



# Demonstration of BAT and BEP in Open Burning Activities in Response to the Stockholm Convention on Persistent Organic Pollutants

## Regional Project Completion Report



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## Abbreviations and Acronyms

BAT	<i>Best Available Techniques</i>
BEP	<i>Best Environmental Practices</i>
BPPH	<i>Battambang Plastic Product Handicraft</i>
ESEA	<i>East Southeast Asia</i>
GEF	<i>Global Environmental Facility</i>
GHG	<i>Greenhouse Gases</i>
ISID	<i>Inclusive and Sustainable Industry Development</i>
ISWM	<i>Integrated Solid Waste Management</i>
MONRE	<i>Ministry of Natural Resources and Environment of LAO PDR</i>
MPWT	<i>Ministry of Public Work and Transportation of LAO PDR</i>
MRF	<i>Materials Recovery Facility</i>
MSW	<i>Municipal Solid Waste</i>
NERC	<i>Natural Environment Research Council</i>
NCEM	<i>Northern Center for Environmental Monitoring</i>
NGO	<i>Non-Governmental Organizations</i>
NIP	<i>National Implementation Plan</i>
PCDD/PCDF	<i>Polychlorinated dibenzo-p-dioxins and dibenzofurans</i>
PM	<i>Project Manager</i>
POPs	<i>Persistent Organic Pollutants</i>
PSC	<i>Project Steering Committee</i>
RC	<i>Regional Coordinator</i>
RECP	<i>Resource Efficient and Cleaner Production</i>
SC	<i>Stockholm Convention</i>
SWM	<i>Solid Waste Management</i>
TEQ	<i>Toxic Equivalent</i>
UNEP	<i>United Nations Environmental Program</i>
UNIDO	<i>United Nations Development Organization</i>
UPOPs	<i>Unintentional Produced Persistent Organic Pollutants</i>

## Glossary of PCR-Related Terms

3Rs	Reduce Reuse Recycle
BAT	Best Available Techniques or the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole
BEP	Best Environmental Practice means the application of the most appropriate combination of environmental control measures and strategies
Craft Villages	Traditional Vietnamese villages or households with developed expertise to make specialized products often involve recycling plastic, paper or metal.
Indicator	Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor. Means by which a change will be measured.
Mongolia ger	A round hut that can quickly be assembled and disassembled to be carried according to the needs of nomads.
National Implementation Plan	A plan for the management of POPs was prepared by each of the parties to the Stockholm Convention as part of a national sustainable development strategy of the Party.
Outcome	The likely or achieved short-term and medium-term effects of an intervention's outputs
Outputs	The products, capital goods, and services that result from a development intervention within UNIDO's sphere of control. They may also include changes resulting from an intervention, which are relevant to the achievement of outcomes.
Positive feedback	A process in which the end products of an action cause more of that action to occur in a feedback loop.
Quaternary Industries	Quaternary industry involves research and development industries e.g., IT
Tertiary Industries	Tertiary industries provide a service e.g., teaching and nursing
Target	Definite ends to be achieved. Specifies a particular value that an indicator should reach by a specific date in the future

## Executive Summary

The main objective of the project **Demonstration of BAT and BEP in Open Burning Activities in Response to the Stockholm Convention on Persistent Organic Pollutants** is to establish resource-efficient waste management systems to reduce UPOPs emissions through the introduction of Best Available Techniques and Best Environmental Practices in open burning sources. This is expected to achieve a reduction of approximately 90% of PCDD/PCDF releases at the pilot demonstration sites of participating countries. These countries of East-Southeast Asia (ESEA) namely Cambodia, Lao PDR, Mongolia, the Philippines, and Viet Nam were identified because of the open burning issues related to them. In these countries, an inefficient municipal solid waste management system led people to open dumps and burn their wastes for convenience; while agricultural residues are openly burned as accustomed practice. In addition, the open burning of coal for cooking and keeping warm in the ger areas in Mongolia, has resulted in significant releases of UPOPs and the indiscriminate disposal of contaminated ash. Also in Viet Nam, the high UPOPs releases were due to improper burning practices in crafts recycling areas.

To accomplish the objective of the project, five components were implemented, namely:

- Component 1. Legislation improvement
- Component 2. Institutional Strengthening
- Component 3. Demonstration Activities
- Component 4. Education and Awareness
- Component 5. Project Management and Monitoring & Evaluation

The five components were designed to have outputs that complement each other and bring synergy in the fulfillment of the project objectives.

For component 1, the strengthened legislation directly enforced a no open burning policy and the enhancement of existing laws on solid waste management particularly open dumping. This secured a more regular collection and disposal of solid wastes, and better maintenance of sanitary landfills. Under this component, the training on financing mechanisms enabled stakeholders particularly from the local and national governments to manage the procurement and maintenance of facilities.

Under Component 2. Capacitating activities led to people being trained on integrated solid waste management and the application of the different BAT and BEP. Some laboratory facilities were upgraded, and selected personnel involved in the project were also trained to carry out sampling and analysis related to UPOPs in open burning sites.

For Component 3, a study by the Northern Center for Environmental Monitoring (NCEM) of Viet Nam across the five countries showed that the level of dioxins and furans at some monitoring locations at the predetermined Demonstration sites, exceeded the limit levels of the enforced national standards. This further justified the need for interventions to reduce the generation of UPOPs from open burning activities.

Some of the predetermined demonstration sites and interventions at the beginning of the project were changed at the request of the national or local authorities of the countries, and more specific interventions were implemented.

The national sites selected for demonstration of BAT and BEP implemented the following interventions:

ESEA Country	Type of Intervention
Cambodia/Battambang Province	Plastic recycling line in Battambang
	Composting plant in Battambang
	Recycling plant in Battambang-ADB Facility
Lao PDR/ Vientiane	Two lines to produce plastic pipes from recycled plastics at SAPLAST
	Material Recovery Facility in THAKHEK
Mongolia/ Tsagaan Davaa	Landfill cell to host ash from stoves used in ger area households
Philippines/ General Santos and Koronadal	Central Material Recovery Facility in General Santos
	Enhancement of Plastic Recycling Facility in Koronadal
Viet Nam/ Minh Khai and Phan Boi	New plastic recycling line in Minh Khai
	Refurbishment of an existing plastic line in Phan Boi
	The line to recycle waste plastic in Minh Khai

The table below is a list of BAT and BEP and those with the tick mark were implemented at the different demonstration sites.

	List of BAT and BEP	ESEA Country				
		KH	LA	MN	PH	VN
BEP	Policy Measures					
	A law or policy on an Integrated solid waste management system (segregation, collection, disposal)	✓	✓	✓	✓	✓
	A law/guideline or policy on open burning	✓	✓	✓	✓	✓
	Guide with respect to the material to be burned and with respect to the burning process (3Ts – Temperature, Turbulence and Time)			✓		
	Education, instructional demonstration, and research alternatives	✓	✓	✓	✓	✓
	Source segregation, reduction, reuse, recycle	✓	✓	✓	✓	✓
BAT	Residue handling after burning			✓		✓
	Modern Landfill			✓		
	Materials Recovery Facility (MRF)	✓	✓		✓	
	Plastic Recycling	✓	✓		✓	✓
	Glass Recycling				✓	
	Recycling to Crafts, Bricks, Tubes, Roofs etc.		✓	✓	✓	✓
	Composting	✓			✓	
	Waste to Energy					
	Co-combustion Technologies		✓*			
	Resource Efficient and Cleaner Production (RECP)					✓
Alternative Techniques (Circular economy, Emerging technologies)					✓	

\*Shredded plastics sent to Kiln

Under Component 4, more than 100 awareness campaign activities were done; among which were trainings and seminars on the law on solid waste management strategies and open burning, health hazards, exhibition, clean-up drive, fun runs, poster, and photo competitions. More than 20,000 people from all walks of life participated, of which 47% were women and 53% were men, not to mention the wider audience reached through the national websites and social media. It is noteworthy to mention that SWM and Open burning and BAT/BEP concepts have been integrated in the curriculum of different schools and universities across the region further expanding the extent of knowledge dissemination.

Component 5 was done to monitor uniformity of preparation and submission of reports and ensure the timely delivery of activities.

The project cost initially allotted per component and per country are summarized below, including the actual co-financing delivered:

Project Component	Grant Amount USD	Country	GEF Grant* (USD)	Co-financing (USD) Delivered
Legislation Improvement	500,000	Cambodia	1,512,000	9,070,000.00
Institutional Strengthening	800,000	Lao PDR	1,512,000	4,455,288.00
Demonstration activities	4,700,000	Mongolia	1,512,000	8,129,920.00
Education and awareness	1,000,000	Philippines	1,512,000	14,488,178.29
Monitoring and evaluation	200,000	Viet Nam	1,512,000	6,068,206.00
Project management cost	360,000			
<b>Total project cost</b>	<b>7,560,000</b>	<b>TOTAL</b>	<b>7,560,000</b>	<b>42,211,592.29</b>

\*The same amount has been allotted per country, but the utilization be higher or lower depending on the need

At the start of the project, the demonstration sites for BAT/BEP involved the rehabilitation of dumpsites. Initial calculations for UPOPs emissions were based on the quantity of wastes diverted from the dumpsites (prevented from open burning) and the equivalent emissions using the UNEP Toolkit. A reduction of 35,167.2 mg TEQ/y was predicted amounting to 93% of the UPOPs emissions if no intervention was employed. Following requests from national and local authorities, some demonstration sites agreed upon during the start of the project were changed. Governments provided different indications, either about the actual demonstration site or the type of intervention, which included recycling, composting, segregation and sorting in materials recovery facility and a landfill. Calculations on the achieved reduction of UPOPs resulting from these BAT/BEP interventions showed that the total achieved UPOPs emissions reduction of 41,126.1 mg TEQ/y from recycling activities are higher than those expected from the rehabilitation of dumpsites (35,167.2 mg TEQ/y) see [Annex B](#).

ESEA Country/ Site	Cost of interventions (equipment only)	Predicted UPOPs Reduction at predetermined demonstration sites* with BAT/BEP intervention	Achieved UPOPs Reduction at actual demonstration sites with BAT/BEP intervention	Cost for 1 g TEQ dioxins reduction	Cost for 1 g dioxins reduction assuming a lifetime of 10 years and O&M costs = 20% of investment cost
	USD	mg TEQ/year	mg TEQ/year	USD/g TEQ·year	USD/g TEQ
Cambodia / Battambang Province	596,622	543.7*	4,876.77	426,621	51,221.63
Lao PdR / Vientiane	838,264	8,113.3	4,347.2	396,653	57,848.24
Mongolia / Tsagaan Davaa	505,024	9,093.2*	22,150	22,801	6,840.21
Philippines/ General Santos	680,000	7,922.2	4,526.0	150,243	45,072.91
Philippines/ Koronadal	75,000	6,070.2*	1,131.5	133,451	19,885.11
Viet Nam / Minh Khai and Phan Boi Villages	386,432	3,424.6*	4,095.1	94,364	28,309.17
<b>Total</b>	<b>3,081,342</b>	<b>35.167.2</b>	<b>41,126.1</b>	<b>1,224,132</b>	<b>209,177.30</b>

\* Predetermined sites are Kampot in Cambodia, Morin Davaa in Mongolia and Lapu-Lapu City in the Philippines and Nam Dinh Village in Viet Nam



The cost to get 1 g reduction of emissions of dioxins was calculated using the total costs of equipment and facilities (cost of interventions) and the total achieved mg TEQ/year UPOPs reduction with the BAT/BEP intervention. The total equipment cost per g TEQ reduced per year is USD 1,224,132 or USD 209,177.30 per g TEQ reduced across the estimated life of equipment of 10 years assuming 20% additional operating and monitoring costs.

Calculation on the socio-economic benefit of the project showed that if no actions are taken to reduce emissions of dioxins from open burning, about 1444 fatalities/year could be expected in the five countries of the Project, assuming a social cost ranging from 1.23 million USD/year to 14.9 million USD/year. An investment of about 3 million USD (as achieved by Project) or of about 9 million USD, as estimated by studies under the Natural Environment Research Council (NERC), will avoid fatalities and related annual social costs.

The interconnectedness of the output activities brought synergy not only towards the accomplishment of the desired outcomes but also among the project team and stakeholders. The activities were carried out in such a way that they can be replicated to other parts of the country. The project addressed the UN Sustainable Development Goals (SDG), particularly SDG 3 on Health and well-being (reduced UPOPs Emissions) and SDG 11 on Sustainable cities (improved waste management), SDG 9 on Industry, and Innovation and Infrastructure (MRF and other recycling facilities) and SDG 12 on Responsible Consumption and Production (3Rs-Reduce, Reuse, Recycle).

Women, children and the marginalized members of the participating countries stand to benefit in the project not only from better health and safety but also from added employment and education gained. This shall affect the way they manage wastes and hopefully result in a change in their way of life.

Even with some delays on implementation of the activities brought about by the pandemic, full operation of the project progressed and shall continue to be sustainably maintained and monitored.

Overall, the prohibition of open burning and the enhanced laws on waste management complemented by the implementation of BAT/BEPs, will visibly improve the quality of living conditions and advance the well-being of stakeholders. Ultimately, the project will contribute to the economic growth in local areas of the participating countries by improving the attractiveness of their tertiary and quaternary industries including tourism, entertainment, education, sales and retail and finance.

## I. PROJECT DESCRIPTION

### Description

#### A. INTRODUCTION

This project is about the **Demonstration of Best Available Techniques (BAT) and Best Environmental Practices (BEP) in Open Burning Activities in Response to the Stockholm Convention on Persistent Organic Pollutants.**

Persistent Organic Pollutants (POPs) are toxic chemicals that adversely affect human health and the environment. They can persist in the ecosystem for a long time and are capable of bioaccumulation and biomagnification through the food chain. They can be transported across long distances, even to far-away countries. POPs are components of products such as flame retardants or surfactants, pesticides like DDT, industrial chemicals, most notably polychlorinated biphenyls (PCB), and two Unintentional Persistent Organic Pollutants (UPOPs) as industrial by-products. These are Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) or dioxins and furans. Long-term exposure to these substances can cause among others cancer, fertility problems, birth defects, greater susceptibility to disease, reduced intelligence, and endocrine problems.

The Stockholm Convention on Persistent Organic Pollutants was entered into force in 2004 and ratified by over 152 countries. It enjoins member states to take measures to eliminate or reduce the release of persistent organic pollutants (POPs) into the environment to protect human health and the environment. The UNEP toolkit<sup>1</sup> identifies several source groups, including open burning processes that produce UPOPs. The open burning sector includes various biomass burning (i.e. agricultural residue burning, forest fires, etc.), backyard wastes and garbage and open dumpsites burning – both accidental and deliberate.

The Stockholm Convention, Best Available Techniques (BAT) and Best Environmental Practices (BEP) defines BAT as the most effective and advanced stage in the development of activities and their methods of operation, and BEP as the application of the most appropriate combination of environmental control measures and strategies. *Guidance for BAT and BEP for Open burning*<sup>2</sup> are summarized as follows:

Table 1 Guidance to BAT and BEP

Guidance for BAT and BEP for Open Burning	
<b>Best Environmental Practice (BEP)</b>	<ul style="list-style-type: none"> <li>• Policy Measures               <ul style="list-style-type: none"> <li>○ A law or policy on an Integrated solid waste management system (segregation, collection, disposal)</li> <li>○ A law or policy on open burning</li> </ul> </li> <li>• Guide with respect to the material to be burned and with respect to the burning process (3Ts – Temperature, Turbulence and Time)</li> </ul>

<sup>1</sup> Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs Jan 2013

<sup>2</sup> Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants, 2007, 2021 updates

Guidance for BAT and BEP for Open Burning	
	<ul style="list-style-type: none"> <li>• Education, instructional demonstration, and research alternatives</li> <li>• Resource Efficient and Cleaner Production (RECP)</li> <li>• Source reduction, reuse, recycle</li> <li>• Residue handling after burning</li> </ul>
<b>Best Available Techniques (BAT)</b>	<ul style="list-style-type: none"> <li>• Recycle Technologies</li> <li>• Materials Recovery Facility (MRF)</li> <li>• Composting</li> <li>• Modern Landfill</li> <li>• Waste to Energy</li> <li>• Co-combustion Technologies</li> <li>• Alternative Techniques and Emerging Technologies (i.e. Circular Economy – design out waste and keep materials in use)</li> </ul>

**Description**

**B. PROJECT RATIONALE**

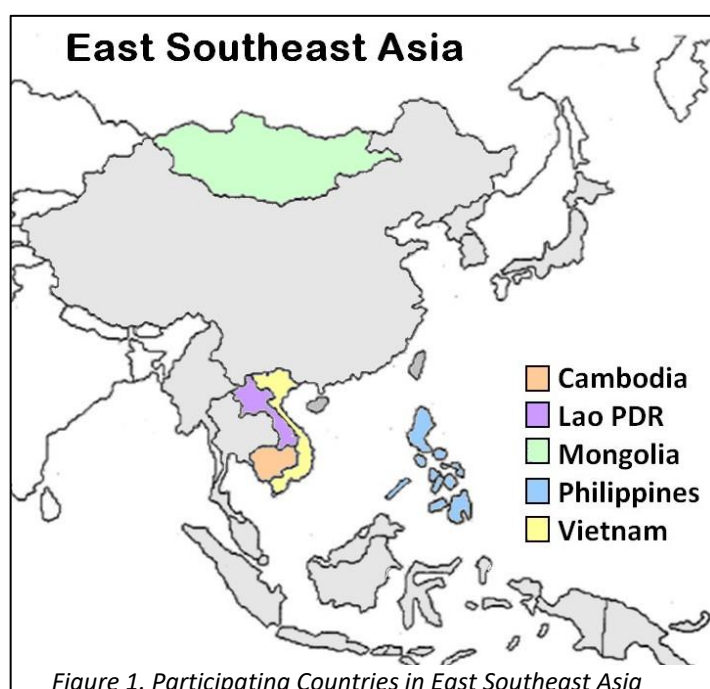


Figure 1. Participating Countries in East Southeast Asia

In East Southeast Asia (ESEA), countries such as Cambodia, Lao PDR, Mongolia, the Philippines, and Viet Nam were accountable for a total of 1118 g TEQ/year PCDD/PCDF releases into the environment (from the countries’ National Implementation Plan). Recent inventories in these countries revealed this data to be much higher as can be seen in Table 2 where open burning activities are one of the major sources of UPOPs.

In the face of risks brought about by all types of open burning, both to the environment and health, these countries still practice open burning often to conveniently dispose waste. Open burning of biomass (agricultural) residues, backyard trash, accidental fires including

dump site fires, release hazardous mixtures of UPOPs.

The Open burning sector, according to the PCDD/PCDFs inventories of the participating countries has been recognized as one of the leading sources of UPOPs. This is mainly due to the insufficient regulatory frameworks to address open burning, UPOPs emissions control and BAT/BEPS, low institutional capacity to manage waste, the non-standardized inventory of waste disposal, limited education and training on waste management and its non-inclusion in education at the university level, low women participation, and the non-capability of laboratories to carry out UPOPs monitoring. In short, waste management which should have included BAT/BEPS, waste recycling, reuse, composting/waste-to-energy, etc. are generally not implemented and external financial and technical assistance is required. The following frames show the issues on open burning in each of the ESEA countries before the project.

### Cambodia



In Cambodia the Government set up a USD 5M environmental fund in March 2015 to allow sub-national government bodies to take responsibility for waste management in their cities. With initiative from the different Ministries and in coordination with municipalities, the national authority has been given the decision-making power for contracting private waste collecting companies. However only a little over one third of the country's waste was collected with only 58% of the population having basic access to waste collection systems. As a result, people have become used to burning garbage in open areas and disposing illegally onto public areas or water bodies.

Dumping sites where most local municipalities transport and treat collected wastes are located quite far and are not designed to comply with technical standards. Thus, for convenience, simple pits or large open space areas without appropriate engineering systems are used as dumpsites.

There are existing plastic recovery sites but the equipment is not updated.

### Lao PDR



In Vientiane, government financial and personnel capacities for solid waste management remain low. Wastes are discarded at municipal landfills, dumped (usually into a water body or on vacant low-lying land), and open burned. A fraction of generated waste is collected for a fee by local governments and disposed in open dumpsites located far from households. Burning is always a common practice to reclaim landfill space. Sometimes, waste pickers burn the waste to search for metal recyclables. The level of awareness on health risks associated with these improper practices is very low. Another source of emission is forest fire and biomass from agriculture wastes. It was estimated that about 50-80% of the households are using fuel wood for cooking and other activities, like bioenergy in factories. Manual waste separation is carried out in landfills by waste sorters, mostly for plastics to be sold to reprocessing plants, but separation is quite ineffective since much of the left-over plastic undergo open burning.

### Mongolia



Forest and steppe fires and burning of waste are common practices in Mongolia. In many areas of the country, residential solid waste disposal practices consist of open burning because of its convenience, force of habit, and avoidance of disposal costs. A major reason for this is the absence of adequate legal guidelines on the disposal of solid waste by the government.

Households in ger areas often use coal for heating, and though the amount of coal burned per year is 10 times less than that used in power plants, the number of toxic emissions is 10 times higher. This is because coal is burned at low temperature (250-350°C) in home stoves, and hot ash and other wastes are not properly disposed. The hot ash is mixed with general wastes at dumpsites, where it ignites resulting in open burning.

### Philippines



In the Philippines, solid waste management is governed by a very comprehensive law known as Republic Act 9003 or the Solid Waste Management Act of 2000. This law stipulates the necessary institutional support mechanism for all Local Government Units, including the establishment of ecological solid waste management programs within their jurisdictions. However even with the law, there still exists hundreds of open dumpsites in the Philippines. Garbage collection is not always efficient, and people still resort to customary backyard burning and open dumping while biomass or agricultural crop residue burning is still prevalent. With 110M people, and high solid waste generation, the volume of waste is insufficient for manual Materials Recovery Facilities to handle and thus end up in landfills.

**Viet Nam**



Major open burning activities in Viet Nam come from forest fire and open burning of biomass or agricultural residues like rice husk and straw, domestic wastes burning, accidental fire, and brick making. Dioxin releases from informal thermal processes and burning activities in Craft Villages is a significant source because of the more than 3000 Craft Villages with serious pollution problems. A variety of informal household scale industries such as food and agriculture, plastics and papers, arts and handicrafts, textile, metal scraps, etc. use low temperature burning devices in a building or a roofed space, often with inadequate ventilation. These devices can be fired with charcoal, oil, waste oil or coal, depending on economic factors and the local fuel supply situation. In larger furnaces for metal recycling, the melt may be treated with fluxes and degasifying chemicals to improve the quality of the molten metal. The situation is of high concern because of the high levels of dioxins and furans measured.

The estimated releases from these countries were identified in Table 2 as reported in their national Implementation Plan (NIP):

Table 2. Baseline data on UPOPs generation from the ESEA Countries obtained from their NIP

ESEA Countries	Total UPOPs g TEQ/year	UPOPs g TEQ/year from open burning	Open Burning %	Landfill Disposal %	Others % (power generations, metal production etc.)
Cambodia	606.664	548.03	90%		10%
Lao PDR (2002)	102.199	91.98	90%		
Mongolia (2013)	42.45	18.08	42.6%	6.6%	50.8%
Philippines (2013)	779.53	438.10	56%	33%	8%
Viet Nam	376.67	22.60	6%		
Total	1907.51	1118			

The high UPOPs release conditions necessitated that a more holistic approach be employed to minimize if not to stop open burning. Thus, the ESEA project, **Demonstration of Best Available Techniques (BATs) and Best Environmental Practices (BEPs) in Open Burning Activities in Response to Stockholm Convention on Persistent Organic Pollutants** was implemented. Activities of the project focused on BAT and BEP applications such as, improved legislation, institutional capacity building, information, and education campaigns. It specifically addressed issues related with improper solid waste management resulting in open burning; with the consequential release of UPOPs and Greenhouse Gases (GHG). Although the project focused on UPOPs, open burning can also release significant by-product pollutants from incomplete combustion such as particulate matter and black carbon, hydrocarbons like benzene, carbon monoxide; CO<sub>2</sub> and other greenhouse gases are responsible for climate change.

To demonstrate that BAT and BEP intervention can significantly lower UPOPs and GHG emissions, the project identified different demonstration sites in the five participating countries.

## Description

## C. APPRAISAL

Cambodia, Lao PDR, Mongolia, Philippines, and Viet Nam differ in terms of managing and addressing problems on waste and open burning. The disparities are mainly brought about by their financial, economic, and socio-economic status. For the most part, they are all in the preliminary stages in the implementation of resource-efficient and integrated waste management practices. The disposal of wastes is more often carried out through open burning both at the household and municipal/city open dumpsites. Thus, open burning became one of the main sources of the formation and release of UPOPs and is foreseen to rise due to the increase in different types of waste including electrical and medical wastes. The following table shows the solid waste releases from these 5 countries, many of which end up in illegal dumpsites. Even with legislation or guidelines on Solid Waste Management (SWM), the wastes in open dumpsites end up being open burned resulting in the release of UPOPs.

Table 3. Baseline information and data on UPOPs Releases from Participating ESEA countries

ESEA Countries	Legislation on SWM	2020 Population	Estimated Solid Wastes generated MT/year	Waste generation kg/cap-day	Amount of waste Open burned kg/capita-day or %	No of Illegal Dumpsites
Cambodia (Phnom Penh)	Law on Environmental Protection and Natural Resources Management	16.7 M (0.16M)	4.5	0.74		
Lao PDR (Vientiane)	SWM strategy drafted by MPWT and improved by MONRE	7.3 M (0.42M)	2M	0.5-0.75	50%	17
Mongolia (Ulaan Bataar)	Law on Waste (SWM)	3.3 M (3M)	2.1 M	0.65 – 1.2	0.17	2612
Philippines (General Santos/ Koronadal)	RA 9003: SWM Act 2000	110 M (0.67 M)	15.5 M	0.41	0.16	353 in 2018 (Zero as of Aug 2021)
Viet Nam (Minh Khai/ Phan Boi)	Law on Environment Protection (LEP)	97M (0.008M)	23.6M*	0.45 – 1.08*		

\* Source: Viet Nam National Environmental Report 2019\_Management of Solid Waste

The project is consistent with the objective of Global Environmental Facility, GEF-5<sup>3</sup> to *promote the sound management of chemicals throughout their life cycles in ways that lead to the minimization of significant adverse effects on human health and the environment*. It addresses Chemicals Focal Area objective CHEM-1 “Phase out POPs and reduce POPs releases”; Outcome 1.3 “POPs releases to the environment reduced” and Output 1.5 “Country capacity built to effectively phase out and reduce releases of POPs”.

The project focused on the demonstration of BAT/BEP to reduce releases of unintentionally produced POPs in pilot locations prioritized by the governments of the participating countries. It also put importance on regulatory and institutional strengthening and awareness-raising of relevant stakeholders to effectively implement national waste management initiatives.

<sup>3</sup> GEF 5 Focal Areas Strategy: Chemicals: [https://www.thegef.org/sites/default/files/documents/GEF-5\\_FOCAL\\_AREA\\_STRATEGIES.pdf](https://www.thegef.org/sites/default/files/documents/GEF-5_FOCAL_AREA_STRATEGIES.pdf)

The project specifically addressed the lack of comprehensive national policies promoting BAT/BEP and the lack of national standards regulating UPOPs releases from open burning. It also focused on providing knowledge to its stakeholders in waste management issues, landfill operations including possible financing mechanisms supporting BAT/BEP, waste management and waste reduction, reuse, and recycling. The project provided for a regional information sharing system including technical knowledge and standard methodology for unintentional POPs monitoring. It implemented interventions related to BAT/BEP leading to closure/stoppage of open dumpsites and open burning activities. One major contribution of the project was raising the awareness on a greater populace on POPs issues.

## Description

### D. OBJECTIVES AND SCOPE

The primary objective of the project was to reduce UPOPs emissions with the introduction of BATs and BEPs in open burning through a resource efficient waste management system. To achieve this objective, demonstration sites in each participating country were identified and site-specific baseline data were approximated from the prevailing solid waste disposal and the UPOPs generating activities. For Cambodia, Lao PDR, Mongolia, and Philippines, it was assumed that solid waste disposed in landfills resulted in 20-30% of waste being open burned without BAT/BEP intervention. The equivalent UPOPs releases from air, land, water was computed using the 2013 UNEP Toolkit for a purely uncontrolled open burning condition. UPOPs emissions after BAT and BEP intervention were calculated the same way, based on 40% estimated amount of waste diverted from the disposal sites. For Viet Nam, the BAT and BEP intervention was based on aluminum recycling. The predicted UPOPs reductions are tabulated in Table 4.

Table 4. Computed UPOPs emissions estimated from solid wastes disposed at demonstration sites

Country/site	MT/year Solid waste disposed Without BAT/BEP (Assumed 20-40% open-burned in the landfill)	Predicted UPOPs Releases without BAT/BEP mg TEQ/year	MT/year Solid waste disposed With BAT/BEP (40% waste is diverted or not burned so 60% goes to landfill)	Expected UPOPs Releases with BAT/BEP mg TEQ/year
Cambodia / Kampot	3600	553.8	2160	10.1
Lao PdR / Vientiane	73000	8335.5	44000	222.2
Mongolia /Morin Daava	60900	9277.5	36500	184.3
Philippines /General Santos	58000	8099.0	35000	176.8
Philippines /LapuLapu City	43000	6201.5	26000	131.3
Viet Nam /Nam Dinh village		5149.8		1725.2
<b>Total</b>		<b>37617.1</b>		<b>2449.9</b>

It was estimated that a potential reduction of 93% could be achieved for emissions to air and in solid residues if open burning practices could be decreased by implementing BAT and BEP interventions. Therefore, it was established to achieve a reduction of approximately 90% of the expected PCDD/PCDF releases at the pilot demonstration sites in the participating countries. This could be achieved by dividing the project into 5 components, each with specific outcomes and outputs.

**Description**  
**E. COMPONENTS**

The project had five components, each with a specific outcome and outputs.

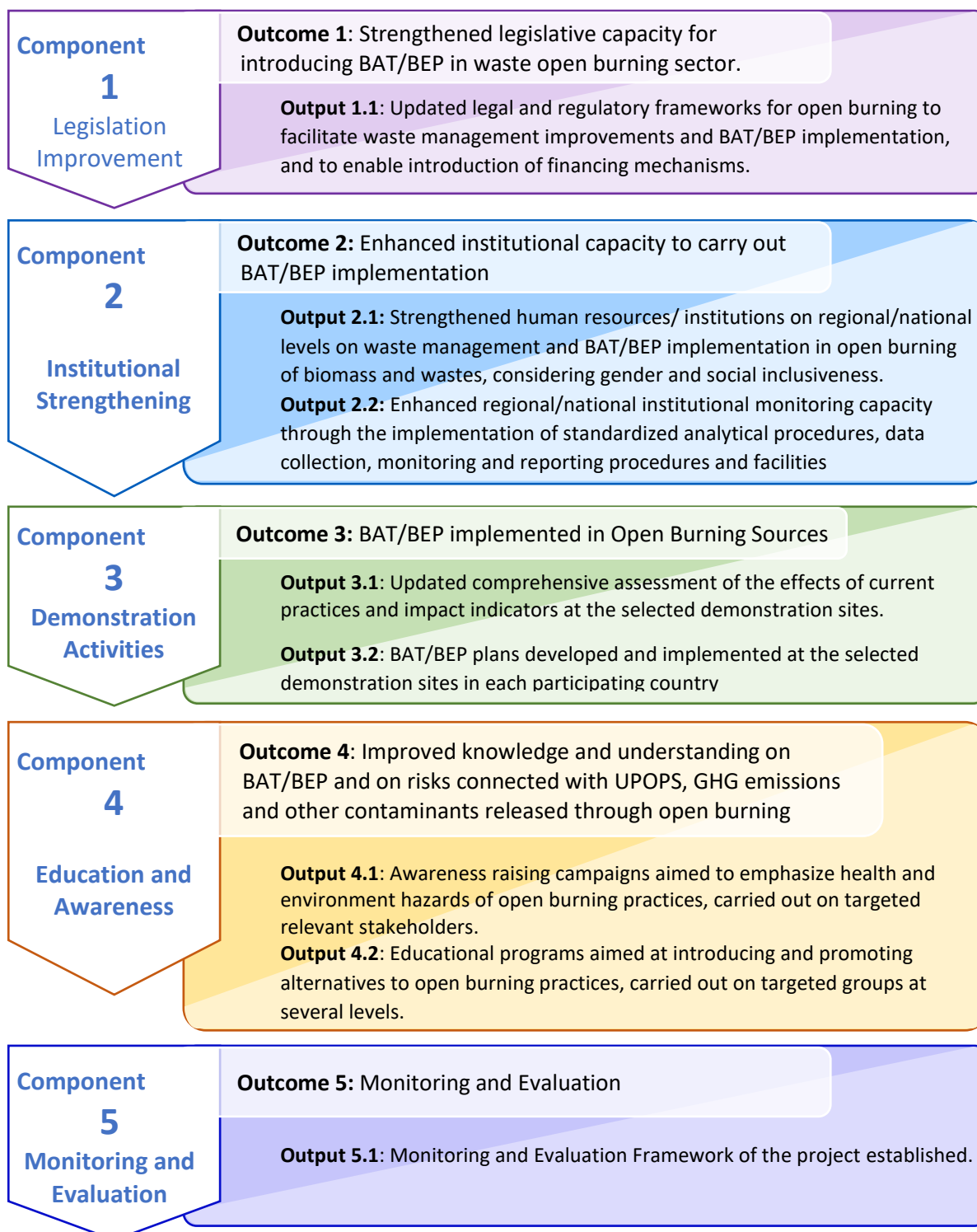


Figure 2. The Five Components of the Project



Description

**F. IMPLEMENTATION AGREEMENTS AND SCHEDULE**

The ESEA BAT/BEP in Open Burning Project was funded by a grant from GEF and UNIDO was the Implementing Agency (IA). The main counterpart in each of the countries for the implementation of the project are the different ministries/department namely:

ESEA Country	Implementing Agencies	
Cambodia		Ministry of Environment (MoE)
Lao PDR		Ministry of Natural Resources and Environment
Mongolia		Ministry of Environment and Tourism
Philippines		Department of Environment and Natural Resources (DENR)
Viet Nam		Ministry of Natural Resources and Environment

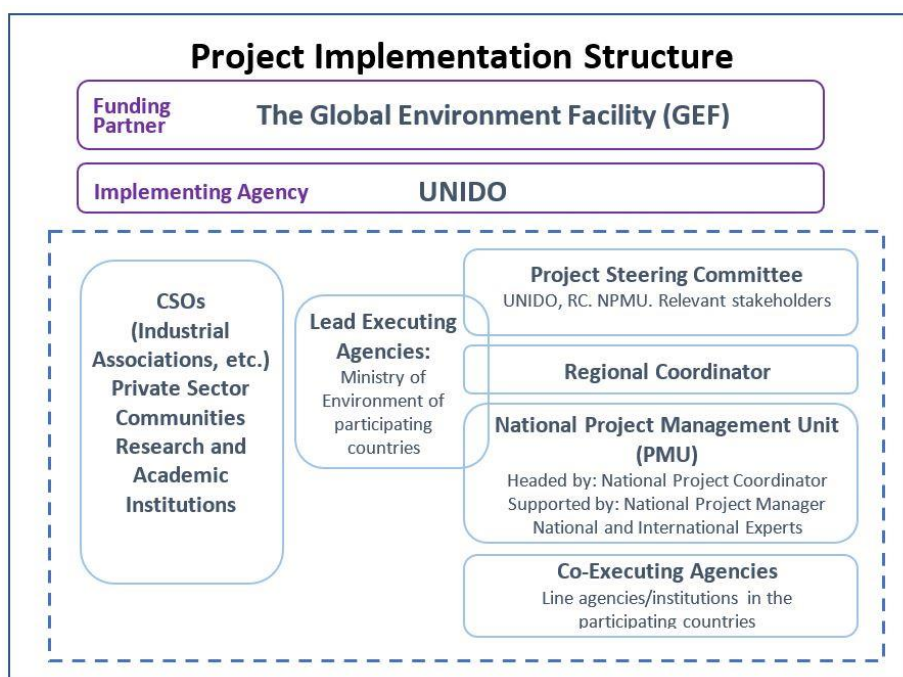


Figure 3. Project Implementation Structure

A Project Steering Committee (PSC) was established comprising of UNIDO Project Manager (PM), the Regional Coordinator (RC), the National Project Coordinators (NPC), and the National Project Managers (NPM). National Project Director (NPD) was made optional but most of the countries have designated NPDs who also came from the National Government Partners. The implementation of the project started

in 2015 and was scheduled to end in 2020 but was extended for another 1.5 years thus ending in 2022. The PSC held its regular session every year, with rotational chairmanship, throughout the project implementation and held Coordination meetings as necessary. National Project offices and Project Management Units (PMUs) were also established in each of the countries that oversaw and managed the day-to-day operations of the project. To support the project implementation, international and national experts were recruited based on required activities. The RC was appointed from among the NPMs and assisted the UNIDO PM in project administration, coordination, preparation of regional reports, and timely delivery of activities and outputs.

### Description

#### G. COST AND FINANCING ARRANGEMENTS

The project was funded by GEF from its Trust Fund with co-financing commitments, in cash or in kind, from the five countries. The source of co-financing mainly came from the participating country’s national and local governments and private sectors. The financial management of the project was provided by UNIDO including all procurements and contracts during the implementation of project activities.

The total grant amount from GEF was USD 7,560,000 and the total co-financing amounted to USD 32,776,434.

## II. Implementation Achievements

This Implementation Achievements show the activities identified and implemented during the duration of the project. They were selected based on the outcome indicators set to achieve project expected results and objectives. Each component had an expected outcome and outputs which were completed and accomplished. An extension period of one and a half (1.5) years turned out to be necessary mainly due to the limitations and restrictions brought about by the COVID-19 pandemic.

### Achievements

#### A. COMPONENT 1 – LEGISLATION IMPROVEMENT

<p><b>Outcome 1</b> Strengthened legislative capacity for introducing BAT/BEP in waste open burning sector.</p> <p><b>Output 1.1</b> Updated legal and regulatory frameworks for open burning to facilitate waste management improvements and BAT/BEP implementation, and to enable introduction of financing mechanisms.</p>	<p><b>Indicators</b> Number of regulatory instruments in national legislations with requirements on BAT/BEP and UPOPs compliant with Stockholm Convention.</p>	<p><b>Target Activities</b></p> <ul style="list-style-type: none"> <li>• New sets of guidance/ guidelines in national legislations focusing on BAT/BEP, UPOPs and open burning control measures adopted.</li> <li>• Incentive systems and financing mechanisms for the adoption of BAT/BEP developed.</li> <li>• National Assessment Report on Open Burning practices</li> </ul>	<p><b>ACCOMPLISHED</b></p>
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Two main outcomes for this component are **Strengthened Legislation** and **Financing Mechanisms** to encourage the adoption of BAT/BEP on open burning. Other outcomes achieved because of this component have been included to highlight the positive feedback resulting from the implementation of the activities to achieve the targets.

The lack or insufficiency in regulations to address open burning and UPOPs releases in each of the participating countries was the main reason why regulatory instruments either in the form of a technical guideline/guidance or an amendment to existing waste management protocols were needed.

Activities conducted under Component 1 were meant to encourage government to strengthen legislation on open burning of solid wastes. Included activities were the assessments of UPOPs releases and impacts of open burning, workshops that focus on health effects of UPOPs and the development of financing mechanisms and incentive systems for solid waste management (SWM).

Sustainable financing of solid waste management (SWM) systems has always been in quandary in low and middle-income countries. It is either SWM has not been the priority of the administration or available funding mechanisms are not disseminated and fully understood by the public in general. In the 5 participating countries, despite the implementation of many development projects and the inclusion of SWM in local government plans and programs, funding for such solid waste management initiatives has always been a challenge.

Table 5. Component 1 Activities to Achieve Target Outcomes

ESEA	TARGET ACTIVITIES		
	Legislating Guides/Laws	Financing Mechanisms and Incentive Systems	Complementing Activity to Legislating and Financing
<b>Regional</b>	1. Toolkit on Integrated Solid Waste Management Toolkit to Implement BAT and BEP to Open Burning		Training on Toolkit
<b>Cambodia</b>	<ol style="list-style-type: none"> <li>1. Technical Guideline on Waste and Landfill Management Introducing BAT/BEP in Cambodia</li> <li>2. Solid Waste Management Including Mechanism Policy 2020-2030 to Reduce Open Burning in Cambodia</li> </ol>	A Manual for using financing mechanisms and incentive systems in waste management.	<ol style="list-style-type: none"> <li>1. Technical Guideline Workshop on Waste and Landfill Management using BAT/BEP together with Financing Mechanisms, Incentive Systems</li> <li>2. Translation of Toolkit</li> </ol>
<b>Lao PDR</b>	<ol style="list-style-type: none"> <li>1. Article 38 of Environmental Protection Law, 2012 strengthened with widespread implementation of existing 3 Rs</li> <li>2. National Waste Management Strategy, the associated Action Plan for Waste Minimization and Recycling, and in the Framework for Sustainable Waste Management</li> <li>3. Co-regulatory instruments with industry, i.e., Circular Economy Design for disassembly and 3Rs</li> </ol>	The development and implementation of appropriate economic instruments and other financial incentives	<ol style="list-style-type: none"> <li>1. Technical workshop on guideline on waste and landfill management to introduce proposed legislative changes</li> <li>2. National Assessment Report and training on impacts of Open Burning</li> <li>3. Translation of Toolkit</li> </ol>
<b>Mongolia</b>	<ol style="list-style-type: none"> <li>1. Improvement of legal and regulatory frameworks for open burning to facilitate waste management improvements and BAT/BEP and to enable introduction of financing mechanisms</li> <li>2. Commissioning Act for permanent usage of the Landfill Cell for Ash Disposal and a Storage and Maintenance Facility for containers for ash</li> <li>4. Amendment of Law on Waste in Mongolia Approved and Ratified</li> </ol>	Training of relevant stakeholders on application of financing mechanisms and incentive systems in support of BAT/BEP implementation	<ol style="list-style-type: none"> <li>1. Training on the newly passed Amendment Law on Waste 2017</li> <li>2. National training course on Law on Waste Management for government employee</li> <li>3. Mongolian University of Science and Technology (MUST) on management, amendments on waste law</li> <li>4. Goods and spare parts received by the Joint</li> </ol>

ESEA	TARGET ACTIVITIES		
	Legislating Guides/Laws	Financing Mechanisms and Incentive Systems	Complementing Activity to Legislating and Financing
	5. Assessment of the current status of implementation and achievement of NIP with proposed solutions for Sound Management of POPs		Laboratory for POPs analysis 5. Translation of Toolkit
<b>Philippines</b>	<ol style="list-style-type: none"> <li>1. Passing of Resolution No. 1468 s 2021, meant to Strengthen the Enforcement of R.A. 9003 or Ecological Solid Waste Management Act of 2000 on Open Burning of Municipal Solid Wastes Including Agricultural Wastes.</li> <li>2. Stricter City ordinances on the use of plastic bags and segregated collection mandatory for barangays and private garbage collectors, on no segregation no collection policy.</li> </ol>	A Manual on Available Financing Mechanisms and Incentive Systems for SWM programs was compiled and published.	<ol style="list-style-type: none"> <li>1. A Report Manual on the Assessment of Impacts of Open Burning Practices in the Philippines.</li> <li>2. Training/Information Dissemination on the newly passed resolution to strengthen the enforcement of 9003</li> <li>3. Training of agriculture sector and local ENRO on Biomass burning alternatives</li> </ol>
<b>Viet Nam</b>	<ol style="list-style-type: none"> <li>1. Law on Environment Protection (LEP) revised in 2020 for the enhancement of SWM practices</li> <li>2. Decree 08/2022/ND-CP included provisions on sound management of POPs and circular economy.</li> <li>3. Amendment of the National technical regulation on industrial waste incinerators</li> <li>4. Developed technical guidance for environmental protection scheme for four types of craft villages</li> <li>5. Develop a draft national technical regulation on thresholds of POPs in articles, products, and equipment</li> <li>6. Draft Technical Guidelines in information disclosure and label of POPs</li> <li>7. Draft technical guideline on retrieval and disposal of discarded products</li> <li>8. Draft regulation on               <ol style="list-style-type: none"> <li>a. POPs exemption</li> <li>b. common industrial solid waste management</li> <li>c. hazardous waste management</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Study on the current economic instruments for environmental management and waste management.</li> <li>2. Guideline for production households/enterprise at craft villages to access fund from Viet Nam Protection Environmental Fund and Viet Nam Craft Village Environment Fund</li> <li>3. Manual for using financing mechanisms and incentive systems in waste management</li> </ol>	<ol style="list-style-type: none"> <li>1. Final report on waste treatment activities in industrial sector, domestic waste and waste in rural areas submitted</li> <li>2. Workshop to introduce guidance on new regulations on waste management, financing mechanisms and incentive systems</li> <li>3. Translation of Toolkit</li> <li>4. Consultative workshop on development of regulation</li> </ol>

Achievements			
B. COMPONENT 2 – INSTITUTIONAL STRENGTHENING			
<p><b>Outcome 2:</b> Enhanced institutional capacity to carry out BAT/BEP implementation</p> <p><b>Output 2.1:</b> Strengthened human resources/ institutions on regional/national levels on waste management and BAT/BEP implementation in open burning of biomass and wastes, considering gender and social inclusiveness.</p> <p><b>Output 2.2:</b> Enhanced regional/national institutional monitoring capacity through the implementation of standardized analytical procedures, data collection, monitoring and reporting procedures and facilities.</p>	<p><b>Indicators</b></p> <ul style="list-style-type: none"> <li>• Number of scientific/ educational/professional centers of competency for POP related topics to be involved in trainings</li> <li>• Number of laboratories adopting best practices on monitoring/ evaluation of UPOPs.</li> </ul>	<p><b>Target Activities</b></p> <ul style="list-style-type: none"> <li>• At least 5 institutions in the region identified to act as sharing information centers for POPs and open burning related topics.</li> <li>• At least 2 laboratories in the region strengthened for POPs analysis and 2 for analysis of basic parameters in landfill management.</li> </ul>	<p><b>ACCOMPLISHED</b></p>

Capacity building of key stakeholders (public officials, academics, technical staff, industry and agriculture and non-government organizations) was important to strengthen institutions’ capability to provide interventions to stop open burning. These activities included training on Integrated SWM, application of Open burning alternatives such as Best Environmental Practices (BEP) and Best Available Techniques (BAT), and capacitating scientists and technologists on sampling and measuring UPOPs releases. Training on financing allowed for strengthened SWM facilities and testing laboratories. A Regional Cooperation Platform or Website was developed and established to facilitate the exchange of information and sharing of experiences at a regional level. This regional platform enabled the participating countries to share knowledge, best practices and lessons learned from the activities undertaken and implemented. It also necessitated each country to also put up their own national platform or website on Open Burning for general awareness and advocacies.

Table 6. Component 2 Activities to Achieve Target Outcomes

ESEA	TARGET ACTIVITIES	
	Institutional Sharing and Training	Strengthening Dioxin Testing Laboratory
<b>Regional</b>	<ol style="list-style-type: none"> <li>1. Regional Website: <a href="http://stopopenburning.org">http://stopopenburning.org</a> Regional Website to be maintained until April 2021 (the web hosting of the content will be turned over to the DENR Philippines)</li> <li>2. Regional Training of Trainers on ISWM and Application of BAT/BEP in Open Burning in Manila</li> </ol>	Regional Training for 10 technicians from laboratories of 5 countries on Monitoring, Analyzing and Reporting for UPOPs and GHGs in Open Burning Activities, implemented by the Dioxin Lab, Viet Nam
<b>Cambodia</b>	<ol style="list-style-type: none"> <li>1. National Training Course on Integrated Solid Waste Management-ISWM, organized in Battambang province for government</li> </ol>	<ol style="list-style-type: none"> <li>1. Train management personnel in monitoring, evaluating, and reporting on U-POPs, GHG emissions and other contaminants released by open burning</li> </ol>

ESEA	TARGET ACTIVITIES	
	Institutional Sharing and Training	Strengthening Dioxin Testing Laboratory
	<ol style="list-style-type: none"> <li>2. Workshop on Financing Mechanisms and Incentive Systems</li> <li>3. Virtual Training Course on Waste Management Planning (Nov 2020 and Dec, 2021);</li> </ol>	<ol style="list-style-type: none"> <li>2. Sampling plan and installation of sample equipment in BTP dumping site</li> <li>3. Inventory report included in the National Report on the Assessment of Impacts of Traditional Open Burning Practices</li> </ol>
<b>Lao PDR</b>	<ol style="list-style-type: none"> <li>1. National Training Course on Integrated Solid Waste Management-ISWM</li> <li>2. Developed regulation on management of toxic waste and hazardous waste materials.</li> <li>3. Guideline and manual for solid waste</li> </ol>	<ol style="list-style-type: none"> <li>1. Inventory report included in the National Report on the Assessment of Impacts of Traditional Open Burning Practices</li> <li>2. Train management personnel in monitoring, evaluating, and reporting on U-POPs, GHG emissions and other contaminants released by open burning,</li> </ol>
<b>Mongolia</b>	<ol style="list-style-type: none"> <li>1. Training on financing mechanisms and incentive systems in support of BAT/BEP implementation organized on April 28, 2017.</li> <li>2. The National training on “Landfill Management and BAT-BEP” organized on Oct 1-2, 2020</li> </ol>	<ol style="list-style-type: none"> <li>1. Inventory results included in the Report of “Assessment of the impacts of common and traditional open burning practices in terms of releases of UPOPs, GHG emissions and other contaminants, and the effects/benefits of BAT/BEP application” on Feb 8, 2018</li> <li>2. UNIDO provided simple lab equipment</li> </ol>
<b>Philippines</b>	<ol style="list-style-type: none"> <li>1. National Training on BAT &amp; BEP in Open Burning</li> <li>2. Alternative Biomass Utilization, ISWM and Health and Environmental Impacts of Open Burning Practices for the Agricultural and government ENRO</li> <li>3. Training for Public Officers and Local Authorities involved in Waste Management</li> <li>4. Training on Application of Financing Mechanism and Incentive Systems</li> </ol>	<ol style="list-style-type: none"> <li>1. Inventory report included in the National Report on the Assessment of Impacts of Traditional Open Burning Practices</li> <li>2. Environmental Management Bureau strengthened their Laboratory using the knowledge gained from the training in their sampling activities</li> <li>3. Sampling by CRL</li> </ol>
<b>Viet Nam</b>	<ol style="list-style-type: none"> <li>1. Integrated Solid Waste Management Toolkit to Implement BAT and BEP to Open Burning in English and Vietnamese version</li> <li>2. Manual for production households/enterprises at craft villages to access fund from Viet Nam Protection Environmental Fund and Viet Nam Craft Village Environment Fund</li> <li>3. Technical workshop on Integrated waste management and solutions to reduce open burning activities</li> </ol>	<ol style="list-style-type: none"> <li>1. Inventory report on number and types of waste disposal facilities, dumpsites and landfills in Viet Nam submitted.</li> <li>2. Identification of open burning sources in Viet Nam</li> <li>3. Development of methodology</li> </ol>

**Achievements**

**C. COMPONENT 3 – DEMONSTRATION ACTIVITIES**

<p><b>Outcome 3:</b> BAT/BEP implemented in Open Burning Sources</p> <p><b>Output 3.1:</b> Updated comprehensive assessment of the effects of current practices and impact indicators at the selected demonstration sites.</p> <p><b>Output 3.2:</b> BAT/BEP plans developed and implemented at the selected demonstration sites in each participating country</p>	<p><b>Indicators</b></p> <ul style="list-style-type: none"> <li>Quantity of UPOPs and other relevant contaminants reduced at the demonstration sites.</li> <li>Quantity of CO<sub>2</sub> emissions reduced.</li> <li>Value of materials recycled. Number of new businesses set up.</li> <li>Number of jobs created and new investments</li> </ul>	<p><b>Target Activities</b></p> <ul style="list-style-type: none"> <li>At least 90% UPOPs reduction due to BAT/BEP implementation and proper waste segregation/recycling at the demonstration sites.</li> <li>At least 20% CO<sub>2</sub> reduction achieved from the demonstration activities.</li> <li>Increase of at least 30% of reused/recycled materials</li> <li>At least one business created/upgraded dealing with recycling</li> <li>At least one job created in the recycling facilities</li> <li>US\$ invested in recycling and proper waste management.</li> </ul>	<p><b>ACCOMPLISHED</b></p>
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This component which is essentially the centerpiece of the project focused on addressing issues concerning open burning. Each country identified demonstration sites where BAT/BEP can be implemented, focusing mainly on waste minimization, recycling, and re-use, to curtail potential sources of UPOPs formation and other harmful and global contaminants. The following table show the different demonstration sites chosen:

Table 7. Demonstration Sites for the 5 Participating ESEA Countries

ESEA Country	Demonstration Sites	Facilities put up in the Demonstration Site
<b>Cambodia</b>	ADB waste sorting center near the open dump site, Battambang city, Battambang province	 <p>New Sorting Equipment at previously running MRF</p>

ESEA Country	Demonstration Sites	Facilities put up in the Demonstration Site
	<p>COMPED center, near the open dump site, Battambang city, Battambang province</p>	 <p>Updated Composting Equipment</p>
	<p>Battambang Plastic Processing Handicraft-(BPPH ) in Tapuong village, Tameourn Commune, in Banteay Meanchey Thmokol district, Battambang province</p>	 <p>Grinding and shredding machine for plastic recycling</p>
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Lao PDR</p>	<p>Thakek land fill site, Khammouan Province MRF and 3Rs</p>	 <p>MRF at the landfill site with manual segregation</p>
	<p>SAPLAST factory Vientiane</p>	 <p>2 new production lines added in the production of plastic pipes from plastic wastes</p>



ESEA Country	Demonstration Sites	Facilities put up in the Demonstration Site
Mongolia	Tsagaan Davaa Disposal Site, Ulaanbatar City	 <p data-bbox="836 577 1378 613">In addition, a landfill for ash was constructed at the Tsagaan Davaa waste disposal site as part of the pilot project.</p> <p data-bbox="884 640 1283 674">Landfill for Ash at waste disposal site</p>
	Ulaanbaatar	 <p data-bbox="884 1070 1283 1104">Segregation Bins with ash collection</p>
Philippines	General Santos City in Mindanao	 <p data-bbox="820 1496 1347 1563">Central Material Recovery Facility (CMRF) with composting and plastic recycling</p>
	City of Koronadal (Mindanao)	 <p data-bbox="788 1984 1378 2018">MRF with Plastic Recycling and Bottle Crushing Facility</p>

ESEA Country	Demonstration Sites	Facilities put up in the Demonstration Site
<b>Viet Nam</b>	Minh Khai craft villages	 <p data-bbox="874 645 1283 678" style="text-align: center;">Plastic Recycling updated equipment</p>
	Phan Boi Craft Villages	 <p data-bbox="772 1227 1197 1256" style="text-align: center;">Equipment for the plastic recycling line</p>

A Materials Recovery Facility (MRF) is one of the Best Available Techniques (BAT) to prevent open burning and open dumping especially if proper solid waste collection is implemented. Sorting and segregation of wastes in the MRF opens the way to other BAT practices such as composting and recycling technologies. For instance, the plastics segregated can be converted to other products like bricks in the Philippines and plastic pellets in Cambodia and Lao PDR, and plastic chairs and crafts in Viet Nam. Likewise segregated metal, glass, paper, and cardboard can also be converted to handicrafts or sold to junk shops. Product compost can be sold as soil conditioner for a variety of agricultural and commercial beneficial uses. Overall, an MRF reduces the total volume of residual wastes that goes to the landfill.

Another BAT is a properly managed sanitary landfill that prevents open burning and secure the disposal of residuals such as ash, like the one in Mongolia. With legislation and implementation of BEP such as recycling and reuse, the expected waste reduction from the waste that goes to a landfill range from 30 to 50%.

Table 8. Component 3 Activities to Achieve Target Outcomes

ESEA	TARGET ACTIVITIES	
	Developing and Implementing BAT/BEP Plans	Addressing Practices and Measuring Impact Indicators
<b>REGIONAL</b>		Analysis by Northern Center for Environmental Monitoring NCEM Dioxin Lab at the demonstration sites
<b>Cambodia</b>	<ol style="list-style-type: none"> <li>1. Improved/enhanced recycling facilities for plastics through more modern equipment for pelletizing plastics</li> <li>2. Waste reduction, segregation at source (from door to door)</li> <li>3. Improved/Enhanced Composting Facilities such as shredders, mechanical turners covered area increased capacity</li> <li>4. Household/market waste collection</li> <li>5. Improved collecting and sorting at MRF</li> </ol>	<ol style="list-style-type: none"> <li>1. Update inventory Unintentionally produced POPs (UPOPs) in 2015</li> <li>2. Sampling conducted for NCEM Analysis at dumpsite and rice fields</li> <li>3. Business model for a sustainable supply chain for recyclable waste in Battambang, focusing on plastic and organic waste has been finalized</li> </ol>
<b>Lao PDR</b>	<ol style="list-style-type: none"> <li>1. MRF at Thakek land fill site, Khammouan, Province to sort mixed recyclables such as plastics (PVC, PP, LDPE, HDPE, PP), paper and cardboard, metals, and aluminum such as cans and glass bottles.</li> <li>2. SAPLAST had new production lines for recycling plastics into pipes; includes HDPE pelletizing line and washing-grinding-extruding line</li> </ol>	<ol style="list-style-type: none"> <li>1. Sampling conducted for NCEM Analysis</li> <li>2. Draft ministerial regulation on pollution control and guideline for management of waste material. Undertaken with the Dept. of Pollution Control</li> </ol>
<b>Mongolia</b>	<ol style="list-style-type: none"> <li>1. Landfill cell for ash constructed at Tsagaan davaa disposal site and stopped open burning in the landfill site</li> <li>2. Two pair fix bins for ash segregation in 150 ger area households in Ulaanbaatar City that are not served by the district heating systems and are using stoves fed with coal for the heating.</li> <li>3. Waste segregation by household</li> <li>4. The assessment of the status of implementation and achievement of National Implementation Plan for the Stockholm Convention in Mongolia and propose of solutions for Sound Management of POPs in Mongolia</li> </ol>	<ol style="list-style-type: none"> <li>1. Collection of necessary samples and target chemicals, including U-POPs and mercury completed. 15<sup>th</sup> of May, 2021 with samples sent to NCEM's Lab for analysis on Jun 30, 2021</li> <li>2. For ash samples, the PCDD/PCDF concentrations were below the Method Detection Limit (MDL), and the dl-PCB concentrations were at very trace level</li> <li>3. U-pops inventory have been done in 2013 in Mongolia and the report of inventory submitted to UNIDO and included the inception report</li> <li>4. Draft of updated National Waste Management Implementation Action Plan submitted to Ministry of Environment and Tourism</li> </ol>
<b>Philippines</b>	<ol style="list-style-type: none"> <li>1. Solid Waste Management Plan Implementation</li> <li>2. Sustainability Management Plan</li> <li>3. Waste reduction, segregation at source</li> <li>4. Materials Recovery Facility at General Santos</li> <li>5. Composting at General Santos</li> <li>6. Recycling Technology for plastic</li> </ol>	<ol style="list-style-type: none"> <li>1. UPOPs Monitoring at Demonstration Site</li> <li>2. Sampling conducted by CRL for NCEM analysis</li> <li>3. Issuance of Implementing Rules &amp; Regulations for use of plastics and Styrofoam</li> <li>4. An approved SWM Plan of GSC that is for implementation for 5 years</li> <li>5. Deputation of 300 Barangay Officials as Enforcers of the Local Government Unit</li> </ol>
<b>Viet Nam</b>	<ol style="list-style-type: none"> <li>1. Two production lines for plastic recycling in Minh Khai (PE) and Phan Boi craft villages (HDPE).</li> <li>2. A waste plastic recycling line in Minh Khai craft villages, using the plastic waste generated after the production process, collected plastic waste at the dumpsite will produce roof tile, brick or fence. The facility will collect all plastic discards produced in the village, reducing open burning.</li> </ol>	<ol style="list-style-type: none"> <li>1. Regional monitoring of PCDD/PCDF and Mercury in Air, Solid and Liquid Samples on the Demonstration Sites</li> <li>2. Identification of open burning sources</li> <li>3. Technical guidelines on segregation, preliminary processing of input materials and management of waste generated from the recycling of scrap plastic</li> </ol>

Achievements			
D. COMPONENT 4 – EDUCATION AND AWARENESS			
<p><b>Outcome 4</b> Improved knowledge and understanding on BAT/BEP and on risks connected with UPOPS, GHG emissions and other contaminants released through open burning</p> <p><b>Output 4.1:</b> Awareness raising campaigns aimed to emphasize health and environment hazards of open burning practices, carried out on targeted relevant stakeholders.</p> <p><b>Output 4.2:</b> Educational programs aimed at introducing and promoting alternatives to open burning practices, carried out on targeted groups at several levels.</p>	<p><b>Indicators</b></p> <ul style="list-style-type: none"> <li>• Number of awareness raising campaigns and activities, disseminated materials, web-based platforms.</li> <li>• Number of institutions in the region engaged and capable of delivering awareness raising campaigns.</li> <li>• Number of universities offering courses that includes UPOPs/ open burning topics</li> </ul>	<p><b>Target</b></p> <ul style="list-style-type: none"> <li>• At least two awareness raising campaigns conducted.</li> <li>• Number of participants (male/female in the awareness raising campaigns)</li> <li>• At least 1 institution per country engaged to conduct dissemination and awareness activities.</li> <li>• Inclusion of UPOPs/open burning topic in at least 1 university education curricula per country.</li> </ul>	<p><b>ACCOMPLISHED</b></p>

A Best Environmental Practice (BEP) is to establish an *Awareness and Education Campaign* to inform stakeholders of the hazards that POPs pose for the environment and health. Local stakeholders were made abreast and capacitated on preventive actions for open burning activities. These included thorough discussions of the management, recycling, and reuse of wastes in open and controlled dumps and possible alternative technologies for recovery and processing of such.

Project activities for this component fall under awareness-raising campaigns and educational programs. The establishment of websites, the conduct of regional and national awareness-raising events, the distribution of information materials, the conduct of trainings, and the development of school modules were among the major activities implemented to meet the targets for this component.

Table 9. Component 4 Activities to Achieve Target Outcomes

ESEA	TARGET ACTIVITIES	
	Raising Awareness and Education on SWM and Open burning	Integrating SWM and BAT/BEP Open Burning in School Curriculum
<b>Regional</b>	<ol style="list-style-type: none"> <li>1. Regional Website: <a href="http://stopopenburning.org/">http://stopopenburning.org/</a> (to be transferred to a new hosting site)</li> <li>2. Regional Poster Making and Photo competition on Open Burning</li> </ol>	
<b>Cambodia</b>	<ol style="list-style-type: none"> <li>1. Various training workshop on Health, SWM and Open Burning Practices</li> <li>2. National project website namely <a href="http://www.stopopenburningcam.org">www.stopopenburningcam.org</a></li> <li>3. Educational Debate</li> </ol>	<ol style="list-style-type: none"> <li>1. Course curriculum on “U-POPs and BAT/BEP in waste management and incentive/ financing systems” for the Royal University of Phnom Penh (RUPP)</li> </ol>

ESEA	TARGET ACTIVITIES	
	Raising Awareness and Education on SWM and Open burning	Integrating SWM and BAT/BEP Open Burning in School Curriculum
	<ol style="list-style-type: none"> <li>Information and Education Campaign (IEC) materials including the project brochure</li> <li>Video cartoon and posters on harmful effects of open burning <a href="https://www.facebook.com/314699302002531/videos/314340019360934/">https://www.facebook.com/314699302002531/videos/314340019360934/</a></li> </ol>	
<b>Lao PDR</b>	<ol style="list-style-type: none"> <li>National website <a href="http://www.stopopenburninglaos.org">http://www.stopopenburninglaos.org</a></li> <li>Various awareness raising campaigns workshop on integrated waste management practices and health hazards of UPOPs in Vientiane</li> <li>Tree Planting, Photo and poster making competitions, including printing t-shirts and caps</li> <li>Tree planting activities, posters, brochure</li> <li>Training course/ workshop on alternative biomass utilization</li> <li>Video documentary <a href="https://www.youtube.com/watch?v=MTWK1gm86yc&amp;t=63s">https://www.youtube.com/watch?v=MTWK1gm86yc&amp;t=63s</a></li> <li>Workshop on Integrated Waste Management for Managers of Waste Disposal and Enterprises involves in Waste Collection</li> </ol>	<ol style="list-style-type: none"> <li>The education curricula at university were jointly developed with the department of engineering, National University of Laos.</li> </ol>
<b>Mongolia</b>	<ol style="list-style-type: none"> <li>Various training and awareness workshops on BAT/BEP and health</li> <li>Training on waste management</li> <li>Training on Biowaste utilization</li> <li>Integrated Solid Waste Management Toolkit translation to local languages</li> <li>National project website created at <a href="http://stopopenburningmn.org">http://stopopenburningmn.org</a> and linked to regional website</li> <li>Short/IEC Video “Don’t Burn Wastes”.</li> <li>Video Documentary: A 10-minute movie on the risk of open burning to human health and environment <a href="https://youtube.com/watch?v=kGvU7tA_Dmc&amp;feature=share">https://youtube.com/watch?v=kGvU7tA_Dmc&amp;feature=share</a></li> <li>Information materials and merchandise</li> </ol>	<ol style="list-style-type: none"> <li>Training course on “Program for ecological education” in Ulaanbaatar for teachers of secondary school.</li> <li>Online training for university professors and teaching staff of ecology, chemistry, agriculture and chemical technology from 6 universities in Ulaanbaatar, to include the topics of waste management, UPOPs and BAT / BEP</li> <li>“Waste Management and Technologies for Processing Resources” book was the first book on waste management in Mongolia and referenced for usage in universities and high schools</li> </ol>
<b>Philippines</b>	<ol style="list-style-type: none"> <li>Workshop on BAT/BEP Sustainability Management Plan</li> <li>Various seminars and trainings on Open Burning for local government and NGOs</li> <li>Stop Open Burning Awareness Fun Runs</li> <li>Information materials and merchandise</li> <li>Zero Waste Month Expo</li> <li>National website on Stop Open Burning: <a href="http://stopopenburningph.org">http://stopopenburningph.org</a> (web hosting will be transferred to the DENR)</li> <li>Video on Central MRF at General Santos <a href="https://www.youtube.com/watch?v=IliBtfyZqCQ">https://www.youtube.com/watch?v=IliBtfyZqCQ</a></li> <li>Documentary Video produced for the project - <a href="https://drive.google.com/open?id=1_k86lWZGMSkQilD1QE4OGkQARUgwoR3l">https://drive.google.com/open?id=1_k86lWZGMSkQilD1QE4OGkQARUgwoR3l</a></li> </ol>	<ol style="list-style-type: none"> <li>Integration into Curriculum of Energy Engineering students of UP Diliman and Pamantasan ng Lungsod ng Maynila</li> <li>Various seminars and trainings on Open Burning for the academe (Chemical Engineering Metro Manila Academe Chapter)</li> <li>Online Training of Engineering Faculty from 13 universities on the curriculum for Sustainability and the Circular Economy with special topic on BAT/BEP for UPOPs</li> </ol>
<b>Viet Nam</b>	<ol style="list-style-type: none"> <li>Cycling Event / “Green Viet Nam Journey” Fun Run</li> <li>Training workshop on biomass utilization in Hanoi</li> </ol>	<ol style="list-style-type: none"> <li>Signing MOU between the PMU, CNREC and Faculty of Environment, Hanoi University of Natural Resources and Environment</li> </ol>

ESEA	TARGET ACTIVITIES	
	Raising Awareness and Education on SWM and Open burning	Integrating SWM and BAT/BEP Open Burning in School Curriculum
	<ol style="list-style-type: none"> <li>Workshop on the environmental and health hazards of U-POPs combined with the National Inception Workshop</li> <li>National training course for national and local authorities on impacts of open burning activities on human health and Environment</li> <li>Photo and Poster making Contests</li> <li>Short/IEC Video animation promote 5R "For a world of zero waste"</li> <li>National website: <a href="http://stopopenburningVietNam.org">http://stopopenburningVietNam.org</a></li> <li>Video documentary on "Stop open burning! I can do, you can do too"</li> <li>Materials and Merchandise - paper fan on open burning activities and BAT/BEP application brochure on project's activities</li> </ol>	<ol style="list-style-type: none"> <li>Organizing Education Curricula at University level on Waste Management and Reduction of Open Burning Activities with students from 4 universities in Hanoi</li> <li>Set of lectures on "Waste management and reduction of open burning activity" for environmental students</li> </ol>

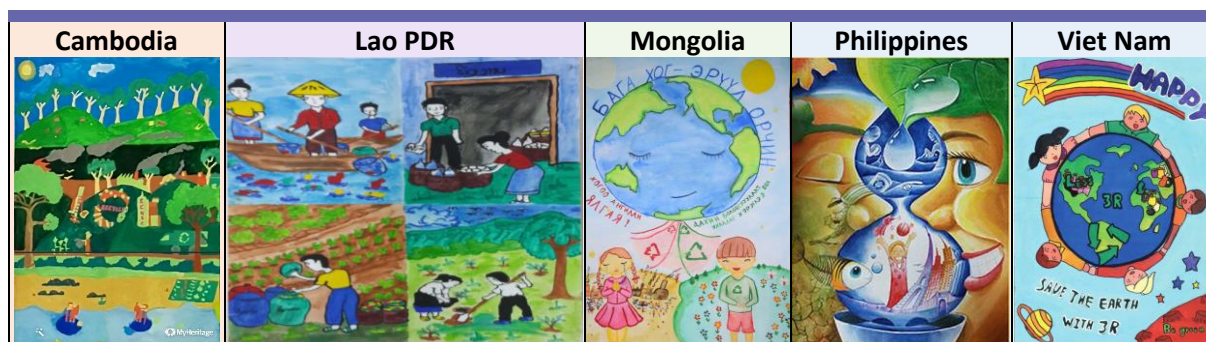


Figure 4. The country winners of the Poster Making Contest

Achievements			
E. COMPONENT 5 – PROJECT MANAGEMENT AND MONITORING & EVALUATION			
<b>Outcome 5</b> Monitoring and Evaluation  <b>Output 5.1:</b> Monitoring and Evaluation Framework of the project established	<b>Indicators</b> <ol style="list-style-type: none"> <li>Regular Steering Committee reports submission</li> <li>MTE and FTE report</li> </ol>	<b>Target</b> Project Meetings and Reports	<b>ACCOMPLISHED</b>

Table 10. Component 5 Activities to Achieve Target Outcomes

ESEA	TARGET ACTIVITIES	
	Project Reporting	Monitoring & Evaluation
<b>Regional</b>	<ol style="list-style-type: none"> <li>Project Implementation Report</li> <li>Annual Steering Committee Meetings</li> <li>NPM Technical Coordination meetings</li> </ol>	<ol style="list-style-type: none"> <li>Monitoring visits at the site</li> <li>Monitoring by Project Teams and PMUs</li> </ol>

ESEA	TARGET ACTIVITIES	
	Project Reporting	Monitoring & Evaluation
	4. Regular PMU Meetings for project progress 5. Final reports of consultants submitted to UNIDO 6. Mid-Term and Final External Evaluation	

### III. Implementation Performance

#### Performance

##### A. DESIGN

The project had five (5) Components and each component had pre-identified outputs in which all activities are implemented via the Project Management Unit (PMU). The PMU was composed of UNIDO, Government Partners, and in some countries, the private sector. Individual consultants or firms were hired in some activities that were implemented. Though the outputs were common for all countries and were already identified in the project document, the approach and specific activities were somehow customized based on the existing situation and the needs of the participating country.

*Component 1* is about Legislation Improvement which was meant to either propose, amend, strengthen, or update the existing legislation by introducing better SWM practices and BAT and BEP in the waste open burning sectors. Training of key people about the law. UPOPs monitoring and financing mechanisms to implement the law is essential here.

*Component 2* is about Institutional Strengthening to build the capacity of the participating countries in implementing BAT and BEP. These are regional capacity-building activities such as the Training of Trainers (TOT) on BAT and BEP in Open Burning and POPs Analysis, Sampling, and Monitoring. The trained people were able to echo what they have learned to train their respective national stakeholders through seminars and workshops. A regional website became the common repository of materials to disseminate information, discuss open burning issues, and share accomplishments, experiences, and learnings of the countries.

*Component 3* are the Demonstration Activities where each participating ESEA country implemented BAT and BEP to reduce open burning in identified demonstration sites. Common among BAT is the MRF for sorting of wastes in order to apply recycling technologies like plastics to bricks, chairs, pipes etc., and composting for organic wastes. Common BEP are household segregation and recycling and IEC and awareness campaigns.

*Component 4* or the Education and Awareness component was assigned to a firm in each of the participating countries. The Information and Education campaign emphasized the health risks of uncontrolled waste disposal, solid waste management and implementation of BAT and BEP. Though they differed in approaches, regional activities were implemented such as seminars and workshops, photo and poster making Competitions, development and production of IEC materials, curriculum integration, campaign and documentary videos. A national website bolstered information dissemination.

*Component 5* or the Monitoring and Evaluation component was done at different levels. At the regional level, participating countries were required to submit progress and annual reports to the Regional Technical Coordinator, Project Manager (PM) in UNIDO, HQ which are presented during Technical Coordination Meetings.

The components and interventions were designed to bring synergy and interconnectedness through their pre-identified outputs. The outputs from one component were meant to reinforce other components and bring positive feedback effects. For example, a law against open burning with the needed financing (Component 1) was able to establish demonstration sites (Component 3) like an MRF or other Best Available Techniques (BAT). This required trained and innovative people (Component 2) to design and operate and maintain. An MRF improved waste management practices such as segregation and collection (Component 3). It made people aware through education and campaigns of the consequences of open burning (Component 4) and enabled them to undertake Best Environmental Practices (BEP) like waste reduction, reuse and recycling to minimize wastes that goes to a landfill. A strong

legislation can also directly prohibit open burning and require periodic monitoring of landfills for UPOPs emissions (Component 3 and 5). Figure 5 shows the interconnection among the components' outputs. The darker lines show a more direct interrelation of the outputs.

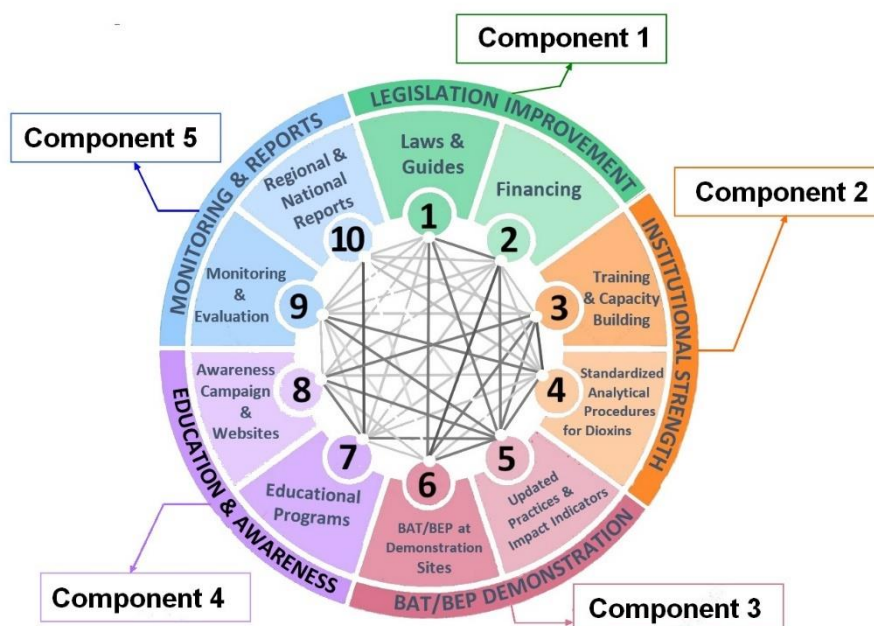


Figure 5. Interconnection Among Project Components and Outputs

## Performance

### B. COST AND FINANCING

The project grant came from the Global Environment Facility Trust Fund with a Total Project Cost of USD 7,560,000 and a total project Co-Financing amounting to USD 32, 776, 434. The cost-breakdown per component is stated below:

Table 11. Breakdown of the Project Cost per Component at the start of the project

Project Component	Grant Amount USD	Confirmed Co-Financing USD
Legislation Improvement	500,000	4,200,000
Institutional Strengthening	800,000	4, 000,000
Demonstration activities	4,700,000	17,576, 434
Education and awareness	1,000,000	4,300,000
Monitoring and evaluation	200,000	600,000
Project management cost	360,000	2,100,000
<b>Total project cost</b>	<b>7,560,000</b>	<b>32,776 434</b>

No earmarking of funds was given per country but an estimated amount of \$1,512,000.00 was initially allotted for each of the countries. Upon implementation of project activities, countries were not limited to the estimated allotted amount since most activities are customized and highly dependent on the nature and weight of the identified project activities. Moreover, some activities may seem to have been



implemented at the national but have also involved regional expenditures. The co-financing commitment delivery by each country are as follows:

Table 12. Co-financing delivered by each ESEA participating country

ESEA	As Stated in the PRODOC (Cash and in KIND)	Total Amount Delivered (USD)
Cambodia	8,000,000	4,455,288.00
Lao PDR	2,600,000	9,070,000.00
Mongolia	6,328,000	8,129,920.00
Philippines	8,982,564	14,488,178.29
Viet Nam	5,740,000	6,068,206.00
<b>Grand Total</b>	<b>31,650,564</b>	<b>42,211,592.29</b>

All procurement and financing concerns were handled by the Procurement and Finance Sections in UNIDO Headquarters including all hiring and payments of contractors and consultants. Though, all decisions arrived at as to the hiring and contracting were in consultation with the project partners through the PMU.

## Performance

### C. DISBURSEMENT PERFORMANCE OF FUNDING AND EXECUTING AGENCIES

With a long list of activities implemented at different levels, the project had engaged both local and international experts, along with national and international firms or companies as consultants and contractors. Overall, consultants and contractors were able to deliver and complete all tasks. Some delays encountered were mainly due to the limitations and restrictions brought about by the Covid-19 Pandemic.

International consultants were available and ready for consultations, while those engaged short-term to deliver outputs diligently edited and considered all inputs by UNIDO and project partners before coming up with their final reports.

All disbursements were done by UNIDO, and most of the time, the target fund utilization for the whole ESEA region was met annually. Disbursement was observed to be done regularly based on the timely payments of consultants and contractors after each accomplishment or completion of task. UNIDO consistently paid all engaged individuals and firms once their outputs were cleared and approved by the Project Manager in consultation with the National PMU.

## IV. Project Results

The main objective of this project is to stop open burning, which have been identified as one of the leading sources of UPOPs generation, through the introduction of BATs and BEPs in open burning sources. The target is to achieve a reduction of approximately 90% of current PCDD/PCDF releases at the

pilot demonstration sites in the participating countries. This Project will play a vital role in supporting the participating countries in fulfilling the objectives reported in the NIPs and specific national plans.

## Results

### A. UPOPs Monitoring and Reduction

An on-the-field activity was done by the Northern Center for Environmental Monitoring-Viet Nam to get a close picture about pollution from U-POPs and Mercury (Hg) at sites of demonstration activities. The main findings were that, although the number of samples in each country was limited, the sampling campaign as seen in Table 13 showed that the levels of some U-POP parameters at several monitoring locations exceeded the limit levels of the enforced national standards, thus justifying the need for interventions to reduce the generation of U-POPs from open burning activities. The concentration of Hg in the analyzed samples from five countries is still not a concern issue. However, for U-POPs (PCDD/PCDF, dl-PCB, HCB), the results showed that the contamination from the burning gas, ash, soil and leachate come from the open landfill sites and uncontrolled burning activities still exists.

A desktop study provided the figures about the achieved reductions of U-POPs at the predetermined intervention sites. In Table 13, calculations on the estimated UPOPs emissions were based on the amount of waste diverted from disposal sites as a result from interventions on rehabilitation of dumpsites.

Table 13. NCEM UPOPs measured and the Predicted Reduction of PCDD/PCDF

ESEA Country/ Predetermined Site	NCEM data UPOPs monitoring Limit: air – 0.6 pg/m <sup>3</sup> Soil/ash Limit – PCDD – 100 ng/kg PCDF – 200 ng/kg	Estimated UPOPs Emissions at Predetermined demonstration sites without BAT/BEP intervention mg TEQ/year	Estimated UPOPs Emissions at Predetermined demonstration sites with BAT/BEP intervention mg TEQ/year	Expected UPOPs Reduction at Predetermined demonstration sites with BAT/BEP intervention mg TEQ/year
Cambodia / Kampot	7.63 pg/m <sup>3</sup> (air) 1504 ng TEQ/Kg (landfill soil)	553.8	10.1	543.7
Lao PdR / Vientiane	0.292 pg/m <sup>3</sup> (air) 330.3 ng TEQ/Kg (landfill)	8335.5	222.2	8113.3
Mongolia / Tsagaan Davaa	0.00 ng TEQ/kg (Ash)	9277.5	184.3	9093.2
Philippines/ General Santos	414 ng TEQ/kg (old dumpsite)	8099	176.8	7922.2
Philippines/ Lapu Lapu	No data	6201.5	131.3	6070.2
Viet Nam / Nam Dinh village	2.675 pg TEQ/m <sup>3</sup> (air) 43.2 - 3855 ng TEQ/kg (landfill)	5149.8	1725.2	3424.6
<b>Total</b>		<b>37617.1</b>	<b>2449.9</b>	<b>35167.2</b>

During the implementation of the project, some of the pilot activities initially envisaged by the project, mainly consisting in rehabilitation of old dumpsites were replaced by the establishment of pilot recycling plant and other interventions. Following requests from national and local authorities, some

demonstration sites agreed during the start of the project had been changed. The new sites and interventions are listed in the Table 14.

Table 14. Type and Capacity of Intervention at the Demonstration Sites

ESEA Country / Predetermined Site	Type of Intervention	Waste diverted MT/yr	ESEA Country / Actual Site	Type of Intervention	Capacity, MT/yr
Cambodia/ Kampot	Landfill rehabilitation	1200 (30% diversion)	Cambodia / Battambang Province	Plastic recycling line in Battambang	1752
				Composting plant in Battambang	3650
				Recycling plant in Battambang-ADB Facility	2555
Lao PDR / Vientiane	Landfill rehabilitation	15000 (20% diversion)	Lao PDR / Vientiane	Two lines to produce plastic pipes from recycled plastics at SAPLAST	2701
				Material Recovery Facility in THAKHEK	6460
Mongolia / Morin Davaa	Landfill rehabilitation	20000 (20% diversion)	Mongolia / Tsagaan Davaa	Landfill Cell to host ash from household stoves used in Gers	50000- 150,000 m <sup>3</sup>
Philippines / General Santos	Landfill rehabilitation	17,000 (30% diversion)	Philippines / General Santos	Central Material Recovery Facility in General Santos	14600
Philippines / Lapu Lapu City	Landfill rehabilitation	13,000 (30% diversion)	Philippines / Koronadal	Enhancement of Plastic Recycling Facility in Koronadal	3650
Viet Nam / Nam Dinh Province	Recycling of Aluminum	17,166	Viet Nam / Minh Khai	New plastic recycling line in Minh Khai	3650
				Line to recycle waste plastic in Minh Khai	3066
			Viet Nam/ Phan Boi	Refurbishment of an existing plastic line in Phan Boi	730

A desktop study provided the figures about the achieved reductions of U-POPs at the new intervention sites. It referred to how much material was taken off the previous open burning stream by installing MRF segregation and recycling lines. It was linked to the capacity of the intervention lines and to the Emission Factors used as reference from the UNEP Toolkit. The outcomes from calculations were compared with the Estimated Expected Reduction done at the start of the project, to check whether the original targets were reached.

Calculation of the total reduction of emissions in the five countries was 41,126.1 mg TEQ/year from recycling activities which are higher than those expected from implementation of rehabilitation of dumpsites (35,167.2 mg TEQ/y).

The cost to get 1 g reduction of emissions of dioxins was calculated using the total costs of equipment and facilities (cost of interventions) and the total achieved mg TEQ/year UPOPs reduction with the BAT/BEP intervention. The total equipment cost per g TEQ reduced per year is USD 1,224,132 or USD 209,177.30 per g TEQ reduced across the estimated life of equipment of 10 years assuming 20% additional operating and monitoring costs.

Table 15. Achieved Reduction of UPOPs and Cost of Intervention at Demonstration Site

ESEA Country/ Actual Demonstration Site	Cost of interventions (equipment only)	Predicted UPOPs Reduction at predetermined demonstration sites* with BAT/BEP intervention	Achieved UPOPs Reduction at actual demonstration sites with BAT/BEP intervention	Cost for 1 g TEQ dioxins reduction	Cost for 1 g dioxins reduction assuming a lifetime of 10 years and O&M costs = 20% of investment cost
	USD	mg TEQ/year	mg TEQ/year	USD/g TEQ·year	USD/g TEQ
Cambodia / Battambang Province	596,622	543.7*	4,876.77	426,621	51,221.63
Lao PdR / Vientiane	838,264	8,113.3	4,347.2	396,653	57,848.24
Mongolia / Tsagaan Davaa	505,024	9,093.2*	22,150	22,801	6,840.21
Philippines/ General Santos	680,000	7,922.2	4,526.0	150,243	45,072.91
Philippines/ Koronadal	75,000	6,070.2*	1,131.5	133,451	19,885.11
Viet Nam / Minh Khai and Phan Boi Villages	386,432	3,424.6*	4,095.1	94,364	28,309.17
<b>Total</b>	<b>3,081,342</b>	<b>35,167.2</b>	<b>41,126.1</b>	<b>1,224,132</b>	<b>209,177.30</b>

\* Predetermined sites are Kampot in Cambodia, Morin Davaa in Mongolia, Lapu-Lapu City in the Philippines and Nam Dinh Village in Viet Nam were different from the actual demonstration sites

Reduction of open burning also results in reduction of CO<sub>2</sub>. To estimate the reductions of CO<sub>2</sub> from the implementation of the different interventions, it is necessary to have the CO<sub>2</sub> Emission Factors, which are linked to the type of material that is burned.

The following were used as the EF for reference.

	<b>Ton CO<sub>2</sub>/ton waste material</b>	
1. Burning of plastics	2.9	<a href="https://www.no-burn.org/wp-content/uploads/Plastic-is-Carbon-Oct2021.pdf">https://www.no-burn.org/wp-content/uploads/Plastic-is-Carbon-Oct2021.pdf</a>
2. Burning of paper	0,65	<a href="https://pdf.sciencedirectassets.com/277910/1-s2.0-S1876610217X00076/1-s2.0-S1876610217309554/main.pdf">https://pdf.sciencedirectassets.com/277910/1-s2.0-S1876610217X00076/1-s2.0-S1876610217309554/main.pdf</a>
3. Burning of organic material	2.5	<a href="https://toogoodtogo.com/en-us/movement/knowledge/the-carbon-footprint">https://toogoodtogo.com/en-us/movement/knowledge/the-carbon-footprint</a>
4. Burning of MSW (0.7-1.7 tCO <sub>2</sub> /t MSW)	1.00	<a href="https://zerowasteurope.eu/wp-content/uploads/edd/2019/09/ZWE_Policy-briefing_The-impact-of-Waste-to-Energy-incineration-on-Climate.pdf">https://zerowasteurope.eu/wp-content/uploads/edd/2019/09/ZWE_Policy-briefing_The-impact-of-Waste-to-Energy-incineration-on-Climate.pdf</a>

Demonstration sites and the interventions implemented in the participating countries varies and for each of them, assumptions have been made to calculate reductions of dioxins. The same assumptions have been used to calculate CO<sub>2</sub> reductions as illustrated below:

1. Plastic recycling: it is assumed that 1 t of plastics taken off the dumpsite avoid the burning of 3 kg of waste.
2. Plastics; an EF of 1.5 tCO<sub>2</sub>/t recycled plastic has been used ( share 1 plastic+3MSW)
3. Organic material composting; EF=2.5 tCO<sub>2</sub>/t organic material
4. MSW: EF= 1 tCO<sub>2</sub>/t MSW

*Estimated Reductions of CO<sub>2</sub> in Demonstration Sites*

**CO<sub>2</sub> REDUCTIONS t/year**

- CAMBODIA	26,152.25
- LAOS	43,723.35
- MONGOLIA	71,450.00
- PHILIPPINES	18,250.00
- VIET NAM	19,815.12
<b>TOTAL</b>	<b>179390.72</b>

The succeeding section discusses the achievements of the project based on UNIDO’s Integrated Results Performance Framework (IRPF) project indicators. The project fulfilled the following indicators: *Output Indicators* – Technical Cooperation Output (TCO) and Policy Analysis & Advice Output (PAO) (TCO 1,2,3 and PAO 1). *Outcome Indicators* – Strengthening Knowledge and Institutions (BUS 1 and KASA1); and *Inclusive and Sustainable Industry Development (ISID) Impact indicators* – environmentally sustainable industries (ENV2) as applied to sustainable communities.

*Table 16. Output Indicators on Technical Cooperation and Policy & Advice*

Results						
B. Output Indicators – Technical Cooperation and Policy & Advice						
	KH	LA	MN	PH	VN	Regional
PAO.1 Number of industrial strategies and industrial policy documents drafted / prepared	1	1	1	2	5	
TCO.1 Number of capacity building activities provided (Training)	6	15	10	5	2	2
TCO. 2 Assets Provided (Set)	3	3	2	2	2	
Platform/website	1	1	1	1	1	1
Toolkit, Check list and Manual	4	5	4	3	3	2
Institutions with Curricula Integration	1	1	18	3	1	
<b>TOTAL</b>	<b>16</b>	<b>26</b>	<b>36</b>	<b>16</b>	<b>14</b>	<b>5</b>

Table 17. Outcome Indicators – Strengthening Knowledge and Institutions

Results										
C. Outcome Indicators – Strengthening Knowledge and Institutions										
KASA.1 Number of actors gaining awareness or knowledge on UNIDO knowledge areas	KH		LA		MN		PH		VN	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<ul style="list-style-type: none"> <li>Workshops, Conventions &amp; Summits</li> </ul>	1311 67.4%	634 32.6%			689 38.2%	1322 61.8%	311 56.8%	237 43%	441 71%	180 29%
<ul style="list-style-type: none"> <li>Poster Making and Photo Competition</li> </ul>	268 74.7%	91 25.3%			12 48%	13 52%	74 46.8%	84 53.2%	1261 50%	1260 50%
<ul style="list-style-type: none"> <li>Others: Fun Run, Expo, debate, cycling, Tree Planting, Clean-Up (MN)</li> </ul>	350 80%	87 20%			190 40%	280 60%	223 39.5%	342 60.5%	527 49.8%	531 50.2%
<b>Total</b>	1929 70.4%	812 29.6%			701 34.4%	1335 65.6%	608 47.8%	663 52.2%	2229 53%	1972 47%
<ul style="list-style-type: none"> <li>Website/Social Media</li> </ul>	Various End-users									
<ul style="list-style-type: none"> <li>Information and Education Campaigns (IEC) - videos, print, and broadcast media</li> </ul>	Various Learners/Participants									
<hr/>										
BUS.1 Improved management practices										
Cambodia	<ul style="list-style-type: none"> <li>Improved Solid waste management from Capacity Built to the all relevant stakeholders including government officers, provincial environmental department and municipality</li> <li>Better management of monitoring, and sampling U-POPs and GHG</li> <li>Waste Segregation at household level for plastics</li> <li>Collection of Market wastes for composting</li> <li>Increased production of plastic recycling products</li> <li>Better management and procedure for composting process</li> <li>More streamlined transfer of knowledge on Open Burning with inclusion into the university curriculum</li> </ul>									
Lao PDR	<ul style="list-style-type: none"> <li>Strengthened Development and enforcement of law on Waste Management</li> <li>Strengthened capacity of urban Development Administration</li> <li>Improved waste management</li> <li>Management of 3Rs and promotion of use of reusable bags/discourage single use plastic</li> <li>Better managed plastic recycling facility</li> <li>Better Information and Education Campaign</li> <li>Improved segregation at MRF</li> </ul>									

BUS.1 Improved management practices	
Mongolia	<ul style="list-style-type: none"> <li>• Improved waste management</li> <li>• Waste segregation in the household level</li> <li>• Ash management</li> <li>• Landfill Site Management</li> <li>• Legislation Management Improved particularly on Open Burning</li> <li>• Education and Awareness Raising</li> <li>• Improved MRF Management due to segregation</li> </ul>
Philippines	<ul style="list-style-type: none"> <li>• Improved solid waste collection and segregation specially in the cities where the project sites are located</li> <li>• Improved law enforcement in businesses and households (segregation of waste, banning/restricted use of plastics, etc.)</li> <li>• Recycling of plastics and bottles into bricks</li> <li>• Recycling of plastics into chairs</li> <li>• Waste management officers with better understanding and application of waste management practices</li> <li>• Strengthened IEC campaign specially in Project Sites</li> <li>• Sustainable operations of the MRF</li> </ul>
Viet Nam	<ul style="list-style-type: none"> <li>• Improved regulation on management, reuse, recycle and treatment of plastic waste</li> <li>• Improved regulations on POPs/UPOPs and hazardous waste management</li> <li>• Integrated BAT/BEP and circular economy in the new Law on Environment Protection (LEP) 2020 and the Decree 08/2002 guiding the implementation of the LEP</li> <li>• Integrated regulation on reduction of open burning activities for agriculture by-products into the LEP</li> <li>• Enhanced environmental management at recycling craft villages, industrial cluster</li> <li>• Strengthened capacity of management staff at local level, enterprises, social organizations, students, etc. in risks to environment and human health due to open burning activities and BAT/BEP applications</li> </ul>

## Results

### D. ISID Impact Indicators – Environmentally Sustainable Industries (SWI)

Environmental Impact Indicators addressed by the project are as follows:

**Human Toxicity:** The strengthening on the laws of open burning and the implementation of BAT and BEP in each of the 5 ESEA countries in the project have reduced the release of UPOPs that are toxic to human health. This has lessened the risk of UPOPs which can bioaccumulate in the body and lead to cancer and reproductive disorders, alteration of the immune system, neurobehavioral impairment, endocrine disruption, genotoxicity, and increased birth defects.

**Air Pollution:** With a decrease in open burning, common air pollutants such as SO<sub>x</sub>, NO<sub>x</sub>, fly ash, odors, dust, and particulate matter released are reduced. Smoke from open burning are not only irritants but can cause respiratory irritation, shortness of breath, and worsen medical conditions such as asthma and heart disease.

**CO<sub>2</sub> and GHG Impact:** Reducing open burning also reduces the emissions of CO<sub>2</sub> and other Greenhouse Gases from landfill and biomass burning, including accidental and forest fires. GHG are known to contribute to Climate Change causing warmer temperatures, changing weather patterns, and disrupting

the usual balance of nature. This poses many risks to human beings and all other forms of life on Earth. The diversion of organic waste from landfill disposal to organic waste composting such as the BAT employed in Cambodia and the Philippines, will reduce methane gas emissions; methane being 25 times more potent than carbon dioxide at trapping heat in the atmosphere. Reduced greenhouse gas emissions will lessen the impact of climate change and the country's obligations to the Paris Agreement.

**Soil Contamination:** Open burning produces ashes that can contaminate the soil. In the NCEM monitoring results, significant amounts of UPOPs were measured in the landfill soil together with some Hg. Other trace metals may also be found in bottom ash from wood and coal burning. The diversion of ashes into landfills such as the BAT employed in Mongolia, and the updated burning facility BAT in Viet Nam will reduce soil contamination from UPOPs and other trace metals.

**Water Pollution:** Properly managed sanitary landfills such as those in Cambodia, Lao PDR, Philippines and Mongolia will minimize the UPOPs and trace metals found in the leachates that can contaminate surface and ground waters.

**Plastic Waste Pollution:** Legislation on single use plastics and the recycling of plastics into crafts such as those demonstrated in Cambodia, Lao PDR, Philippines and Viet Nam have reduced the waste that goes to the landfill. Plastics are non-biodegradable and when burned may release UPOPs. Plastic waste when not properly managed can cause floods and contaminate water bodies like canals and in oceans can endanger animal life.

## Project Results

### E. SOCIOECONOMIC AND SOCIOCULTURAL RESULTS

The following are the socio-economic benefits of the project:

**Jobs:** The implementation of the Project created short-term and long-term jobs in waste management, government, and environmental NGOs. It also promoted new businesses and mobilized new investments with significant employment opportunities. In Cambodia and the Philippines, illegal landfill waste scavengers have been hired as MRF sorters, operators of waste management equipment. The new equipment set up in Viet Nam and Lao PDR, allowed new production lines and better production outputs.

**Health & Safety:** Disease prevention and reduction of accidents are major socioeconomic benefits of the Project. Properly protected waste management workers in PPE and landfill scavengers are not anymore exposed to open burning which are known to contribute to increasing birth defects, fertility problems, greater susceptibility to disease, reduced intelligence, and some types of cancers.

The Education and Awareness Campaign of Component 4 brought important health and safety benefits by increasing awareness about the dangers connected with open burning and inappropriate waste management.

**Education:** The training received by relevant stakeholders in the participating countries built their capacity in waste management and the monitoring of UPOPs emissions. Technical knowledge and expertise on topics connected with open burning and waste management were enhanced, notably including the application of BAT/BEPs.

The seminars, workshops, fun projects like fun run, cycling, quiz bowls and poster/picture contests made it possible to reach all sectors of society to allow them to integrate proper waste management such as waste reduction and recycling as a way of life.

The inclusion of Waste Management and UPOPs in the curriculum of basic and tertiary education will provide a new generation of students with the knowledge and awareness of the benefits of proper waste management and the hazards of UPOPs.



The websites, toolkits, information materials, reference materials and textbooks created will continue to guide and foster awareness about open burning, encouraging better regulatory measures and creating innovative technologies and practices that can enhance the BAT/BEP guidelines under SC.

**Welfare:** The Project improved the occupational environment of the workers and created a cleaner, safer, and more comfortable living condition for those who reside close to open burning places. The regular and improved collection of solid wastes provided a sense of aesthetics and cleanliness in communities and adapting the 3Rs as a way of life.

Former waste scavengers were provided with a regular sustainable income that allowed them to provide for the education of their children.

**Economic Growth:** MRFs as a Best Available Technique (BAT) allowed for the recovery of recyclable materials as trash to resource. In Cambodia and the Philippines, plastics were converted to bricks, organic wastes into compost and recovered recyclables like metals, paper and cardboard sold to junkshops as additional sources of income for the community. In Mongolia, some of the recovered ashes were also converted to bricks. In Lao PDR and Viet Nam, updated equipment increased production of recycled plastics, with better quality and higher value-added.

Modern and installed facilities such as the MRF system in Cambodia and the Philippines, the ash landfill in Mongolia and updated recycling equipment in Lao PDR and Viet Nam have become model facilities which other local governments would like to replicate. This will encourage more opportunities for infrastructure and other business ventures in the public/private sector with a deeper insight into the BAT/BEPs and the costs and benefits of these measures.

**Energy:** Some energy savings were reported by Viet Nam with the operation of the new equipment.

**Technology:** The implementation of Project components Legislation Improvement and Institutional Strengthening provided capacity and enabling environments for introducing, developing, diffusing local and imported waste management technology. BAT/BEPs on demonstration sites developed within the Project component 3 were adapted to meet specific local circumstances and needs. The know-how will be transferred on local and national levels, as well as to other regions/countries with comparable open burning practices.

## Project Results

### F. SOCIAL AND ECONOMIC COSTS

Determining the social cost associated to emissions of dioxins is very challenging because depends on population, population density, lifestyles, nutrition habits, weather conditions, distance of sources of emissions from people, available health care services etc.

A reference in literature was found to be compared to the above calculated costs of reductions *Health risks and economic costs of exposure to PCDD/PCDF from open burning: a case study in Nairobi, Kenya.2015*, where it was reported that “Potential excess cancers due to dietary exposure to PCDD/F associated with all illegal waste burning in Nairobi were estimated to be 636 cases over the 30-year time period or 21 cases/year” and that “the opening of the new sanitary landfill that can reduce 50 % of waste disposed at the Dandora dumpsite, the economic benefits of avoided cancer deaths is expected to be US\$ 0.16–1.93 million”.

Emissions of dioxins from the Dandora dumpsite were not available, therefore the relationship between quantities of emitted dioxins and intake from population are missing.

Broad calculations can be done assuming that open burning activities at non-controlled dumpsites are similar and that are proportional to population (the higher the population, the more waste generated, and thus the higher is the occurrence of open burning).

Under the above assumptions, with reference to report about Nairobi, considering that population in Nairobi in 2015 (date of report) was 187,311 the following calculations were carried out:

- Incidence of cancer deaths in 30 years:  $636/187311 = 0.0339$  fatalities/population
- Costs/death: 0.16-1.93 million USD = 252-3035 USD/death

Using the above figures referred to population of the Cities where interventions were implemented and where open burning at backyards and at dumpsites happens, the following Table was prepared

Table 18. Social costs in relation to estimated fatalities due to open burning

City	Population	Fatalities/ person	Fatalities in 30 years	Cost at 252 USD/ fatality	Cost at 3035 USD/ fatality
Battambang	161072	0.0339	5460	1376005.882	16572134
Vientiane	419090	0.0339	14207	3580202.052	43118703
Ulaanbaatar	2998433	0.0339	101647	25615013.43	308498277
General Santos	594400	0.0339	20150	5077840.32	61155736
Koronadal	174,942	0.0339	5931	1494494.518	17999170
Minh Khai	2100	0.0339	71	17939.88	216062
Phan Boi	5952	0.0339	202	50847	612380
	4,355,989		<b>43,399</b>	37,212,343	448,172,462

Figures show that social costs are ranging from 37,212,343 to 448,172,462 and can be avoided by investing about 3 million \$ on interventions to reduce dioxins. Fatalities are 43,399 in 30 years, equivalent to 1444 fatalities/year over a population of 4,355,989

A different calculation can be done by taking into account a different reference that estimates how much it would cost to reduce the emissions from different sources (Natural Environment Research Council - NERC Knowledge Transfer Network on POPs-Costs of reducing emissions of dioxin-like compounds- Andrew Marsh-Patrick Entec UK Ltd 20th September 2006), I that paper, to reduce 240 mg TEQ/year of dioxins emitted by burning of domestic waste, a cost of 0.42 £M/g TEQ was estimated (year 2006).

Table 19. Cost of UPOPs Reduction of the Project

Cost for reducing 240 mg TEQ/year (NERC) £	Cost for reducing 1 mg TEQ/year (NERC) USD	Reductions achieved by Project Mg TEQ/year	Cost of reduction according to NERC	Cost of reductions UNIDO
0.42M/gTEQ	2,345	41,126.1	9,123,098	3,081,342

If no actions are taken to reduce emissions of dioxins from open burning, about 1444 fatalities/year could be expected in the five countries of the Project, with a social cost ranging from 1.23 million USD/year to 14.9 million USD/year. An investment of about 3 million USD (as achieved by Project) or of about 9 million USD, as estimated by NERC paper, will avoid fatalities and related annual social costs.

## Project Results

### G. WOMEN IN DEVELOPMENT

The project mainstreamed gender balance in all the activities, and benefits among women and their involvement in all the activities have always been equally considered. The project implementation was conducted having in mind global and specific national and local gender dimensions. The project observed UNIDO's gender policy and the women participation across the ESEA region.

All training workshops would show that the participation of both genders was greatly encouraged and assured as seen in Table 17. Most of the training and workshop reports including awareness raising events showed the balanced number of participants in terms of gender for each country. In general, the implementation of the project significantly improved the long-term gender equality in training and employment.

## V. Key Issues for the Future

The accomplishments of the project can only be recognized when the following key issues are followed with the appropriate actions and steps, not only to sustain but to magnify its results and widen the effects it has brought to the environment and the public.

As part of this report, the following section discusses some of the key issues that should also be considered for future decisions and actions of the authority and sectors concerned.

### Key Issues for the Future

#### A. Legislation Improvement

Legislation Improvement is an important Best Environmental Practice (BEP) intervention undertaken in the project because it not only prohibited open burning and open dumping but more importantly it opened the door to a more efficient SWM in the demonstration sites in each participating ESEA country. The key issues that need to be addressed in each country are summarized as follows:

In Cambodia, the laws outline compliance requirements and fines, but the mechanism, management, and means are not clearly identified. To improve this, the following are recommended: creation of a monitoring team in the municipality to oversee the service providers, identify indicators for monitoring to better enforce the law and the use apps like Go Green Cambodia. These measures can be piloted at the demonstration site and potentially be implemented in the whole of Cambodia.

In Lao PDR, there is a need to expand further the law and legislation particularly on guidelines for the collection of fees and solid waste handling. The work on 3R initiatives must be continued to the rest of Vientiane province and Oudomsay Province. There is a need to also expand the scope of waste recycling particularly composting, to include agreements between the provincial government and private enterprises. The initiative of SAPLAST to expand their production must be supported to include new products, such as bigger pipe size.

In Mongolia, the amendment of the Law on Waste was instrumental in the fulfillment of the National Implementation Plan (NIP). A key issue in the future is the presence of an independent disposal facility emission monitoring to ensure compliance and demonstrate transparency to all project stakeholders: Even the best available technologies should be subject to third party monitoring, as learned from the project activities. Despite regular local government monitoring, third party monitoring was required to make the results available to stakeholders.

In the Philippines, despite the sound and comprehensive law on waste, consultations revealed that it was still necessary to issue a National Solid Waste Management Commission (NSWMC) resolution to strengthen the implementation of the law especially the prohibition of open burning, to include BAT/BEP implementation. The resolution issued under this project emphasizes the different roles of each of the national agencies involved in the management of waste. There is a need to follow this through and see to it that each of these agencies fulfill their obligations. The NSWMC on the other hand should take advantage of the presence of these agencies in the Commission and relentlessly ask that the agencies carry out their tasks as necessary.

In Viet Nam, with the many revisions and guidelines on the Law on Environmental Protection (LEP) 2020, further support is needed for the development of regulation on standard of recycled products, to allow the recyclers to assess the market widely while the demands on recycled materials and products are increasing. At the local level, Hanoi has already issued a Directive in 2020 on the enhancement of the management of straw and agriculture by-products, thus reducing further open burning. The replication of the BAT/BEP model in plastic recycling should be considered and promoted at all levels, from household, enterprises, and industrial clusters to utilize plastic discards into higher added value recycled products.

The assessment of the traditional open burning should also have a follow-up not only to know the improvement, if there is any, after the implementation of the project but also to know what and where should be the concentration in strengthening the implementation of the prohibition on open burning. Adaptation and agreement of the local communities can only be successful if there are viable alternatives to traditional practices. Hence, any introduction of legislation that requires compliance should always be accompanied by proper and possible alternatives through the usual information dissemination or via simple trainings.

The manual on the incentive and financing mechanism and the SWM Toolkit were two significant documents that the project had produced but should also be updated so that LGUs and concerned sectors are apprised on the new windows available to seek funds and new technologies and approaches they can employ in addressing their problem on waste to protect their constituents and the environment.

## Key Issues for the Future

### B. Institutional Strengthening

Strengthening various institutions in addressing POPs should be continued and replicated in the different regions of each country. New programs can be developed and enriched through time by reviewing and sourcing from previous programs and activities. All satellite offices and other concerned agencies could

be capacitated by utilizing those that were already trained. Funding for such trainings should also be allotted to ensure implementation, in that case, it is high time that this sector also is given priority and in line with the programs that are being undertaken by the government.

**Key Issues for the Future**

**C. Maintenance, Operations and Monitoring of the Intervention**

The maintenance of the facilities established in the demonstration sites under this project, should be sustained and full capacity operations must be ensured to truly achieve the objective of the project. This will require the full cooperation and constant monitoring by the government agencies in charge in these demonstration site. Strict implementation of the regulations/laws by local authorities should be enforced at the same time ensuring that their constituents are exposed to alternative techniques.

Enough budgetary allocations should also be included in local or national government’s annual planning for the continuous effective operation of the project facilities while ensuring updated training of staff to run the facility and address any breakdowns that can happen. A program for a self-sustaining facility should also be developed in the demonstration sites.

Recommendations for replication of the BAT/BEP models developed under the project to achieve bigger impacts should be considered.

**Key Issues for the Future**

**D. Continued Information and Education Campaign**

Information and Education Campaign (IEC) is a significant component of any program/project that should not be a one-time activity but a continuing one if the project initiatives are to be sustained and developed. This project has initiated several activities to gain and ensure the awareness and participation of the various sectors, from national and local officials, decision-makers, establishments, and the local citizens. These activities, though seemingly difficult, should be replicated and enhanced until such time that the processes are already embraced by the citizens and become part of their way of life.

Reproduction and distribution of information materials should be continued, and materials should be updated periodically to serve as reminders to the community. Other sectors such as the NGOs, business sectors and academe, who played a part in the implementation of the project can also be given bigger tasks in the future to hasten the process.

**VI. Lessons Learned**

Lessons learned in project implementation help improve work and decision-making processes in the future. They are meant to be utilized in every phase of projects that are to be implemented. It also allows to repeat successes and avoid repeating mistakes and help improve cost-effectiveness during project implementation. The following discussions show the lessons learned on what went well and those that did not and hopefully would guide other project implementers in carrying out their projects.

Cambodia	What went well
	<ul style="list-style-type: none"> <li>The government policy to give priority and empower (decentralize) the sub-national/ local authority and private sectors/NGOs motivated the stakeholders to execute the project well. With a strong partner and stakeholder commitment, and high project</li> </ul>

	<p>ownership, they contributed to achieve success in all the phases of the project from the preparatory phase through implementation to project execution.</p> <ul style="list-style-type: none"> <li>• The project management structure, with its committed and flexible project managers at the implementing agency and the coordinating agency, lead to efficient and effective project implementation.</li> <li>• Financial support from the donor with some contribution from the government of Cambodia and executing partner provided a good financial support mechanism to the BAT/BEP project.</li> <li>• Fund Flow from the donor/UNIDO as GEF implementing agency is fast and without delay, which facilitated the project implementation process.</li> <li>• Good cooperation and collaboration among the Project Management Unit and local consultants /partners, international consultants and the UNIDO PM.</li> <li>• Some local consultants with experiences on POPs obtained from involvement with the NIP development project were selected to be involved in the project. With strong support by the Ministry of Environment which assisted and promoted the project, it was able to move forward smoothly.</li> <li>• Enhanced institutional capacity and technical capability of public bodies and relevant stakeholders. In particular, the national regulation for the sound management of wastes in Cambodia was strengthened with the development of legislative, technical guideline, and documents related to waste management, which were subsequently adopted by the Government.</li> <li>• Local municipalities and national government officers, private sector, NGO, had their management capacity built on the implementation of BAT/BEP and waste practices through a training and workshop.</li> <li>• Transfer of best available technologies (BAT) and adoption of best environmental practices (BEP) at the selected demonstration landfill, which contributed to the total elimination of the emissions of U-POPs from waste burning at the demonstration site.</li> </ul> <p><b>What could have gone better</b></p> <ul style="list-style-type: none"> <li>• The project implementation was deadlocked in some places because of the lockdowns and restrictions brought about by the pandemic due to Covid-19.</li> <li>• The change in demonstration site under Component 3, from the first partner, Phnom Penh City Hall (PPCH) to the new partner Battambang province provided some delays and inconsistency of data collection and comparisons.</li> <li>• The project could have collected more contributions from co-financing by partners as they can possibly afford.</li> </ul>
<b>Lao PDR</b>	<b>What went well</b>
	<ul style="list-style-type: none"> <li>• Flexible support from PM of UNIDO and headquarters</li> <li>• Collaboration effort on the localization of materials</li> <li>• Local government support</li> <li>• Collaboration among 5 countries</li> <li>• Immediate support from UNIDO</li> <li>• Integration of Waste Management and POPs into the Education Curriculum</li> <li>• Government support (different ministries, finance, foreign affairs) in putting up the components</li> </ul> <p><b>What could have gone better</b></p> <ul style="list-style-type: none"> <li>• COVID disrupted the project timeline</li> <li>• Delays in the Follow up with consultant</li> </ul>
<b>Mongolia</b>	<b>What went well</b>
	<ul style="list-style-type: none"> <li>• The Project schedule was flexible: Flexibility in the Project schedule was an integral component of the management of project risks including security issues, changes in shipping routes, variable approvals completion timing, countries ratification of relevant Conventions. Flexibility was built into the Project through regular</li> </ul>

	<p>communication (on-going regular NPM meetings and stakeholder updates throughout the project)</p> <ul style="list-style-type: none"> <li>• Relationships between participating countries: Extensive discussions with participating countries PIUs and related stakeholders relating to implementation of the project and processes was very important. It was recognized by project stakeholders that the benefits of the project exceeded expectations and increased awareness established during the reconnaissance have contributed significantly to the success of the project.</li> <li>• The open burning of waste decreased over the duration of the Project as awareness of the Stop Open Burning activities was communicated via local media and through government channels.</li> <li>• Independent disposal facility emission monitoring is important to ensure compliance and demonstrate transparency to all project stakeholders. Even the best available technologies should be subject to third party monitoring, as learned from the project activities. Despite regular local government monitoring, third party monitoring was required to make the results available to stakeholders. Following the detection of this breach, improved processes were put in place at the facility to reduce the risk of any further breach.</li> <li>• Effective communication with stakeholders provided faster project implementation. The positive cooperative foundations developed with all stakeholders because of the Communication Strategy were maintained throughout the Project and played a significant role in implementation success.</li> <li>• Awareness raising allowed users in the Ger areas to use only coal briquettes in open burning.</li> <li>• Advocacy Plan (AP) and Sustainability Management Plan (SMP)</li> </ul> <p><b>What could have gone better</b></p> <ul style="list-style-type: none"> <li>• Due to Covid restrictions ash recycling is not yet fully operational</li> <li>• More capacity building on UPOPs awareness</li> </ul>
<b>Philippines</b>	<b>What went well</b>
	<ul style="list-style-type: none"> <li>• The adaptable nature of the project allowed for proper steps to fully address the issue and to successfully deliver better results by focusing on the other site and later on also was able to assist another LGU.</li> <li>• Given the project time and budget, stakeholders involvement went well since they were mobilized and were always part of project activity implementation</li> <li>• The existence of the project framework and formulation of the workplan were significant tools before project implementation. They helped set the direction on when, how, and what possible activities were to be implemented given the goal of the project.</li> <li>• Several meetings and site visits conducted prior to the formal identification of the team members and actual project implementation have allowed people to have a sense of the group and the project itself.</li> <li>• The existence of a project manager as well as having the project team to take care of specific aspects of the project a lot of things was one critical factor that ensured its success and timely implementation.</li> <li>• The open line of communication from the regional project manager to the national project manager and project coordinator, to team members, to consultants, and vice versa, was vital to the success of the project. Most misunderstandings and unnecessary issues were prevented.</li> <li>• The systematic fund administration of UNIDO was one of the prodding factors that made the project run as expected and on time.</li> <li>• Because of the resolutions, national agencies are tasked to draft guidelines on open burning</li> <li>• More Local Government Units were motivated to replicate the Demo sites</li> </ul> <p><b>What could have gone better</b></p>

	<ul style="list-style-type: none"> <li>• Though project sites were already determined through a set of criteria, observations, existing data, and consultation with the national government, it could have been more beneficial if further consultations with the actual community and affected stakeholders were also conducted before it was finalized. Consultations were done after the sites were already determined hence, there was a need to change the project site since it was later found out that the other site could do without the project.</li> <li>• The project might have tried to meet the stakeholders’ goals and needs, but their involvement could have been better if more time were devoted to them in order to truly understand their requirements. Though, given the project time and budget, stakeholders' involvement, in this case, may have been enough. Some of the stakeholders did not become part or were not represented in the teams but in most cases, they were included in project activities. If more time were allotted to understand specially their business requirements, then it could have led to a deeper sense of ownership of the project and more productive contributions in order to meet the objectives of the project as well as becoming partners in the effort to sustain the project activities.</li> <li>• Some disruptions were also met due to the lockdowns and restrictions brought about by the pandemic.</li> </ul>
<b>Viet Nam</b>	<b>What went well</b>
	<ul style="list-style-type: none"> <li>• The project supported to develop quite comprehensively the regulations on POPs/UPOPs management</li> <li>• For the first time, 4 technical guidance for writing environmental protection scheme for four types of recycling craft villages (plastic, metal, paper and bamboo mating) were developed, which provided a useful tool for both local authorities and households in environmental management of recycling villages</li> <li>• Households at recycling villages have potential opportunities to access financial supports, which provided in the guideline and manual for production households/enterprises at craft villages to access fund from Viet Nam Protection Environmental Fund and Viet Nam Craft Village Environment Fund</li> <li>• Capacity on monitoring, analysis and reporting UPOPs and Hg of laboratories were strengthened through the regional training activities and also through the regional monitoring campaign</li> <li>• Also, for the first time, a completed BAT/BEP model for plastic recycling was introduced to craft village, with expectations on resource efficiency, higher quality of outputs and similar capacity for replication</li> <li>• Series of communication activities were carried out, from workshops, training, events to contest and communication materials were designed and delivered to a number of audiences.</li> </ul>
	<b>What could have gone better</b>
	<ul style="list-style-type: none"> <li>• Covid 19 has affected the implementation of the many projects especially trainings that were replaced with guidelines. Though the guidelines can reach many people, the benefits of in person training are more direct and personalized.</li> <li>• Dissemination of the BAT/BEP models in plastic recycling and its tangible recycled plastic products should be promoted, together with the financial and environmental benefits, for transitioning to a greener recycling industry in Viet Nam</li> </ul>



## VII. Conclusion

### Conclusion

#### A. OVERALL ASSESSMENT

The overall accomplishments of the project in all participating countries are most worthwhile. The design of the output activities was meant to be interconnected and bring synergy not only towards the accomplishment of the desired outcomes but also among the project team and stakeholders. The activities were carried out in such a way that they can be replicated to other parts of the country. The goals towards environmental, social, and economic sustainability have been addressed particularly SDG 3 on Good Health and Well Being (lessened UPOPs emissions) and SDG 11 on Sustainable Cities (Better solid waste management), SDG 9 on Industry, Infrastructure and Innovation (new SWM facilities established) and SDG 12 on Responsible Consumption and production (3Rs of reuse, reduce and recycle). Women, children, the marginalized members of society stand to benefit in the project not only from better health and safety but also from added employment and education gained. This has affected the way they manage wastes and is expected to continue to be absorbed as a way of life for everyone.

Solid waste management in each country has still a long way to go, but it is worthy to take notice of the effort and the accomplishments achieved by each government in handling this project. The benefits of the project may still take a long time to be realized but with the active involvement of the project partners, their roles, and responsibilities as implementors, the trainings and technologies received, and their sense of ownership over the project, positive results can be expected earlier. All the project activities have helped local stakeholders manage their waste properly and avoid open burning. The implementation of the law should dictate the way forward for the national agencies to take part in and make a difference, for people to take charge and be responsible in managing their waste and eventually stopping open burning.

### Conclusion

#### B. FOLLOW-UP ACTIONS NEEDED

Follow-up actions are necessary to maintain the momentum and to prevent the loss of interest and to take advantage of the enthusiasm of the actors and parties involved in the undertaking.

Project outputs were shown based on the targets that were set during project implementation, but it should be noted that this approach is limited only to piloting strategies. The presence of a Sustainability Management Plan such as that in the Philippines and Mongolia is a guiding document that can be used to help realize the real benefits and impacts of the project which can be seen over time. The sustainability of the effort is highly dependent on all actors to be led by the government units in the demonstration sites with the National Government as their driving force to keep the momentum.

## VIII. ANNEXES

### ANNEX A. ACHIEVED REDUCTION OF U-POPS FROM IMPLEMENTATION OF DEMONSTRATION ACTIVITIES

During the last phase of the project "Demonstration of BAT and BEP in open burning activities in response to the Stockholm Convention on POPs", two different investigations were carried out to either get a picture about the main outcomes got from the interventions that were completed during the implementation of *Component 3-Demonstration Activities* and get information about the actual situation of emissions of U-POPs at sites that were selected to host the pilot projects. Two reports were produced:

1. **Investigation on achieved reductions of dioxins and related costs;** a desktop study aimed at estimating the reduction of emissions achieved from demonstration activities in each of the five participating Countries: Viet Nam, Cambodia, Laos, Mongolia, and Philippine, and at confirming that the targets of the project in terms of total reductions of emissions were achieved.

The estimates were carried out using the standard emission factors (EF) provided by the UNEP Toolkit, (which gives, for each identified POPs emission source, an emission factor in  $\mu\text{gTEQ}$  per unit of energy or per unit of volume of material burned). No correlation with actual situation of pollution at sites was neither necessary nor investigated. The main assumption envisaged that all materials being recycled by the pilot plants were taken off the open burning stream, resulting in reductions of emissions at site because the recycled material no longer contributes to open burning.

The results were either figure about the reduction of emissions of U-POPs achieved by each facility and an estimate about the total amount of reductions. Some estimates about socio-economic costs from reduction of risks to people living in the surrounding of the sites were also carried out, however they should be considered factual because referred to available literature and not on accurate information about sites.

2. **Monitoring program of PCCD/PCDF and Mercury in air, soil and water at sites selected for the demonstration activities in the five countries;** an on-the-field activity aimed at taking samples to get a close picture about pollution from U-POPs at sites of demonstration activities to confirm that selection of sites for demo activities was matching the actual pollution situation. The Northern Center for Environmental Monitoring-Viet Nam was contracted to conduct environmental monitoring and analysis of U-POPs and Hg concentration in five countries: Viet Nam, Cambodia, Laos, Mongolia, and Philippine.

Measurement campaign was limited to 127 samples for all sites and included sampling of air, soil and water, to provide a figure about pollution at site to be used as baseline to promote further analysis/interventions as follow up of the pilot intervention implemented within the UNIDO project on BAT/BEP.

A total number of 62 U-POP samples and 65 Hg samples (included the field sampling QC samples) of air, ash, soil, leachate and surface water samples were taken and analyzed.

The main findings were that, although the number of samples in each country was limited, the sampling campaign showed that the levels of some U-POP parameters at several monitoring locations exceeded the limit levels of the enforced national standards, thus justifying the need for interventions to reduce the generation of U-POPs from open burning activities.

The two activities provided different, not comparable outcomes because:

- a) The desktop study provided figures about the achieved reductions of U-POPs referred to how much material was taken off the previous open burning stream by installing demo recycling lines. It was linked to capacity of lines and to the Emission Factors used as reference.
  - b) The sampling campaign instead addressed the locations where the demo plants were sited and gave a picture about pollution from U-POPs at time of sampling. It was linked to actual pollution rate at site at that time. Sampling did not address the type and capacity of recycling facility at sites and their effects on reduction of burned material.
- The activity provided the concentration of U-POPs in the sampled materials which were compared with national and international standard to provide a reference about pollution levels at sites.

Below some additional information about the two activities

**1. Investigation on achieved reductions of dioxins and related costs**

The following Emission Factors were used (UNEP Toolkit)

**Table II.6.5 PCDD/PCDF emission factors for source category 6b Open Burning of Waste and Accidental Fires**

6b	Open Burning of Waste and Accidental Fires	Emission Factors (µg TEQ/t material burned)				
		Air	Water	Land	Product	Residue
1	Fires at waste dumps (compacted, wet, high organic carbon content)	300	ND	10*	NA	NA
2	Accidental fires in houses, factories	400	ND	400	NA	NA
3	Open burning of domestic waste	40	ND	1*	NA	NA
4	Accidental fires in vehicles (µg TEQ per vehicle)	100	ND	18	NA	NA
5	Open burning of wood (construction/demolition)	60	10	10	NA	NA

\* Based on a few field measurements and consistent with the biomass burn  $EF_{Land}$  where the release in the ashes is 5%-10% of the  $EF_{Air}$ .

And

**Table II.9.3 PCDD/PCDF emission factors for source category 9a Landfills, Waste Dumps and Landfill Mining**

9a	Landfills and Waste Dumps	Emission Factors (µg TEQ/t waste disposed of)				
		Air	Water	Land	Product	Residue
1	Hazardous wastes	NA	5	NA	NA	NA*
2	Mixed wastes	NA	0.5	NA	NA	50
3	Domestic wastes	NA	0.05	NA	NA	5

\*The residues of wastes from category 1 to 8 are accounted in the respective categories.

The outcomes from calculations were compared with the estimates done during the PPG phase, to check whether original targets were actually reached. However, due to changes at political and administrative level, sites and type of interventions agreed during the PPG phase had been changed. Governments provided different indications, either about sites and type of intervention in particular about restoration of dumpsites.

As a result, the achieved reductions for each country were different than predicted, nevertheless the total reduction of emissions in the five countries was satisfactory providing a total reduction value about 68% higher than estimated during the PPG.

Table 1 Predicted dioxins reductions

Country/site*	Before BAT/BEP PCDD/PCDF mgTEQ/year	Predicted achievements PCDD/PCDF mg TEQ/year
Cambodia - Kampot	553.8	10.1
Lao PdR - Vientiane	8335.5	222.2
Mongolia Morin Daava	9277.5	184.3
Philippines - General Santos	8099.0	176.8
Philippines – Lapu Lapu	6201.5	131.3
Viet Nam - Nam Dinh village	5149.8	1725.2
<b>Total</b>	<b>37617.1</b>	<b>2449.9</b>

Table 2 – Achieved dioxins reductions (sites and types of interventions changed)

Country/site	Achieved reductions mgTEQ/year
CAMBODIA/Battambang	4876.765
LAO PDR/Vientiane- Thakhek	4347.223
MONGOLIA/ Tsagaan Davaa	22149.5
PHILIPPINES/General Santos-Koronadal	5657.5
VIET NAM/Minh Khai- Phan Boi	4095.1248
<b>Total</b>	<b>41126.1128</b>

## 2. Monitoring program of PCCD/PCDF and Mercury in air, soil and water at sites selected for the demonstration activities in the five countries

Air samples: Two air samples collected at the landfill in Viet Nam and Cambodia and 1 sample collected at a control site in Cambodia showed a PCDD/PCDF TEQ concentration higher than the limit of 0.6 pgTEQ/m<sup>3</sup>, assumed as reference by some countries in the region (Japan, Taiwan, Viet Nam). Remaining samples were below the limit.

Concentrations were correspondingly 3.0, 11.1 and 2.8 times exceeding the reference limit; Hg contamination was mostly concentrated in the gas phase but values were quite lower than the reference limit of  $0.3 \mu\text{g}/\text{m}^3$  or  $0.1 \mu\text{g}/\text{m}^3$ , enforced in Viet Nam and Cambodia respectively.

Ash and soil samples: Values of PCDD/PCDF, dl-PCB, and HCB ash and soil samples taken at landfills were remarkable. PCDD/PCDF concentrations ranged from 0.000 ngTEQ/kg to 4281 ngTEQ/kg; the highest dl-PCB concentration was up to 584 ngTEQ/kg and HCB was up to 105  $\mu\text{g}/\text{kg}$ . PCDD/PCDF TEQ levels in two samples were about 3.6- 3.2 times the reference value of 1200 ngTEQ/kg enforced in Viet Nam. HCB levels were 10.5 and 5.7 times the reference limit of  $10 \mu\text{g}/\text{kg}$ .

Leachate, surface water samples: In general, U-POP and Hg concentrations in analyzed samples were at low level. Only one leachate sample taken at Battambang landfill in Cambodia had PCDD/PCDF concentration 1.3 times exceeding the permitted standard for wastewater from industrial activities and from polluted treatment areas (10 pgTEQ/l).

Hg concentration in analyzed water samples were mostly at low level. One leachate sample from the old dumpsite in Philippines showed Hg concentration close to the regulation limit value for wastewater for Viet Nam and Mongolia ( $1 \mu\text{g}/\text{L}$ ).

It can be concluded that although the number of samples in each country was limited, the sampling campaign showed that the levels of some U-POP parameters at several monitoring locations exceeded the limit levels of the enforced national standards, thus justifying the need for interventions to reduce the generation of U-POPs.

- PCDD/PCDF congener profiles somewhat confirmed that the main source of PCDD/PCDF contamination was from the open landfill sites and the uncontrolled burning of solid wastes. Furans were the predominant congeners in air samples.
- Congeners with more chlorine substituents (HpCDDs/HpCDFs, OCDD/ OCDF) were the dominant ones in the ash and soil samples.
- One air sample collected at the control site in Cambodia had PCDD/PCDF concentration exceeding the standard limit by 2.8 times.
- The concentration of Hg in the analyzed samples from five countries is still not a concern issue. However, for U-POP (PCDD/PCDF, dl-PCB, HCB), the results showed that the contamination from the burning gas, ash, soil and leachate come from the open landfill sites and uncontrolled burning activities still exists. These contaminations accumulate over time increasing pollution and risks to the surrounding population and environment.

## ANNEX B. ACHIEVED REDUCTIONS OF DIOXINS AND RELATED COSTS

### ACHIEVED REDUCTIONS OF DIOXINS AND RELATED COSTS

In the following the calculations of reductions of PCDD/F achieved through the implementation of Component 3 of project (Pilot Plants) are introduced.

Assumptions were used in case of missing information/data, with reference to international literature.

#### EXPECTED REDUCTIONS OF PCDD/F

In the Project Document, the following reductions of dioxins from the implementation of the project were estimated

Outcome 3: BAT/BEP implemented in the open burning sources

The estimated U-POPs reduction potential from these demonstration activities is summarized in the table below:

Country/site	Before BAT/BEP PCDD/PCDF mg TEQ/year	After BAT/BEP PCDD/PCDF mg TEQ/year
Cambodia - Kampot	553.8	10.1
Lao PdR - Vientiane	8335.5	222.2
Mongolia Morin Daava	9277.5	184.3
Philippines - General Santos	8099.0	176.8
Philippine – Lapu Lapu	6201.5	131.3
Viet Nam - Nam Dinh village	5149.8	1725.2
Total	37617.1	2449.9

Original interventions were mostly based on rehabilitation of dumpsites to stop the open burning, which were assumed to reduce emissions of about 98%.

During the implementation of the project, following requests from national and local authorities, the pilot activities were mostly replaced by pilot recycling plants.

The following demo facilities were organized and implemented.

Cambodia: Rehabilitation of Kampot dumpsite- Phnom Penh, was replaced by three interventions at Battambang City:

1. Composting plant by COMPED company- Battambang
2. Plastic recycling plant by Plastic Products company- Battambang
3. Rehabilitation of a recycling line by Leap Lim Company- Battambang

#### Laos

Establishment of a Material Recovery Facility at SAPLAST Company -Vientiane was replaced with one line to produce plastic pellets + two lines line to produce plastic pipes from recycled plastics;

### Mongolia

Intervention on rehabilitation of Morin Davaa dumpsite – Ulaanbaatar replaced by establishment of a new cell for hot ash (from ovens in Gers) storage at Tsagaandavaa dumpsite

### Philippines

Rehabilitation of Tumbler dumpsite in General Santos replaced by establishment of a Material Recovery Facility by a new established sanitary landfill .

Lapu Lapu: intervention on rehabilitation of dumpsite replaced by improvement of a Material Recovery Facility at Barangay Paraiso dumpsite -Koronadal City

### Viet Nam

Interventions in Nam Dinh craft village on aluminum scraps replaced by establishment of two lines for plastics recycling in Phan Boi craft village and one line to recycle plastics in Minh Khai craft village

## 1. ASSUMED EMISSION FACTORS IN THE PROJECT DOCUMENT

In the project document, the following Table was assumed as reference for the calculations of reduction of dioxins releases :

**Table II.6.5 PCDD/PCDF emission factors for source category 6b Open Burning of Waste and Accidental Fires**

6b	Open Burning of Waste and Accidental Fires	Emission Factors ( $\mu\text{g TEQ/t}$ material burned)				
		Air	Water	Land	Product	Residue
1	Fires at waste dumps (compacted, wet, high organic carbon content)	300	ND	10*	NA	NA
2	Accidental fires in houses, factories	400	ND	400	NA	NA
3	Open burning of domestic waste	40	ND	1*	NA	NA
4	Accidental fires in vehicles ( $\mu\text{g TEQ}$ per vehicle)	100	ND	18	NA	NA
5	Open burning of wood (construction/demolition)	60	10	10	NA	NA

\* Based on a few field measurements and consistent with the biomass burn  $EF_{\text{Land}}$  where the release in the ashes is 5%-10% of the  $EF_{\text{Air}}$ .

And

**Table II.9.3 PCDD/PCDF emission factors for source category 9a Landfills, Waste Dumps and Landfill Mining**

9a	Landfills and Waste Dumps	Emission Factors ( $\mu\text{g TEQ/t}$ waste disposed of)				
		Air	Water	Land	Product	Residue
1	Hazardous wastes	NA	5	NA	NA	NA*
2	Mixed wastes	NA	0.5	NA	NA	50
3	Domestic wastes	NA	0.05	NA	NA	5

\*The residues of wastes from category 1 to 8 are accounted in the respective categories.

Resulting in the following reference:

Baseline for dumpsites				
	Open burning Emission Factor (UNEP update Main Cat. 6) $\mu\text{g}$ TEQ/t	Landfill and waste dump Emission Factor (UNEP main cat. 9) $\mu\text{g}$ TEQ/t	Amount of waste burned (% of total disposed of)	Releases mg TEQ/a
Air	300	NA	30%	
Land	10	NA	30%	
Water	NA	0.5	100%	
Residue	NA	50	100%	
Total				

It was also assumed that, by taking off plastics from the stream of waste to dumpsite open burning is reduced by 40% and open burning accordingly.

Reductions of emissions were calculated as the difference from values before BAT/BEP and after BAT/BEP as follows

	Before BAT/BEP	After BAT/BEP	Achieved reductions	%
	mgTEQ/year	mgTEQ/year		
Country/site				
Cambodia - Kampot	553.8	10.1	543.7	98.18%
Lao PdR - Vientiane	8335.5	222.2	8113.3	97.33%
Mongolia Morin Daava	9277.5	184.3	9093.2	98.01%
Philippines - General Santos	8099	176.8	7922.2	97.82%
Philippine – Lapu Lapu	6201.5	131.3	6070.2	97.88%
Viet Nam - Nam Dinh village	5149.8	1725.2	3424.6	66.50%
<b>Total</b>	<b>37617.1</b>	<b>2449.9</b>	<b>35167.2</b>	<b>93.49%</b>

#### ACTUAL REDUCTIONS OF EMISSIONS RESULTING FROM IMPLEMENTATION OF SELECTED BAT/BEP

A more detailed estimate of reductions of dioxins achieved by implementation of agreed interventions was carried out. Assumptions used in the Project Document were double checked to be confident that were suitable to be applied to new interventions and replacing those initially envisaged by Project.

Implemented Emission factors (EF):

1. The reference to UNEP Toolkit was confirmed.
2. Baselines for the calculations: baselines calculated basing on stream of waste to dumpsites were confirmed



3. Assumption that, after rehabilitation of dumpsite about 100% open burning activities will end (some emissions from water and residue will remain); not confirmed because interventions were not aimed at rehabilitation activities.
4. As all interventions were including recycling activities; it was decided to assume the following:
  - a. The reduction of plastics dumped to dumpsite to be accounted as reduction of open burning (100% plastics assumed no longer be burned at dumpsite). It comes out from the reflection that most of recycled plastics will come from avoided open burning at backyards.
  - b. The reduction plastics to dumpsites resulting in 3 kg of waste not burned/kg of plastics; come from the reflection that, once combustion is started by combustible recyclables such as plastics, generation of methane and smoldering will induce combustion of other waste such as paper, trimmings, organic material which continues its burning for quite a long time. This assumption is more conservative than assuming 100% reduction of open burning after rehabilitation of dumpsites.
  - c. Emission Factors to water and residue were not accounted because interventions were not related to dumpsite.
  - d. Reference capacity for equipment supplied by UNIDO was calculated as incremental capacity in cases of upgrading of existing facilities(e.g. if an existing plant 1 t/h capacity is replaced by a new plant 5 t/h capacity, contribution to reduction of open burning is assumed to be 4 t/h)

## 2. SPECIFIC ASSUMPTIONS FOR EACH COUNTRY

### CAMBODIA

#### Composting plant by COMPED

Intervention consisted of supply of new equipment and roofing to an existing, very basic, composting plant operated by COMPED by Battambang dumpsite.

New capacity is assumed 10 t/day organic material in input; efficiency is assumed 20% (1000 g of organic material produce 200 g of compost) .

It was assumed that the organic material, if not processed at COMPED, will be dumped and somehow burned at dumpsite/backyards together with other commingled waste resulting in generation of dioxins ( current generation of waste is about 100 t/d)

Reduction of open burning is calculated assuming that 100% of material in input to COMPED, mostly trimmings, will not be involved in open burning ;

Current input of organic material at COMPED, Battambang City is about 3 t/d, which gives an incremental capacity of 7 t/d (10t/d -3t/d)

#### Plastic Recycling line by Plastic Products Handicraft (PPH)-Battambang

Intervention consisted of a plastic recycling line to be installed at PPH facility in Battambang. Plastic in input to new line is diverted from burning activities, avoiding combustion of MSW. It was assumed that 1 kg of plastic diverted from dumpsite results in avoided combustion of 3 kg of MSW. New capacity of plastic line is 4.8 t/day against a former capacity of 0.5 t/d. Incremental capacity is assumed as 4.3 t/d.

#### Rehabilitation of a MRF funded by Asian Development Bank at Battambang City

Intervention consisted of supply of additional equipment to improve the efficiency of an already existing Material Recovery Facility located by Battambang's dumpsite. Reference capacity is 7 t/d, existing capacity was 0.7 t/d; incremental capacity is 6.3 t/d

## LAOS

Intervention consisted in a new plastics pelletizing line and in two new plastic pipes production lines located by SAPLAST company-Vientiane

Plastic in input to new line will be diverted from dumpsite/backyards, avoiding combustion of MSW. It was assumed that 1 kg of plastic diverted from dumpsite results in avoided combustion of 3 kg of MSW. causing emissions of dioxins according to UNEP Toolkit

Capacity of new pelletizing line: 7.4 t/d; existing capacity is 2.5 t/d; incremental capacity is assumed 5.4 t/d

About pipes production lines, it was assumed that 30% virgin plastic material is added to recycled plastics to produce pipes, therefore only 70% of capacity of new plastic line was used to calculate reductions of dioxins. Incremental capacity is 100% because the old lines were discontinued years ago.

MRF in Thakhek City:

Reference capacity in TOR was 10 t/d, but offered capacity was 40 t/d. As current collection of general waste is 17.7 t/d, an input capacity of 17.7 tons/day MSW was assumed;

## MONGOLIA

New ash cell by Tsagaandavaa dumpsite

Intervention consisted of erection of a new cell where to dump ash generated by coal stoves used in Gers. Currently hot ash is mixed with general waste in the bins by the Gers where start combusting other materials (paper, plastics). Moreover, when dumped at dumpsites the mix ignites other waste dumped there, resulting in open burning. The emission factor was assumed according to UNEP Toolkit *Table II.6.5-open burning of waste.*

To estimate open burning, it was considered that generation of waste in UB is 1,200,000 t/year (ref. year 2010), of which 700,000 t/y from Gers (JICA report 2016) In wintertime the ash produced from the small stoves used for heating/cooking is 40% of generated waste. This ash, still hot, with a content of unburnt carbon, once dumped to bins and then to Tsagan Davaa dumpsite, ignites more waste.

According to recent studies, combustible material in waste generated by Gers is about 70%, which gives 490,000 t/y which can be ignited by hot ash. Assuming that waste burning by hot ash happens only in the heating period October-April, (seven months where stoves are used for heating)) the total amount of combustible waste is 408,000 t/y.

The following references were assumed:

- Winter season: from October to April (7 months).
- Generation of waste in Gers: 700,000 t/y
- Generation in 7 months: 408,000 t/y
- Combustible materials in waste 70% = 285,800 t/y. Waste ignited by hot ash in bins and at landfill: assumed 25% of dumped MSW = 71450 t/y

## PHILIPPINES

New MRF at General Santos City sanitary landfill

The capacity of MRF, set as 10 t/d in the RFP, was updated to 40 t/d (capacity of new facility). It was assumed that 100% waste processed at MRF results in reduced open burning.

### Refurbishing of a MRF in Koronadal City

A recycling line (not operating) was upgraded to a capacity of 10 t/d. It is assumed that 100% waste which is processed at MRF results in reduced open burning.

### **VIET NAM**

#### Reduction of open burning in Phan Boi and Minh Khai plastic handicrafts villages

Intervention consisted of:

	Capacity t/day
N. 1 New plastic recycling line in Minh Khai	10
N. 1 rehabilitation of an existing plastic line in Phan Boi	2
N. 1 line to recycle waste plastic in Minh Khai	8.4

#### PHAN BOI

It was assumed that the plastic discards (manually discarded before being sent to line) are sent to dumpsite, where are burnt together with MSW causing emissions of dioxins according to UNEP Toolkit *Table II.6.5-open burning of waste*.

According to information gathered, discarded plastic is about 20% of material in input. It was also assumed that firing 1 kg of plastic contributes to additional burning of 3 kg of MSW.

Another source of open burning originates from extruders filters. The plastic from cleanup of extruders is currently burnt in fireplaces. This contribution was not accounted because of lack of data.

Content of PVC in the plastic discards: PVC, with its chlorine content, contributes to generation of dioxins. The content of PVC in the plastic discards was not known, and was not accounted.

#### MINH KHAI

New line: The reference was 10t/d with reference to one shift of 9.5 hours; actual installed capacity was 2 t/day but VNCPC confirmed that daily production will be 10 t/d because shifts will be increased to 22 hours/d.

#### PHAN BOI

Refurbished line: it was assumed that the refurbished line will improve efficiency of old line by 30%, resulting in 30% less discards to dumpsite; One kg of recycled plastic will avoid burning of 3 kg of waste at dumpsite.

#### PLASTIC DISCARDS RECYCLING

It was assumed that 100% of discards from production lines are recovered by new plant avoiding burning of 3 kg of waste for each kg of dumped plastic material.

## ECONOMICS

The cost to get 1 gTEQ reduction of emissions of dioxins was calculated. Details for each country are shown in the Table below and are compared to outcomes expected from the Project Document. Analysis shows that the outcome of 41,126.60 mgTEQ/y reduced emissions of dioxins from recycling activities are higher than the figure expected from the original assumption about rehabilitation of dumpsites (35,167.1 mgTEQ/y).

About cost of interventions, only the cost of equipment was accounted, taking off other costs such as transportation to site, training, spare parts, which, being site specific, would affect the general soundness of calculations.

Country	Cost of interventions (equipment only)	Achieved dioxins reduction	predicted emissions after BAT/BEP (Project document)*	Cost for 1 gTEQ dioxins reduction	Cost for 1 g dioxins reduction assuming a lifetime of 10 years and O&M costs = 20% of investment cost
	USD	mg/year	mg/year	USD/gTEQ x year	USD/gTEQ
CAMBODIA*	596,622	4,876.80	543.7	426,621	51,221.63
LAOS*	838,264	4,347.20	8,113.30	396,653	57,848.24
MONGOLIA*	505,024	22,150	9,093.20	22,801	6,840.21
PHILIPPINES GENSAN*	680,000	4,526.00	7,922.20	150,243	45,072.91
PHILIPPINES KORONADAL*	75,000	1,131.50	6,070.20	133,451	19,885.11
VIET NAM*	386,432	4,095.10	3,424.60	94,364	28,309.17
<b>TOTAL</b>	<b>3,081,342</b>	<b>41,126.60</b>	<b>35,167.20</b>	<b>1,224,132</b>	<b>209,177.30</b>

\* INTERVENTIONS CHANGED

### Comparison with expected outcomes

	Investment cost USD	Achieved reduction of dioxins mgTEQ/y
Project Document	4,700,000	35,167.20
Actual implementation of Project	3,081,342.3	41,126.60

## SOCIAL/ECONOMIC COSTS

Determining the social cost associated to emissions of dioxins is very challenging because depends on population, population density, lifestyles, nutrition habits, weather conditions, distance of sources of emissions from people, available health care services etc.

A reference in literature was found to be compared to the above calculated costs of reductions: *Health risks and economic costs of exposure to PCDD/Fs from open burning: a case study in Nairobi, Kenya.2015*, where it was reported that "Potential excess cancers due to dietary exposure to PCDD/F associated with all illegal waste burning in Nairobi were estimated to be 636 cases over the 30-year

time period or 21 cases/year” and that “the opening of the new sanitary landfill that can reduce 50 % of waste disposed at the Dandora dumpsite, the economic benefits of avoided cancer deaths is expected to be US\$ 0.16–1.93 million”.

Emissions of dioxins from the Dandora dumpsite were not available , therefore the relationship between quantities of emitted dioxins and intake from population is missing.

Broad calculations can be done assuming that open burning activities at non-controlled dumpsites are similar and that are proportional to population ( the more is population, the more is generated waste, the more is open burning).

Under the above assumptions, with reference to report about Nairobi, considering that population in Nairobi in 2015 (date of report) was 187,311, the following calculations were carried out:

- Incidence of cancer deaths in 30 years:  $636/187311 = 0.0339$  fatalities/population
- Costs/death: 0.16-1.93 million USD = 252-3035 USD/death

Using the above figures referred to population of the Cities where interventions were implemented and where open burning at backyards and at dumpsites happens, the following Table was prepared

City	population	fatalities/pers on	fatalities in 30 years	cost at 252 USD/fatality	cost at 3035 usd/fatality
Battambang	161072	0.0339	5460	1376005.882	16572134
Vientiane	419090	0.0339	14207	3580202.052	43118703
Ulaanbaatar	2998433	0.0339	101647	25615013.43	308498277
General Santos	594400	0.0339	20150	5077840.32	61155736
Koronadal	174,942	0.0339	5931	1494494.518	17999170
Minh Khai	2100	0.0339	71	17939.88	216062
Phan Boi	5952	0.0339	202	50847	612380
<b>4,355,989</b>			<b>43,399</b>	<b>37,212,343</b>	<b>448,172,462</b>

Figures show that social costs are ranging from USD 37,212,343 to USD 448,172,462 and can be avoided by investing about 3 million USD on interventions to reduce dioxins. Fatalities are 43,399 in 30 years, equivalent to 1444 fatalities/year over a population of 4,355,989

A different calculation can be done by taking into account a different reference that estimates how much it would cost to reduce the emissions from different sources (*NERC Knowledge Transfer Network on POPs-Costs of reducing emissions of dioxin-like compounds-Andrew Marsh-Patrick Entec UK Ltd 20th September 2006*). In that paper, to reduce 240 mgTEQ/year of dioxins emitted by burning of domestic waste, a cost of USD 0.42 M/gTEQ was estimated (year 2006).

Assuming the above values, with reference to the total reduced emissions of 38,987.6mgTEQ/year achieved by Project, results are

Cost for reducing 240 mgTEQ/year (NERC) USD	Cost for reducing 1 mg mgTEQ/year (NERC) USD	Reductions achieved by Project mgTEQ/year	Cost of reduction according to NERC	Cost of reductions UNIDO
0.42M/gTEQ	2,345	38,987.6	9,123,098	3,081,342

**Conclusions:**

If no actions are taken to reduce emissions of dioxins from open burning, about 1444 fatalities/year could be expected in the five countries of the Project, with a social cost ranging from 1.23 million USD/year to 14.9 million USD/year. An investment of about 3 million USD (as done by Project) or of about 9 million USD, as estimated by NERC paper, will avoid fatalities and related annual social costs.

**ASSOCIATED REDUCTIONS OF CARBON DIOXIDE**

Reduction of open burning results in reduction of CO<sub>2</sub> as well because less material is burnt. To estimate the reductions of CO<sub>2</sub> from the implementation of interventions, it is necessary to have the CO<sub>2</sub> Emission Factors, which are linked to the type of material that is burned.

The following EF have been found in literature:

	Ton CO <sub>2</sub> /ton waste material	
Burning of plastics	2.9	<a href="https://www.no-burn.org/wp-content/uploads/Plastic-is-Carbon-Oct2021.pdf">https://www.no-burn.org/wp-content/uploads/Plastic-is-Carbon-Oct2021.pdf</a>
Burning of paper	0,65	<a href="https://pdf.sciencedirectassets.com/277910/1-s2.0-S1876610217X00076/1-s2.0-S1876610217309554/main.pdf">https://pdf.sciencedirectassets.com/277910/1-s2.0-S1876610217X00076/1-s2.0-S1876610217309554/main.pdf</a>
Burning of organic material	2.5	<a href="https://toogoodtogo.com/en-us/movement/knowledge/the-carbon-footprint">https://toogoodtogo.com/en-us/movement/knowledge/the-carbon-footprint</a>
Burning of MSW (0.7-1.7 tCO <sub>2</sub> /t MSW)	1.00	<a href="https://zerowasteurope.eu/wp-content/uploads/edd/2019/09/ZWE_Policy-briefing_The-impact-of-Waste-to-Energy-incineration-on-Climate.pdf">https://zerowasteurope.eu/wp-content/uploads/edd/2019/09/ZWE_Policy-briefing_The-impact-of-Waste-to-Energy-incineration-on-Climate.pdf</a>

Demo plants implemented in the countries are different and for each of them assumptions have been made to calculate reductions of dioxins. Same assumptions have been used to calculate CO<sub>2</sub> reductions as illustrated below:

5. Plastic recycling: it is assumed that 1 t of plastics taken off the dumpsite avoid the burning of 3 kg of waste.
6. Plastics; an EF of 1.5 tCO<sub>2</sub>/t recycled plastic has been used ( share 1 plastic+3MSW)
7. Organic material composting; EF=2.5 tCO<sub>2</sub>/t organic material
8. MSW: EF= 1 tCO<sub>2</sub>/t MSW

Reductions of CO<sub>2</sub> are:

<b>CO<sub>2</sub> REDUCTIONS</b>	
<b>t/year</b>	
CAMBODIA	26152.25
LAOS	43723.35
MONGOLIA	71450.00
PHILIPPINES	18250.00
VIET NAM	19815.12
<b>TOTAL</b>	<b>179390.72</b>