17 July 2010.

2.2.5 National mechanism relating to Stockholm Convention

The national implementation and collaboration mechanism comprised of the National Environment Board and the National Environmental Sub-Committee: Stockholm Convention on POPs, as follows:

1) The National Environment Board

The National Environment Board (NEB) was established by the Enhancement and Conservation of National Environment Quality Act B.E. 2535(1992). It consists of the Prime Minister as Chairperson, a Deputy Prime Minister entrusted by the Prime Minister as First Vice-Chairperson, the Minister of Natural Resources and the Environment as Second Vice-Chairperson, relevant Ministers and related agencies, and no more than eight additional qualified experts, with the Permanent Secretary of the Ministry of Natural Resources and the Environment acting as a member and the Secretary.

The NEB has the following powers and duties: (1) to submit policies and plans for the enhancement and conservation of national environmental quality to the Cabinet for approval; (2) to prescribe Environmental Quality Standards; (3) to consider and approve the Environmental Quality Management Plan proposed by the Minister; (4) to consider and approve the Provincial Action Plan for environmental quality management; (5) to suggest to the Cabinet in respect to financial, fiscal, taxation, and investment promotion measures for the implementation of the policies and plans for the enhancement and conservation of national environmental quality; (6) to propose for amendment or improvement of laws relating to the enhancement and conservation of environmental quality to the Cabinet; (7) to consider and approve the Action Plan for the prevention or remediation of danger caused by the contamination of pollutants or spread of pollution proposed by the Pollution Control Committee; (8) to consider and approve the setting of emission or effluent standards proposed by the Minister; (9) to supervise, oversee and expedite the enactment of royal decrees and the issuance of ministerial regulations, rules, local ordinances, notifications, rules and orders which are necessary to ensure systematic operation of the laws relating to the enhancement and conservation of environmental quality to the fullest extent possible; (10) to submit recommendations to the Prime Minister for his/her consideration in the case where it appears that any government agency or a state enterprise infringes or refrains from complying with the laws, rules and regulations relating to the conservation of environmental quality, which may cause severe damage to the environment; (11) to specify measures for strengthening and fostering of cooperation and coordination among government agencies, state enterprises, and the private sector in matters concerning the enhancement and conservation of environmental quality; (12) to supervise the management and administration of the Environmental Fund; (13) to submit reports on the state of national environmental quality to the Cabinet at least once a year; and (14) to perform other functions as prescribed by this Act or by other laws to be within the authorities and duties of the National Environment Board.

2) National Environmental Sub-Committee: Stockholm Convention on Persistent Organic Pollutants

National Environmental Sub-Committee: Stockholm Convention is established by the order of the National Environmental Board No. 1/2003 dated 19 May 2003. The components and mandates of the sub-committee have been updated 3 times according to

orders of National Environmental Board No. 18/2004 dated 12 July 2004, No. 23/2009 dated 28 September 2009 and No. 5/2018 dated 3 May 2018.

At the present, the national environmental sub-committee on the Stockholm Convention is chaired by a senior expert of National Environment Board and the Director-General of the Pollution Control Department is vice-chair person. There are 17 members from related agencies, namely, Department of Industrial Work, Department of Agriculture, Food and Drug Administration, Customs Department, Department of Environmental Quality Promotion, Department of Health, Department of International Trade, Department of International Organization, Department of Treaties and Legal Affairs, Department of Local Administration, Bureau of Budget, Office of National Economic and Social Development Board, Bangkok Metropolitan Authority, Industrial Estate Authority of Thailand, Federal Trade Institute, National Metal and Materials Technology Center (MTEC) and the Pollution Control Department serves as its Secretariat as well as an external expert.

The roles and responsibility of the national environmental sub-committee on Stockholm Convention are as follows: (1) to consider and give the approval for ratification of the SC and prepare the country's position during COP meetings, review POPs and other meetings; (2) to support and provide suggestions on carrying out the National Implementation Plan (NIP) for implementation of the Stockholm convention on POPs; (3) to propose the coordination with all relevant agencies to fulfill obligations under the SC; (4) to supervise the collaboration with the Secretariat of the SC; and (5) to appoint working groups as appropriate.

2.3 Assessment of the Status of POPs in Thailand

2.3.1 Assessment of POPs pesticides (Annex A, Part I)

1) Assessment of POPs pesticides

a) Initial SC POPs pesticides

At the initial stage of the SC, there were 9 SC POPs pesticides listed in the Convention, which were aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene.

Thailand has never produced any of the 9 POPs pesticides. Based on Thailand's first POPs inventory assessment report[31], most initial SC POPs pesticides (except HCB and mirex) had been imported into the country in the past, but their total import amounts were not specified. During 1981-2004, all of the 9 POPs pesticides became successively classified as Category 4 HSs and are controlled by the DOA, the FDA and the DIW. A survey of DOA's annual records of imports of hazardous agricultural substances during 2007-2017 found no import data for the classified POPs. Additionally, a search in FDA's hazardous substance registration database found no record of any of the classified POPs pesticides. Based on Thailand's first inventory assessment report, there were about 220 kg of obsolete initial SC POPs pesticide stockpiles in the country in 2004. During 2010-2013, the PCD conducted a follow-up inventory of obsolete SC POPs pesticides and found a combined 54 kg of chlordane in DOA's and DOAE's custodies, and 7 liters of

[31] The Kingdom of Thailand, Plan for the Implementation of its obligation under the Stockholm Convention on the Persistent Organic Pollutants (POPs) in Thailand, May 2007

dieldrin in DOA's custody. A subsequent survey in 2018 found about 31 kg of chlordane remained in DOAE's custody, pending final disposal. All of the obsolete SC POPs pesticides previously held in DOA's custody had been collected and destroyed in an environmentally sound manner by industrial waste incineration.

b) Newly listed POPs pesticides

Thailand has never produced any of the 7 newly listed POPs pesticides. Five of these pesticides (except chlordecone and PeCB) had been imported into the country in the past. However, during 1993-2012, 6 of these 7 newly listed pesticides, including α-HCH, β-HCH, γ-HCH (lindane), chlordecone, technical endosulfan, and PCPs, were banned by all three HSA enforcement agencies (DOA, FDA, and DIW).

α-HCH, β -HCH and γ-HCH (lindane)

Lindane (γ-HCH) has been banned by the DOA since 2001 and by the FDA since 2012, with an exception for medical use as a second-line treatment for scabies and lice in humans. FDA had granted an import license for lindane to a pharmaceutical company in 1984. After lindane was removed from the National List of Essential Medicines for treatment of scabies and lice in humans in 2012, this firm voluntarily withdrew its import license in 2015.

The 2017 POPs pesticides inventory assessment did not find any record of import of lindane in the database of the two enforcement agencies (DOA and FDA). However approximately 0.9 tonnes of lindane stock still remained in the custody of the previous license holder in 2017, awaiting final disposal.

α-HCH and β-HCH were banned since 2001 by the DOA, the DIW and FDA. Because Thailand has never produced SC POPs pesticides and because α-HCH and β-HCH are by-products from the production of lindane, it can be concluded that these 2 substances have never been individually produced or imported.

There are some monitoring data on lindane, reported between 2003-2018, in surface water, sediment, aquatic plants, sea water, raw water, tap water, meat and cooked food. The level of lindane detected did not exceed the limit according to relevant standards.

Chlordecone

Chlordecone was classified as a Category 4 HS under the control of the FDA since 1995 and later under the supervision of the DOA since 2000. As of 2017, there is no outstanding stock of chlordecone.

Thailand's food and agricultural commodity standards require that food and feed are free of chlordecone. However, since chlordecone is considered irrelevant to Thailand, there is no mandate to monitor chlordecone in the environment. Thailand has never received any request or granted any licence for chlordecone imports. There is no evidence to suggest that chlordecone has been imported into or used in Thailand.

Technical endosulfan:

Technical endosulfan (except capsule suspension (CS) type) has been banned since 2004 by the DOA and the FDA. In 2002, α-endosulfan and β-endosulfan were classified as Category 3 HS under the DOA, which means prior authorization is mandatory for their production, import, export, and possession. Prior to the ban by the DOA, approximately

8,700 tonnes of technical endosulfan were imported during 1996-2003. After 2004, the import ceased. As for α- and β-endosulfan, the DOA's annual records of imports of hazardous agricultural substances show no import during 1996-2017.

Pentachlorophenol and its salts and esters (PCP)

Globally, PCP has been produced commercially and used as a wood preservative since the 1930s [UNEP (2019)[32]] and as herbicides in paddy fields in Japan since 1960s until 1990s [Seike et.al (2007)[33], Masunaga et al. (2001)[34]]. In Thailand, PCP was banned by the DOA in 1993 and later by the FDA and the DIW in 2000 and 2003, respectively. PCP has never been approved for agricultural uses in Thailand. There is no information to suggest that PCP has ever been imported into the country. The 2017 POPs pesticides inventory assessment study did not find any record of registration, import or export of PCP granted by any of the three enforcement agencies (DOA, FDA and DIW). Also, there is no information to suggest the use of PCP in wood products, such as utility poles, fences, railway sleepers, etc., in Thailand.

Noted, however, that the existing hazardous substance registration data as well as the factory registration data in Thailand can be traced back until around 1970s and 1960s, respectively. There is no data to allow assessment of PCP imports before 1970s. However, Thailand's economy during the period of intense global uses of PCP (from the Thai democratic revolution in 1932 to the end of World War II in 1945) is considered a rural agrarian economy [Leturque and Wiggins (2011)[35]]. The oldest wood treatment factory registered in Thailand was established in 1979 [DIW factory database (2020)[36]] while the oldest wood kiln/treatment facility, operated by the Ministry of Agriculture, was established in 1956 [Forest Industry Organization[37]]. Similarly, Thailand's green revolution only started in 1960s. The oldest fertilizer production factory registered in Thailand was established in 1970. Therefore, despite the lack of national records, it is considered unlikely that PCP was intentionally imported into Thailand during 1930s to 1970s.

The application of PCP as a pesticide in Thailand is, therefore, considered irrelevant. However, PCP may have been indirectly imported via imports of PCP-contaminated products, particularly products prone to microbial degradation such as leathers and textiles.

c) Environmental monitoring of SC POPs pesticides:

Thailand has published guidelines on maximum allowable concentrations (MAC) for SC POPs pesticides in surface water, groundwater, soil and maximum residue limits (MRL)

[32]UNEP, Guidance on preparing inventories of pentachlorophenol and its salts and esters, Revised April 2019, Secretariat of the Basel, Rotterdam and Stockholm conventions, United Nations Environment Programme, Geneva

[33]N. Seike, et.al, PCDD/F Contamination over Time in Japanese Paddy Soils, Environ. Sci. Technol. 2007, 41, 2210-2215

[34] S.Masunaka, et.al, "Identifying Sources and Mass Balance of Dioxin Pollution in Lake Shinji Basin, Japan", Environ. Sci. Technol. 2001, 35, 1967-1973

[35]Henri Leturque and Steve Wiggins, "Thailand's progress in agriculture: Transition and sustained productivity growth", Overseas Development Institute, 2011

[36] Department of Industrial Works, "Factory Search" (factory type 03405), Department of Industrial Works, https://www.diw.go.th/hawk/content.php?mode=data1search, last accessed: April 23, 2020

[37]Forest Industry Organization, Bangpho Wood Industry Section (in Thai), http://www.fio.co.th/dep/woodin/data/history.jpg, last accessed: April 23, 2020

or extraneous maximum residue limits (EMRL) for agricultural products. The publication of these guidelines led to a mandate to monitor levels of relevant SC POPs pesticides in food and feed and in the environment.

Most monitoring efforts conducted by DOA, PCD, Metropolitan Waterworks Authority (MWA), Provincial Waterworks Authority (PWA) and Department of Medical Sciences (DMS) showed that the levels of SC POPs pesticides residues were within the standard limits. Especially, in 2017 the DMS assessed the population's exposure to toxic substances including 6 initial POPs and 4 new POPs in cooked food. The results showed that POPs Pesticide residues in all of the sampled food groups were below the detection limits. However, four academic research works found traces of DDT and metabolites, HCHs, technical endosulfan and metabolite, aldrin, dieldrin, heptachlor, and lindane above the applicable MAC and MRL/EMRL in certain agricultural areas.

2) POPs pesticides management

Most POPs pesticides are regulated as hazardous substances under the Hazardous Substance Act B.E. 2535 (1992), as follows:

1. Control as Category 4 Hazardous Substances with prohibition on production, import, export or possession of 15 POPs pesticides; namely (1) endrin in 1981; (2) DDT was banned for uses in agriculture in 1983 and for uses in public health in 2003; (3) toxaphene in 1983; (4) aldrin, (5) dieldrin and (6) heptachlor in 1988; (7) pentachlorophenol and its salts and esters were banned for uses in agriculturein 1993; (8) chlordane and (9) chlordecone were banned for uses in public health in 1995 and for uses in agriculture in 2000; (10) mirex in 2001 (11) HCB, (12) α-HCH and (13) β-HCH in 2001; (14) lindane was banned for uses in agriculture in 2001 and for public health uses in 2012 and (15) endosulfan except capsule suspension formulae in 2004 and specific formulae of capsule suspension being classified as Category 3 Hazardous Substance for agriculture uses in 2002.
2. PeCB is the only relevant SC POPs pesticide currently pending a decision to control as a hazardous substance under HSA.

In addition, MRLs/EMRLs in food have been issued to prevent harmful effects from consumption of food containing pesticide residues, i.e., aldrin, dieldrin, chlordane, DDT, endrin and heptachlor, in different types of food by the FDA, MOPH, according to the Notification of Ministry of Public Health No. 387 B.E. 2560 (2017) on pesticide residues in food.

2.3.2 Assessment of PCBs (Annex A, Part I & II)

1) Review of PCBs assessment

PCBs were included in the initial list of POPs under the SC and, hence, had been addressed in Thailand's first NIP. The PCD has periodically submitted reports to the Secretariat in accordance to its obligation under Article 15 of the convention.

2) Update on management actions taken for PCBs

Updates on control of PCBs and equipment containing PCBs and elimination of PCBs usages are as follows,

1) In 2004, there was a notification for reclassification of PCBs to be Category 4 HS according to the HAS, meaning that it is banned to produce, import, export or have PCBs in possession, including equipment contain PCBs compounds.
2) In 2004, the DIW designated end-of-life devices, transformers and power capacitors that contain PCBs a chemical waste, classified as Category 3 HS. Any production, import, export, or possession of these devices requires prior approval from DIW.
3) In 2008, the DIW issued a notification to totally phase-out PCBs by 2012. The notification obligated device holders to prepare and implement a plan to phase-out and completely dispose of PCBs by 2012. Any movement of affected devices also needed prior approval from the DIW.

Since PCB oils was not one of the wastes or discarded materials that were allowed to be treated or disposed of by waste management processors, industrial waste incinerators in Thailand were not allowed by law to incinerate PCB oils. All PCB oils, therefore, were collected and exported to third countries (France, the Netherlands, etc.) for final destruction. In particular, as reported in Thailand's National Reporting of the Stockholm Convention (Fourth Reporting Cycle), 761 tonnes of PCB wastes were exported to France (20 t), the United Kingdom (452 t), Belgium (33 t), and other countries (256 t) for final destruction during 1992-2002. Moreover, in 2012, 110 tonnes of transformers contaminated with PCBs and 100 tonnes of waste containing PCB oils were exported to the Netherlands and France for final disposal.

In terms of the awareness of the environmentally sound management of PCBs, the Ministry of Industry, through the DIW, published documentation related to the legal obligations and guidance on the management of PCBs. The Ministry of Natural Resources and Environment, through the PCD, published PCBs management handbooks, guidelines for the management of PCB-contaminated devices, monographs, as well as general documents to raise awareness about PCBs and their environmental and health impacts.

PCBs have been monitored through several activities as follows:

1) In 2006-2007, the Department of Environmental Quality Promotion (DEQP) studied PCBs in sediments in Chao Praya River, estuaries and the upper Gulf of Thailand. The study found the highest accumulations in areas around Klong Toey District (Bangkok) and Amphoe Prapradang (Samut Prakarn Province). The level of PCBs, though, was in pg/g (dw) range. This level of contamination was considered low in comparison to similar areas in other countries. The study found no PCB accumulation in sediments in central areas from Nontaburi Province upward.
2) From 2004 to 2009, the Ministry of Education, in collaboration with the Inter-University Program on Environmental Toxicology, Technology and Management of Chulabhorn Research Institute, Asian Institute of Technology, and Mahidol University's Center for Environmental Health, Toxicology and Management of Chemical, conducted research under the project "The evaluation of PCBs and dioxin-like PCBs contaminated coast of Thailand by using chemical and biological techniques" to assess the accumulation of PCBs in seafood from the eastern coast of Thailand. The

study found PCB contaminations in mussels, oysters, and shrimps ranging between 19-1,100 ng/g (lipid-adjusted weight), and the levels of PCBs in shrimp was higher than those in mussels and oysters.

2.3.3 Assessment of POP-PBDEs (Annex A, Part I, IV, V and IX) HBB (Annex A, Part I) and HBCD (Annex A Part I & VII)

1) Assessment of POP-PBDEs HBB and HBCD

a) Tetrabromodiphenyl ether and pentabromodiphenyl ether (c-pentaBDE):

Tetrabromodiphenyl ether and pentabromodiphenyl ether (or commercial pentabromodiphenyl ether, c-pentaBDE) is considered a historical substance of which production has ceased over 15 years ago. Thailand has never produced this substance. There is no record of c-pentaBDE ever being imported into or used in Thailand. C-pentaBDE was listed as Category 3 HS in 2017. As of 2019, no firm filed any request to process or to handle this substance.

Since worldwide production of c-pentaBDE was ceased more than 15 years ago, stockpile of c-pentaBDE in Thailand is believed to be zero. Thailand's only involvement with c-pentaBDE is believed to be through imports of transport vehicles that may contain c-pentaBDE (produced before 2005), possibly in their seats and interior fabrics. The cumulative amount of c-pentaBDE imported into Thailand via these vehicles is estimated at 1.5 tonnes. These contaminated materials are believed to have reached end-of-life and have been replaced with locally produced parts. The removed materials are believed to be discarded as municipal solid waste (MSW), which could have been landfilled, incinerated, or openly dumped depending on the MSW management system available to the relevant communities.

b) Hexabromodiphenyl ether and heptabromodiphenyl ether (c-octaBDE):

Polybrominated diphenylethers (PBDEs) were imported into Thailand in the 1090s to produce UL 94 V0 grade acrylonitrile butadiene styrene (ABS) resins. However, due to the lack of supplier data disclosure in the past, the type of these PBDEs could not be confirmed. Since these ABS resins were produced 20-30 years ago (before the widespread uses of computers and database management systems to store industrial transactions), information related to the types of the end-use products or the final market destinations are no longer traceable. C-octaBDE was listed as Category 3 HS in 2017. As of 2019, no firm has filed any request to process or to handle this substance.

Since worldwide production of c-octaBDE was ceased more than 15 years ago, stockpile of c-octaBDE in Thailand is believed to be zero. Due to the lack of historical data, Thailand's inventory team developed a predictive model to estimate the levels of octaBDE based on results from a product survey for the types of BFR used in everyday products and the corresponding wastes found at waste management sites. Based on the developed model, the total amount of c-octaBDE in the affected ABS is estimated at 12 tonnes. Most of these products are believed to have reached end-of-life, leaving about 1,000 monitors, with about 300 kg of c-octaBDE remaining in hibernation. ABS resins extracted from end-of-life (EOL) monitors are shredded and sold as recycled ABS chips, with ABS-V0 grade commanding a higher price than general grade. Most of the ABS-V0 chips found in Thailand were flame-retarded with tetrabromo bisphenol-A (TBBPA).

Nevertheless, ABS-V0 chips with c-octaBDE may still be found, especially those from recycling shops located in the central part of the country.

c) Decabromodiphenyl ether (c-decaBDE):

Before being listed in Annex A of the SC, decaBDE was a popular flame retardant. Unlike the other SC industrial POPs, worldwide production and sale of decaBDE have not yet ceased. C-decaBDE may have been imported into Thailand in the past but due to the non-unique import classification code, the total amount of decaBDE ever imported into the country is unknown. C-decaBDE was recently listed as Category 3 HS in 2019. In 2018, the DIW received (voluntary) notifications for the intentions to import about 70 tonnes of decaBDE. However, since decaBDE was not a controlled substance at the time, it was uncertain whether or not the notified activities actually took place. Results from a questionnaire survey indicated that producers along the electrical and electronic (EEE) supply chain had phased-out the use of c-decaBDE since 2006, as a result of the enforcement of the EU RoHS Directive. This result could imply historical uses. It was not clear whether or not the compounding of the affected resins took place in Thailand. Nevertheless, since the phase-out was commenced more than 10 years ago, stock of decaBDE for these historic uses (if they existed) may already be exhausted.

Results from field survey suggested that decaBDE may find other uses in applications that faced lower restriction such as upholstery and drapery textiles, rubbers and silicone parts. Also, the survey found BFR in interior textiles and underhood parts in several passenger cars. It is not known whether these flame-retarded materials were imported or locally produced. With limited responses from stakeholders and limited access to material samples, the type of the BFR cannot be confirmed at this time.

The uses of decaBDE were confirmed for polystyrene (PS) housings of CRT TVs produced before 2006. The number of the affected TVs is estimated at 5 million sets. The corresponding amount of PS resins that contained decaBDE is estimated at 10,000 tonnes and the total amount of decaBDE is estimated at 920-1,500 tonnes. About half of this amount is believed to have already been disposed of; leaving about 500-820 tonnes remaining ‘in-stock’ in the use and hibernation phases of products. The affected PS resins are recycled along with other plastic resins that can be extracted from e-waste. The concentration of decaBDE in the shredded PS chips and, consequently, the recycled PS pellets depend on the feedstock that arrived at the recycling shops. While decaBDE concentrations in most batches tested were low, concentration in black PS-V0 chips can be high. Due to low demand from local compounders, these recycled materials are believed to be exported. Apart from PS from CRT TVs, Thailand’s 2019 POPs Industrial Chemicals Inventory Assessment reported traces of decaBDE in shredded PS chips from other applications. Unfortunately, the source of these chips could not be confirmed. The assessment also found TBBPA to be the most popular BFR for casings of computer CRT monitors found in Thailand. As for decaBDE in other WEEE components, the study did not yet find decaBDE in other rigid polymeric resins other than PS.

For decaBDE uses in textile applications, the average amount of decaBDE in flame retarded fabrics is estimated at 300 kg per year and the cumulative amount of decaBDE in impregnated fabrics that are in use phase is estimated at 3 tonnes. DecaBDE can be released from the affected products at any stage throughout products’ life-cycle. Results from an emission model suggested the releases from EEE in the form of dust are now shifting from the use phase to the dismantling and recycling facilities. Moreover,

the model indicates that residues from end-of-life (EOL) management will become an important emission source of decaBDE in the next 10 years. Plastic resins extracted from casings of e-waste are likely to be recycled. Due to the relatively high values of the affected resins, most of the decaBDE in polymeric resins are likely to be recirculated along with these engineering plastics. Half of the relevant amount is believed to have been returned into the material cycle, while the fate of the remaining half is still unclear.

d) Hexabromobiphenyl (HBB):

Hexabromobiphenyl (HBB, CAS No 36355-01-8) can be considered a legacy chemical, with no new production for decades. Thailand has never produced this substance and there is no data to suggest that HBB has ever been imported into or used in Thailand. HBB was totally banned as a Category 4 substance under HSA since 2013. In the same year, wastes, substances and articles containing, consisting of or contaminated with HBB at a concentration level of 50 mg/kg or more were classified as chemical wastes which were also classified as Category 3 HS that required prior approval from the DIW. No report of any detection of HBB in the food chain or in any of Thailand's environmental media was found. HBB is, therefore, considered irrelevant for Thailand.

e) Hexabromocyclododecane (HBCD):

HBCD is not manufactured in Thailand but imported by producers of expanded polystyrene (EPS) foams beads for use as a flame retardant in self-extinguish grade EPS (SE-grade EPS) in order to produce EPS-core sandwich panels for applications such as cold storages and cleanrooms, etc. There are two local EPS bead producers, producing about 12,000 tonnes of SE-grade EPS beads per year. Based on local EPS bead production capacity and EPS bead import/export statistics, the total amount of HBCD-contaminated SE-grade EPS is estimated at 175,000 tonnes, with the corresponding amount of HBCD of about 1,300 tonnes [890-1,770 tonnes]. Most of the relevant amounts of HBCD are believed to remain within SE-grade EPS foams which are currently in the use phase.

There is no information related to HBCD uses for other purposes. Local industries have been unable to provide information on their involvement. Samples with HBCD were yet to be found. Furthermore, there is no report of detecting HBCD in environmental media. Nevertheless, considering the large scale of the 'likely' relevant products, the number of samples explored was still too low to arrive at any conclusion.

HBCD was no longer imported into Thailand after key global manufacturers terminated their production, though HBCD may still be available from certain areas. Local EPS bead producers have ceased to use HBCD and have instead switched to Polymeric FR (CAS No 1195978-93-8) – a novel substance offered by the same suppliers as a drop-in substitute for HBCD. Because EPS beads have a limited useful life of about 6 months, the affected EPS beads are expected to remain in the market only for a relatively short time after the phase-out of HBCD.

2) Legal Status of POP-PBDE, HBB and HBCD

PBBs were banned (Category 4) in 2013 while 7 PBDE homologs (penta-, octa-, deca-BDE) were listed as Category 3 Hazardous Substances in Thailand in 2017 and 2019 (Table 6). Any production, import, export, or having in possession of any of the Category 3 HS in Thailand requires prior authorization from the DIW, Ministry of Industry.

Table 6: HBB and PBDEs Control under Thai Hazardous Substance Act

No.	Substance	CAS No. (Thai HSA)	Category	Started	CAS No. (SC)
1	hexaBB	36355-01-8	4	2013	36355-01-8
2	octaBB	27858-07-7	4	2013	
3	decaBB	13654-09-6	4	2013	
4	Wastes, substances and articles containing, consisting of or contaminated PCB, PCT, or PBB, or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more	-	3	2013	[Basel Y10]
5	tetraBDE (BDE-47)	40088-47-9*	3	2017	5436-43-1
6	pentaBDE (BDE-99)	32534-81-9*	3	2017	60348-60-9
7	hexaBDE (BDE-153)	68631-49-2	3	2017	68631-49-2
8	hexaBDE (BDE-154)	207122-15-4	3	2017	207122-15-4
9	heptaBDE (BDE-175)	446255-22-7	3	2017	446255-22-7
10	heptaBDE (BDE-183)	207122-16-5	3	2017	207122-16-5
11	decaBDE (BDE-209)	1163-19-5	3	2019	1163-19-5

Note: (*) CAS number differs from those listed in SC Annex A

HBCD is not yet a 'classified' substance under the HSA. Consequently the low POPs content for HBCD has not been established and, hence, waste containing HBCD is not yet classified as hazardous waste. Nevertheless, HBCD's inherent hazards meet the requirements for voluntary declaration under DIW's 'list 5.6'. In 2016, a local distributor filed an intention to import about 8 tonnes of HBCD for EPS foam application. This is presumed to be the final import.

2.3.4 Assessment of HCBD (Annex A, Part I)

There is no information related to production and use of hexachlorobutadiene (HCBD) in Thailand. Since Thailand has no chlorinated solvent production plant, there is no major source for HCBD.

However, HCBD may be unintentionally generated as a by-product of chemical and thermal processes. EDC/VCM, allyl chloride and epichlorhydrin production processes, and municipal waste incinerators may be sources of the unintentionally produced HCBD in Thailand, and there is no analytical data for the emissions from these sources. Nevertheless, emissions from incineration from these plants are under regulatory control for PCDD/F emission (with limits of 0.5 ng TEQ/m^3 (7% O_2) for industrial waste incinerators and 0.1 ng TEQ/m^3 (7% O_2) for municipal waste incinerators). Waste related to the EDC/VCM, allyl chloride and epichlorhydrin production processes are also incinerated with regulatory control for dioxin emission (limit 0.5 ng TEQ/m^3 (7% O_2)). These facilities are operated according to BAT. With

appropriate technology/practices that the industry put in place to control the generation and emission of PCDD/F, the generation and emission of HCBD should simultaneously be minimized.

HCBD was not covered in the Pollutant Release and Transfer Registers (PRTR) pilot project, implemented in Rayong province in 2013. However, the PCD had monitored HCBD in ambient air in Bangkok and Rayong Provice during 2006-2009 and fround annual average between 0.14 − 0.22 μg/m^3.

HCBD is listed in DIW's 2016 soil and groundwater standards. Relevant factories are required by the Ministry of Industry's Ministerial Regulation on the Control of Contamination within Factory into Soil and Groundwater B.E. 2559 (2016) to periodically monitor and report their soil and groundwater quality. As of 2019, none of the listed factories was required to monitor and report levels of HCBD contamination in their soil and groundwater. Finally, a search for information in international journals did not yield any report on the detection of HCBD in environmental media in Thailand.

2.3.5 Assessment of PCNs (Annex A, Part I)

It is not known whether PCNs (as chemical substances) have ever been imported into Thailand. PCNs were not among the controlled substances typically requested by parties along supply chains.

In 2013, DIW designated wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyls (PCBs), polychlorinated terphynyls (PCTs), polychlorinated naphthalenes (PCNs) or polybrominated biphenyls (PBBs), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more as chemical wastes which are also classified as Category 3 HS that require prior approval from the DIW. A search in DIW database found no record that could be linked to PCNs. Apart from this filing, the 2019 POPs Industrial Chemical Inventory Assessment study did not find any other data related to PCNs in Thailand.

2.3.6 Assessment of PeCB (Annex A, Part I)

PeCB is not yet classified as a Hazardous Substance under HSA. There is no record that PeCB was ever produced in Thailand. Except for small amounts imported for research/laboratory purposes, there is no information as to whether PeCB has ever been imported into Thailand. A search for published articles also found no reports related to PeCB in Thailand. There is no data to suggest that PeCB had ever been used as an intermediate chemical to produce other chemical substances in Thailand. However, PeCB may have been indirectly imported as impurity in PCNB, 2,4-D products, phthalocyanine dyes, and dioxazine dyes.

2.3.7 Review and management of DDT (Annex B, Part I & II)

DDT is listed as Category 4 Hazardous Substance under the HSA. Production, import, export and having possession of DDT for agricultural use and for health and medical use was prohibited in 1983 and 2003 respectively. There is no stockpile of DDT in the possession of any government or private agency.

2.3.8 Assessment of PFOS, its salts and PFOSF (Annex B, Part I & III)

1) Assessment of PFOS, its salts and PFOSF

PFOS is a surfactant that may be used in textile (possibly mainly for export-oriented products), paper (food packaging), metal plating, and firefighting foam applications. Information from stakeholder interviews indicated that most export-oriented firms had phased out PFOS since 2009 as a result of the publication of the EU's PFOS Directive[38]. Information from local chemical distributors indicates that some small plating companies still prefer to use PFOS.

Nine PFOS-releated substances were recently listed as Category 3 HSs in 2013 and 2017. Based on import statistics, the remaining demand for PFOS for plating applications is estimated at 300-400 kg per year. PFOS was detected in several products sold in Thailand including textiles, sun screen cream, and bottled water. There were also reports of detecting PFOS in effluent of industrial wastewater treatment plants, groundwater, surface water, and tap water, with the concentration levels appearing to be associated with the areas where PFOS may have been used.

Results from a survey of PFOS in firefighting foams in 2019 found possible stockpiles of PFOS-containing foams in foams stored in petroleum refineries and oil depots that were imported before 2009. Based on the amount of firefighting stock required by law, the amount of PFOS relevant firefighting foams is estimated at 925,000 liters, with the corresponding amount of PFOS of about 3,700 – 5,500 kg.

For firefighting training, which is considered the largest PFOS release source that leads to contamination of groundwater, the survey found that most fire trainings in Thailand do not use actual foams, due to the high price of firefighting foams. However, expired foams may be used in firefighting trainings in certain high-risk areas, such as petroleum complexes and nearby industrial estates. Effluent water both from firefighting trainings and real fire extinguishing within industrial estates are required to be collected and treated at the source before they are allowed to be released to the industrial estate's central wastewater treatment plant. However, in the absence of regulatory limit, the level of PFOS in the effluents has never been confirmed.

PFOS can contaminate surface water and groundwater. PFOS that leached from sewage sludge can accumulate in agricultural plants, where they can transfer to humans through the food chain. In fact, PFOS residues in meat, milk, eggs, and fishes had been reported [Sadia et al.(2020)[39]]. Existing treatment plants may not be able to handle (remove or destroy) PFOS-contaminated inputs. Depending on the sources of the influents and treatment technique, some types of PFOS, particularly linear and long-chain congeners, may be captured in organic matter fractions and the rest may remain in the aqueous phase. Some of the WWTP sewage sludge is being used as soil conditioner.

Moreover, based on Thailand's 2019 POPs Industrial Chemicals Inventory report, the following areas may be contamined with PFOS but have not been checked and/or controlled:

[38] Directive 2006/122/EC of The European Parliament and of the Council of 12 December 2006, Official Journal of the European Union, OJ L 372

[39] M. Sadia et al., Trace level analyses of selected perfluoroalkyl acids in food: Method development and data generation, Environmental Pollution 263 (2020), 113721

- Wastewater treatment plants that receive wastewater from factories that use or have used PFOS and/or central WWTP that cannot separate incoming water
- WWTP effluent water, effluent from plating plants, sewage sludge and landfill leachate
- Areas that receive contaminated biosolids, particularly areas where these biosolids are used as soil conditioners
- Soil and groundwater in the affected areas
- Landfills, particularly industrial waste landfills.

Additionally, as PFOS-containing firefighting foams will become expired over the next 10 years or so, Thailand will need to develop a plan/measure to ensure that these foams are contained (including fire-water runoff) and dispose of in an environmentally sound and efficient manner.

2) Implementation status on PFOS, its salts and PFOSF

Thailand has classified 1 and 8 substances among PFOS, its salts and PFOSF group as Category 3 Hazardous Substances under the HSA in 2013 and 2017, respectively (Table 7). Any production, import, export and possession of these substances requires prior authorization from the DIW, Ministry of Industry.

Table 7: PFOS-related substances Control under Thai Hazardous Substance Act

No.	Substance Name	CAS No	Category	Started
1.	Sulfluramid	4151-50-2	3	2013
2.	Perfluorooctane sulfonic acid (PFOS)	1763-23-1	3	2017
3.	Didecyldimethylammonium perfluorooctane sulfonate	251099-16-8	3	2017
4.	Diethanolammonium perfluorooctane sulfonate	70225-14-8	3	2017
5.	Tetraethylammonium perfluorooctane sulfonate	56773-42-3	3	2017
6.	Perfluorooctane sulfonyl fluoride	307-35-7	3	2017
7.	Potassium perfluorooctane sulfonate	2795-39-3	3	2017
8.	Lithium perfluorooctane sulfonate	29457-72-5	3	2017
9.	Ammonium perfluorooctane sulfonate	29081-56-9	3	2017

Source: Ministry of Industry's Notification on List of Hazardous Substances B.E. 2556 and B.E. 2560

In addition, a project, funded by the Global Environment Facility (GEF), on "Application of Industry-Urban Symbiosis and Green Chemistry to reduce releases of POPs and hazardous chemicals as well as GHG emissions, to support inclusive and sustainable growth" is ongoing from 2019 to 2023. This project also includes a pilot study on the management of PFOS, its salts and PFOSF.

2.3.9 Assessment of Unintentional POPs (Annex C)

1) Assessment of unintentional POPs (uPOPs)

In 2019, Thailand conducted a uPOPs inventory assessment covering relevant activities that took place in Thailand during the baseline year 2017. The assessment closely followed the methodology and emission factors (EFs) as given in the latest version (2013) of the UNEP Toolkit, which covers 4 uPOPs (PCDDs/PCDFs, PCBs, and HCB). This 2017 uPOPs study covers the assessment of all 9 of UNEP-identified potential source groups, which are further divided into 74 source categories and 237 technology/activity classes.

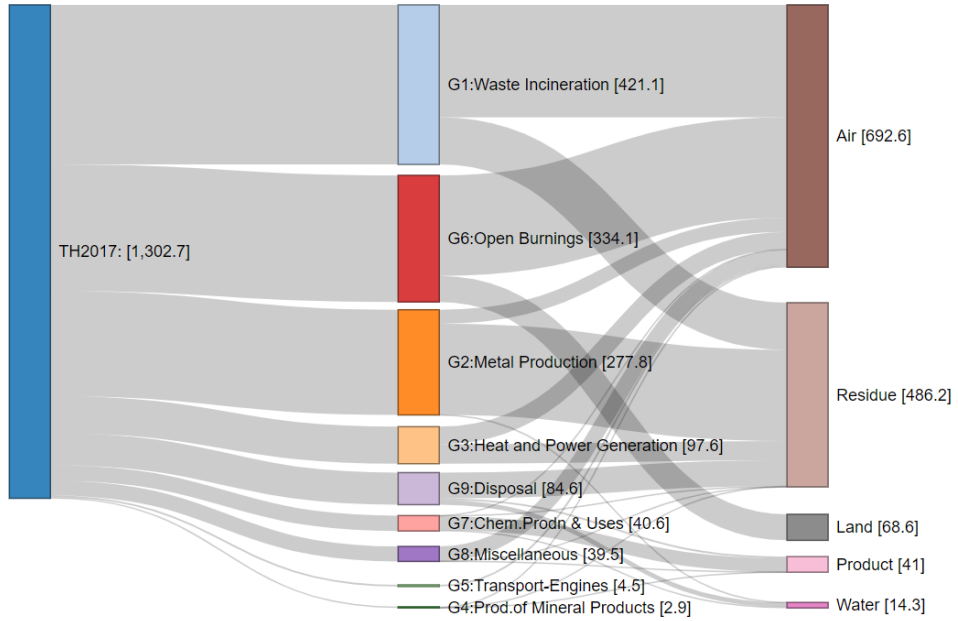
An overview of the estimated PCDD/Fs emissions in Thailand for the baseline year 2017 is shown numerically in Table 8 and visually in Figure 14, where emissions into air, water, land, products, and residues are 692.6, 14.3, 68.6, 41.0, and 486.2 g TEQ/a, respectively – totaling to an overall emission of 1,303 gTEQ/a.

Table 8: Overview of the estimated PCDD/Fs emissions in Thailand in 2017

	Source Groups	Annual Releases (g TEQ/a)						Destruction (g TEQ/a)
		Air	Water	Land	Product	Residue	Subtotal	
G1	Waste Incineration	296.8	0.0	0.0	0.0	124.3	**421.1**	-
G2	Ferrous and Non-Ferrous Metal Production	37.0	0.2	0.0	0.0	240.7	**277.8**	**-21.59**
G3	Heat and Power Generation	46.4	0.0	0.0	0.0	51.2	**97.6**	-
G4	Production of Mineral Products	2.9	0.0	0.0	0.1	0.0	**2.9**	-
G5	Transportation	4.5	0.0	0.0	0.0	0.0	**4.5**	-
G6	Open Burning Processes	265.5	0.0	68.6	0.0	0.0	**334.1**	-
G7	Production of Chemicals and Consumer Goods	0.2	2.2	0.0	36.4	1.8	**40.6**	-
G8	Miscellaneous	39.3	0.0	0.0	0.0	0.2	**39.5**	-
G9	Disposal	0.0	11.9	0.0	4.6	68.0	**84.6**	-
	Total	**692.6**	**14.3**	**68.6**	**41.0**	**486.2**	**1302.7**	**-21.59**
	Grand Total			**1,303**			**1,281**	

Source: Thailand's 2017 uPOPs Inventory, March 2020
Note: Figures in this table have been rounded to increase their legibility. Some subtotals may not correspond to the sums of the separate figures.

Figure 14: Profile of the estimated PCDD/Fs emissions in Thailand in 2017 (unit: g TEQ/a)



Source: Thailand's 2017 uPOPs Inventory, March 2020

The three highest emission source groups are G1: Waste Incineration (421.1 gTEQ/a), G6: Open Burning Processes (334.1 gTEQ/a) and G2: Ferrous and Non-Ferrous Metal Production (277.8 gTEQ/a). These source groups contribute to 32%, 26% and 21% of Thailand's total PCDD/Fs emission in 2017, respectively.

a) G1: Waste incineration

High releases from MSW incinerators were mostly (63% of all emission from G1) contributed by 57 small and inefficient incinerators. While these incinerators helped dispose of only about 0.3% of Thailand's MSW in 2017, they were responsible for 20% of the country's total PCDD/Fs release.

b) G6: Open burning processes

The burning of agricultural residues in paddy and maize fields is the main contributor for this source group, responsible for about 20% of country's total PCDD/Fs release. The high level of PCDD/Fs released resulted from the combination of the high activity rates, the relatively poor combustion efficiency, and the involvement of chlorinated herbicides.

c) G2: Ferrous and Non-Ferrous Metal Production

The main PCDD/Fs emissions from metal production is the release into residues, which accounts for about 87% of the total release from this source group in 2017. Emission from metal production ranks third in the 2017 uPOPs inventory, with about 241 gTEQ/a released into residues; the transfer and management of which was controlled by Thai law. With an improved waste transfer reporting system, a large portion of residues from metal production plants could be traced. Some (21.6 gTEQ/a) of the PCDD/Fs embedded in these residues were destroyed via incineration in cement kilns.

d) G3: Heat and Power Generation

Heat and power generation contributed 98 gTEQ/a (7.5%) to Thailand's 2017 total PCDD/Fs emission, with about 48% and 52% released into air and residues, respectively.

Although ranked 4th for PCDD/F emission, this source group is of high importance due to its close tie to the country's Climate Change Master Plan and Sustainable Development Goals. While biomass has been widely regarded as a green energy source with low carbon footprint, relatively high PCDD/F emission contribution from biomass (73% of this source group total) deserves national attention. Biomass is a major part of Thailand's renewable energy portfolio. Diverting unused biomass residues from agricultural fields to power plants also helps curb biomass open burning problems. However, attention should also be paid to ensure that the risks from unintended PCDD/Fs generation/emissions are under control. Particularly, research and development into new power plant/combustion technology with low PCDD/Fs generation should be promoted. Moreover, due to potentially high PCDD/F emissions into residues coupled with potentially high amounts of residue generation from biomass power plants, technology for the ultimate destruction of PCDD/Fs will be needed. Note, however, that PCDD/F in ashes from biomass is normally low and can be brought back to soil as fertilizer. However different processes and different biomass have different PCDD/F formation potential and different types of residues: bottom, boiler and filter ash. For facility with efficient air pollution control system (APCs), dioxins and heavy metals are most likely captured in filter ash. Therefore, research into PCDD/F in ashes and their use should be conducted.

2) Comparison to emissions in 2004

In 2006, Thailand reported total emission of 1,096.7 g TEQ/a for the 2004 reference year, using the 2005 version of UNEP Toolkit's methodology and EFs. The 2006 report was Thailand's first attempt to assess its national PCDD/Fs emissions, covering 8 source groups with 31 source categories and 53 unique activity entries. The same set of activities leads to a total emission of 336.5 g TEQ/a when recalculated using the lastest (2013) UNEP Toolkit's EFs.

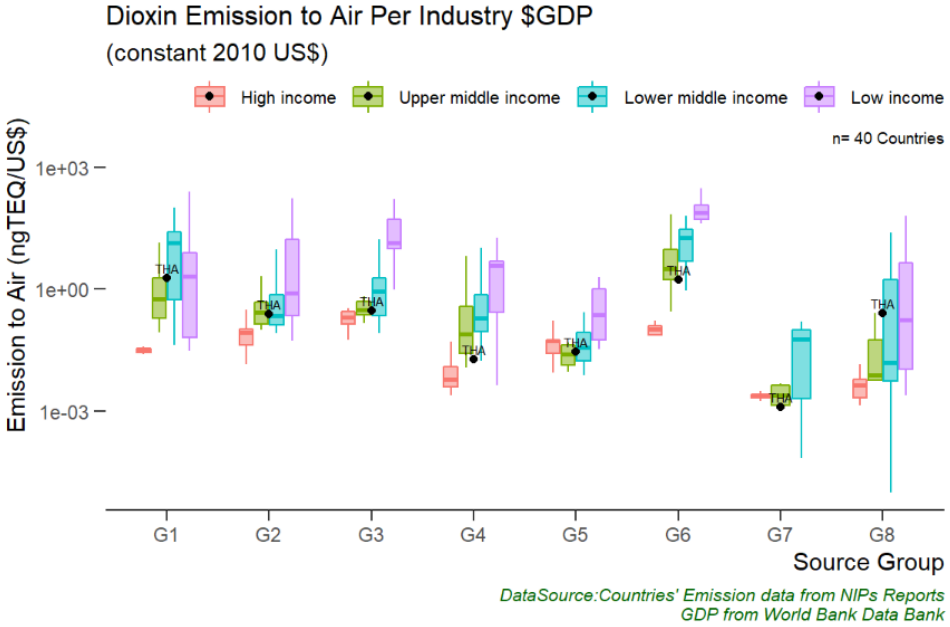
Since the current uPOPs inventory study assesses PCDD/Fs from 9 source groups with 74 source categories and 237 technology/activity classes, the net results from these two baseline years (2004 and 2017) cannot be directly compared. However, when comparing similar sources per unit activity, the emissions per unit activity from several source categories are declining. Activities that were identified with high releases potential were improved and, hence, received better class allocations. Unfortunately, new activities with poor technologies also have concurrently been taking place, leading to only a moderate improvement in the overall national performance. It is, therefore, important to lay down measures to prevent installation of new plants/activities with inferior technology and, instead, to promote the adoption of BAT & BEP.

3) Comparison with emissions from other countries

Figure 15 compares Thailand's dioxin emission to air per unit industry $GDP with 40 other countries based on income level. Thailand's overall results compare well with those from other upper-middle income countries.

Thailand's emissions from Source Groups 4, 6 and 7 were on the lower range among the upper-middle income group, while emissions from Source Groups 1 and 8 were on the high range. As previously stated, the main emission from Source Group 1 was from the improper MSW incineration, while crematoria were responsible for the high emission from Source Group 8.

Figure 15: Thailand's PCDD/Fs emission into air per industry $GDP in comparison with 40 other countries based on income level



Source: Thailand's 2017 uPOPs Inventory, March 2020

4) uPOPs Management

In Thailand, there are five air emission standards for dioxins/furans from different sources, as follows[40]:

1) A maximum of 0.1 ng I-TEQ/Nm^3 for new waste incinerators with capacities over 50 tonnes per day, and a maximum of 0.5 ng I-TEQ/Nm^3 for older waste incinerators (any size) and new incinerators with capacities of 1-50 tonnes per day.
2) A maximum of 0.5 ng I-TEQ/Nm^3 for industrial hazardous waste incinerators.
3) A maximum of 0.5 ng I-TEQ/Nm^3 for infectious waste incinerators.
4) A maximum of 0.5 ng I-TEQ/Nm^3 for industrial incinerators fueled with processed used oils or synthetic fuels.
5) A maximum of 0.5 ng I-TEQ/Nm^3 for cement plants using waste as fuel or raw materials for production.

Additionally, the PCD issued the Notification on Guidance on Efficient Management of Municipal Waste via Incinerators, dated 26 September 2018, to provide guidelines for the reduction of dioxins/furans from municipal waste incinerators.

[40] Note that all air emission standards in Thailand are prescribed on dry air basis at 7% excess O_2 and 25°C, while the UNEP Toolkit quotes emission concentrations at 11% excess O_2 and 0°C. Concentrations in air expressed at 7% O_2 will be approximately 1.4 times the values expressed at 11% O_2. Similarly, limit values expressed at 7% O_2 will be lowered by a factor of 1.4 times when expressed at 11% O_2. Unless otherwise indicated, all air emission values in this report are based on the Thai standard condition: 7% O_2, 25°C, and 1 atm.

On the implementation of Best Available Techniques and Best Environmental Practices (BAT/BEP), Thailand participates in the Eastern and Southeast Asia Regional BAT/BEP Forum (ESEA Regional BAT/BEP Forum) and has joined the following programs: 1) Demonstration of BAT and BEP in fossil fuel-fired utility and industrial boilers in response to the SC on POPs in ESEA region, with United Nations Industrial Development Organization (UNIDO), during 2010-2016; 2) Regional plan for introduction of BAT/BEP strategies to industrial clusters of Annex C of Article 5 sectors 2 in ESEA region,with UNIDO, during 2010-2016; and 3) Greening the scrap metal value chain through promotion of BAT/BEP to reduce U-POPs releases from recycling facilities, with UNIDO, during 2018-2023. In addition, the translation of BAT/BEP manuals was carried out for emission sources including industrial boilers, steel and metal plants, and crematoria, for distribution to business operators and the public.

On dioxins/furans awareness-raising, Thailand has organized campaigns on relevant issues and disseminated information on the impacts of dioxins/furans to human health and the environment, as well as on how to reduce their emissions, so that the youth, business operators, and the public are aware of their hazards. Educational modules have been designed for graduate study, while short training courses are held by Chulabhorn Research Institute and the Ministry of Education. Campaigns on reduction of these pollutants are carried out regularly together with other media campaigns by the PCD and the DEQP, under MNRE.

On the capability of dioxins/furans analysis, there are public and private laboratories in Thailand with dioxins/furans testing capacity. Among these are the 3 government facilities: (1) the National Dioxin Laboratory, established in 2012 and run by the DEQP (MNRE), has scientific equipment and readiness for analyzing dioxins/furans in the environment; (2) the Dioxin Laboratory, established in 2010 and run by the Department of Medical Services, MOPH, has capacity to analyze dioxins/furans in food and living samples; and (3) the Bureau of Quality control of Livestock Products, DLD (MOAC), has capacity to analyze dioxin/furans and PCBs in feed and fats.

2.3.10 Obsolete stockpiles, contaminated sites and waste

1) Stockpile of POPs pesticides

Based on Thailand's first inventory assessment report, there were about 220 kg of obsolete initial SC POPs Pesticide stockpiles in the country in 2004. During 2010-2013, the PCD conducted a follow-up inventory of obsolete SC POPs pesticides and found a combined 54 kg of chlordane in DOA's and DOAE's custodies, and 7 liters of dieldrin in DOA's custody. A subsequent survey in 2018 found about 31 kg of chlordane remained in DOAE's custody, pending final disposal. All of the obsolete SC POPs pesticides previously held in DOA's custody have been collected and destroyed in an environmentally sound manner by industrial waste incineration.

In 2017, approximately 0.9 tonnes of lindane remained in the custody of a pharmaceutical company (pending final disposal) as a result of the firm's voluntary withdrawal of license as a result of the removal of the substance from the National List of Essential Medicines for treatment of scabies and lice in humans in 2015.

2) Stockpile of POPs Industrial Chemicals

- **c-pentaBDE and c-octaBDE**

Stockpiles of c-pentaBDE and c-octaBDE in Thailand are assumed to be zero because the worldwide production was ceased more than 15 years ago and there is no record of these substances ever being imported into the country. Thailand's only involvement with c-pentaBDE is believed to be through imports of transport vehicles that may have contained c-pentaBDE, possibly in their seats and interior fabrics. These contaminated materials are believed to have reached their end-of-life and been discarded as municipal solid waste.

Based on Thailand's 2019 POPs Industrial Chemicals Inventory report, c-octaBDE was found in some ABS housing of high-end computer monitors produced during the 1990s. The total amount of octaBDE in the affected ABS is estimated at 12 tonnes, of which about 300 kg are believed to still remain in hibernation.

- **c-decaBDE**

Unlike the other SCs industrial POPs, worldwide production and sales of c-decaBDE have not yet ceased. Due to the non-unique import classification code, the total amount of c-decaBDE that has been imported into Thailand is unknown.

Based on Thailand's 2019 POPs Industrial Chemicals Inventory report, c-decaBDE was found in polystyrene (PS) housings of TV CRT monitors produced before 2006. The total amount of c-decaBDE in this application is estimated at 920 – 1,500 tonnes. About half of this amount is believed to have already been disposed of, leaving about 500-820 tonnes remaining 'in-stock' in the in-use and in-hibernation products.

Housings of end-of-life (EOL) TV CRTs that arrive at e-waste dismantling shops are mostly recycled. Shredded chips and plastic pellets obtained from these recycling activities are returned back to the material cycle. The affected materials are mostly black flame-retarded (also known as V0 grade) PS. Based on the inventory, most of the recovered materials are believed to be exported – previously as shredded chips, and currently as plastic pellets.

Based on the 2019 inventory assessment, decaBDE finds other uses in upholstery and drapery textiles, rubber and silicone parts, including interior textiles and underhood parts in passenger cars. It is not known whether these flame-retarded materials were imported or locally produced, and their sources should be investigated. If these decaBDE-affected materials were locally produced, the sites of production should be assessed for contamination. Based on the inventory, cumulative amount of c-decaBDE in impregnated fabrics that are in use-phase is estimated at 3 tonnes. However, c-decaBDE in motor vehicles is not yet included in this figure, and should be assessed.

- **HBCD**

Based on Thailand's 2019 POPs Industrial Chemicals Inventory report, HBCD was no longer imported into Thailand since 2017. Before the phase-out of HBCD, the shipments of the imported HBCD were transported from the port directly to the customers, resulting in zero stockpile of HBCD at distributor's warehouse. HBCD may be indirectly imported in SE-grade EPS beads. However, due to the absence of a unique product tariff code, the import/export amount of SE-grade EPS beads cannot be determined. The total amount of

HBCD-contaminated SE-grade EPS is estimated at 175,000 tonnes, with the corresponding amount of HBCD of about 1,300 tonnes [890-1,770 tonnes]. Most of the relevant amounts of HBCD are believed to remain within SE-grade EPS foams, which are currently in the use phase.

- **HCBD**

HCBD in transformer oils and hydraulic fluids in Thailand has never been studied. There is no information about HCBD in these oils at this time. Since HCBD can be screen-tested in a cost-effective manner, potentially contaminated oil and fluids can be checked for HCBD. Indeed, high-chlorine oils that were previously checked for PCB contaminations are considered to also have been checked for HCBD contamination.

- **PCBs**

Thailand banned PCBs by listing them as Category 4 substances under the HSA in 2003 and 2004, respectively. The ban covers all activities, including the production, import, export, or possession of PCBs. The ban also covers devices that contain PCBs. PCB containing transformers were collected and exported to capable countries (France, the Netherlands, etc.) for final destruction. Nevertheless, the effectiveness of the actions has not been evaluated. Therefore, PCB-containing devices should be randomly checked at electricity generation sites.

- **PCNs**

The former uses of PCNs in closed and open applications were identical to the uses of PCBs. In 2013, DIW designated wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCBs), polychlorinated terphynyls (PCTs), polychlorinated naphthalenes (PCNs) or polybrominated biphenyls (PBBs), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more, as chemical wastes which are also classified as Category 3 hazardous substances that require prior approval from the DIW. There is no record or data related to the use of PCNs in Thailand.

For PCNs in closed applications: since former uses of PCNs in closed applications are identical to the uses of PCBs, measures taken to address PCBs in closed applications should have also covered PCNs. Also, since the methods recommended to electricity authorities to identify PCB-containing transformers and capacitors (year of manufacture, the word “Non-inflammable Oil”, the density, the chlorine contents, etc.) are not specific to PCBs, devices with PCNs should also have been collected and submitted to final destruction as PCBs.

For PCNs in open applications: since the major use of PCNs was almost 100 years ago, products that might have PCNs are most likely to have reached their end-of-life. Unlike the situation in developed countries, the mass production and consumption of electricity and electric machines/equipment in Thailand did not start until after World War II. It is unlikely to find houses with electric cables produced during 1920s to 1960s in Thailand. On the other hand, corrosion protection paints for metal constructions such as bridges, towers, ships, pressure pipes, etc. may have contained PCNs. The UNEP guidance suggests that metal construction built before 1980 should be compiled. Therefore, information on anti-corrosion paints should be documented, including whether the constructions have been (partly) sand blasted to remove paints.

Note that former uses of PCNs are also identical to the uses of short-chain chlorinated paraffins (SCCPs) and PCBs. The inventory assessment study for PCNs (as well as PCBs uses in open applications) should be conducted together with the study for SCCPs.

- **PeCB**

There is no record to suggest that PeCB was ever produced in Thailand. Except for small amounts imported for research/laboratory purposes in 2018, there is no information to whether PeCB has ever been imported into Thailand. PeCB may have been indirectly imported in the past as an impurity in PCBs oils. However, since PCBs oils as well as PCB-containing devices were required by the DIW's 2008 notification to be properly disposed by 2012, PeCB from this source is therefore presumed to be zero.

- **PFOS, its salt and PFOSF**

PFOS may have been previously used in Thailand in textiles (possibly mainly for export-oriented products), paper (food packaging), metal plating, and firefighting foams applications. Most export-oriented firms have phased-out PFOS since 2009 as a result of the publication of EU's PFOS Directive. However, some small plating companies still cannot phase-out the use of PFOS; the remaining demand for PFOS for plating application is estimated at 300-400 kg per year. Stockpiles of PFOS-containing foams are in petroleum refineries and oil depots that imported them before 2009. Based on the amount of firefighting stock required by law, the amount of PFOS remaining in relevant firefighting foams is estimated at 3,700 – 5,500 kg.

3) Contaminated sites and waste

Emission of industrial POPs occurs throughout the life cycles of relevant products: all sites where the manufacture products and articles containing industrial POPs (or the use of POPs-containing process chemicals), the use of these products, recycling, and the end-of-life treatment of these products have taken place are potentially contaminated. Based on the 2019 POPs Industrial Chemicals Inventory report, the lack of data on the flow of POPs BFR-affected materials/parts along supply chain has made it impossible to identify possible contaminated sites along the pre-consumer value chain. Emissions from other unconfirmed sources, such as plastic compounders and flame-retarded textile finishers, are also possible. If these activities exist, emissions from these facilities (particularly residues, WWTP sludge and effluent water) can be significant as seen in other countries.

In addition, residues and effluent water from treatment plants from the following activities may be contaminated with PFOS: metal plating, textile finishing, paper finishing, and central wastewater treatment plants in relevant industrial estates. Effluent from these relevant sites should be analyzed for potential contamination with PFOS.

Regarding PCBs, PCB-containing devices were decommissioned and all PCBs oils were reportedly disposed of according to the UNEP's POPs waste guidance. However, since PCBs are highly persistent, areas where PCB-containing transformers and capacitors were installed, repaired and/or reconditioned, stored, and decommissioned may be contaminated with PCBs. These areas should be assessed and levels of PCBs contaminations should be appropriately evaluated and documented. Moreover, since former uses of PCNs in closed applications are identical to the uses of PCBs, measures taken to address PCBs in closed applications should also cover PCNs.

Regarding pesticides, most POPs pesticides have been banned as Category 4 HSs under the HSA. During 1981-2004, all of the 9 POPs pesticides were successively banned, and during 1993-2012, 6 of the 7 new SC POPs pesticides (except PeCB) were banned by all three HSA enforcement agencies (DOA, FDA, and DIW). The ban covers all activities, including the production, import, export or possession thereof. And since Thailand has never produced these POPs pesticides, potential sites that may still be contaminated are associated with historical post-import activities.

In terms of uPOPs, the current (2013) UNEP Toolkit suggests 13 potential categories (10a to 10m) of "Contaminated Sites and Hotspots" in its Source Group 10. According to the findings of Thailand's 2017 uPOPs Inventory Asessment, potentially relevant contaminated sites and activities in Thailand include: chlorine (chlor-alkali) and chlorinated organics (chlorinated paraffins) production sites, application sites of PCDD/F-containing chemicals (dyes and pigments) and pesticides, textile and leather factories, sites of former PCB use and storage, production (pulp & paper) using elemental chlorine, waste incinerators, metal production sites (including cable/e-waste burning), fire accidents, dredging of sediments, landfills and dump sites, and ball clay & kaolin clay sites. Beyond the above UNEP Toolkit-listed sites and activities, other potential uPOPs contaminated sites also described here are associated with other key uPOPs emission sources that have been establised by Thailand's 2017 uPOPs Inventory. These sources and their associated contaminated sites are also important to Thailand's POPs context, for examples, crematoria and open burning of agricultural biomass.

The followings are potential activities that may have contributed to POPs contaminated sites in Thailand:

a) E-waste dismantling, plastic shredding and recycling

As plastic resins extracted from housings of e-waste are an important source of income for e-waste dismantlers, EOL TVs are dismantled, and their PBDEs-affected housings are shredded at e-waste recycling facilities. Based on the inventory, PBDE emission in the form of dust was prominent as levels of PBDEs in recycling facilities were detected on the high range, possibly contributed by dismantling and shredding of PS from CRT TVs. Unless there is a major change in the recycling technology and/or practices to reduce dust emission in these operations, plastic recycling activity will continue to be an important source of decaBDE emission into the environment for the next 10 years. Therefore, the sites of these activities should be assessed for contamination.

In terms of uPOPs, PCDD/F emissions from thermal wire reclamation and e-waste recycling, particularly open burnings of halogenated cables and circuit boards, can be very high, both to air and to soil. It should be noted also that the extent of open burning of cables and e-waste in the past could have been much higher than the values reported for 2017 uPOPs Inventory, due to the increase in public awareness of the negative impacts and the associated improvement in the practise over the years. Thus far, there has been no study to assess levels of PCDD/Fs and other uPOPs releases from thermal wire reclamation and e-waste recycling activities in Thailand. However, PCDD/Fs have been detected in chicken eggs taken from free-range chickens raised in/near areas known to have burned cables [Petrlik et.al., (2017)[41]], indicating a cause for

[41] J. Petrlik, et.al, "Chicken Eggs as an Indicator of POPs Pollution in Thailand: Results of sampling conducted in 2015 – 2016", Arnika, Bangkok - Prague, 2017

concern. Therefore, areas with cable and e-waste burning practise, both historical and current, should be regarded as likely contaminated sites and the levels of PCDD/Fs and other UPOPs should be investigated.

b) Pesticides-related contamination sites

Most POPs pesticides (except PeCB) have been banned as Category 4 hazardous substances for several years. Since Thailand has never produced any POPs pesticides, potential sites that may still be contaminated are associated with historical post-import activities, including facilities where these pesticides were repackaged, and well as their storage sites. Therefore, the locations of such sites should be identified, and POPs pesticide residues in soil and groundwater near these sites should be studied.

In terms of uPOPs, as described in the 2017 uPOPs Inventory (Source Group 7), several chlorinated aromatic pesticides may contain PCDD/Fs, especially those produced using old technologies. Unfortunately, current pesticide management system in Thailand does not yet allow for the tracing of the high-use/high-risk areas, nor are there established systems to monitor the releases of PCDD/Fs into the environment. Therefore, pesticides with high risks of PCDD/F contamination should be compiled and a pesticide tracing system (spatial and temporal) should be developed to enable an intelligence-based monitoring system for current and future substances of concerns.

c) Textile and leather production

Based on the 2019 POPs Industrial Chemicals Inventory assessment report, decaBDE finds uses in upholstery and drapery textiles. It is not known whether these flame retarded materials are imported or locally produced. Thus, the sources of these textiles should be investigated. If these decaBDE-affected materials are locally produced, their sites of production should be assessed for potential contamination. In addtion, as another group of textile finishing chemicals, the contamination of PFOS and related substances should also be similarly investigated.

Textile and leather factories use several chemicals that may be contaminated with PCDD/Fs and other uPOPs, including chemicals used for tanning and finishing, dyes and pigments, as well as incidental chemicals such as organochlorine biocides in raw hides and raw fibers. UPOPs may also be unintentionally produced via bleaching processes and/or burning of residues. High PCDD/F releases into air, wastewater, sludge, and products can be anticipated. However, due to the lack of measurement data, the estimation of the releases of PCDD/Fs into these vectors has not been possible. It is therefore necessary that PCDD/Fs releases from this industry be systematically studied to investigate the potential magnitude of contamination in Thailand.

Note that areas with high concentration of textile and leather factories also coincide with other potential uPOPs contaminated sites, such as chlorine (chlor-alkali) and chlorinated organics (chlorinated paraffins, EDC) production sites, and production sites (pulp & paper) using elemental chlorine. It may be beneficial to consider simultaneous studies of several potentially contaminated sites that are located in the same vicinities.

d) Landfills and waste dumps

Industrial POPs-affected waste may be disposed in landfill, possibly resulting in contamination, e.g., reported detection of PBDEs in leachate from a MSW dumpsite

[Kwan et al. (2013)[42]]. Based the 2019 POPs Industrial Chemicals Inventory report, c-pentaBDE-affected automobile seats and interior textiles are believed to have been discarded as MSW, and could possibly have been landfilled. Residues generated during e-waste management could also be disposed of by landfill. Moreover, since Thailand has not yet enacted WEEE regulation, other POPs contaminated waste and residues, such as residues from e-waste management and off-cuts from HBCD-containing SE-grade EPS foams, are also believed to have been discarded as MSW. Assuming that open burnings are no longer practiced after 2018 as a result of the implementation of the national MSW management master plan, increasing amount of POPs containing wastes and residues will be diverted to and stored in landfills in the next 10 years. This industrial POPs storage further increases risks over the life cycle of the landfills, particularly from the releases of brominated flame retardants into landfill gas or landfill leachate, and the unintended formation and releases of brominated dioxins and furans from incomplete combustion and smouldering during landfill fires.

Several activities release high amount of PCDD/Fs and other uPOPs into residues and waste. While some of these residues are destroyed in cement kiln, the majority are believed to be disposed of in waste dumps and landfills. Currently, Thailand still has no regulatory requirement to monitor the releases of PCDD/Fs and other POPs from landfills, nor are there requirements to keep inventory of residues and waste stored in each site.

In case of disposal in secure landfill, POPs within residues and waste are likely to outlive landfill liners. These engineered landfill systems will eventually lose their ability to contain POPs, which further underlines the need to establish a system for deposition inventory of waste in landfills and waste dumps to aid future management, including excavation and mining.

e) Additional activities that generate uPOPs-contaminated residues not destined to landfills

According to Thailand's 2017 uPOPs inventory assessment, several activities released significant amounts of PCDD/F and other uPOPs into their residues. The production of metals, especially aluminum and iron/steel, is the activity group that released the largest amount of PCDD/F into residues. Some of the uPOPs embedded in these residues were destroyed via incineration in cement kilns, while the majority of the residues were used for other purposes and could not be traced further. Waste incineration was the next major activity that generate large amount of uPOPs-contaminated residues, mostly from improper MSW incineration and followed by medical waste (MW) incineration. Power generation makes up the third activity group, with PCDD/F release into residues from biomass power plants and fossil-fuel power plants estimated at 28.4 and 20.7 gTEQ/a, respectively.

Despite the supposedly high levels of uPOPs contamination, there has been no report or study to assess the actual contamination levels in these residues in Thailand. Thus, such assessment should be made a priority. Also, areas that receive residues from these activities should be regarded as potentially contaminated sites. Apart from residues from industrial settings that are managed under the Factory Act, there is currently no

[42] C. Kwan, et al., PBDEs in leachates from municipal solid waste dumping sites in tropical Asian countries: Phase distribution and debromination, Environ Sci Pollut Res (2013) 20:4188–4204

system to keep track of the amounts and the movement of residues from their generation sources to their final destinations. Such a system is necessary to ensure that uPOPs-contaminated residues will be disposed of in environmentally sound manners.

It is noted that the 2013 UNEP Toolkit does not yet account for water releases from wet scrubbers. Therefore, water releases from these activity groups should also be assessed. In addition, areas immediately surrounding these facilities should also be considered potentially contaminated due to the relatively high levels of uPOPs emission into air.

As a case in point, sludge residues from pulp and paper production process may be approved for uses as soil conditioners, provided that they do not possess hazardous characteristics, including having dioxin (2,3,7,8-TCDD) contents below 10 μg/kg. Since the application to land (especially if repeated over time) can result in the contamination into the food chain, it is imperative to assess the levels of uPOPs in pulp and paper sludge (both from the old Cl_2 and the modern ClO_2 bleaching technologies), as well as other types of residues that are utilized for soil conditioning.

f) Production of chlorine (chlor-alkali, CAK) and chlorinated organics (chlorinated paraffins, CPs and ethylene dichloride, EDC)

Manufacturing of chlorine using graphite anodes can release significant amounts of uPOPs into residues. Although all of the registered CAK production plants in Thailand (located in Rayong and Samut Prakan Provinces) are currently based on membrane technology with titanium electrodes for their chlorine productions, graphite anodes may have been used in the past. Therefore, historical uses of graphite anodes should be investigated. If found relevant, the possible contamination/deposition into land and sediments in nearby rivers should be assessed.

Thailand has never had production sites for any chlorinated aromatic chemicals or chlorinated solvents. However, there are two chlorinated paraffins (CPs) plants built in the 1980s (in Rayong and Samut Prakan Provinces). Based on UNEP 2013 Toolkit's relatively high emission factors of PCDD/F, PCB, and HCB for chlorinated paraffins, CP production plants and nearby environment should be assessed for possible contamination of the relevant uPOPs. Thailand also has production sites for ethylene dichloride (EDC), as part of the polyvinyl chloride production process. According the the UNEP Toolkit, oxychlorination of ethylene to make EDC is a potential source of HCBD, PCDD/F, and other uPOPs which would be released into wastewater effluent. EDC production sites are located in Rayong Province, and, like CP and CAK productions, should also be assessed for uPOPs contamination.

g) Wastewater treatment

PFOS has been detected in the effluents from central industrial wastewater treatment plants of industrial zones, as well as in groundwater, surface water and tap water, with concentration levels that appeared to correlate with the areas where PFOS may have been used, e.g. Samut Prakarn and Rayong Provinces.

Since there has been no regulatory requirement to control the release of PFOS from factories, neither firms nor industrial estates have analyzed/reported PFOS in their effluent water, WWTP sludge, or residues. Residues from WWTP may be disposed of in landfill or burned in incinerators, depending on the waste characteristics (and factory

type). Moreover, upon prior approval from the responsible authority, WWTP residues may be used as biosolids for soil conditioning. Nevertheless, since wastes/residues from metal plating and textile finishing are likely to contain other toxic metals/chemicals, they are unlikely to be approved to be used as biosolids. However, the fate of PFOS carried over in effluent water to industrial estates' central WWTP is still unknown, and should be investigated.

h) Other relevant activities

Additional activities that have potentially contributed to uPOPs-contaminated sites in Thailand include, for examples, crematoria, open burning of agricultural biomass, dredging of sediments, and accidental fires. Thailand's 2017 uPOPs inventory estimates that open burning of rice paddies, maize, and sugarcane released about 223 and 67 gTEQ/a of PCDD/F into air and into land, respectively. Due to these high levels of the estimated emissions and their implications for the country's food production, the associated potential contaminated sites should be urgently assessed and managed. Crematoria have collectively been a known source of PCDD/F emission in Thailand, and areas in the vicinity of certain crematoria appear to be contaminated according to a limited number of existing studies [Hatfield (2010)[43]]. Along with planned efforts to upgrade the country's crematoria, further studies should also be made to assess areas surrounding crematoria for uPOPs contamination.

Regarding sediment dredging, unlike the regular pesticide contamination monitoring in water and sediments (by the DOA), no analytical data is available on the contamination of uPOPs and other POPs in dredged sediments in Thailand. It is thus imperative to assess the level of uPOPs and other POPs (as well as other toxic chemicals such as toxic metals) in this media both to document the level of contamination over time and to prevent unintentional relocation/contamination of POPs to new areas, particularly areas used for agriculture and residential housing.

In terms of accidental fires, Thailand still has no system to record the details of chemicals burned during fire accidents, neither are there records of the amounts of PCDD/F or other uPOPs released from these incidents. Therefore, a guideline for responding to fire accidents with potential for high uPOPs releases should be developed, samples (soot) from high-risk fires should be collected and analyzed, and a guideline for proper clean-up actions should be provided to ensure safety to human health and the environment.

Sites contaminated with POPs substances represent important sources of potential human exposure. While relevant activities may have been commenced years ago and the relevant areas/sites may have already been repurposed, and/or covered with other structures/constructions, due to the persistent nature of POPs, these areas/sites may still act as sources for POPs. However, except for power transformers/capacitors installation sites, relevant industrial activities were historically clustered in/around industrial areas in 2-3 provinces near Bangkok. These areas should be investigated for possible contamination with all relevant POPs (as well as other pollutants, such as mercury and other toxic metals). This area-based approach to identify contaminated sites could effectively facilitate efforts to simultaneously address all relevant POPs

[43] Hatfield Consultant, "National Inventory of Crematoria and Preliminary Design of Central Crematorium Facility in Thailand: Final Report" 2010.

toward better understanding of the problems, mitigating the risks, and eventual rehabilitation. Subsequently, POPs substances that are found relevant will then be further investigated in detail.

2.3.11 Registration for specific exemptions and acceptable purposes

The SC prescribed obligations to eliminate and restrict chemicals under Annexes A and B of the Convention, specifically on production and uses, including import and export. However, Annexes A and B to the Convention also set forth a number of specific exemptions for which Parties may register in accordance with Articles 3 and 4 of the Convention. If at any time there are no Parties registered for a given specific exemption, no new registrations may be made in respect of that exemption. As of the end of December 2019, there are specific exemptions for 10 substances for which Parties may register, as summarized in Table 9.

Table 9: Specific exemptions for POPs substances listed in Annex A

	POPs Substances	Activity	Specific exemptions
1	Decabromodiphenyl ether (BDE-209)	Production	As allowed for the Parties listed in the Register of Specific Exemptions
		Use	In accordance with the provisions of Part IX of Annex A
2	Hexabromocyclododecane (HBCD)	Production	As allowed for the Parties listed in the Register of Specific Exemptions in accordance with the provisions of Part VII of Annex A of the Convention
		Use	Expanded polystyrene and extruded polystyrene in buildings in accordance with the provisions of Part VII of Annex A
3	Hexabromo- and heptabromodiphenyl ether	Use	Articles in accordance with provisions of Part IV of Annex A
4	Pentachlorophenol and its salts and esters	Production	As allowed for the Parties listed in the Register of Specific Exemptions in accordance with the provisions of Part VIII of Annex A
		Use	Pentachlorophenol for utility poles and cross-arms in accordance with the provisions of Part VII of Annex A
5	Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds	Production	Fire-fighting foam: None. For other production, as allowed for the Parties listed in the Register in accordance with the provisions of Part X of Annex A
		Use	In accordance with the provisions of Part X of Annex A
6	Polychlorinated biphenyls (PCBs)	Use	Articles in use in accordance with the provisions of Part II of Annex A
7	Polychlorinated naphthalenes, including dichlorinated naphthalenes, trichlorinated naphthalenes, tetrachlorinated naphthalenes, pentachlorinated naphthalenes, hexachlorinated naphthalenes, heptachlorinated naphthalenes, octachlorinated naphthalene	Production	Intermediates in production of polyfluorinated naphthalenes, including octafluoronaphthalene
		Use	Production of polyfluorinated naphthalenes, including octafluoronaphthalene
8	Short-chain chlorinated paraffins (Alkanes, C10-13, chloro)	Production	As allowed for the Parties listed in the Register
		Use	• Additives in the production of transmission belts in the natural and synthetic rubber industry

	POPs Substances	Activity	Specific exemptions
			• Spare parts of rubber conveyor belts in the mining and forestry industries • Leather industry, in particular fat-liquoring in leather • Lubricant additives, in particular for engines of automobiles, electric generators and wind power facilities, and for drilling in oil and gas exploration, petroleum refinery to produce diesel oil • Tubes for outdoor decoration bulbs • Waterproofing and fire-retardant paints • Adhesives • Metal processing • Secondary plasticizers in flexible polyvinyl chloride, except in toys and children's products
9	Technical endosulfan and its related isomers	Production	As allowed for the Parties listed in the Register of Specific Exemptions
		Use	Crop-pest complexes as listed in accordance with the provisions of Part VI of Annex A
10	Tetra- and penta-bromodiphenyl ether	Use	Articles in accordance with the provisions of Part V of Annex A

Four relevant POPs, technical endosulfan, DDT, lindane, and PCBs, were banned as Category 4 HSs under the HSA in Thailand. Accordingly, there is no need for specific exemptions for these entries. (Note that specific exemptions for DDT and lindane have already expired.)

Thailand is in the process of making decisions on registrations for specific exemptions for (1) c-decaBDE (2) HBCD (3) c-octaBDE (4) PCNs (5) SCCPs (6) c-pentaBDE (7) PFOA, its salts and PFOA-related compounds, and (8) PFOS, its salts and PFOSF.

Moreover, note (ii) of Annex A of the Convention allows notification of POPs in articles in use, i.e. for chemicals occurring as constituents of articles manufactured or already in use before or on the date of entry into force of the obligation with respect to these chemicals. As such, Thailand is in the process of making decisions to notify the following POPs in articles in use in pursuant to note (ii) of Annex A: (1) c-decaBDE (2) HBCD (3) c-octaBDE (4) PCNs (5) SCCPs (6) c-pentaBDE (7) PFOA, its salts and PFOA-related compounds, and (8) PFOS, its salts and PFOSF.

2.3.12 POPs monitoring

In Thailand, the monitoring of POPs is carried out both domestically and through international collaboration as follows:

1) Environmental Monitoring of Persistent Organic Pollutants (POPs) Project in East Asian Countries (POPsEA project), since 2004 until present, with technical and financial supports from the Government of Japan, for the monitoring of 9 POPs pesticides in the atmosphere of East Asian countries[44].

[44]Ministry of the Environment Government of Japan, " POPs Monitoring Project in East Asian Countries, 2006: Background Air Monitoring of in East Asian Countries 2004-2006", https://www.env.go.jp/en/chemi/pops/eaws/background04-06.pdf, last accessed April 27, 2020

2) A capacity building project on PCDDs/PCDFs sampling and analysis of POPs in key media; e.g., ambient air, breast milk and blood, with technical and financial supports from the Japanese Government's SAICM Quick Start Program (QSP) during 2009 – 2010[45].

3) A project entitled "Implementation of the POPs Monitoring Plan in the Asian Region"[46], funded by GEF during 2018 – 2020, is carried out to monitor POPs in various media, such as undisturbed ambient air, breast milk, sediments, chicken eggs, duck eggs, fish, and beef, etc.

On laboratory capacity, there are private and public laboratories in Thailand with POPs analysis capability such as (1) National Dioxin Laboratory at the Research and Training Center, Department of Environmental Quality Promotion, MNRE, is capable of sample collections and analysis of dioxins/furans, PFOS, PBDE, etc. in environmental media; (2) Dioxin Laboratory at the Department of Medical Services, MOPH, is capable of sample collection and analysis of dioxins/furans, pesticides, and other brominated POPs in food and living samples, (3) Trace Element Analysis Laboratory at the National Metal and Materials Technology Center, National Sciences and Technology Development Agency, is capable of sample collection and analysis of POPs industrial chemicals in manufactured products, (4) various multinational laboratories specialized in analysis of POPs in environmental media and manufactured products.

Table 10: List of public laboratories in Thailand with POPs analysis capability

Organization	Analytical Capability
Agricultural Production Sciences Research and Development Division, Department of Agriculture	OCPs in environmental media (water and sediments
Bureau of Quality and Safety of Food, Department of medical sciences	OCPs, PCBs, PCDDs/PCDFs in food and drinking water
National Institute of DIOXIN, Department of Environment Quality Promotion	PCBs, PCDDs/PCDFs in environmental media (air and ambient air)
	PFOS/PFOA in surface water, PBDEs in environmental media (sediments, surface water)
National Institute of Health, Department of medical sciences	OCPs in human serum
Faculty of Engineering, Mahidol University	PFOS in environmental media (air, soil, water), drinking water, and in products (cosmetics, textiles, food packaging)
Trace Element Analysis Laboratory, National metal and materials technology center	PBBs, PFOS, HBCD, and PBDEs in manufactured products (plastics, textiles, e-waste, and dust/abrasion from material) and environmental media (soil, surface water, groundwater)

[45]UN Environment, "POPs GMP Projects National Capacity Building", https://www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/persistent-organic-pollutants/pops-gmp-projects-national, last accessed: April 27, 2020

[46]UN Environment, "GMP2 Asia", https://www.unenvironment.org/explore-topics/chemicals-waste/what-we-do/persistent-organic-pollutants/global-monitoring-plan-4, last accessed: May 13, 2020

2.3.13 Economic and Social Impacts of POPs

There is insufficient study to enable the evaluation of the impact of POPs on the Thai society and economy. Also, the benefit assessment of POPs management has not been studied. Nevertheless, relevant economic and social impacts of POPs can be qualitatively assessed as follows:

In case of POPs pesticides, with Thailand's pre-market control of agricultural chemicals, economic impacts from the restriction of POPs pesticides are, so far, perceived as minimal. Traditionally, the DOA has been leading the efforts to ensure the viability and availability of alternatives to highly hazardous pesticides, including those listed in SC Annex A and B. Such alternatives include direct drop-in substitution with other synthetic pesticides, substitution with natural reagents and organisms, as well as good agricultural management practices. DOA also provides technical and technological assistants to farmers, private firms and other agencies in areas of plant protections.

In the case of POPs industrial chemicals, there is no study to quantify the economic impacts of these substances in Thailand. For economic impacts from the restriction of POPs industrial chemicals, since most of the 'legacy' POPs industrial chemicals were phased-out years ago, only the switching costs of the 'non-legacy' substances (decaBDE, HBCD, and PFOS) are considered relevant. Since alternatives to these substances had been made available and industry-wide restriction had been commenced globally, economic impacts to industrial users as results from introducing measures to phase out the uses of these substances are perceived as minimal. Besides, global supplies of HBCD and PFOS have already been limited for several years. Nevertheless, for PFOS, it is estimated that there are about 925,000 litres of PFOS contaminated AFFF foams remaining in stock. The cost for replacing these foams with PFOS/PFOA-free foams before their expiration is estimated at 140-190 million THB[47]. The costs for irreversible destruction of these contaminated foams as such can be high but cannot be estimated at this time.

Additionally, there are decaBDE- and HBCD-contaminated products/materials that are currently in their use-phase and will need to be properly disposed of at the end-of-life. Since decaBDE is found to be contaminated in recyclable plastics [please see section 2.3.3], removing decaBDE-contaminated materials from the bulk of recyclable materials (for example at e-waste dismantling sites) will require not only the installation of sophisticated tools to sort out the contaminated materials but also appropriate material management system. Waste processors will also need to pay additional costs to install pollution control equipment and to provide appropriate PPEs to workers to limit occupational exposures. For PS contaminated with decaBDE (estimated at 5,000 t), the loss of opportunity to recover and recycle these materials is estimated at 150 million THB[48]. These materials, on the other hand, have to be disposed of in an environmentally sound manner. Since Thailand does not yet have a system for the separate collection of EOL products (particularly e-waste, contaminated textile products, end-of-life vehicles and EPS foamed panels) or an approved system for the disposal and final destruction of decaBDE and HBCD in manufactured products, the cost for proper disposal of such contaminated products cannot be estimated at this time.

In controlling unintentional releases of POPs, there are economic impacts to private and public operators to minimize the generation and the release of uPOPs. This includes replacing improper MSW incinerators with better alternatives, installing appropriate pollution control systems, changing to best available technology to minimize or avoid the generation of uPOPs,

[47] Assume replacement costs of about 150-200 THB per liter
[48] Estimated at 30,000 THB per tonne.

finding alternatives to open burning in agricultural fields, and adopting best environmental practices, etc.

Additionally, the government needs to implement measures and put in place monitoring schemes, which incur costs to the public. These measures include legal measures (e.g. strengthening regulations on POPs pesticides and banning industrial POPs), finding alternatives to POPs pesticides as well as techniques to reducing POPs release, sampling and analysing POPs residues in the environment and living organs, raising awareness, and enhancing capacity of government-run POPs laboratories, etc.

Social impacts of POPs may be associated with health effects of POPs substances which include the prevalence of type 2 diabetes [Magliano, et.al. (2014)[49], Zong et.al. 2018[50]], cancer of various organs, cardiovascular diseases (including hypertension), inflammatory diseases, dementia, birth defects, learning disability, obesity, as well as increased susceptibility to infectious diseases [please see for example WHO (2010)[51], Ruzzin (2012)[52],Wahlang (2018)[53], Alharbi (2018)[54], Rylander (2005)[55], and Fry and Power (2017)[56]]. Several of these POPs-related diseases coincide with or are closely related to the growing NCDs observed in many countries including Thailand [please see for example: Juntarawijit & Juntarawijit (2018) [57]].

POPs may impact different groups of people differently [please see section 2.3.21]. However, there are several vulnerable groups such as: i) informal agricultural and waste management workers and their family members who are exposed via occupational and para-occupational exposure, ii) people living in or near areas with frequent/recurring open burning who may be at risk of exposure to dioxin and other uPOPs, iii) people living near improperly operated incineration sites and/or landfills who may be impacted from long-term exposures to many types of POPs. Since these vulnerable groups are usually low-income earners, they generally have a lower chance/leverage to mitigate the impacts. Although these vulnerable people can access public health services or “the universal health coverage” scheme, this is still not without costs to the society. For informal workers, there is also “opportunity cost” of sick

[49] D.J. Magliano, V.H.Y. Loh, J.L, Harding, J.Botton, J.E.Shaw, Persistent organic pollutants and diabetes: A review of the epidemiological evidence, Diabetes & Metabolism 40 (2014) 1-14

[50] Geng Zong, Damaskini Valvi, Brent Coull, Thomas Göen, Frank B. Hu, Flemming Nielsen, Philippe Grandjean, Qi Suna, Persistent organic pollutants and risk of type 2 diabetes: A prospective investigation among middle-aged women in Nurses' Health Study II, Environment International 114 (2018) 334–342, https://doi.org/10.1016/j.envint.2017.12.010

[51] World Health Organization, Persistent Organic Pollutants: Impact on Child Health, World Health Organization, 2010

[52] Jérôme Ruzzin, Public health concern behind the exposure to persistent organic pollutants and the risk of metabolic diseases, BMC Public Health 2012, 12:298

[53] Banrida Wahlang, Exposure to persistent organic pollutants: impact on women’s health, Rev Environ Health 2018; 33(4): 331–348

[54] Omar M.L. Alharbi, Al Arsh Basheer, Rafat A. Khatta, Imran Ali, Health and environmental effects of persistent organic pollutants, Journal of Molecular Liquids 263 (2018) 442–453

[55] Lars Rylander, Anna Rignell-Hydbom and Lars Hagmar , A cross-sectional study of the association between persistent organochlorine pollutants and diabetes, Environmental Health: A Global Access Science Source 2005, 4:28

[56] Kristiann Fry and Melinda C. Power , Persistent organic pollutants and mortality in the United States, NHANES 1999–2011, Environmental Health (2017) 16:105

[57] C. Juntarawijit and Y Juntarawijit, Association between diabetes and pesticides: a case-control study among Thai farmers, Environmental Health and Preventive Medicine, (2018) 23:3, DOI 10.1186/s12199-018-0692-5

leaves and other indirect costs as a result of their sickness, such as care services often provided by their own relatives.

Implementing POPs measures complying with the SC would provide at least three benefits to Thailand. First, it would promote healthy and high living standards for the population. Banning or reducing application of POPs would prevent POPs contamination to the environment and food-chain. Therefore, it would help decrease health risks, especially the aforementioned NCDs. Second, banning POPs in the public and private sectors would benefit international trade negotiation. As POPs regulations will become harmonized among trade partners, POPs issues can no longer be used as an excuse for the non-tariff barriers between trading partners who are parties to the SC. Lastly, private sectors who use 'POPs-free' materials would face fewer obstacles expanding their market, especially when exporting to trading partners who regulate POPs-embedded products.

2.3.14 Gender-related issues

In 2018, the Thai population was 66.41 million, 50.98% of these were females and 49.02% were males. However, the labour force participation rates of female and males in 2018 were 60.5% and 77.6%, respectively [NSO (2019)[58]]. In 2019, the labour force in the formal sector was 17.1 million, of which 53.2% were male workers and 46.8% were female workers, whereas the informal sector's labour force was 20.4 million, with the shares of male and female workers of 55.7% and 44.3%, respectively [NSO (2019)[59]].

In 2019, the NSO estimated life expectancy at birth for females and males at 80.1 and 73.0 years, respectively [NSO (2019b)[60]]. In 2013, Thailand's year of life lost (YLL) was 6.4 million years: 3.9 million years in men and 2.5 million years in women, respectively. The main causes for these YLLs in male were road traffic accidents, cardiovascular diseases (CVDs), and liver cancer which contributed to 11.7%, 8.8%, and 6.9% of total YLLs in male respectively (or about 444,600 years, 334,400 years, and 262,200 years, respectively). As for females, the main causes of YLLs were CVDs, diabetes, and ischemic heart diseases which contributed to 10.6%, 8.4%, and 7.0% of total YLLs in females respectively (or about 265,000 years, 210,000 years, and 175,000 years, respectively) [IHPP (2013)[61]].

There is growing evidence of differing health effects of POPs for male and female. These differences may arise from socio-economic, cultural, physiological, as well as biological factors. Possible differences that may lead to different exposures are the follows.

1) Exposure at workplaces

Due to difference in their roles in the society, male, female, children, and elderly are exposed differently to POPs in their daily life. Male or the more muscular population are

[58]NSO 2019a, "Social Indicator 2019", Social Statistic Analyzing and Forecasting Group, Statistical Forecasting Division, National Statistical Office, Ministry of Digital Economy and Society, 2019.
[59] NSO 2019c, "The Informal Employment Survey 2019" (in Thai), Statistical Forecasting Division, National Statistical Office, Ministry of Digital Economy and Society, 2019.
[60] NSO 2019b, "Thailand Key Indicator 2019" (in Thai), Social Statistic Analyzing and Forecasting Group, Statistical Forecasting Division, National Statistical Office , Ministry of Digital Economy and Society, 2019.
[61]IHPP 2013, "Burden of Disease Thailand 2013" (in Thai), International Health Policy Program, http://www.thaincd.com/document/file/download/knowledge/report_BOD_2556.pdf, last accessed: May 29, 2020

more likely to be directly exposed to POPs in their workplaces while female or the more feminine population are more likely to be indirectly or unknowingly exposed to residues left on ground and/or in products. For example, in agriculture, men usually take the role of pesticides applications while women (also children and elderly) take the role of planting and harvesting. As a result, men are at higher risk of pesticides poisoning as evident in the DDC's annual epidemiological surveillance reports, where the number of men who suffered from pesticide poisoning was typically about 1.6 times that of women [please see for example DDC (2015)[62]]. Unfortunately, unlike the acute effects of pesticide poisoning, data on the chronic effects from long-term, low-dose, indirect exposure to pesticides are not readily available.

Similarly, in informal e-waste dismantling and plastic recycling, men are more likely to be in charge of heavy machinery/power tools (such as shredder, grinders, etc.) while women take care of the detailed disassembly, housekeeping and/or disposal the unwanted residues. Moreover, due to the informal nature of these works, women with small/preschool children also tend to bring or carry their children along to their work sites. Again, due to their chronic effects, data related to health effect from exposure to POPs in the workplaces in Thailand are currently not available.

Moreover, for workers in the informal sector, data from the 2019 National Informal Employment Survey indicates a much larger number of men who have been hurt from exposure to harmful chemicals than women (82% to 18%, respectively) [NSO (2019)[63]].

2) Exposure at home

Females are more likely to allocate their time (before and after work) to housework than males. In 2019, Thailand's contributing family workers were 22.4% and 11.7% for female and male workers, respectively [World Bank (2019)[64]]. Like most countries, irrespective of income, it was found that women bear a disproportionate responsibility for housework and care (unpaid works), while men are responsible mostly for market works (paid works) [World Bank 2012[65]]. As a result, female (and also children) are at higher risk than male from exposure to POPs industrial chemicals (such as PBDEs) and uPOPs at home. In addition, female (due to their higher proportion of body fat) and children (due to their developmental needs) are typically more susceptible to health damage from exposure to POPs than male.

Females are more likely to take parts in cooking for their family more than males counter part. For those households in rural areas that use biomass-fired stoves, female's risks from exposure to dioxin and other uPOPs can be escalated. Moreover, if they get sick, female workers with health problem from POPs are likely to affect their family circumstances more than the case of male workers. Apart from female workers'

[62] DDC 2015, "Annual Epidemiological Surveillance Report 2015: Pesticide Poisoning", Bureau of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health.
[63] NSO 2019c, The informal employment survey 2019, Labor Statistics Group, Social Statistics Division, National Statistical Office, Ministry of Digital Economy and Society, 2019
[64] World Bank 2019, World Bank Data Bank: Indicators, The World Bank, https://data.worldbank.org/indicator/, last access: April 29, 2020
[65] World Bank 2012, World Development Report 2012: Gender Equality and Development, World Bank. https://openknowledge.worldbank.org/handle/10986/4391, last accessed: April 29, 2020

contribution to the family income, women tend to have more responsibility in taking care of other family members (e.g. children and the elderly).

3) Exposure through food and environment

There is no information to suggest different exposure to POPs substances through food and the environment between male and female. However, due to their higher proportion of body fat, women are typically more susceptible to health damage from exposure to POPs than men.

2.3.15 Public and stakeholder awareness, information and education

Thailand has continually established public awareness measures to promote POPs understanding with participation from several agencies as follows.

1) MNRE, by the PCD, from 2007 to the present. Publications of various communication materials, i.e. folders and posters have been widely distributed, for instance the PCBs management manual[66], an awareness-raising document entitled "the silent threats of dioxins and furans"[67], the launching of a project for public awareness on the danger of dioxins and furans and how to avoid exposure. Meetings and seminars were also organized to promote POPs awareness and capacity development for all concerned agencies under the SC obligations.

2) MOPH, by the Food and Drug Administration (FDA), has continually provided information on hazardous pesticide formulations for human health and the environment to the public with the publication of International Chemical Safety Cards (ICSCs) in Thai language[68] for further development into computer programs and databases on chemicals data. The FDA also worked on projects to enhance student and consumer knowledge about chemical safety, e.g., a project to improve the learning process and pilot schools to incorporate chemical hazards and chemicals safety data under the GHS system in basic school curriculums, a project to develop youth's learning center on GHS and chemicals safety, a project to improve children's skills and knowledge on chemicals safety. The FDA also authored a book and a teaching manual for a 4th grade course on chemicals labels (the book is entitled "ฉลาก ฉลาดรู้ ฉลาดใช้"[69]) to inform students about the meaning of the GHS labels, good practices when handling/using chemicals, as well as emergency responses.

3) MOAC, by the DOA, has provided regular training courses on chemicals storage and hazardous wastes management to provide general knowledge to concerned parties, as well as training courses for the general public and owners of agricultural supply stores on

[66]Pollution Control Department, PCBs Management Handbook, www.pcd.go.th/public/Publications/print_haz.cfm?task=PCB08, last accessed: April 27, 2020
[67]Pollution Control Department, " the silent threats of dioxins and furans" (in Thai), http://www.pcd.go.th/info_serv/haz_dioxin.html, last accessed: April 27, 2020
[68] Technical and Planning Division, Food and Drug Administration, "International Chemical Safety Cards" (in Thai), http://thaiipcs.fda.moph.go.th/eng/Knowledgebase/ViewKnowlegde/9, last accessed: April 27, 2020
[69]International Programme on Chemical Safety , "Labels: Better understanding for safer usages " (in Thai), Technical and Planning Division, Food and Drug Administration, 2008, http://thaiipcs.fda.moph.go.th/PDFfile/research/4.หนังสืออ่านเพิ่มเติม%20ฉลาก%20ฉลาดรู้%20ฉลาดใช้.pdf, last accessed: April 27, 2020

the following legally binding activities: pesticide fumigations[70], selling of hazardous agricultural chemicals[71]. Additionally, the DOA also provides training on the uses of plants extracts to control agricultural pests.

4) M-Industry, by the DIW, has continually promoted awareness and knowledge to the public concerning POPs impacts on health and the environment and POPs control under the Hazardous Substances Act B.E. 2535, through their websites and various publications[72].

5) Ministry of Education, through various academic institutes, e.g., 1) Chulabhorn Research Institute has launched a project entitled "Regional Chem Helpdesk to Strength(en) the Sound Management of Chemicals"[73] with publication on chemical management supported by Q&A between experts and chemicals users. It has established a graduate program and short courses on toxicity, mechanism of toxicity, impacts to human health and environment, sources, and (combined) exposures to multiple chemicals and 2) Institute for the Study of Natural Resource and Environmental Management, Mae Fah Luang University conducted a study on levels of knowledge and farmers' chemical use practices to study chemical types, amounts and farmers' behavior and compiled a knowledgebase on chemical uses in agriculture.

2.3.16 Reporting (Article 15)

Thailand has periodically submitted National Reports according to its obligation under Article 15 of the Convention as follows: 1) the 1st National Report in 2007; 2) the 2nd National Report in December 2010; 3) the 3rd National Report in August 2014 and 4) the 4th National Report in August 2018.

2.3.17 Relevant activities of non-governmental stakeholders

Organizations other than the government have been instrumental in participating and implementing many forms of activities toward a better understanding of the situation as well as reducing risks. Followings are examples of non-governmental organizations and their activities:

1) Thai Health Promotion Foundation (ThaiHealth)

ThaiHealth was established in 2001 under the Health Promotion Foundation Act, as an autonomous government agency, aiming to develop well-being in society by mitigating the risk factors for non-communicable diseases. ThaiHealth receives its funding from a 2% levy on excise taxes on tobacco and alcohol, and provides its partners with financial and technical supports and evaluates their performances [Pongutta et.al (2019)[74]]. ThaiHealth operates by a multisectoral approach that emphasizes the coordination among

[70] Training courses for the uses of hazardous substances for professional services, Department of Entomology, Kasetsart University, http://ento.agr.ku.ac.th/services#

[71] M. Koonthong, Knowledge for sellers of hazardous agricultural chemicals (in Thai), Department of Agriculture, Ministry of Agriculture and Cooperative, http://www.doa.go.th/th/wp-content/uploads/2020/02/Pdf-Final.pdf

[72] Department of Industrial Works, "International Environmental Agreements" http://oaep.diw.go.th/meas/document.php, last accessed: April 27, 2020

[73] World Health Organization, "Chem HelpDesk", http://www.chemhelpdesk.org/, last accessed: April 27, 2020

[74] S. Pongutta, et al., Lessons from the Thai Health Promotion Foundation, Bulletin of World Health Organization (2019) 97: 213-220, doi: http://dx.doi.org/10.2471/BLT.18.220277

stakeholders based on three key factors – scientific evidence, policy decisions, and citizen and civil society organizations [Pongutta et al. (2019)[74]]. Examples of chemical risk-related activities sponsored by ThaiHealth include reducing pesticide use in paddy fields and promoting organic alternatives, and estimating the quantity and investigating the disposal route of polyurethane foam waste in Thailand and making recommendation for the disposal technology.

2) *The Royal Project Foundation*

The Royal Project is an initiative of the late His Majesty, King Bhumibol Adulyadej of Thailand. It was founded in 1969 to solve the problems of deforestation, poverty, and opium production by promoting alternative crops. It was the world's first project to replace drug crops with legal crops, and is one of the most successful projects of this type.

As one of its several developmental missions, the Royal Project Foundation produces agricultural products in accordance with 3 types of standard protocols, namely GAP, McDonald's GAP, and organic standards (IFOAM and Organic Thailand). As its first priority, the foundation's Plant Protection Center advices and regulates the use pesticides by its affiliated farmers. The center prohibits the use of more substances (14, as of June 2018) in addition to all the agricultural substances already banned by the DOA (which include all relevant POPs pesticides). The center also monitors pesticide residues in products received from all farmers using rapid test kits, and also has its own ISO/IEC 17025-accredited facility for randomized monitoring analyses via GC, GC-MS, and LC-MS-MS. Furthermore, the Royal Project conducts research aimed at reducing reliance on harmful synthetic pesticides, including biological pest control methods and alternative chemicals from natural sources. It also conducts educational activities (including learning centers and demonstration farms), and organizes collection of contaminated/hazardous waste from affiliated farms/laboratory for proper disposal. [Jonglekha (2018)[75]]

3) *Ecological Alert and Recovery - Thailand (EARTH)*

EARTH serves as a watchdog group, monitoring the Thai government's industrial-related policies, and hotspots with activities/practices that potentially impact human health and the environment, e.g. e-waste recycling, municipal waste management, etc. EARTH aims to provide academic work, enabling the communities who are affected by industrial pollutants to demand government accountability. For POPs-related activities, EARTH partnered with Arnika (a Czech non-governmental organization and an IPEN participant) and released monitoring reports for POPs in several areas in Thailand including Map Ta Phut industrial complex, Samut Sakhon, Tha Tum industrial complex, and the pulp and paper industrial area near Khon Kaen Province [Arnika (2018)[76]].

[75]N. Jonglekha, The Royal Project Foundation's method to produce produces pesticides-free agricultural products and the protection of farmers, consumers, and the environment from hazardous substances (in Thai), presentation document presented at the Inception Workshop, 15 June 2018, Thailand Science Park, Thailand

[76]Arnika, Toxic Hot Spots in Thailand, Prague – Bangkok, December 2018, https://english.arnika.org/publications/download/531_419aa01a5f2c9242d191855f18287e6d, last accessed: April 28, 2020

4) International Pollutants Elimination Network (IPEN)

IPEN is a global network of public interest organizations for improving chemical policies and raising public awareness to ensure that hazardous substances are no longer produced, used, or disposed of in ways that harm human health and the environment. An IPEN participating organization, the Czech non-governmental organization Arnika Association, conducted a joint project with the Thai partner, Ecological Alert and Recovery-Thailand (EARTH) to sample POPs contamination in four hotspots areas in Thailand from February 2015 to March 2017, as described above.

5) Thai-PAN

Thai-PAN is an NGO that brings together stakeholders and experts from various organizations and fields, who share common awareness and concern regarding the hazards of pesticides and related issues, such as the registration, import, advertisement, sale, and regulation of these chemicals. Thai-PAN's mission are: to assemble knowledge base on the hazards of agricultural chemicals; to communicate and alert these issues to the general public; and to drive towards more stringent pesticide management and control policies along the pesticide life cycle. Their ultimate goals are pesticide safety for farmers, consumers, and the environment, as well as sustainable development. Their partners include several academic institutions, government departments, and other public benefit organizations/foundations [Thai-PAN (2020)[77]].

As part of their activities, Thai-PAN regularly samples fruits and vegetables from different markets nationwide to monitor levels of residues and report their findings on a yearly basis [please see for example Thai-PAN (2017)[78]]. Thai-PAN also hold annual seminars to alert the public on pesticide use patterns and associated risks in Thailand.

6) Actions taken by private organizations

Several outlets for agricultural produces also play active roles to support farmers to adopt Good Agricultural Practices (GAP) and reduce pesticide usages. Followings are examples of such organizations and their activities:

Siam Makro PCL

As a distributor of agricultural products, Siam Makro PCL has been making efforts to reduce pesticide contamination along its entire supply chain. Through various activities and campaigns, in collaboration with local communities and relevant government agencies/universities, the company has advocated, educated, and supported upstream suppliers to enhance their production practices according to relevant standards, including GAP (good agricultural practice) for farmers, and GMP (good manufacturing practice) for collectors/packers as well as its own distribution centers and stores. This has resulted in the communication and traceability of pesticide usage all along its supply chain. The company monitors pesticide residues in their products using their own DMS-certified screening laboratories (using test kits), as well as via external ISO/IEC17025-accredited

[77] Thai-PAN, Thailand Pesticide Alert Network: Thai-PAN, https://www.thaipan.org/about , last accessed: April 28, 2020

[78] Thai-PAN, Fruits and Vegetables Pesticides Residues Monitoring Report 2017 (in Thai), Thailand Pesticide Alert Network, https://www.thaipan.org/wp-content/uploads/2018/10/pesticide_doc36.pdf, last accessed: April 28, 2020

laboratories for detailed analyses. It has also contributed to the establishment of a network of DMS-certified regional laboratories that provide pesticide residue screening, both pre- and post-harvest. [Ekisawatwikul (2018)[79]]

Srimuang Market, Ratchaburi Province

Srimuang Market is a fruit and vegetable hub located in Ratchaburi Province. It is a market place/outlet for farmers to bring their produce for direct sales to operators, such as hospitals, restaurants, etc., at fair prices. The market established a system to ensure pesticide-free agricultural produce that meet regulartory limits as well as demands from domestic and international markets.

Srimuang Market acts as a facilitator and/or product development department for farmers. In addition to providing basic knowledge and networking activities to their farmers/society, the market established a tracking system to enable product trace-back to the farms and supported farmers to adopt the GAP system. The market also established and operated a pesticide residues screening laboratory since 1998. Upon finding non-compliance produces, the farm owner will be notified and the cause of non-compliance investigated. As a result, Thai-PAN found that there was a lower chance of finding pesticide residues above the limits (MRLs) in fruits and vegetables sampled from Srimuang Market [Thai-PAN (2016)[80]].

2.3.18 International collaborations

Thailand has participated in several international collaborative activities as follows:

International collaborations to reduce unintentional releases of POPs under SC Article 5:

1) The National Inventory of Crematoria and Feasibility Study on the Establishment of Cremation Center in Thailand, in collaboration with the World Bank in 2009.
2) Two projects under the East and South East Asia Regional Forum on Best Available Techniques and Best Environmental Practices: ESEA Regional Forum on BAT/BEP, namely: 1) Demonstration of BAT and BEP in fossil fuel-fired utility and industrial boilers in response to the SC on POPs in ESEA region, in collaboration with the United Nations Industrial Development Organization (UNIDO), in 2010-2016; 2) Regional plan for introduction of BAT/BEP strategies to industrial clusters of Annex of Article 5 sectors in ESEA region in collaboration with UNIDO, in 2010-2016.
3) The project entitled “Greening the Scrap Metal Value Chain through Promotion of BAT/BEP to Reduce U-POPs Releases from Recycling Facilities”, in collaboration with UNIDO, with the financial support from the Global Environment Facility, 2018-2022.
4) The project entitled “Applications of Industry-Urban Symbiosis and Green Chemistry for Low Emission and Persistent Organic Pollutants (POPs)-Free Industrial Development in Thailand”, in collaboration with UNIDO, with the financial support from the Global Environment Facility in, 2019-2023.

International collaborations to support the evaluation of the effectiveness according to Article 16 of the SC:

[79] P. Ekitsawatwikul, Siam Makro’s Quality Assurance (in Thai), Siam Makro, presentation document presented at the Inception Workshop, 15 June 2018, Thailand Science Park, Thailand
[80] Thai-PAN, “Fruits and Vegetable pesticide residues monitoring report 2/2559” (in Thai), http://www.thaipan.org/sites/default/files/file/pesticide_doc30_0.pdf, last accessed: April 28, 2020

1) Environmental Monitoring of Persistent Organic Pollutants (POPs) in East Asian Countries since 2004 until present, with financial and technical supports from the Japanese government to monitor 9 pesticide POPs in the atmosphere of member countries in East Asian Region, and to gather baseline data for the effectiveness evaluation
2) Capacity building on PCDDs/PCDFs sampling and analysis to promote analyses of POPs monitoring in air, breast milk and blood, with financial and technical supports from the Japan SAICM Quick Start Program (QSP) by the Japanese government, in 2009-2010.
3) Implementation of the POPs Monitoring Plan in the Asian Region to enhance capability of the Asian Region countries to monitor 23 POPs, with financial support from Global Environmental Facility, in 2018-2020.

2.3.19 Overview of technical infrastructure for POPs assessment, measurement, analysis, alternatives and prevention measures, research and development – linkage to international programs and projects

Thailand carries certain technical capacity for POPs assessment, measurement and analysis. Sophisticated instruments such as GC-MS, HRGC/HRMS, GC-MS/MS and LC-MS/MS are available from several private and public laboratories for the determination of POPs substances. Particularly, with a growing number of scientific equipment centers in academic and research institutes, Thailand has established Thailand Scientific Equipment Center Network (TSEN), currently with 20 members from the country's leading universities, national institutes, and a forensic science department[81]. However, depending on the POPs substance and the purpose of testing, the determination of POPs contamination in different media also requires sophisticated sample collection and treatment as well as skillful laboratory experts, which typically focuses on specific areas namely POPs pesticides, POPs industrial chemicals, uPOPs and POPs in environmental media. Examples of public laboratories with POPs analysis capabilities in specific areas are shown in Table 11.

Table 11: List of public laboratories with POPs analysis capabilities and their focused areas

Organization	POPs analysis capability and focused areas
Agricultural Production Sciences Research and Development Division, DOA	OCPs in fruits, vegetables, soils and water
Food Industry Laboratory Service Center	• OCPs in cereals, vegetables, starches, fruits, juices, oil and fats, and their products • PCBs and DL PCBs in oil and fats, seafood and seafood products
Bureau of Quality and Safety of Food, DMSC	• OCPs, PCBs, PCDDs/PCDFs in food and feed, drinking water
The Central Laboratory (Thailand) Company Limited, MOAC	• OCPs in vegetables, fruits, rice, water (surface water, drinking water, tap water, groundwater, wastewater)
Bureau of Quality Control of Livestock Products, DLD	• OCPs and PCBs in feed and raw materials • PCBs and dioxins in feed and fats
National Dioxin Institute, DEQP	• PCDDs/PCDFs, PCB and DL-PCBs in stack exhaust air, ambient air, soil, sediments and water

[81] http://tsen.in.th/

	• PBDEs, PFOS and PFOA in water, leachates, sediment
National Institute of Health of Thailand, DMSC	• OCPs in human serum
Faculty of Engineering, Mahidol University	• PFOS and PFOA in environment media (ambient air, soil, sediment, water), food and feed, and consumer products (cosmetics, textiles, food packaging)
National Metal and Materials Technology Center (MTEC), MHESI	• HBCD, PBDE, PFOS/PFOA in (synthetic) materials and products, and liquid media (water, wastewater, leachates)
	• Rapid identification of BFRs in solid polymers
Thai Textile Institute	• PFOS in textiles
Thai Electrical and Electronic Institute	• PBDEs in polymers

1) POPs pesticides in food and feeds:

Due to the relatively more stringent regulation, national infrastructures established for the assessment of POPs pesticides in food and feed (including surface water) are considered more extensive than those for other POPs and/or other media. There are laboratories established throughout the value chain of food and feed production, from farm to food products and market-places. Particularly, most private and public laboratories can offer organochlorine pesticide (OCPs) testing services for almost every relevant medium. Large private firms/farms also have established their own OCPs analysis capability.

Additionally, test kits (based on thin layer chromatography) have also been developed and widely employed for the detection of OCP residues (screening test) in fruits and vegetables[82]. There is also a TRM (Thailand Reference Material) developed and certified for OCP in soil (endosulfan)[83].

2) POPs Industrial Chemicals

Due to high demand for certification/declaration of RoHS-compliant products along the EEE supply chain, many laboratories in Thailand (both private & public, and both national & multi-national) can offer PBBs, PBDEs and PFOS analysis services based on IEC 62321 (for PBBs/PBDEs) and CEN/TS 15968:2010 and ISO 25101:2009 (for PFOS) standards. Moreover, to save cost and to reduce risk (from legal violation), most large OEM firms employ ED-XRF and FT-IR for random checking of incoming materials. Nevertheless, due to the lack of demand for the determination of other POPs industrial chemicals (PCNs, PCP, PeCB, HBCD, and HCBD), there is currently no laboratory accredited for these substances.

Since the required analytical instruments for the determination of POPs industrial chemicals in food & feed and in environmental media are similar to those for OCPs and other pesticides, it is believed that the basic infrastructures exists. However, due to the apparent lack of regulatory/commercial demand for testing/monitoring of POPs industrial chemicals in these media, no laboratory offer these services on a

[82] Y. Putson, "GPO-TM kit", Government Pharmaceutical Organization (GPO), http://blqs.dmsc.moph.go.th/assets/qsd/PPTGPOTMKIT.pdf

[83] TRM-E-5001, http://www.nimt.or.th/etrm/index.php?menu=product&trmcode=TRM-E-5001

commercial basis. Nevertheless, at least one private laboratory has been accredited for their ability to determine PFOS, PFOA, PBBs, PBDEs, and HBCD in wastewater.

It should be noted that existing infrastructure for testing of POPs industrial chemicals in manufactured products aim towards pre-order/pre-market approval of the products/materials. For POPs in manufactured products that are already in use phase and/or have reached EOL management sites, the cost for testing a wide variety of 'uncontrolled' products/parts will be prohibitive. Therefore, different intelligence-based infrastructure and testing strategies will be needed.

3) uPOPs

As part of the previous NIPs, infrastructure for the determination of PCDD/Fs, PCBs and DL-PCBs in food and feed, in human serum and tissues, as well as in environmental media (ambient air, water, soil, sediments) had been established and the presence of these uPOPs had been monitored. Nevertheless, because uPOPs require highly sensitive testing techniques and sample collection can often be difficult to conduct, the costs for the monitoring of uPOPs in all media remain very high.

As for the newly listed uPOPs (PeCB, PCNs and HCBD), existing infrastructure for the determination of VOCs, OCPs and PCDD/Fs can be applied to analyze HCBD, PeCB, and PCNs, respectively, in media of interest.

2.3.20 Overview of technical infrastructure for management, treatment and safe disposal of POPs

Thailand has a state-of-the-art industrial waste incinerator capable of irreversible destruction of OCPs and chlorinated compounds[84] other than PCB-contaminated oil. The incineration of industrial HW is regulated by MOI's B.E. 2545 (2002) Notification on the Air Emission Standards for Incinerators of Hazardous Industrial Waste, which sets an upper PCDD/F air emission limit of 0.5 ng TEQ/m^3 (7% O_2 and 25°C).

1) POPs pesticides

Regarding national infrastructure for the management of POPs pesticides, the DOA, under the MOAC, which is the responsible agency, operates a system for POPs pesticides collections for final disposal by the approved industrial waste incinerators.

2) POPs industrial chemicals

PCBs and PCNs:

For PCBs in closed applications, the DIW issued a notification to totally phase out PCBs by 2012. End-of-life devices, transformers and power capacitors that contain PCBs were collected and exported to the third countries for final destruction.

Since former uses of PCNs in closed applications are identical to the uses of PCBs, measures taken to address PCBs in closed applications should have also covered PCNs. Also, since the methods recommended to electricity authorities to identify PCB-containing transformers and capacitors (year of manufacture, the word "Non-inflammable Oil", the density, the chlorine contents, etc.) are not specific to PCBs,

[84] http://www.akkhie.com/index.php?incinerator

devices with PCNs should also have been collected and submitted to final destruction as PCBs.

For PCBs/PCNs in open applications, (polymeric) materials contaminated with PCBs/PCNs may have been disposed of in industrial waste incinerators or cement kilns. However, there is currently no system to identify and isolate PCB-/PCN-contaminated materials for separate treatment.

PFOS and PFOS-related substances:

AFFF foams deployed in industrial settings are required by law to be collected and properly treated before discharge. Similarly, wastewater from plating factories is also required to be properly treated before discharge. The sludge from the wastewater treatment may be incinerated in hazardous waste incinerators or sent to secure landfill. However, with no regulatory limits for PFOS in the effluent exhausts or leachates, the effectiveness of these treatment systems cannot be confirmed.

As for PFOS currently stocked in AFFF foams, there is currently no technical infrastructure to address these unused materials when they expire and become waste in the near future.

PBDEs and HBCD:

There are several options available for irrevesible disposal of relevant materials (PBDEs, HBCD, and contaminated resins, plastics, and textiles), namely, solid waste incineration, hazardous waste incineration, thermal and metallurgical production of metals, and cement kiln co-incineration. However, there is currently no system to identify and separate the contaminated materials both at the source and at waste collection sites. There is also no system to reduce the volume of the contaminated wastes.

3) uPOPs

Regarding the management of unintentional POPs, industrial waste containing uPOPs is disposed of at either cement plants or secure landfills.

2.3.21 Identification of impacted populations or environments

Citizens may be impacted by POPs directly via occupational exposure and indirectly via contacts with contaminated indoor and outdoor environment (such as soil, water, and air) and the consumption of contaminated food and water. The pathway to and the scale of the impact, however, may be different depending on the type of POPs.

For POPs pesticides, the scale of the impact can be large even though Thailand does not produce any pesticide. As an agricultural country, agriculture in Thailand uses about 34% of the total work forces and occupies about 47% of the country's land area. Farmers who mix and/or apply POPs pesticides may be directly exposed. Due to the persistency of POPs pesticides, family members or other farm workers who perform subsequent works may be indirectly exposed during planting and harvesting, while children of farmers who use parents' workplace as playground may also be indirectly exposed. On the consumer side, citizens may be indirectly exposed via consumption of contaminated food and water.

For POPs industrial chemicals, certain groups of industrial workers (plastic compounders, plastic parts converters, EPS foams converters, textile finishers, e-waste processors and plastic

recyclers, etc.) may encounter high level of POPs substances such as PBDEs, PFOS and HBCD in their workplaces. While formal industrial workers can protect themselves via the use of personal protective equipment (PPE), informal workers such as e-waste dismantlers are unlikely to have access to proper PPE in their workplace. Moreover, due to the informal nature of most e-waste processors in Thailand, children and family members of e-waste workers may also be indirectly exposed.

Additionally, POPs industrial substances that are embedded in products/materials can be continuously released from the products during use phase and accumulated in indoor dusts. Consequently, the general public, particularly children and toddlers, may be repeatedly and chronically exposed to low doses of multiple POPs industrial chemicals via ingestion of the contaminated indoor dusts.

Finally, people who live near uncontrolled landfill, waste incinerators, or areas where contaminated devices are improperly disposed of may be exposed to the substances that continue to leach out. Moreover, since POPs have a tendency to out-last landfill liners, groundwater and areas around landfills where contaminated materials have been deposited may be at risk of contamination.

For uPOPs, people living near areas where there are activities that release high amount of uPOPs may be at risk. As summarized in section 2.3.9, these include areas where wastes are improperly incinerated, areas with repeated open burning activities (both open burning of MSW and agricultural wastes), areas downwind of busy crematoria, and areas where contaminated residues are disposed of, etc.

As mentioned in section 2.3.13, the health effects of POPs substances to humans include the prevalence of type 2 diabetes, cancer of various organs, cardiovascular diseases (including hypertension), inflammatory diseases, dementia, birth defects, learning disability, obesity, as well as increased susceptibility to infectious diseases. Several of these POPs-related diseases coincide with or are closely related to the growing NCDs observed in many countries including Thailand.

Thailand has not yet imposed a mandate to require periodic monitoring of hazardous chemicals, especially POPs, in human and the environment. With the lack of monitoring data, the scale of the impacts and magnitude of threats to public health and environmental quality and social implications for workers and local communities cannot be assessed at this time. Through the country's early restrictions of POPs pesticides in the original list and PCBs as well as the prescription of the maximum level of residues of POPs pesticides in food and feed, it is anticipated that health impacts from the initial SC POPs pesticides and PCBs have been minimized.

Nevertheless, Thailand has participated in the UNEP project "Implementation of the POPs Monitoring Plan in the Asian Region" (also known as "GMP2 Asia") which includes monitoring of level of relevant POPs in abiotic and biotic matrices. The preliminary results[85] from a pooled sample taken from 60 young mothers indicated that the average Thai population has the following levels of OCPs and POPs industrial chemicals:

- Non-detectable levels of the following OCPs and POPs industrial chemicals: pentachlorophenol, pentachloroanisole, PBB 153, PeCB, HBCD, and HCBD

[85] To be published

- Relatively low levels of chlordane, dieldrin, HCB, beta-HCH, PBDEs, PCBs, NDL-PCBs, and mirex
- Relatively low levels of p,p'-DDE (the predominant environmental breakdown product of DDT) and PCDD/Fs with respect to the levels in WHO/UNEP human milk global surveys [van den Berg et al.(2017)[86]], but still relatively high with respect to their daily TDI values (assuming an average infant weight of 5 kg, consuming breast milk at a rate of 125 g milk/kg_{bw}/day [van den Berg et al.(2017)[86]])

Although DDT was banned almost 40 years ago, the fact that the monitoring results still showed trace of p,p'-DDE in human milk strongly illustrate the environmental persistence of DDT.

Note that data from pooled samples are not meant for the assessment of particular impacted population. Nevertheless, since this is the average value, it is likely that some infants have consumed above the WHO TDI of 0.01 mg/kg_{bw}/day for ΣDDT and 1-4 pg/kg_{bw}/day for PCDD/Fs.

It should be noted also that the levels of PFOS and PFOS-related substances are considered relevant to Thailand. However, at the time of this report, monitoring data related to PFOS/PFAS in human serum for the Thai population is not yet available, although there are some indications of the presence of PFOS/PFAS in local food chain [Sadia et al. (2020)[87], Zhao et al. (2012)[88]].

2.3.22 Relevant activity for the assessment and listing of new chemicals and to manage existing chemicals

Assessment of new chemicals can proceed under the HSA by issuing notifications to control new chemicals as hazardous substances. The notifications specify chemical names or chemical properties to be controlled, Category level to be assigned to, timeframe for enforcement and the responsible agencies. The procedures for listing a new hazardous substance are to (1) collect relevant information on the substance (toxicity, production, use, import and export information, relevant domestic and international regulations), (2) conduct a public hearing on the proposal among the stakeholders, (3) present relevant information and the results of the public hearing to the Sub-committee for the Stockholm Convention and (4) submit an official letter to the DIW, acting as the secretariat to the Hazardous Substance Committee, to issue a notification to control the substance.

A similar process applies in assessing and specifying laws and regulations to manage existing chemicals.

[86] Martin van den Berg, Karin Kypke, Alexander Kotz, Angelika Tritscher, Seoung Yong Lee, Katarina Magulova, Heidelore Fiedler and Rainer Malisch, WHO/UNEP global surveys of PCDDs, PCDFs, PCBs and DDTs in human milk and benefit–risk evaluation of breastfeeding, Arch Toxicol (2017) 91:83–96, DOI 10.1007/s00204-016-1802-z

[87] M. Sadia, et al., Trace level analyses of selected perfluoroalkyl acids in food: Method development and data generation, Environmental Pollution 263 (2020) 113721

[88] Y.G. Zhao, et al., Environmental contamination, human exposure and body loadings of perfluorooctane sulfonate (PFOS), focusing on Asian countries, Chemosphere 89 (2012) 355–368

2.4 Implementation of the 1st National Implementation Plan

Thailand ratified the SC on 31 January 2005. The national sub-committee on the SC was established, with the Pollution Control Department (PCD) under the Ministry of Natural Resources and Environment assigned as the country's focal point. As a Party to the Convention, Thailand has developed and submitted its first National Implementation Plan (NIP) in 2008. The NIP sets out the outlines, strategies and action plans to be taken in POPs management.

Thailand's first NIP addressed 12 chemical substances or groups of substances listed in Annexes A, B, and C. The management procedure was then set up for the 5 years action plan (2008-2012) comprising of:

1) Action plans on POPs pesticides
2) Action plans on PCBs
3) Action plans on unintentional release of POPs
4) Action plan on socio-economic analysis due to uses of POPs

Table 12: Implementation of the 1st National Implementation Plan B.E. 2552-2555 (2009-2012)

SC Obligations	Implementation
1. Measures to reduce or eliminate release from intentional production and use (Article 3)	Thailand has followed legal measures to prohibit all 10 intentional POPs by listing them as Category 4 Hazardous Substances under the Hazardous Substance Act B.E. 2535 as follows:

No	SC POPs	Year of ban		
		DOA	FDA	DIW
1	Aldrin	1988	2003	-
2	Chlordane	2000	2003	-
3	DDT	1983	2003	-
4	Dieldrin	1988	2003	-
5	Endrin	1981	2003	-
6	Heptachlor	1988	2003	-
7	Hexachlorobenzene (HCB)	2001	2003	2003
8	Mirex	2001	2003	2003
9	Polychlorinated Biphenyls (PCBs)	-	-	2004
10	Toxaphene	1983	2004	-

In 2004, the DIW designated end-of-life devices, transformers and power capacitors that contain PCBs a chemical waste, classified as Category 3 HS. Any production, import, export, or possession of these devices requires prior approval from the DIW.

In 2008, the DIW issued a notification to totally phase-out PCBs by 2012. The notification obligated device holders to prepare and implement a plan to phase-out and completely dispose of PCBs by 2012. Any movement of the affected devices also needed prior approval from the DIW.

Since PCBs oil was not one of the wastes or discarded materials that were allowed to be treated or disposed of by waste management processors, industrial waste incinerators in Thailand were not allowed by law to incinerate PCBs oils. All PCBs oils, therefore, were collected and exported to third countries (France, the Netherlands, etc.)

SC Obligations	Implementation
	for final destruction. Particularly, as reported in Thailand's National Reporting of the Stockholm Convention (Fourth Reporting Cycle), 761 tonnes of PCBs wastes were exported to France (20 t), the United Kingdom (452 t), Belgium (33 t), and other countries (256 t) for final destruction during 1992-2002. Moreover, in 2012, 110 tonnes of transformers contaminated with PCBs and 100 tonnes of waste containing PCB oils were exported to the Netherlands and France for final disposal.
2. Article 4: Register of exemptions	One relevant POPs, DDT, was banned as Category 4 HSs under the HSA in Thailand. Accordingly, there is no need for specific exemptions for this entry.
3. Operation to reduce or eliminate POPs releases from unintentional production (Article 5: Measures to reduce or eliminate releases from unintentional production)	Thailand has set up standard values for dioxin and furan releases from 5 sources which are 1) waste incinerators 2) hazardous industrial wastes 3) infectious wastes incinerators, 4) industrial incinerators fueled with processed used oils or synthetic fuels and 5) cement plants using wastes as fuels or raw materials for production. Additionally, BAT/BEP projects have been introduced to reduce or eliminate dioxin/furan releases from electricity and heat generation, incinerations, and iron/metal industrial works. [please see section 2.3.9 for more information]
4. Operation to reduce or eliminate POPs releases from stockpiles and waste (Article 6: Measures to reduce from stockpiles and wastes)	Thailand has developed the Obsolete Pesticides Inventory during the year 2004 with additional surveys in 2010-2011. In 2018 the Inventory was updated. Additionally, for raising awareness on pesticides and obsolete pesticides, a document on "Obsolete Pesticides" is published for dissemination of basic knowledge on pesticides and obsolete pesticides, potential risks from pesticides and obsolete pesticides, protection from harm from pesticides and obsolete pesticides and their safe handling practices. Another document on "Obsolete Pesticides Management" is published to provide basic knowledge in practices related to safe storage of obsolete pesticides and emergency responses.
5. Operation for information exchange (Article 9: Information exchange)	Thailand has designated PCD as National focal point to the SC to facilitate information sharing and exchange relevant to POPs management while developing websites of the national focal point to enhance information sharing and awareness of POPs among academic and interested people as well as the public at large.
6. Operation for public information, awareness and education (Article 10: Public information, awareness and education)	Please see information under section 2.3.15.

SC Obligations	Implementation
7. Operation on research, development and monitoring (Article 11: Research, development and monitoring)	Under the 1st NIP, Thailand has conducted research, development and monitoring projects for POPs to cover: The research project on health affected by exposure to dioxin/furan and bio-degradation of dioxin/furan through assessed contamination in mussel, oyster and prawn from the eastern coast of Thailand under "The evaluation of PCBs and dioxin-like PCBs contaminated coast of Thailand by using chemical and biological techniques" project with collaboration between the Center of Excellence on Environmental Health, Toxicology and Management of Chemicals (ETM), Asian Institute of Technology (AIT) and Chulabhorn Research Institute 1) The research project on PFOS and PFOA contamination and its relation with ground-surface water pollutants, the study case for the lower Chao Phraya River by the Engineering Faculty, Mahidol University. 2) The monitoring project for dioxin/furan release from various sources, i.e. electricity plants, industrial boilers, iron and metal industrial plants and central incinerators by the Department of Pollution Control. 3) The monitoring project for environment PCBs by the Department of Environmental Quality Promotion to monitor PCBs in sediment along the Chao Phraya River, river mouth and the upper Gulf of Thailand. 4) The study project of POPs piling and spreading in the environment of agricultural areas along the important river basin by the DOA. 5) The monitoring project of organochlorine pesticides and POPs in plant, vegetable and fruits by the FDA. 6) The analysis project of POPs in foods among the risk groups by the Department of Health and the FDA. 7) The primary study of organochlorine pesticides formulation among the Thai population by the Department of Medical Sciences to specify chemical types and quantities as the guideline to reduce and solve POPs problems. On the capability of dioxins/furans testing laboratories, there are various laboratories in Thailand with dioxins/furans testing capacity as follows: (1) National Dioxin Laboratory run by Department of Environmental Quality Promotion, MNRE, having scientific equipment and readiness for analyzing dioxins/furans in environment; and (2) Dioxin Laboratory run by Department of Medical Services, MOPH, having capacity to analyze dioxins/furans from food and living samples.

SC Obligations	Implementation
8. Submission of national reports (Article 15: Reporting)	Thailand has continually submitted national reports which are: The 1st National report in 2007. The 2nd National report in December 2010. The 3rd National report in August 2014. The 4th National report in August 2018.
9. Operation of effectiveness evaluation (Article 16: Effectiveness evaluation)	Thailand has participated in various effectiveness evaluation projects under SC Article 16 as followings: 1) Environmental Monitoring of Persistent Organic Pollutants (POPs) in East Asian Countries from 2004 to present with technical and financial supports by the Japanese government. This project aims to cover 9 POPs pesticides in the atmosphere of East Asian member countries as the database for effectiveness evaluation under SC Article 16. 2) Capacity building on PCDDs/PCDFs sampling and analysis to enhance capacity for POPs analytical monitoring in main samples i.e. air, breast-feeding and blood with technical and financial supports from Japan SAICM Quick start Program (QSP) provided by the Japanese government during 2009-2010. 3) Implementation of the POPs Monitoring Plan in the Asian Region to enhance Asian regional capability for POPs analytical monitoring with coverage of 23 types with financial support from the Global Environmental Facility during 2018-2020. Regarding laboratory potential and capacity enhancement, Thailand has continually managed all relevant laboratory functioning to support the national POPs monitoring in the long run to support the SC effectiveness evaluation.

□□□

3 Strategy and action plan of the National Implementation Plan

3.1 Policy statement

POPs substances possess specific traits – high toxicity, persistence to degradation in the environment, long-range transport across international boundary, and bioaccumulation in the food-web and in the environment - for which global action is needed. Thailand endeavors to reduce and eliminate the production, use and release of POPs into the environment in order to protect human health and the environment from adverse effects of POPs. Accordingly, the Thai government has updated its NIP to establish it as the main strategy to manage POPs with the goal for production reduction/elimination and for it to involve participation by all parties concerned.

Moreover, with insights regarding POPs adverse impacts, Thailand has established the SC sub-committee since 2004 as the coordination mechanism for all parties concerned to successfully achieve the NIP goal to reduce/eliminate production, use and release of POPs to benefit human health and environmental protection.

3.2 Implementation strategy

Thailand has developed a POPs management strategy to achieve the SC obligations comprising of:

1) Capacity and capability development for concerned agencies and human resources.
2) Database development and gather information related to POPs.
3) Improvement of POPs related laws and regulations.
4) Promotion of BAT/BEP for reduction/elimination of POPs uses and/or releases.
5) Manual and operation guideline development to manage POPs and wastes containing POPs.
6) Specifying and management of stockpiles of POPs in an environmentally sound manner.
7) Promotion and use of economic incentives and social tools and measures.
8) Study and research on POPs monitoring.
9) Strengthen public awareness, knowledge and education on POPs.
10) Coordination and common implementation with major national plans and strategies including where appropriate:
    a. The 20-Year National Strategic Plan (2017-2036)
    b. The 12th National Economic and Social Development Plan (2017-2021)
    c. The 20-Year National Strategic Plan for Public Health (2017-2036)
    d. The Environment Quality Plan (B.E. 2560-2564 (2017-2021))
    e. The 20-Year Pollution Management Strategy (B.E. 2560-2579 (2017-2036)) and the Pollution Management Plan (B.E. 2560-2564 (2017-2021))
    f. The Fourth National Strategic Plan on Chemicals Management (B.E. 2555-2564 (2012-2021))
    g. The National Waste Management Master Plan B.E. 2559-2564 (2016-2021)

h. The Action Plan for the National Agenda of "Solving Particle Pollution" (B.E. 2562-2567 (2019-2024))

11) Integration of collaboration and coordination between SC and relevant conventions on chemicals and wastes management i.e. Rotterdam Convention, Basel Convention and SAICM [please see section 2.2.3]. Particularly, the following emerging policy issues are considered:

a. chemicals in products (CiP),

b. hazardous substance within the life cycle of electrical and electronic products,

c. endocrine-disrupting chemicals,

d. per-fluorinated chemicals and the transition to safer alternatives, and

e. highly hazardous pesticides

3.3 Action plans

Considering country's current situation, Thailand has formulated 15 action plans to meet the SC obligations. For clarity, these action plans are described in the two sections. This section describes existing gaps in the implementation, proposes actions/activities to resolve the situations and/or provides goals to be achieved for each action. More details of each action plans in terms of activities, indicators, implementing bodies, timeline, estimated budget and targeted financial sources, are provided in the next section.

In order to achieve the goals outlined in the strategies and action plans, sufficient budget allocation from the government as well as external and international funding organizations will be necessary. Such efforts will also require continuous collaboration and co-operation from all relevant parties in the government, industrial sector, private sector, local administrations and the general public.

The execution of these action plans is tasked at two types of executing bodies 1) the core implementing bodies, which are responsible according to/as mandated by relevant policies and/or laws, are tasked with coordinating with other agencies in order to realize the objectives of the plans, and 2) the supporting bodies, are tasked with aiding and cooperating with the core implementation bodies. A total of 37 organizations are in charge of the execution of all of the proposed action plans.

3.3.1 Institutional and regulatory strengthening measures

There are many laws and regulations related to POPs in Thailand. However, there is a need for these laws and regulations to be updated to be in line with added substances on the new substance list under the SC. Another purpose would be to improve the efficiency of the enforcement. The goals are set as follows.

Updating laws and regulations:

- Control POPs and candidate POPs as Hazardous Substances under the Hazardous Substance Act B.E. 2535
- Set standards relating to the environment and food products for all concerned POPs
- Set standards related to POPs (for examples, PFOS and PFOA) in drinking water
- Set standards for POPs released from the point sources into the environment

- Review the dioxin benchmarks for classifying industrial waste into hazardous waste according to the Notification of the Ministry of Industry on disposal of sewage or unused materials, B.E. 2548 (in accordance with the Basel Convention)
- Set a requirement that any point source has to report data on emission to the environment together with data according to the Pollutant Release and Transfer Register (PRTR)
- Update the law on hazardous chemicals to cover industrial POPs and apply it to both products manufactured domestically and imported products.
- Issue the criteria on activities that are harmful to health to concerned facilities that are the source of POPs (such as junk shops, recycling facilities that are of smaller size than 50 horsepower)

Some of the goals for improving the efficiency of law enforcement and regulations are to:

- Exercise the existing laws and regulations that concern uPOPs
- Include uPOPs release issue in the government policy on promoting electricity production from biomass
- Increase strict control of import and export of POPs
- Cover POPs in dangerous chemical laws to cover industrial POPs and enforce on products manufactured domestically and imported products
- Set up appropriate measures to increase the capability of local government organisations on (1) the management of used products that contain POPs and (2) how to appropriately control and manage the release for unintentional POPs at the point source
- Request that the point source must report data on emission to the environment and PRTR data
- Increase the efficiency of controlling uPOPs release by encouraging the local government authorities (organisations) to follow the PCD's guidelines on efficient waste management by incinerators[89]
- Increase the efficiency of the control of dioxin release from medical waste incinerators by developing an efficient system for controlling medical waste transportation
- Increase the efficiency of the control of the dioxin release from cremation kilns by training operational staff on the use and maintenance of the cremation kilns according to Standard Operation Procedure (SOP)

3.3.2 Management of POPs pesticides (Annex A, Part I)

1) Develop pesticide material flow database for the whole value chain

Most POPs pesticides have been banned as Category 4 Hazardous Substances under the HSA. The ban covers all activities, including the production, import, export or possession thereof. The DOA oversees most activities along the pesticide value chain, from import, formulation, repackaging, to sales. However, quantitative data are collected only for import/export activities, but data for the subsequent domestic activities such as incoming/outgoing volume or remaining stocks for relevant

[89] The improvement of waste management and related reduction of emissions require the that relevant parties implement the waste hierarchy (3R towards circular economy) with reduction of generation, reuse and recycling and only then energy recovery in cement plants and incinerators, in line with national waste management master plan.

domestic stakeholders have not yet been collected. Thus, the following activities are proposed to develop a domestic pesticide value chain database and to help track and predict domestic flow and distribution of POPs pesticides:

1. Conduct a pilot project to develop an online multi-dimensional (e.g., sale amounts and time periods, locations of registered distribution shops, application locations and time periods, use modes, packaging management, etc.) data collection and reporting system for 2-3 candidate POPs pesticides, to assess contamination-risk areas.
2. Analyze data obtained from the online reporting system to predict the flow of pesticides in the environment and to be able to properly monitor risk areas.

2) Managing obsolete POPs pesticide stocks

Obsolete POPs pesticide stocks remaining in the country are pesticides that were allowed in the past by the government but were later banned as Category 4 Hazardous Substances. These chemicals became obsolete POPs pesticides and their stocks needed proper disposal. As of 2018, there were about 0.931 tonnes of obsolete POPs pesticide stocks, pending disposal. These remaining obsolete stocks, therefore, shall be destroyed via hazardous waste incineration.

As a preparation for future management of pesticides prior to listing them as Category 4 Hazardous Substances, a stockpile surveying and reporting system shall be established to help indicate/forecast the country's balanced stock in advance. Based on such data, responsible agencies can device proper management mechanisms to minimize the final amounts of obsolete pesticide stocks that will occur, as well as minimize adjustment burden/switching costs brought about by the ban upon relevant stakeholders, e.g., pesticide formulators, vendors, users/farmers, etc.

Thus, to ensure that future obsolete pesticide stockpiles are managed, collected, and disposed of in a timely and environmentally proper manner, the main proposed activities are:

1. Set up a stockpiles reporting system that is accessible to the public, and develop mechanisms to support the proper disposal of obsolete pesticide stocks.
2. Create online pesticide information dissemination media that will readily reach and educate all parties along the pesticide value chain, regarding appropriate and environmentally friendly pesticide management, including types of hazardous substances, storage methods, application methods, personal protection, sorting and disposal of packaging, etc.

3) Revising existing standard limits

Currently, environment, food, and drinking water quality guidelines used by the relevant agencies to monitor various environmental media do not cover all relevant SC POPs Pesticide substances. These standards should therefore be revised to include all relevant SC POPs pesticides.

4) POPs pesticides monitoring

Pesticide monitoring data in the environment, food, and humans are basis for the assessment of risks to humans and the environment, and need to be made systematic, coherent, and readily available to the public. The main activities to obtain meaningful data for assessment of the current situation and to establish context-relevant, well laid-out and long-term national monitoring programs include the following:

1. Update the list of POPs pesticides that should be monitored, and set up monitoring plans for the upated POPs pesticides residues in the envrionment, humans, animals, and food products.

2. Regularly monitor POPs pesticides residues in the envrionment, humans, animals, and food products in risk areas.
3. Create POPs monitoring data storage systems, which may be separately maintained and operated by the different responsible authorities.
4. Study towards creating a pesticide distribution model that is multi-dimensional to predict risk areas/hotspots, and to analyze correlation between the model's predictions and potentially related illness data of local populations.
5. Monitor and analyze the POPs pesticides residues in soil and groundwater in former formulation and repackage sites.

5) Phasing out POPs pesticides

To achieve the goal of reducing and eliminating the use of POPs pesticides and reducing the effects of POPs pesticides residues on humans and the environment, the main activities include:

1. Drive national research funding agencies to allocate funds for alternative solutions to replace the use of POPs pesticides.
2. Develop techniques to detect and identify legally permitted pesticides, especially candidate POPs pesticides and pesticides with high risk of smuggling.

3.3.3 Management of PCBs (Annex A, Part I & II), HCBD, PCNs, and PeCB (Annex A, Part I)

1) Management of PCBs

PCBs were banned in Thailand more than 15 years ago. PCBs containing devices were completely phased-out by 2012. As it is now illegal for anyone to have PCBs or PCB-containing devices in their possession, there is no site with PCB-containing equipment in use or in storage.

However, since PCBs are highly persistent, areas where PCBs containing transformers and capacitors were installed, repaired and/or reconditioned, stored, and decommissioned may be contaminated with PCBs. According to the PCD, PCBs containing devices were decommissioned and all PCBs oils were reportedly disposed of according to the UNEP's POPs wastes guidance. While monitoring data showed relatively low levels of PCBs contaminations in sediments in Chao Praya River, estuaries and the upper gulf of Thailand, data related to the assessment of levels PCBs contaminations in and/or surrounding these (historical) potentially contaminated sites are missing. Therefore, these areas should be assessed and levels of PCBs contaminations should be appropriately evaluated and documented.

2) Management of HCBD

There is no information related to production and uses of HCBD in Thailand. Since Thailand has no chlorinated solvent production plant, there is no major source for HCBD. A search for information in international journals did not yet find a report on the detection of HCBD in environmental media in Thailand.

With water solubility of 3.2 mg/L, HCBD contamination into aqueous effluents, soil, and underground water can be anticipated. Therefore, to ensure public safety, relevant

standards, particularly drinking water standards, should be updated and the current level of HCBD in environmental media as well as in biota in Thailand should be reviewed against the newly published standards/guideline values.

Moreover, with essentially no new uses for HCBD for a relatively long period of time, the risk phase of HCBD is believed to have shifted to the unintentional formation during waste disposal. Therefore, it is proposed that emissions of HCBD from landfills and dump sites into all relevant environmental media (air, soil, water) are monitored.

3) Management of PCNs

PCNs in closed applications:

Since former uses of PCNs in closed applications are identical to the uses of PCBs, measures taken to address PCBs in closed applications should also cover PCNs. Also, since the methods recommended to electricity authorities to identify PCBs-containing transformers and capacitors (year of manufacturing, the word "Non-inflammable Oil", the density, the chlorine contents, etc.) are not specific to PCBs, devices with PCNs should also be collected and submitted to final destruction as PCBs.

However, unlike PCBs devices, PCNs are not yet (officially) controlled. It is therefore proposed that the government conducts a nationwide survey for PCNs in transformers, power capacitors and coupling capacitors, produced before 1990 and manages them in a similar approach as previously done for PCBs. Moreover, since PCNs have been used in hydraulic fluids in the mining sector until 1989, it is proposed that an inventory of PCNs in hydraulic oils should also be developed.

PCNs in open applications:

Since the major use of PCNs was almost 100 years ago, products that might have PCNs have most likely reached end-of-life. Unlike the situation in developed countries, the mass production and consumption of electricity and electric machines/equipment in Thailand did not start until after World War II. It is unlikely to find houses with electric cables produced during 1920s to 1960s.

On the other hand, corrosion protection paints for metal constructions such as bridges, towers, ships, pressure pipes, etc. may contain PCNs. The UNEP guidance suggested that a database of metal construction built before 1980 should be compiled. Information on anti-corrosion paints should be documented, including whether the construction has been (partly) sand blasted to remove paints.

Note that former uses of PCNs are also identical to the uses of short-chain chlorinated paraffins (SCCPs) and PCBs. The inventory assessment study for PCNs (as well as PCBs uses in open applications) can be conducted together with the study for SCCPs.

PCNs in environmental media:

Products, parts and materials that may contain PCNs (such as Neoprene rubbers, cutting oils, oils for lubrication in gear and machinery) have most likely reached end-of-life. The risk phase of PCNs, therefore, is believed to have already shifted to the disposal phase. It is therefore important to monitor the emission of PCNs from relevant locations such as e-waste processing sites, landfills, dump sites and incineration sites. It is also important to study the level of PCNs in environmental media to assess the risk of PCNs in Thailand.

It should be noted that PCNs are also listed in Annex C of the convention. It is therefore proposed that unintentional releases of PCNs from chemical and thermal processes be assessed and the environmental quality standard be reviewed accordingly.

Again, all efforts to monitor PCNs, PCBs, and SCCPs/CPs should be conducted together.

Identification of hotspots:

Since former uses of PCNs in closed applications are identical to the uses of PCBs, areas identified as hotspots for PCBs are also potential contaminated sites for PCNs. While assessing historical sites for potential contaminations with PCBs[90], it is proposed that PCNs are also included. A start could be the screening of waste oils in maintenance shops

Similarly, since former uses of PCNs in open applications are identical to the use of SCCPs, PCNs should be included when assessing potential contaminated sites for SCCPs.

4) Management of PeCB

Since quintozene may be contaminated with and/or biologically degraded to PeCB, areas where these substances were applied in large quantities may be contaminated with PeCB. Moreover, with potentially high concentration of PeCB in contaminated products (large emission factor (EF) in to products), areas where phthalocyanine dyes and pigments were heavily used (textiles and leather finishers) are potentially contaminated with PeCB. These areas should be investigated in more detail. Particularly, a screening activity to study the levels of all relevant uPOPs (PeCB, PCBs, PCNs, PCDD/Fs) in relevant chemicals should be conducted.

3.3.4 Management of HexaBDE, HeptaBDE (Annex A, Part I & IV), TetraBDE, PentaBDE (Annex A, Part I & V), DecaBDE (Annex A, Part I & IX), HBB (Annex A, Part I) and HBCD (Annex A, Part I & VII)

1) Management of HBB and PBDEs

HBB can be considered a legacy material, with no new production for decades. Thailand never produced HBB and there is no data to suggest that HBB has ever been imported into or used in Thailand. HBB has been totally banned as a Category 4 HS under the Thai HSA since 2013. No report of any detection of HBB in the food chain or in any of Thailand's environmental media was found. HBB is, therefore, considered irrelevant for Thailand.

Thailand never produced any type of PBBs/PBDEs. All of the SC listed PBBs/PBDEs are listed under the HSA. PBDEs were listed as Category 3 HSs; pentaBDEs and octaBDEs in 2017 and decaBDE in 2019.

Although all commercial PBDEs are designated Category 3 HSs, the content of PBDEs in materials, parts, and/or finished products are beyond the scope of the existing controls. Therefore, the following actions are proposed:

- Lay down measures to prohibit marketing of PBDE contaminated products, in line with RoHS-like measures put in place elsewhere in the world.
- Conduct a full survey/inventory for POPs flame retardants in products that still lack data.

[90] A start could be the screening of waste oils in maintenance shops.

- Publish low POP concentrations for PBDEs, in line with levels agreed upon under the Basel convention.
- Lay down plans and supports for proper management of contaminated products, including: Develop methods to identify and separate out PBDEs contaminated materials/parts before mixing with other uncontaminated materials.
- Conduct research to gather intelligence information to enable accurate identification of PBDEs in EOL products.
- Lay down clear policy/measures to prohibit mixing and recycling of contaminated material with other cleaner material to prevent further spread out of PBDEs.
- Verify and develop a guideline for environmentally sound management of the contaminated materials.
- Establish activities and facility for the environmentally sound management of PBDE containing waste.

Finally, as Thailand is making a transition toward a more circular economy, it is important that all valuable materials/products are recovered. Researches toward finding better alternatives, and technology to eliminate the unwanted PBDE while preserving the valuable base materials shall be encouraged.

2) Management of HBCD

HBCD may be added to EPS/XPS, textile and HIPS to impart a flame retardant property. Only the uses of HBCD to produce SE-grade EPS foams had been confirmed. The total amount of HBCD contaminated SE-grade EPS foams is estimated at 175,000 tonnes and the corresponding amount of HBCD is estimated at 1,300 tonnes (between 890-1,770 tonnes). Most of the relevant amounts of HBCD are believed to still be in use-phase. As such, it is proposed that the PCD notify flame retarded expanded polystyrene (EPS) currently in use in pursuant to note (ii) of Annex A of the Convention.

Emissions of HBCD during EPS foam use phase is believed to be low. However, emissions are highly likely during the decommissioning and disposal of the constructed panels. Thus, it is imperative that the affected foams or panels be clearly marked to allow for easy identification, in line with the provisions of Part VII of Annex A of the SC.

It is also necessary to identify appropriate disposal routes and develop guidance for the decommissioning and disposal of the affected panels to protect workers from exposure to HBCD and to prevent further releases to the environment. As Thailand is making a transition toward a more circular economy, proper marking of BFR in products will be an important measure to avoid unnecessary risk of cross-contamination of substances of potential concern into sensitive products (such as food packaging, buoys, etc.) even after the phase-out of HBCD.

According to UNEP guidance[91], all sites where the manufacture of products and articles containing HBCD, the use of these products, recycling and the end-of-life treatment of these products have taken place may be potentially contaminated. Workers can be exposed to HBCD and fine particles resulting from hot wire cutting of EPS boards at production site

[91] United Nations Environment Programme (UNEP), Guidance for the inventory of Hexabromocyclododecane (HBCD), April 2019

and at construction site. However, except for the confirmed uses in EPS foams, information related to sources, releases, and environmental fate of HBCD at the national level is lacking. Particularly, the levels of exposure of the general population as well as workers to HBCD are currently unknown.

It is therefore proposed that research studies are conducted, particulary to confirm levels of HBCD in following areas:

- Sites where HBCD was used in production and compounding
- Household dust (results from this study can help confirm the uses of HBCD in textiles and other household items)
- Dust and soil in and around e-waste dismantling sites and plastic shredding facilities
- HBCD in other products/ applications (in case the study of indoor dusts indicates possible uses or concerns)
- The releases of HBCD along pre- and post-consumer SE-grade EPS foams value chain (including sludge from wastewater treatment)
- Landfill and dumpsite leachates and sediments[92]

Finally, once potential sources are confirmed, a full inventory shall be conducted to provide appropriate baseline data for HBCD for the country.

3.3.5 Management of PFOS, its salts and PFOSF (Annex B, Part I & III)

Nine PFOS-related substances were recently listed as Category 3 HSs in 2013 and 2017 which means any production, import, export, or possession requires prior approval from the DIW. PFOS is a surfactant that may be used in Thailand in textile (may be only for export oriented products), paper (food packaging), metal plating, and firefighting foams applications.

PFOS can contaminate surface water and groundwater. PFOS leached from sewage sludge can be accumulated in agricultural plants and animals, where they can transfer to humans through the food chain. Existing treatment plants may not be able to handle (remove or destroy) PFOS contaminated inputs. Depending on the sources of the influents and treatment technique, some types of PFOS, particularly linear and long-chain congeners, may be captured in organic matter fractions and the rest may remain in aqueous phases. Some of the WWTP sewage sludge is being used as soil conditioner. Without analysis results from water and wastewater treatment plants, it is not possible to trace the fate of PFOS.

Therefore, it is proposed that following areas/media are checked and appropriately controlled:

- Wastewater treatment plants that receive wastewater from a factory that uses or used PFOS and/or central WWTP that cannot separate incoming water
- WWTP effluent water, effluent from plating plants, sewage sludge and landfill leachate
- Areas that receive contaminated biosolids, particularly areas where these biosolids are used as soil conditioners
- Soil and groundwater in the affected areas
- Drinking water

[92] This study should apply for all POPs industrial chemicals, not limited to HBCD.

- Landfills, particularly industrial waste landfills

Responsible parties also need to develop a plan/measure to handle PFOS in firefighting foams that will expire over the next 10 years or so.

3.3.6 Register of specific exemptions

Thailand has been in the process of taking a decision to register for special exemption for following POPs industrial chemicals (1) decaBDE (2) HBCD (3) c-octaBDE (4) PCNs (5) SCCPs (6) c-pentaBDE (7) PFOA, its salts and PFOA-related compounds and (8) PFOS, its salts and PFOSF for specific uses for metal plating in closed systems and for fire-fighting foams (for Class B fires) that have already been installed. The proposed goals and activities for specific exemptions are;

- To set up a policy regarding request for special exemption for all POPs within the time frame designated by the SC
- To obtain information from those in the industry sector who wish to apply for special exemptions.

Moreover, the government should notify flame retarded expanded polystyrene (EPS) currently in use pursuant to note (ii) of Annex A of the Convention. It is imperative that the affected EPS foams or panels be clearly marked to allow for easy identification, in line with the provisions of Part VII of Annex A of the SC.

3.3.7 Measures to reduce or eliminate releases from unintentional production

The preliminary unintentional POPs inventory study covers relevant activities that took place in Thailand in 2017. It covers the assessment of all 9 UNEP-identified potential source groups. From the estimated PCDD/Fs emissions in Thailand for the baseline year 2017, the main emission source groups in decreasing order are G1: Waste incineration, G6: Open Burning Processes, G2: Ferrous and Non-Ferrous Metal Production, G3: Heat and Power Generation, G9: Disposal, G7: Production of Chemicals and Consumer Goods, and G8: Miscellaneous (Crematoria). To reduce uPOPs releases, the proposed measures/activities according to the abovementioned source groups are:

a) G1: Waste incineration

The high releases from MSW incinerators were mostly contributed by 57 small and inefficient incinerators, while medical waste incinerators are also important in terms of the national public health. Therefore, the main proposed activities to reduce the emission of uPOPs from waste incineration include the following:

1. Phase out MSW incinerators with technically improper air pollution control systems (to be implemented by SAOs/LAOs).
2. Include waste incinerators into Green Public Procurement (GPP) and encourage subdistrict/local administrative organizations to follow PCD’s notification on “guidelines for efficient management of municipal waste via incinerators”.
3. Release stringent waste sorting measures to reduce the amount of waste that must be incinerated.
4. Organize trainings for local officials on municipal waste incinerator maintenance and operation according to standard operation procedures (SOPs).
5. Enforce the already existing uPOPs emission standards that cover municipal waste incinerators and medical waste incinerators.

6. Develop effective manifest systems for medical waste transport (including revising the MOPH's regulation on medical waste disposal), and develop an effective oversight program for infectious waste management that covers the entire medical waste life cycle.
7. Inspect uPOPs in exhaust air and ashes from medical waste incinerators, as well as monitor environmental media contamination in nearby areas.

b) G6: Open Burning Processes

A relatively large portion of PCDD/Fs generated in agricultural field burnings, are transfered to land, which poses long-term risks to the communities that rely on food and feed produced from these land areas. Emissions from biomass open burning are, therefore, identified as a hotspot that need to be addressed. The associated main activities proposed include:

1. Monitor uPOPs releases to air and soil, as well as related food chains, in areas with biomass burning.
2. Issue incentive measures for consumers and private sectors to support agricultural products made without open burning and/or financial measures for farmers to produce agricultural products without open burning. Also, Implement social mechanisms to promote markets for certified agricultural products made without open burning, e.g., sugarcane by 2022.
3. Control pollution from agricultural waste burning by utilizing agricultural waste, and by promoting alternatives to monocropping and crops that require open burning.
4. Study alternatives to biomass open burning.

c) G2: Ferrous and Non-Ferrous Metal Production

The main vector for this source group is the release into residues, which accounts for about 241 gTEQ/a, or 87% of the total release from this source group in 2017. Some of the PCDD/Fs embedded in these residues were destroyed via incineration in cement kilns, while the rest of the residues were used for other purposes and could not be traced further. Thus, the main activities to reduce the uPOPs emission from this source group include:

1. Monitor uPOPs in residues and air from metal production plants, especially aluminum, iron/steel, and copper.
2. Enforce the already existing uPOPs emission standards that cover the pollutant threshold limits for classifying industrial wastes as hazardous wastes.
3. Study dioxin standard threshold levels that are used to designate industrial waste as hazardous waste, according to MOI's Notification on Industrial Waste Disposal, B.E. 2548 (in accordance with the Basel Convention's levels).
4. Report the phasing out and the release reduction of POPs substances every year in PCD's annual Thailand State of Pollution Reports.

d) G3: Heat and Power Generation

Biomass power plants were the key contributors for this source group, being responsible for about 48% of the emission, followed by fossil fuel power plants and household cooking with biomass. More than half of the PCDD/Fs generated are released into ashes which, if not properly controlled, could be further spread out. The main activities to reduce the uPOPs emission from this source group therefore include:

1. Study the suitability of technology used to produce electricity from various fuel types, in terms of uPOPs formation and the management of uPOPs in ashes, in order to minimize risk of conflicts among different government measures and policies.
2. Enforce the already existing uPOPs emission standards that cover the pollutant threshold limits for classifying industrial wastes as hazardous wastes.
3. Study dioxin standard threshold levels that are used to designate industrial waste as hazardous waste, according to the MOI's Notification on Industrial Waste Disposal, B.E. 2548
4. Report the phasing out and the release reduction of POPs substances every year in PCD's annual Thailand State of Pollution Reports.
5. Evaluate the risks and release campaigns and supporting measures to change the way biomass is used for cooking in households, restaurants, and food carts.

e) G9: Disposal

The main contributors (93%) for this source group are activities related to landfills and waste dumps, particularly landfilling or open dumping of wastes contaminated with hazardous components or mixed wastes, with residue being the main pathway. The main activities to reduce the uPOPs emission from this source group therefore include:

1. Study the composition and POPs contamination levels in landfilled municipal and hazardous wastes, and set up data recording systems.
2. Issue notifications to designate sources/emitters of relevant POPs as pollutant sources (e.g., landfills, etc.) and to specify emission limits.
3. Report the phasing out and the release reduction of POPs substances every year in PCD's annual Thailand State of Pollution Reports.

f) G7: Production of Chemicals and Consumer Goods

The main sources for PCDD/Fs in products were dioxin contamination in chlorinated chemicals, particularly, chlorinated paraffins and dioxazine pigments, and residuals in paper recovered from contaminated paper waste. The relevant proposed activity is to study release and contamination status of uPOPs in risk areas, for both current and historical activities, e.g., chlor-alkali plant (historical), ethylene dichloride plants (historical), etc. These screening activities should also include other relevant uPOPs (PeCB, PCBs, PCNs.)

g) G8: Miscellaneous

Miscellaneous sources contributed about 39.5 gTEQ/a (3%) to the total emission in 2017, with crematoria being responsible for almost all (98%) of the PCDD/Fs released from this source group.

Crematoria were identified in Thailand's 2004 inventory as a potential hotspot and actions have been taken to reduce the emission. Consequently, through efforts laid down by the previous NIPs, the number of improved crematoria has increased and Thailand's country-specific emission factors have been made available. Nevertheless, the improvement appeared moderate because the derived country-specific EFs were still higher than those of UNEP's Toolkit Class 2 crematoria. This finding points toward the contribution of other important factors, particularly operation and maintenance. As Thailand is planning to upgrade all crematoria to meet PCD's Type-3 specification, it is crucial that responsible agencies put in

place measures to ensure that the performance of the upgraded crematoria also meet at least UNEP Class 2 performance.

The main activities to reduce the uPOPs emission from this source group therefore include:

1. Issue measures to support upgrading of crematoria towards PCD's level 3.0 and include crematoria into Green Public Procurement to select technology and control uPOPs generation.
2. Develop uPOPs screening/indication methods as alternatives to the expensive direct PCDD/F measurements.
3. Organize trainings for local officials on crematoria maintenance and operation according to standard operation procedures (SOPs).
4. Study release and contamination status of uPOPs for both current and historical activities, e.g., crematoria (current & historical).

h) Cross-cutting issues

Examples of proposed activities to address cross-cutting issues that are common among the 3 main POPs groups include:

1. Study the suitability and effectiveness of disposal methods for POPs-containing waste in Thailand (e.g., cement kilns, hazardous waste incinerators, other potential incinerators).
2. Activities to improve POPs monitoring result reporting.
3. Revise the Promotion and Conservation of National Environmental Quality Act, B.E. 2535 to mandate pollutant sources to report their pollutant emission and PRTR inventory data that include sufficient additional parameters (metadata) for the evaluation of POPs emission per unit activity in question.

3.3.8 Measures to reduce or eliminate releases from stockpiles and waste

Information from the POPs inventory study indicates that there are stockpiles of POPs pesticides due to the ban of substances. In addition, there is a need to manage end-of-life products that contain POPs which may accumulate after measures to limit or prohibit the use of products containing POPs are implemented. The following activities are proposed.

1) Verify and conduct pilot project on environmentally sound temporary storage and management of POPs-contaminated wastes using the guidelines developed under the Basel Convention
2) Provide manuals/guidelines/ technical criteria for temporary storage of POPs-containing wastes and environmentally sound management of POPs-contaminated wastes using the guidelines developed under the Basel Convention

3.3.9 Information exchange

Thailand has set up a national focal point for the SC to facilitate the provision of information exchange relating to the management of POPs. A website has been established in order to disseminate information and raise awareness on POPs among academics, interested parties and the general public. However, it is necessary to keep the website up-to-date in order to provide the public with readily accessible, up-to-date, and accurate information.

Proposed activities to achieve the goals are:

- To report on products that are contaminated with PCBs (Annex A)
- To report on the status on the use of chemicals that contain PFOS (Annex B)
- To report on the reduction and release of uPOPs
- To prepare the full POPs inventory assessment report in order to revise and improve the data from the preliminary POPs inventory assessment report

3.3.10 Identification of contaminated sites and, where feasible, remediation in an environmentally sound manner

Many activities that took place in the past, in some cases more than decades ago, may release POPs and contaminate the nearby environment [please see section 2.3.10]. Sites contaminated with POPs substances represent important sources of potential human exposures. While relevant activities may have been commenced years ago (decades in some cases) and relevant areas/sites may have already been repurposed, and/or covered with other structures, due to the persistent nature of POPs, these areas/sites may still act as sources for POPs. Unfortunately, there is insufficient data and/or study to help identify these contaminated sites. Also, there is no policy instrument that addresses the identification and remediation of contaminated sites in Thailand.

However, since relevant industrial activities were historically clustered in/around industrial areas/estates in 2-3 provinces near Bangkok, instead of site-by-site investigation, these areas can be investigated for possible contamination with all relevant POPs (as well as other pollutants, such as mercury and other toxic metals). This area-based approach to identify contaminated sites can effectively facilitate efforts to simultaneously address all relevant POPs toward better understanding of the problems, mitigating the risks, and eventual rehabilitation. Subsequently, POPs substances that are found relevant will then be further investigated in detail.

Therefore, it is proposed that the following areas/POPs related activities are systematically investigated for potential POPs contamination and the findings are made available to the public. Moreover, in case of positive findings, appropriate risk mitigation plan and/or remediation, where feasible, shall be explored.

a) E-waste management sites including dismantling, plastic shredding and recycling, and sites where open burning of halogenated cables and circuit boards were historically or are currently practiced

b) Textile and leather production and finishing sites

c) Landfills and dumpsites

d) Industrial estates and/or areas where following activities took place in the past:
    - POPs pesticides repackaging and storage sites
    - Chlor-alkali and chlorinated organics (chlorinated paraffins, EDC) production sites
    - Production sites (pulp & paper) using elemental chlorine

e) Areas surrounding activities that generate large amounts of uPOPs as well as areas that receive residues and/or effluent from these activities, including:
    - Waste incineration (MSW, medical waste, and waste to energy)
    - Power generation (biomass power plants and fossil power plants)

- Crematoria

f) PFOS/PFOA, PBDEs and HBCD[93] related industrial wastewater treatment plants and areas that receive outputs (effluent, sludge) from these plants
    - Textile, leather and/or paper finishers
    - Plastic compounders and/or formulators
    - Metal plating

g) Areas where PCB-containing transformers and capacitors were installed, repaired and/or reconditioned, stored and decommissioned (also cover PCNs)

h) Other major excavation activities that may lead to relocation of POPs including sediment dredging and landfill excavation

For most newly listed POPs, criteria for determining contaminated sites (environmental standards) are also needed. This activity is covered in action plan 1 (Institutional and regulatory strengthening measures).

Note that activities related to the identification of contaminated sites for POPs pesticides, POPs industrial chemicals and uPOPs are also addressed under specific measures to manage the corresponding POPs.

3.3.11 Public information, awareness and education

Thailand has continuously carried out activities to raise awareness and provide knowledge on POPs. With additional focus on newly listed POPs, the main implementation plans are as follows.

- Continually strengthen public awareness on relevant POPs substances, focusing on new POPs, among citizens of all sectors through various channels and media. Strengthen awareness among the public, workers in operation sites or emission sources, operation owners, etc. on the rights for protection against exposure hazardous chemicals, which may result from private sectors' failure to abide by relevant regulations.
- Strengthen awareness and knowledge on uPOPs and their proper management among farmers, small and medium operators, and other related sectors
- Set up a systematic online database for various data-holding government agencies that links data across the agencies and is easily accessible, without withholding data, to allow for statistical analysis and POPs status evaluation. Responsible government agencies in charge of POPs must make monitoring data open and available to the public and analyse their data to generate knowledge and information towards policy-making and implementation.
- Organize trainings for local officials on municipal waste incinerator maintenance and operation according to standard operation procedures (SOPs). Other topic of training includes the management and disposal of POPs-containing wastes.

3.3.12 Research, development and monitoring

Apart from research, development and monitoring activities related to POPs pesticides, industrial and unintentional POPs that are already mentioned in other activity plans, other objectives and activities that cover all three groups of POPs are as follows.

[93] These investigation should also concurrently include the investigation of PFOA and SCCPs contamination

- To strengthen human resources, improve the capability of laboratories in analysing POPs and increase the number of research projects related to POPs, research funding agencies should be better informed on the issues and hence allocate more funds for research and monitoring activities in the environment, human and food chain
- To develop a mechanism to better manage potentially new POPs substances (candidate POPs) in a timely manner, rather than acting after the substance is listed in the Annexes, it is proposed to develop a generic protocol/criteria to trigger proactive actions, including the gathering country's baseline data/information for the substances, forecasting uses patterns and the potential stockpile, etc., and be ready for negotiation once a new substance is officially proposed to the SC.
- To study and develop country-specific emission factors for POPs (for calculating POPs release).

3.3.13 Technical assistance and financial resources and mechanisms

As a developing country, Thailand is not required to provide technical assistance according to Article 12 of the SC. However, the ability of Thailand to fulfil its obligations under the SC depends partly on the provision of adequate financial and technical assistance.

Thailand has received financial and technical assistance through international collaboration programs, both for managing and monitoring of POPS. Such programs help facilitating Thailand to comply with the SC obligations. In this regard, the operational goals are to cooperate with international organizations for POPs management and to ask for funding from GEF, under GEF-7 and GEF-8 funds.

3.3.14 Effectiveness evaluation

Parties of the SC have a duty to comply with the obligations, which include assessment of the effectiveness of the Convention. The assessment is made on the basis of existing scientific, environmental, technical and economic information. The PCD acting as the national focal point shall cooperate by submitting information mentioned above and other information requested by the meeting of the Parties. In addition, Thailand shall coordinate and cooperate with other Parties, both regionally and globally, in POPs monitoring activities and shall conduct POPs monitoring activities domestically as appropriate and according to her capabilities.

3.3.15 Gender-related issues

The majority of the Thai population is females and most of female workers are in the informal sector, some of which are farmers. However, the majority of male workers are in the formal sector, which has better social welfare than the informal sector. Therefore, women and men have different exposure to POPs. In addition, women dominate in cooking activities, both for household consumption and for income generating. For this reason, gender-related activities shall focus on creating awareness among the female population.

The goals for gender-related activities are set to raise awareness for women, children, youth, and the elderly regarding POPs by 2025 and to launch campaigns and set up measures to promote proper use of biomass as fuel for cooking in households, food carts and restaurants. In addition, the Lesbian, Gay, Bisexual, Transgender, Queer, and Intersex (LGBTQI) group is also included in these gender-related activities.

Moreover, the activities related to public awareness (Article 10) and reduce the generation and releases of uPOPs (Article 5) as mentioned above are also incorporating gender-related issues.

3.4 Detailed action plans

3.4.1 Institutional and regulatory strengthening measures

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
Review & update existing regulations							
1.1 Regulate POPs substances including candidate POPs as Hazardous Substances under the Hazardous Substance Act B.E. 2535	1.1.1 Issue notifications to control POPs substances as Hazardous Substances under the Hazardous Substance Act B.E. 2535 1) Consider controlling new industrial POPs substances that are not yet classified as Hazardous Substances, i.e., PeCB, HCBD, HBCD, esters of PCP, PCNs, and PFOA group 2) Consider elevating control level and/or specify utilization conditions in accordance with the objectives permitted by the convention for the current Class-3 Hazardous Substances, i.e., PFOS group, BDE group, and SCCPs 3) Consider controlling candidate POPs according to MNRE's control proposal (item 1.1.2)	Inclusion of current POPs and/or candidate POPs in the national Hazardous Substance list	M-Industry	MNRE MOAC MOPH FTI I-EA-T	2564 – 2568	Regular gov. spending	RTG
	1.1.2 Prepare proposal for the control of candidate POPs and submit to the National Hazardous Substances Committee for classification as Hazardous Substances under the Hazardous Substance Act B.E. 2535.	Proposal for the control of candidate POPs	MNRE	M-Industry MOAC MOPH FTI	2564 – 2568	5	RTG
1.2 Establish criteria for chemical assessment that cover substance properties as described in Paragraph 1 of	1.2.1 Revise assessment criteria both for new POPs (pesticides and industrial) and for currently permitted POPs, to cover chemical property criteria described in Paragraph 1, Annex D of the SC	Appropriate criteria for chemicals assessment	M-Industry MNRE MOAC MOPH	FTI	2564 – 2566	0.5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
Annex D of the SC by 2023							
1.3 Establish additional standard limits for POPs in environmental media and in food by 2025.	1.3.1 Issue notifications to specify environmental standard limits for all POPs substances	Notifications specifying standard limits for POPs substances in environmental media	MNRE	MOAC MOPH MWA PWA EGAT PEA MOT MoEN	2564 – 2568	20	RTG
	1.3.2 Issue notifications to specify standard limits in food for all POPs substances	Notifications specifying standard limits for POPs substances in food	MOPH MOAC	MNRE	2564 – 2568	10	RTG
	1.3.3 Issue notifications to specify drinking water standard limits for POPs substances, e.g., PFOS and PFOA	Notifications specifying additional standard limits for POPs substances in drinking water	MOPH	MNRE MWA PWA	2564 – 2565	2	RTG
1.4 Establish additional POPs emission limits from sources by 2025	1.4.1 Issue notifications to designate sources/emitters of relevant POPs as pollutant sources (e.g., landfills, power plants, metal production plants, biomass open burning, crematoria, etc.) and to specify emission limits	Notifications specifying POPs emission limits for POPs from sources	MNRE M-Industry MOAC	MOPH FTI EGAT PEA MEA	2564 – 2568	10	RTG
	1.4.2 Specify POPs monitoring criteria (including related parameters) in relevant media according to their sources (e.g., PBDEs, HBCD, SCCPs, PFOS)	POPs monitoring criteria (including related parameters)	MNRE	MHESI	2565 – 2566	2	RTG
1.5 Revise the Promotion and Conservation of National Environmental Quality Act, B.E. 2535 to mandate	1.5.1 Revise the Promotion and Conservation of National Environmental Quality Act, B.E. 2535 to mandate pollutant sources to report their pollutant emission and PRTR inventory data that include sufficient additional parameters (metadata) for the evaluation of POPs emission per unit activity in question. (For example, dioxin emission concentrations from waste	A revised version of the Promotion and Conservation of National Environmental Quality Act, B.E. 2535 that mandates	MNRE LAOs	M-Industry MOAC MOPH MOI	2564 – 2567	5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
pollutant sources to report their pollutant emission and PRTR inventory data	incinerator/factory stacks must be accompanied by other parameters such as temperature, oxygen levels, exhaust rates, overall emission durations, and associated production volumes/activity rates from the same time periods.) The pollutant sources must also report their PRTR inventories.	pollutant sources to report their pollutant emissions and PRTR inventory data					
	1.5.2 Set up reporting systems for pollutant emission data and PRTR inventories for submission to local authorities and/or pollution control officers, according to the revised version of the Promotion and Conservation of National Environmental Quality Act, B.E. 2535	Annual pollutant emission and PRTR inventory reports	MNRE	M-Industry MOAC MOPH MOI	2565 – 2568	2	RTG
1.6 Amend regulations on hazardous chemicals to include industrial POPs substances and enforce them towards both domestically produced and imported products	1.6.1 Issue notifications to i) prohibit the uses of penta- & octaBDE contaminated materials in all products, ii) prohibit the uses of decaBDE in high-risk products (products that are in close contact with users; e.g., garments, textiles, automobile passenger compartment parts) and in non-exempt applications, and iii) prohibit the uses of decaBDE in all applications by 2023. While the uses of decaBDE are still permitted (during transition period), operators must follow conditions and be responsible for the environmental disposal of the waste of their products.	Notifications to prohibit the use of POPs substances (in manufactured products)	M-Industry MNRE MOC	FTI MOT	2563 – 2565	1	RTG
	1.6.2 Issue notifications to mandate producers to declare the use of POPs in their products and to make appropriate markings on such parts to facilitate management throughout products' life-cycle	Notifications mandating the declaration of POPs contents in products	M-Industry (TISI)	MOC MOF MNRE	2564 – 2566	1	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
1.7 Control operations that are hazardous to public health (sources of POPs emissions) and control the quality of POPs-related public health monitoring	1.7.1 Issue notifications to specify criteria for operations that are considered hazardous to public health due to POPs emissions, e.g., junk shops, recycling plants and waste disposal plants below 50 horsepower, etc.	Notifications specifying criteria for operations that are considered hazardous to public health due to POPs emissions	MOPH MOI	MNRE LAOs MOL MOAC	2564 – 2568 & continue thereafter (for additional POPs to be listed in the future)	5	RTG
	1.7.2 Issue notifications to specify criteria for environment-induced illnesses and (biological) laboratory testing standards according to the Control of Occupational and Environmental Diseases Act B.E.2562 (2019)	Notification specifying criteria for environment-induced illnesses	MOPH MOI	MNRE LAOs MOL MOAC	2566-2568 & & continue thereafter	5	RTG
Strengthen law enforcement							
1.8 Enhance law-enforcement efficiency to reduce and control uPOPs emissions	1.8.1 Enforce existing uPOPs emission standards that cover the following activities: municipal waste incinerators (especially technically improper ones), medical waste incinerators, industrial waste incinerators, industrial operators that utilize used oils as fuel, and pollutant threshold limits for classifying industrial wastes as hazardous wastes	Emission monitoring data and law enforcement/penalty evaluation report	MOI	M-Industry MNRE MOPH	2564 – 2568	5	RTG
	1.8.2 Encourage sub-district administrative organizations to follow PCD's notification on "guidelines for efficient management of municipal waste via incineration"	- Percentage of efficiently managed municipal waste incinerators - Operation and uPOPs emission reports	MNRE	MOI	2564 – 2565	2	RTG
1.9 Tighten the control on import and export of POPs by 2025	1.9.1 Review existing gaps, challenges, and obstacles in the control of POPs import and export, and identify solutions.	Method to manage POPs import and export control gaps	MNRE M-Industry MOAC MOPH MOF	FTI MOC MOL	2564	1	RTG
	1.9.2 Organize training programs for customs officials	- Number of	MNRE	MHESI	2564 – 2568	1	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	regarding the list of POPs substances that have been controlled as Hazardous Substances, to prevent illegal import and export	trainings - Number of trainees	M-Industry MOAC MOPH MOF	Customs			
	1.9.3 Define customs tariff and statistical codes (HS Code) to cover new POPs, including candidate POPs	HS Codes for new and candidate POPs	MNRE M-Industry MOAC MOPH MOF	FTI	2564 – 2568	1	RTG
1.10 Enhance enforcement efficiency of chemical regulations to cover industrial POPs substances and apply the regulations to domestic and imported products	1.10.1 Study and develop data formats (or reporting template) and systems to support operators' data declaration throughout supply chains (including sale volumes) for the purpose of tracking industrial POPs and other hazardous chemicals, which will benefit continual POPs risk management and monitoring efforts in humans, animals, plants, and environmental media according to local contexts	Data formats that are suitable for developing declaration systems along supply chains	MNRE MHESI	MOC MOF MNRE MOPH M-Industry	2564 – 2565	10	RTG
1.11 Set up measures to enhance the capability of subdistrict administrative organizations (LAOs) in managing POPs-containing materials and waste, as well as in controlling uPOPs release sources by	1.11.1 Organize trainings for local LAOs officials on the proper and continual management of POPs-containing materials and waste, and on the selection of environmentally sound waste incinerators (e.g., employing proper incineration methods while also prohibiting management of POPs-contaminated waste via landfilling)	Number of trained LAOs officers	MOI MNRE MOPH M-Industry MOAC	MHESI	2564 – 2568	1.5	RTG
	1.11.2 Organize meetings among LAOs to exchange information and experiences, and to foster collaborations among themselves towards proper, continual, and systematic management of POPs	- Number of attending LAOs - Number of meetings per year	MOI	MNRE MOPH M-Industry MOAC	2564 – 2568	1.5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
2025							
1.12 Enhance dioxin/furan emission control efficiency from municipal waste incinerators and crematoria	1.12.1 Develop an effective manifest system for medical waste transport, including revising MOPH's regulation on medical waste disposal, to control medical waste transfer and ensure proper disposal. And develop an effective oversight program for infectious waste management that covers the entire medical waste life cycle, from sources to transport, and to disposal.	Manifest data of medical waste's entire life cycle	MOPH MOI DOLA	MNRE	2564 – 2568	1.5	RTG
	1.12.2 Organize trainings for local officials on crematoria maintenance and operation according to standard operation procedures (SOPs)	Number of crematoria that meet their operational specifications	MNRE LAOs		2564 – 2568	[illegible]	RTG

3.4.2 Management of POPs pesticides (Annex A, Part I)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
2.1 Develop a multi-dimensional online reporting system that incorporates spatial, temporal, application mode, and other descriptive aspects related to pesticide distribution and use	2.1.1 Conduct a pilot project to develop an online multi-dimensional (e.g., sale amounts and time periods, locations of registered distribution shops, application locations and time periods, use modes, packaging management, etc.) data collection and reporting system for 2-3 candidate POPs pesticides, to assess contamination-risk areas	An online reporting system	MOAC	MHESI MOI DOLA	2564 – 2565	10	RTG
	2.1.2 Analyze data obtained from the online reporting system to predict the flow of pesticides in the environment and to be able to properly monitor risk areas	Report on the analysis and prediction of related chemical flows in the environment	MOAC	MHESI MOI DOLA	2566 – 2568	5	RTG
2.2 Dispose of obsolete POPs	2.2.1 Develop mechanisms to support the proper disposal of obsolete pesticide stocks, and set up a	- Mechanism for sound disposal of obsolete	MOAC MOPH	MOI	2568 & thereafter	5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
pesticide stocks in environmentally sound manners	stockpiles reporting system that is accessible to the public	pesticide stocks - Updated reports on obsolete pesticide stocks					
	2.2.2 Create online pesticide information dissemination media that will readily reach and educate all parties along the pesticide value chain, regarding appropriate and environmentally friendly pesticide management, including types of Hazardous Substances, storage methods, application methods, personal protection, sorting and disposal of packaging, etc.	- Number of target groups accessing online media - Number of target groups who acquired appropriate pesticide management knowledge	MOAC MOE MOPH MHESI MNRE	MOI	2565 – 2566	5	RTG
2.3 Adequate POPs pesticide residue monitoring data in the envrionment, humans, animals, and food products by 2025	2.3.1 Revise the types of POPs pesticides that should be monitored, and set up monitoring plans for POPs pesticides residues in the envrionment, humans, animals, and food products	Monitoring plans for POPs pesticide residues in the envrionment, humans, animals, and food products	MNRE MOAC MOPH	NHCO MOI MHESI	2565 – 2566	6	RTG/GEF
	2.3.2 Regularly monitor POPs pesticides residues in the envrionment, humans, animals, and food products in risk areas (according to the monitoring plans in 2.3.1)	- POPs pesticide monitoring data in risk areas - Number of monitored risk areas - Number of related chemical substances that have been investigated	MNRE MOPH	MOAC MOI MHESI	2565 & continue according to monitoring plans	20	RTG
	2.3.3 Create POPs monitoring data storage systems, which may be separately maintained and operated by the different responsible authorities	Readily accessible monitoring data	MNRE MOPH	MOAC MHESI	2564 – 2565	5	RTG

3.4.3 Management of PCBs, HCBD, PCNs, PeCB (Annex A, Part I & II) and other Legacy Industrial POPs

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
3.1 Take steps to ensure that there is no use and/or possession of equipment and products containing PCBs, HCBD, PCNs and PeCB by 2025	3.1.1 Track possession data among target groups and operators of equipment and products containing PCBs, HCBD, PCNs and PeCB, and randomly check closed-application equipment and products that may contain these substances (e.g., transformer oil, capacitor oil, hydraulics oil) as well as contamination in surrounding areas.	Reports that include equipment/product information and their volumes	EGAT MEA PEA	MNRE FTI	2564 – 2568	5	RTG

3.4.4 Management of HexaBDE, HeptaBDE (Annex A, Part I & IV), TetraBDE, PentaBDE (Annex A, Part I & V), HBB (Annex A, Part I), HBCD (Annex A, Part I & VII) and DecaBDE (Annex A, Part I & IX)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
4.1 Reduce and cease the use of products that contain BDEs by 2030	4.1.1 Conduct full survey/inventory for POPs flame retardants in products that still lack data, e.g., textiles, automotive, rubber/silicone, construction materials	Full inventory	MNRE	M-Industry FTI I-EA-T	2564 – 2566	10	RTG/GEF
	4.1.2 Define methods and means to identify, sort, and collect WEEE that contain POPs flame retardants from the recycling routes (to be in accordance with the Basel Convention)	Manual for collecting and sorting WEEE that contains POPs flame retardants	MNRE	FTI MOI DOLA I-EA-T M-Industry	2564 – 2567	10	RTG/GEF
	4.1.3 Estimate/specify the types and quantities of equipment and products containing recycled BDEs, as well as utilization rates of recycled products	Estimated domestic quantities of relevant sorted and recycled BDEs	MNRE	FTI MOI I-EA-T M-Industry	2564 – 2567	3	RTG/GEF
	4.1.4 Study the suitability of disposal technology for	Appropriate technology for the disposal of wastes	MNRE	MHESI FTI	2564 –	5	RTG/GEF

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	BDEs contaminated wastes	containing BDEs		I-EA-T MOI M-Industry	2567		
	4.1.5 Prepare recommendations/guidelines for environmentally sound management of BDEs containing wastes	Recommendations/guidelines for management of waste containing BDEs	MNRE	FTI I-EA-T LAOs M-Industry	2565 – 2568	1	RTG/GEF
4.2 Identify insulation foams for cold storage rooms and other products that contain or are contaminated with HBCD, in Thailand and neighboring countries (regional project)	4.2.1 Prepare an HBCD survey manual for HBCD in insulation foams in cold storage rooms and other products	HBCD survey manual	MNRE	MHESI FTI I-EA-T LAOs	2564	5	RTG/GEF
	4.2.2 Conduct survey of insulation foams in cold storage rooms and other products that may contain HBCD. Also, assemble an inventory of HBCD-containing products, and clearly mark them to facilitate proper decommissioning and disposal	A survey report of insulation foams in cold storage rooms and other products that contain HBCD	MNRE	FTI I-EA-T LAOs	2564 – 2565	10	RTG/GEF
	4.2.3 Develop technology for the management of HBCD containing foams and prepare a work instruction manual for the management of HBCD containing foams/wastes	Manual on the management of HBCD-containing products/wastes	MNRE	MHESI FTI I-EA-T LAOs	2565 – 2569	5	RTG/GEF

3.4.5 Management of PFOS, its salts and PFOSF (Annex B, Part I & III)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
5.1 Phase out and cease the use of PFOS, its salts,	5.1.1 Revise regulations to mandate reporting of the use and stockpiling of PFOS, its salts, and PFOSF substances	Inventory report on the use and stockpiling of PFOS and related substances	M-Industry	FTI I-EA-T LAOS	2564 – 2565	1	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
and PFOSF substances	5.1.2 Forecast the quantities of chemical products containing PFOS, its salts, and PFOSF that are expiring, e.g., firefighting foams	Quantities of relevant expiring products	MNRE MOI (DDPM/LAOs)	FTI M-Industry	2564 – 2567	1	RTG/GEF
	5.1.3 Study the suitability of technology for disposing chemical wastes that contain PFOS, its salts, and PFOSF substances	Data on appropriated technology for final disposal of waste containing PFOS and related substance	MNRE MOI (DDPM/LAOs)	FTI MHESI M-Industry	2565 – 2567	5	RTG/GEF/ Private org.
	5.1.4 Prepare recommendations/guidelines for environmentally sound management of chemical waste containing PFOS, its salts, and PFOSF substances that are currently in stock, as well as relevant fire-fighting foams that have not yet expired. (If they cannot be sent for proper disposal, relevant fire-fighting foams can only be used in actual fire incidents (not in fire-fighting drills) and run-off water must be collected and properly treated.)	Recommendations/guidelines for the management of relevant PFOS containing waste	MNRE LAOs MOI (DDPM/LAOs)	FTI MOI M-Industry	2566 – 2568	5	RTG/GEF

3.4.6 Register for specific exemptions (Article 4)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
6.1 Recommendation to support decision for the requests for specific exemptions for all relevant POPs within the time frame designated by the SC	6.1.1 Assess POPs substances' production, use, import/export status towards decision on the necessity to request specific exemptions for (1) decaBDE; (2) SCCPs; (3) PFOA, its salts, and PFOA-related compounds; and (4) PFOS, its salts, and PFOSF for hard metal plating only in closed systems. [please see activities 5.1.1 – 5.1.4 for PFOS, its salts, and PFOSF]	Resolutions from relevant committees on specific exemption registration	MNRE	M-Industry MOAC MOPH FTI I-EA-T	2564 – 2565	1	RTG
6.2 Obtain information from operators who request specific exemption registration	6.2.1 Notify operators to confirm their requests for specific exemption for necessary applications, e.g., the use of decaBDE in underhood automotive parts and PFOS in unexpired firefighting foams (including PFOA)	Report on domestic uses of POPs substances	MNRE FTI	MOI M-Industry	2564	1	RTG

3.4.7 Measures to reduce or eliminate releases from unintentional production (Article 5)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
7.1 Generate uPOPs inventory data that reflect Thailand's contexts	7.1.1 Assemble full inventory for the main emission sources/activities as indicated by the Preliminary Inventory, and derive Thailand's specific uPOPs emission factors (Efs), e.g., ashes from biomass power plants, etc.	Inventory data and Thailand's specific Efs	MHESI MoEN MNRE	M-Industry I-EA-T LAOs EGAT PEA MEA.	2564 – 2568	10	RTG/GEF
7.2 Apply BAT/BEP towards	7.2.1 Prepare and revise manuals/technical criteria/training programs related to BAT/BEP	Manuals/technical criteria/training programs	MNRE M-Industry	MHESI NOB	2564 – 2568	10	RTG/GEF/ ความช่วยเหลือแบบ

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
new uPOPs sources and adopt BEP guidelines for existing sources by 2025	guidelines, by prioritizing activities that release the highest amounts of uPOPs	towards uPOPs reduction	FTI I-EA-T	(Crematoria) MOAC MOPH			ทวิภาคี/ภาคเอกชน
	7.2.2 Organize BAT/BEP practical training for operators and relevant parties, giving priority to activities that release the highest amounts of uPOPs	- Number of organized trainings - Number of trainees	MNRE M-Industry FTI I-EA-T NOB (Crematoria) MOI (LAOs)	MHESI MOPH	2564 – 2568	5	RTG/GEF/ ความช่วยเหลือแบบทวิภาคี/ภาคเอกชน
	7.2.3 Offer tax incentives and honorary awards to business operations/operators who adopt BAT/BEP to reduce or cease their POPs releases	Number of operations/operators who adopt BAT/BEP	MOF M-Industry MOAC	MHESI MOPH MNRE	2564 – 2568	10	RTG/GEF/ ความช่วยเหลือแบบทวิภาคี/ภาคเอกชน
	7.2.4 Specify BAT/BEP methods and measures for local administrative organizations towards reducing uPOPs from major sources (e.g., municipal waste incinerators, open burning) that are within their responsibility	- Management measures comparable to ISO 9000/14001 for relevant tasks - Manuals according to applicable emission source types	MNRE MOI (LAOs) MoEN	NOB M-Industry	2564 – 2568	5	RTG/GEF/ ความช่วยเหลือแบบทวิภาคี/ภาคเอกชน
7.3 uPOPs release reduction measures for major uPOPs sources within 2025	**Waste incineration**						
	7.3.1 Release stringent waste sorting measures to reduce the amount of waste destined for incinerators and to reduce moisture contents in municipal solid waste (to be implemented by LAOs)	Notification on household waste sorting	MOI DOLA MOPH	MNRE	2565 – 2568 & Continue thereafter	10	RTG
	7.3.2 Phase out municipal waste incinerators with technically improper air pollution control systems (to be implemented by LAOs)	- Target number of decommissioned improper incinerators at 20 units/year - Zero newly installed improper incinerators	MOI LAOs	MNRE BMA	2564 – 2566	50	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	7.3.3 Include waste incinerators into Green Public Procurement to control uPOPs by selecting technology based on Environmental Technology Verification (ETV) protocol and apply IQ/OQ/PQ during installation	Procurement specifications for environmentally friendly waste incinerators	MNRE (DEQP)	MHESI M-Industry (DIW)	2564 – 2565 & Continue thereafter	10	RTG
	7.3.4 Maintain municipal waste incinerators to ensure that they perform optimally and according to their specifications	- Number of serviced incinerators - uPOPs measurements before and after maintenance	LAOs BMA	MNRE	2565 – 2568	๓0	RTG
	Medical waste incineration						
	7.3.5 Inspect uPOPs in exhaust air and ashes from medical waste incinerators (especially those operating at higher capacities and/or near populated areas), as well as monitor environmental media contamination in nearby areas	uPOPs monitoring results, including contamination in nearby areas	MNRE MOPH LAOs	FTI	2564 – 2565	5	RTG
	Open burning processes						
	7.3.6 Monitor uPOPs releases to air and soil, as well as related food chains, in areas with biomass burning	Monitoring results towards evaluation of future status	MNRE MOPH	LAOs	2564 – 2568	15	RTG
	7.3.7 Issue incentive measures for consumers and private sectors to support agricultural products made without open burning and/or financial measures for farmers to produce agricultural products without open burning. (To be implemented in conjunction with the ongoing national agenda on air pollution.)	Incentive measures for consumers/business/farmers to avoid open burning practices	MOF M-Industry MOAC LAOs	DOLA MNRE MOPH	2564 – 2568	5	RTG
	7.3.8 Enhance zone-based management efficiency by evaluating and learning from previous operations, in order to improve emergency response plans and to be ready for future incidents. (To be implemented in conjunction with the ongoing	Data towards evaluating and issuing control measures against open burning	MOAC MOI MOPH	M-Industry MNRE	2564 – 2568	5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	national agenda on air pollution.)						
	7.3.9 Control pollution from agricultural waste burning by utilizing agricultural waste, by promoting alternatives to mono-cropping and crops that require open burning, by banning open burning, and by applying social measures on those who start wildfires. (To be implemented in conjunction with the ongoing national agenda on air pollution.)	Reduction in agricultural and forest burning	MOI MOAC MNRE	MOPH MOT	2564 – 2568	5	RTG
	7.3.10 Implement economic measures and mechanisms to promote markets for certified agricultural products made without open burning, e.g., sugarcane, by 2022. (To be implemented in conjunction with the ongoing national agenda on air pollution.)	Agricultural measures for open burning reduction or incentive measures for products made without open burning	MOAC MOF	MOPH MNRE	2564 – 2568	5	RTG
	Ferrous and non-ferrous metal production						
	7.3.11 Monitor uPOPs in residues and air from metal production plants, especially aluminum, iron/steel, and copper	Monitoring data	M-Industry	MNRE FTI I-EA-T	2564 – 2565	5	RTG
	Crematoria						
	7.3.12 Issue measures to support upgrading of crematoria towards PCD's level 3.0 and include crematoria into Green Public Procurement to select technology and control uPOPs generation	Number of upgraded & GPP-based crematoria	MNRE DOLA	MOI M-Industry MHESI NOB MOPH	2564 – 2568	10	RTG
	Landfills						
	7.3.13 Set up systems to prevent the spread of pollutants during landfill excavation, and investigate pollutants in previously buried waste	Pollutant database from previously landfilled waste	MOI (LAOs)	MNRE	2564 – 2568	10	RTG

3.4.8 Measures to reduce or eliminate releases from stockpiles and wastes (Article 6)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
8.1 Environmentally sound disposal of POPs-containing wastes by 2025	8.1.1 Verify and conduct pilot project on environmentally sound temporary storage and management of POPs-contaminated wastes using the guidelines developed under the Basel Convention	Data in Thailand's contexts	MNRE	M-Industry I-EA-T FTI	2564 – 2565	8	RTG
	8.1.2 Provide manuals/ guidelines/ technical criteria for temporary storage of POPs-containing wastes and environmentally sound management of POPs-contaminated wastes using the guidelines developed under the Basel Convention	Number of manuals/ guidelines/ technical criteria	MNRE	M-Industry I-EA-T FTI MOE MOPH	2566	40	RTG
8.2 Environmentally sound disposal of POPs by 2025	Please see activity: 3.4.2 (Management of POPs pesticides (Annex A, Part I))						
8.3 Environmentally sound disposal of end-of-life products containing BDEs by 2027	Please see activity: 3.4.4 (Management of HexaBDE, HeptaBDE (Annex A, Part IV), TetraBDE, PentaBDE (Annex A, Part V), HBB (Annex A, Part I), HBCD (Annex A, Part VII) and DecaBDE (Annex A, Part IX))						
8.4 Environmentally sound disposal of chemical waste containing PFOS, its salts, and by 2032	Please see activity: 3.4.5 (Management of PFOS, its salts and PFOSF (Annex B, Part II))						

3.4.9 Information exchange (Article 9)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
9.1 Annex-A POPs status update report	9.1.1 Report status on PCB-contaminated products to the secretariat every 5 years (Annex A, Part II, Paragraph (g))	Periodic report (every 5 years)	MNRE	MOAC M-Industry	On going	0.5	RTG
9.2 Annex-B POPs status update report	9.2.1 Report status on the use of PFOS-containing chemical products to the secretariat every 4 years (Annex A, Part III, Paragraph 3)	Periodic report (Every 4 years)	MNRE	M-Industry	On going	0.5	RTG
9.3 uPOPs reduction update report	9.3.1 Report uPOPs release reduction status to the secretariat every 5 years (Article 5, Paragraph a(V))	Periodic report (Every 5 years)	MNRE	M-Industry	On going	0.5	RTG
9.4 Full POPs inventory assessment report	9.4.1 Revise and update the 2017 Preliminary POPs Inventory Assessment Report	A full POPs Inventory Assessment Report for Thailand	MNRE	M-Industry MOAC FTI PEA MEA	On going	5	RTG/GEF

3.4.10 Identification of contaminated sites and, where feasible, remediation in an environmentally sound manner

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
10.1 Develop multi-dimension online reporting system for pesticides that integrates spatial, temporal, and application mode information	Please see activity: 3.4.2 (Management of POPs pesticides (Annex A, Part I))						
10.2 Landfill management system	Please see activities: 3.4.7 & 3.4.12 (Research, development and monitoring (Article 11) & Measures to reduce or eliminate releases from unintentional production (Article 5))						
10.3 Investigation of potential POPs contaminated sites	Please see activity 3.3.12 (Research, development and monitoring) (12.12.3: Study release and contamination status of uPOPs, industrial POPs, POPs derivatives, and POPs precursors in risk areas, for both current and historical activities, e.g., in textile and leather production and use (current), chlor-alkali plant (historical), ethylene dichloride plants (historical), and crematoria (current & historical), etc.)						

3.4.11 Public information, awareness and education

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
11.1 Continually strengthen public awareness on relevant POPs substances, focusing on new POPs, among citizens of all sectors through	11.1.1 Strengthen awareness among the public, workers in operation sites or emission sources, operation owners, etc. on the rights for protection against exposure to hazardous chemicals, which may result from private sectors' failure to abide by relevant regulations or from ignorance of responsible government agencies	- Number of events per year - Number of participants per year	MNRE M-Industry MOAC MOPH MOL	FTI I-EA-T M.Society MOE MOI	2564 – 2565	10	RTG
	11.1.2 Responsible government agencies in charge of POPs make monitoring data open and available to the	Data and knowledge made	MNRE M-	MOPH MOL	2564 – 2568	2	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
various channels and media	public according to the Official Information Act, B.E. 2540, and also analyze their data to generate knowledge and information towards policy-making and implementation	known to the public	Industry MOAC	FTI I-EA-T MOI (LAOs)			
	11.1.3 Strengthen awareness and educate various target groups -- government agencies, business operators, the media, community leaders, children, women, underprivileged individuals, the elderly, etc., -- regarding all POPs substances, through various channels and media such as printed media, electronic media, meetings, seminars, exhibitions, and community information & learning networks	- Number of information distribution channels - Number of media outlet types - Number of target groups for awareness-raising	MNRE M-Industry MOAC MOPH MHESI FTI I-EA-T MoEN	MOI MOL M.Society MOE Public Communication Private Enterprises	2564 – 2568 & Continue thereafter	10	RTG
11.2 Strengthen awareness and knowledge on BDEs and their proper management for small & medium operators and all sectors of the population	11.2.1 Train/educate business operators and the general public about BDEs as well as technically proper and environmentally sound management of BDE-containing waste	- Number of trainings organized - Number of trainees	MNRE M-Industry DOLA MOPH (DDC)	MOI MOE	2564 – 2566	1	RTG
11.3 Strengthen awareness and knowledge on uPOPs and their proper management among farmers, small & medium operators, and all	11.3.1 Train/educate business operators and the general public about uPOPs substances as well as technically proper control of uPOPs releases	- Number of trainings organized - Number of trainees	MNRE M-Industry MOAC MOPH	MOI DOLA	2564 – 2568	1.5	RTG
	11.3.2 Organize practical trainings for local administrative organizations on BAT/BEP for main uPOPs sources	Trainings throughout the country by 2027 (in order of urgency)	MNRE MOI (LAOs)	M-Industry MOE	2564 – 2568	1.5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
sectors of the population							
11.4 Upgrade Thailand's SC Focal Point's website by 2022	11.4.1 Upgrade Thailand's SC Focal Point's website, e.g., POPs database	Upgraded website for the SC Focal Point	MNRE	MOPH MOI M-Industry	2564 – 2565	2	RTG
11.5 Set up an online database that systematically gathers data from various government agencies	11.5.1 Set up a systematic online database for various data-holding government agencies that links data across the agencies and is easily accessible, and transparent, to allow for statistical analysis and POPs status evaluation	Readily accessible online database for POPs status evaluation	MNRE DOLA	M-Industry MOAC MOPH EGAT PEA I-EA-T MOI	2564 – 2568	10	RTG
11.6 Follow and report POPs management status	11.6.1 Report the phasing out and the release reduction of POPs substances every year in PCD's annual Thailand State of Pollution Reports	POPs status data in PCD's annual Thailand State of Pollution Reports	MNRE		2564 – 2568	1.5	RTG
11.7 Include POPs in school and university curricula by 2025	11.7.1 Drive to include POPs and other pollutants in school and university curricula	Number of relevant curricula	MNRE	MOE M-Industry MOAC MOPH FTI MOI	2564 – 2568	10	RTG
11.8 Train and educate target groups by 2025	11.8.1 Organize trainings for local officials on municipal waste incinerator maintenance and operation according to standard operation procedures (SOPs)	Number of waste incinerators that meet their operational specifications	MNRE LAOs	M-Industry	2564 – 2565	1.5	RTG
	11.8.2 Organize training on the management and disposal of POPs-containing wastes	Number of organized trainings	MNRE	I-EA-T FTI M-Industry	2566 – 2567	2	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
11.9 Strengthen awareness and educate all sectors of the public by 2022	11.9.1 Prepare information media and drive for compulsory elementary level curriculum to strengthen awareness on hazards from the use of chemicals in general, and on personal protection and risk reduction related to daily uses of chemicals among the public	- Online media - Number of target groups	MOAC MOE MOPH MHESI	MOI MNRE	2564 – 2565	5	RTG

3.4.12 Research, development and monitoring (Article 11)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
12.1 Allocate additional budget for POPs-related research and development	12.1.1 Drive national research funding agencies to allocate funds for POPs monitoring in the environment, humans, and the food chains	- Allocated research funding -Number of additional POPs research personnel	TSRI NRCT	MNRE M-Industry MOAC MOPH MOL M.Society MHESI MOE	2564 – 2568	-	RTG
	12.1.2 Drive national research funding agencies in the country to allocate funds for alternative solutions to replace the use of POPs pesticides	- Allocated research funding -Number of additional POPs research personnel	TSRI NRCT	MNRE M-Industry MOAC MOPH MOL M.Society MHESI MOE	2564 – 2568	-	RTG
12.2 Enhance the capability of regional testing laboratories as well as private	12.2.1 Allocate additional personnel and equipment for POPs analysis in research organizations	Number of participating regional laboratories	MHESI MOPH MNRE	TSRI	2564 – 2570	30	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
laboratories							
12.3 Develop Thailand's management and planning mechanisms for candidate POPs	12.3.1 Develop a generic protocol that will trigger domestic actions, leading to data gathering and transfer towards responsible agencies for their implementation planning and setting of relevant standard limits for candidate POPs, as soon as new candidate POPs are proposed to the SC by the POPs Reviewing Committee. (To be able to report to the secretariat within 2 years according to Article 7, Paragraph 1.)	A generic action-triggering protocol	MHESI	M-Industry MNRE FTI MOPH	2565 – 2568	10	RTG
12.4 Derive POPs Emission Factor	12.4.1 Study and derive country specific POPs emission factors for emission evaluation towards PRTR	POPs emission factors	MNRE M-Industry MOAC MHESI	TSRI MOPH	2565	10	RTG
12.5 Environment- and public health-friendly methods for the disposal of POPs-containing waste by 2025	12.5.1 Study the suitability and effectiveness of disposal methods for POPs-containing waste in Thailand (e.g., cement kilns, hazardous waste incinerators, other potential incinerators)	Options for the disposal of POPs-containing waste	MNRE M-Industry MHESI	I-EA-T FTI MOE NOB	2564 – 2568	5	RTG
12.6 Landfilled waste composition data	12.6.1 Study the composition and POPs contamination levels in landfilled municipal and hazardous wastes, and set up data recording systems	Database on waste compositions in landfills and their POPs contamination levels	MHESI	M-Industry MOI	2565 – 2567	10	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
12.7 Generate spatial and temporal pesticide application data	12.7.1 Study towards creating a pesticide distribution model that is multi-dimensional (incorporating parameters such as pesticide types, temporal and spatial application data, geology and hydrology of surface water and groundwater, etc.) to predict risk areas/hotspots, and to analyze correlation between the model's predictions and potentially related illness data of local populations (starting with a pilot project for 2-3 relevant pesticides)	Pesticide distribution model that can predict the flows of target chemicals	MHESI MOPH MOAC	MOI DOLA MWA PWA DOA	2566 – 2568	15	RTG/GEF
12.8 Generate POPs pesticides residue data in former formulation and repackaging sites	12.8.1 Monitor and analyze the POPs pesticides residues in soil and groundwater in former formulation and repackage sites	Information on POPs pesticides contamination in soil and groundwater	MHESI	MOAC MNRE MOI	2565 – 2567	10	RTG
12.9 Develop capability to identify legally permitted pesticides	12.9.1 Develop techniques to detect and identify legally permitted pesticides, especially candidate POPs pesticides and pesticides with high risk of smuggling	Pesticides fingerprinting techniques	MHESI MOAC MNRE		2565 – 2567	5	RTG
12.10 Monitor POPs industrial chemicals	12.10.1 Study the flow paths and quantities of chemicals throughout their life cycles (Material Flow Analysis) by conducting a pilot project for 1-3 high-impact target chemicals (under the project entitled "Application of industry-urban symbiosis and green chemistry for low emission and persistent organic pollutants free industrial development in Thailand", in collaboration with UNIDO)	Material flow analysis data	MNRE M-Industry MHESI MOPH	FTI MHESI MOE	2564 – 2568	5	RTG
	12.10.2 Study to assess the status of use and contamination of Legacy POPs in open applications in Thailand, e.g anti-rust protective coatings, gaskets, sealants	Product information and quantification report	MHESI	MOT	2564 – 2568	5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	12.10.3 Study and revise Thailand's low POPs content limits for the definition of hazardous waste	Suggestion for appropriate low POPs content limits for Thailand's industrial waste	MHESI MNRE		2565 – 2567	20	RTG
12.11 Conduct survey to assess the quantities of POPs-containing products	12.11.1 Investigate domestic sources of Mirex utilization as industrial POPs	Report on the uses of Mirex in industrial applications in Thailand	MNRE MHESI	FTI I-EA-T M-Industry	2565 – 2568	4	RTG
	12.11.2 Study and research flame retardants in plastics and textiles to enable sorting and separation of materials that contain different types flame retardants from recycling routes	Sorting and separation methods for materials that contain different types of flame retardants	MNRE MHESI	MOPH MOI DOLA FTI I-EA-T M-Industry	2565 – 2568	4	RTG
12.12 Monitor contamination of all POPs substances from factories, business operation sites, and other sources	12.12.1 Gather soil and underground water contamination data for relevant POPs within factory perimeters (which operators must monitor and report according to M-Industry's notification) and submit to MNRE for inclusion into the annual report	Annual soil and groundwater contamination data report	M-Industry	FTI I-EA-T Private Company	2564 – 2568	10	RTG
	12.12.2 Analysis of soil and underground water contamination data by relevant data-holding government agencies	Analysis reports based on available soil and underground water contamination data	MOAC MNRE		2564 – 2568	5	RTG
	12.12.3 Study release and contamination status of uPOPs, industrial POPs, POPs derivatives, and POPs precursors in risk areas, for both current and historical activities, e.g., in textile and leather production and use (current), chlor-alkali plant (historical), ethylene dichloride plants (historical), and crematoria (current & historical), etc.	- Information on risk areas and their contamination - Proposed risk reduction/mitigation solutions	MHESI MNRE	FTI MOD	2565 – 2568	40	RTG
	12.12.4 Study dioxin standard threshold levels that are used to designate industrial waste as hazardous waste,	Appropriate dioxin standard threshold levels for	MNRE MHESI		2564 – 2565	5	RTG

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
	according to M-Industry's Notification on Industrial Waste Disposal, B.E. 2548 (in accordance with the Basel Convention's levels)	hazardous waste					
12.13 Promote research on monitoring and reduction of dioxin from waste and biomass burning, as well as the effects of organochlorine contamination	12.13.1 Develop uPOPs screening/indication methods as alternatives to the expensive direct PCDD/F measurements	Alternative uPOPs screening/indication methods	MNRE MHESI	MOAC MOPH MoEN	2564 – 2568	5	RTG
	12.13.2 Study alternatives to biomass open burning, e.g., for areas that practice multiple cultivation cycles per year. Example approaches include: agricultural waste management machineries that are accessible to the average farmers, and/or guidelines on methods to reduce uPOPs from open biomass burning	Number of alternative options	MOAC MHESI	MNRE DOLA MOPH M.Society	2564 – 2568	5	RTG
	12.13.3 Study the public's level of knowledge and their awareness on behavioral adjustment towards dioxin reduction	Data on public awareness	MOPH (DOH)		2564 – 2565	1.5	RTG
12.14 Obtain impact evaluation method for accidental landfill fire	12.14.1 Study methods to evaluate uPOPs release from accidental municipal waste landfill fires	Evaluation methods	MHESI	MNRE MOI (DDPM)	2565 – 2568	10	RTG
12.15 Obtain suitable technology for electricity generation from various fuel types	12.15.1 Study the suitability of technology used to produce electricity from various fuel types, in terms of uPOPs formation and the management of uPOPs in ashes, in order to minimize risk of conflicts among different government measures and policies	Policy suggestions	MHESI	MNRE	2565 – 2567	15	RTG

3.4.13 Technical assistance and financial resources and mechanisms (Article 12 and 13)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
13.1 Set up POPs management collaborations with international organizations and request GEF-7 and GEF-8 funding/support	13.1.1 Hold meetings/seminars to enhance information and capacity in obtaining GEF's support to operate and implement activities according to the SC	Number of meetings/seminars	MNRE	M-Industry MOAC MOPH FTI	2565 – 2568	0.50	RTG

3.4.14 Reporting (Article 15)

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
14.1 Status update report for Annex-A POPs	14.1.1 Report status on PCB-contaminated products to the secretariat every 5 years (Annex A, Part II, Paragraph (g))	Periodic report (every 5 years) A report every 5 years	MNRE	MOAC M-Industry	2564 – 2568	1	RTG
14.2 Annex-B POPs status update report	14.2.1 Report status on the use of PFOS-containing chemical products to the secretariat every 4 years (Annex A, Part III, Paragraph 3)	Periodic report (every 4 years)	MNRE	M-Industry	2564 – 2568	1	RTG
14.3 uPOPs reduction status report	14.3.1 Report uPOPs release reduction status to the secretariat every 5 years (Article 5, Paragraph a(V))	Periodic report (every 5 years)	MNRE	M-Industry	2564 – 2568	1	RTG

3.4.15 Effectiveness evaluation

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
15.1 Establish national POPs monitor by 2023	15.1.1 Set up national POPs monitoring plans	National POPs monitoring plans	MNRE	M-Industry MOAC MOPH MHESI I-EA-T FTI	2564 – 2566	1	RTG
	15.1.2 Conduct monitoring activities according to the national POPs monitoring plans	POPs monitoring data (for implementation evaluation)	MNRE	M-Industry MOAC MOPH MHESI I-EA-T FTI	Continuous -	As indicated in respective monitoring plan	RTG

3.4.16 Gender-related issues

Goal	Activity	Indicator	Implementing Body		Duration (B.E.)	Estimated Budget (MB)	Financial Sources
			Core	Supporting			
16.1 Set up POPs awareness-raising plans for women, children, youth, and elderly by 2025	16.1.1 Evaluate the risks and release campaigns and supporting measures to change the way biomass is used for cooking in household, restaurants, and food carts. Also, disseminate knowledge and raise awareness among the public, including women, men, and the LGBTQI group	Information on risks and related measures	MNRE M.Society MOL	MOF M-Industry MOE MOI MOPH	2564 – 2570	5	RTG
	*Please see activities: 3.3.11& 3.3.7 (*Public information, awareness and education *&* Measures to reduce or eliminate releases from unintentional production (Article 5)*)*						

3.5 Prioritization of Action Plans

Activities in the Second National Implementation Plan as described in Section 3.4 are considered to be important such that they should be implemented simultaneously. There is no need to set robust criteria for prioritizing these activities since each of them is of equal importance. Consequently, prioritization of the action plans should be categorized into three priority areas, in order for the public to correctly understand the obligation to achieve the targets of POPs controls. These priority areas are health protection, raising public awareness and accurate knowledge, and building capacity of relevant agencies. However, some activities of each priority areas, as below, will be spotlighted for stakeholder participation.

1. **Priority area 1** Activities related to strengthening regulations to producing safe food, ensuring healthy life, and good environment include:

   1.1) Strengthening existing regulations, for example, setting environmental quality standards covering POPs, listing as Category 4 Hazardous Substances (prohibits production, export, import, and possession), declaring and collecting data of POPs on products manufactured in Thailand and imported from other countries, controlling open burning, etc.

   1.2) Supporting (synthetic) chemical-free agriculture or organic farming or biological cultivation or integrated pesticide management.

   1.3) Establishing a monitoring and assessment system for products containing POPs in all kinds of recycling processes.

   1.4) Controlling all kinds of POPs and candidate POPs as Hazardous Substances under the Hazardous Substance Act.

   1.5) Establishing new emission standards of releasing POPs to the environment (all media of environment) for all sources of POPs releases.

   1.6) Compiling the list of contaminated sites, assessing the risk and enforcing the law to limit the releases

   1.7) Encouraging the uses of BAT/BEP to reduce/prevent the releases from high risk for sources

2. **Priority area 2** Activities related to raising awareness and accurate understanding for every sector, including private entrepreneurs and local administrative organizations (LAOs) in product wastes containing POPs and unintentionally released POPs. These activities include:

   2.1) Raising awareness and understanding among staffs of local authorities, especially waste separation measures, and isolating products containing POPs from other substances or materials.

   2.2) Raising awareness and understanding among people in all stakeholders at the local level, especially small and medium private firms, children, women, elderly, and disadvantaged people.

   2.3) Monitoring POPs in the environment (including surface water, ground water, sea water, soil, sediments, air) especially at locations having high risk of POPs contamination and locations where water is abstracted for producing pipe water.

2.4) Establishing a marking system or declaring information on materials or products containing industrial POPs, in order for separators to manage these materials or products discretely from other substances.

2.5) Establishing a tracking system for the products containing POPs, and data on stocks of POPs. The POPs identification system should cover all the supply chain and consumer networks (especially raw materials and substances used in the production process and in products) to assist in tracking POPs data.

2.6) Publishing BAT/BEP guidelines and providing practical training and/or pilot projects, etc. to demonstrate their effectiveness.

3. **Priority area 3** Activities related to building the capacity of government agencies and local authority organizations in monitoring small and medium industrial firms related to products containing POPs, monitoring activities that release POPs unintentionally, and monitoring the quality of the environment as well as emission standards at point sources of POPs. These activities include:

3.1) Empowering staffs of local authority organizations, together with providing budgets for operating and maintaining the waste incinerators under their supervision.

3.2) Improving of POPs laboratories in terms of equipment and personnel, at the national, local, and the private sector levels. A guideline for managing recycle activities that prevent POPs contamination is also suggested, as well as research of new technologies for testing POPs.

3.3) Establishing an integrated data management system, with data from various government and private agencies, for evaluating the incidents or surveillance of the situation of POPs. The management should also provide accessible data for every stakeholder including the public and other agencies.

3.4) Reporting the uses of HBCD in cold storage rooms, clearly marked to identify the HBCD so that it can be disposed of easily and safely, and preventing people who dismantle the facilities and who are nearby from being exposed to POPs.

3.5) Adopting a guideline for monitoring PFOS, its salts and PFOSF applied in product, released POPs and POPs accumulation in the environment. Reporting the PFOS released into the environment continuously is needed and should be frequently updated, especially for the locations with high risk or near areas that are known to use PFOS.

3.6) Setting measures to reduce the unintentionally released POP at the sources of POPs releases especially from the high priority (high release potential) source groups.

3.7) Publishing BAT/BEP guidelines and providing practical training and/or pilot projects, etc. to demonstrate their effectiveness.

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Annexes

Annex 1. Government and key stakeholders for the implementation of action plans

ACFS	National Bureau of Agricultural Commodity and Food Standards
BMA	Bangkok Metropolitan Administration
Customs	The Customs Department
DDPM	Department of Disaster Prevention and Mitigation, Ministry of Interior
DEDE	Department of Alternative Energy Development and Efficiency, Ministry of Energy
DEQP	Department of Environment Quality Promotion, Ministry of Natural Resources and Environment
DIW	Department of Industrial Works, Ministry of Industry
DLA	Department of Local Administration, Ministry of Interior
DOA	Department of Agriculture, Ministry of Agriculture and Cooperatives
DOH	Department of Health, Ministry of Public Health
EGAT	The Electricity Generating Authority of Thailand
FTI	The Federation of Thai Industries
I-EA-T	The Industrial Estate Authority of Thailand
LAOs	Local Administrative Organizations
MEA	The Metropolitan Electricity Authority
MHESI	Ministry of Higher Education, Science, Research and Innovation
M-Industry	Ministry of Industry
MNRE	Ministry of Natural Resources and Environment
MOAC	Ministry of Agriculture and Cooperatives
MOC	Ministry of Commerce
MOD	Ministry of Defence
MOE	Ministry of Education
MoEN	Ministry of Energy
MOF	Ministry of Finance
MOI	Ministry of Interior
MOL	Ministry of Labour
MOPH	Ministry of Public Health
MOT	Ministry of Transport
MSDHS	Ministry of Social Development and Human Security
MWA	The Metropolitan Waterworks Authority
NHCO	National Health Commission Office
NOB	National Office of Buddhism
NRCT	The National Research Council of Thailand
PEA	The Provincial Electricity Authority
PWA	The Provincial Waterworks Authority
TISI	Thai Industrial Standards Institute, Ministry of Industry
TSRI	Thailand Science Research and Innovation

Annex 2. List of Working Groups