MINISTRY OF ENVIRONMENT AND FORESTRY
REPUBLIC OF INDONESIA

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BASEL & STOCKHOLM CONVENTIONS REGIONAL CENTRE for SOUTHEAST ASIA

MINAMATA INITIAL ASSESSMENT REPORT

REPUBLIC OF INDONESIA
2022

FOREWORD

The Minamata Convention on Mercury is a global agreement to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds due to their characteristics which are toxic, corrosive, persistent, and bioaccumulative. This objective is achieved through setting out a range of measures, including controlling the supply and trade of mercury, controlling mercury products and manufacturing processes that use mercury or mercury compounds and artisanal small-scale gold mining (ASGM).

Indonesia has ratified the Minamata Convention on Mercury through Law No. 11 of 2017 concerning Ratification of the Minamata Convention on Mercury. As a follow-up to the ratification, Indonesia issued Presidential Regulation No. 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (*Rencana Aksi Nasional Pengurangan dan Penghapusan Merkuri*, RAN-PPM). Furthermore, the Minister of Environment and Forestry Regulation No. P.81/Menlhk/Setjen/Kum.1/10/2019 has also been stipulated for the implementation of the RAN-PPM.

As a Party and in accordance with Article 20 of the Convention, Indonesia has developed this Minamata Initial Assessment (MIA) document which contains recommended action plans that have not been included in the RAN-PPM to support the fulfillment of the provisions of the Minamata Convention. The recommended action plans are based on a review of the updated mercury inventory and identification of sources of emissions and releases in Indonesia, assessment of policy, regulatory and institutional framework assessment, identification of populations at risk and gender dimensions as well as the involvement of various stakeholder institutions in raising public awareness and training related to mercury.

With the development of this MIA document, it is hoped that Indonesia will have an integrated and sustainable work plan comprises policies, strategies and action plans for an environmentally sound management of mercury at the national level. It is also hoped that this document will become a guidance that is comprehensive and useful as a reference for other stakeholders in planning and implementing their mercury-related activities/programs.

The success in the development of this MIA document is achieved through cooperation and support from all stakeholders, including the government, the private sector, academia and society in general. We would like to thank the work team and all experts as well as the ministries/agencies and other relevant stakeholders for their work and contribution in the preparation of this document. Hopefully this MIA document can be a guideline for all of us for the realization of a mercury-free Indonesia.

Jakarta, 2022

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ABBREVIATIONS AND ACRONYMS

3R	Reuse, recycle, recovery
ADB	Asian Development Bank
AFR	Alternative Few and Raw Materials
AGC	Artisanal Gold Council
AGRU	Acid Gas Removal Unit
AMAN	Alliance of Indigenous Peoples of the Archipelago
AMDAL	Environmental Impact Management Assessment
APBD	Regional Revenue and Expenditure Budget
APBN	National Revenue and Expenditure Budget
APC	Air Pollution Control
APERLINDO	Indonesian Electrical Lighting Industry Association
API-P	Producer Importer Identification Number
API-U	General Importer Identification Number
APKI	Indonesian Pulp and Paper Association
APRI	Indonesian Community Miners Association
ASGM	Artisanal and Small-Scale Gold Mining
ASI	Indonesian Cement Association
ASPERA	People's Mining Association
AST	Annual Surveillance Test
Au	Gold
Avgas	Aviation Gasoline
Avtur	Aviation Turbine Fuel
B-2-B	Business to Business
BAT/BEP	Best Available Techniques/Best Environmental Practice
Bapedal	Environmental Impact Management Agency
Bappenas	Ministry of National Development Planning/National Development Planning Agency
BAU	Business As Usual
bbl	Oilfield Barrel
BBPK	Center for Pulp and Paper
BBPOM	Center for Drug and Food Control
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe/ Federal Institute for Geosciences and Natural Resources
BMKG	Meteorology, Climatology, and Geophysical Agency
BNPB	Indonesian National Board for Disaster Management
BOB BSP	Joint Venture Bumi Siak Pusako Company
BOE	Barrel of Oil Equivalent
BOPD	Barrels of Oil Per Day
BPJS	Social Security Administration
BPK	Audit Board
BPOM	National Agency of Drug and Food Control
BPPT	Assessment and Application of Technology

BPS	Statistics Indonesia
BRS	Basel, Rotterdam and Stockholm
BSCRC-SEA	Basel and Stockholm Conventions Regional Centre for Southeast Asia
BSTB	Billions of Stock Tank Barrels
BW	Body Weight
CAS	Chemical Abstracts Service
CEMS	Continuous Emission Monitoring Systems
CFL	Compact Fluorescent Lamp
Cl_2	Clorine
CFPPs	Coal Fired Power Plants
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
ComDev	Community Development
Covid-19	Coronavirus disease 2019
CN	Cetane Number
CSR	Corporate Social Responsibility
cSt	Continuous Settling Tank
DANIDA	Danish International Development Agency
DED	Detailed Engineering Design
DG	Director General
DGMC	Director General of Mineral and Coal
DIKPLD	Local Environmental Management Performance Information Document
Dirjen Daglu	Director General of Foreign Trade
Dirjen IKFT	Director General of Chemical, Pharmaceutical, and Textile Industry
Dirjen PDN	Director General of Domestic Trade
Dirjen PKTN	Director General of Consumer Protection and Trade Order
Dirjen PSLB3	Director General of Solid Waste, Hazardous Waste, and Hazardous Substance Management
DKI	Special Capital Territory of Jakarta
DLH	Environmental Services Office
DMFT	Decayed, Missing, and Filled Teeth
dmt	Dry Metric Ton
DOE	Department of Energy
DPD	Regional Representatives Council
DPR	House of Representative
DPRD	Regional People's Representative Assembly
DPR-RI	Indonesia House of Representative
DT-B2	Registered Distributor of Hazardous Substances
EEA	European Environment Agency
EEFL	External Electrode Fluorescent Lamps
EEZ	Exclusive Economic Zone
EF	Emission Factor
EMEP	European Monitoring and Evaluation Programme

EN	European Standards
EPRI	Electric Power Research Institute
ESP	Electrostatic Precipitator
ESP PM	Electrostatic Precipitator Particulate Matter
EVs	Electric Vehicles
FBC	Fluidised Bed Combustion
Fe	Iron
FF	Fabric Filter
FGD	Flue Gas Desulphurization
FKH	Faculty of Veterinary Medicine
FO	Fuel Oil
FOB	Free on Board
FS	Feasibility Study
GAKESLAB Indonesia	Association of Medical and Laboratory Equipment Companies in Indonesia
GDE	Geo Dipa Energy
GDP	Gross Domestic Product
GEF	Global Environment Facility
Germas	Healthy Community Movement
GoI	Government of Indonesia
GR	Government Regulation
GRDP	Gross Regional Domestic Product
GWh	Giga Watt Hour
HBM	Human Biomonitoring
Hg	Mercury
HgCl2	Mercury-dichloride
HgO	Mercury oxide
HgS	Mercury sulfide
HgSO4	Mercury-sulphate
HgTPD	Mercury Temperature Programmed Desorption
HPMV	High-Pressure Mercury Vapor Lamps
HS	Harmonized System
ICEL	Indonesian Center for Environmental Law
IDO	Industrial Diesel Oil
IDR	Indonesian Rupiah
IFO	Intermediate Fuel Oil
IMA	Indonesian Mining Association
IMDG	International Maritime Dangerous Goods
INAFOR	International Conference of Indonesia Forestry Researcher
INCAM	Indonesian Center for Artisanal Mining
INSW	Indonesia National Single Window
IPCS	International Programme on Chemical Safety
IPEN	International Pollutants Elimination Network
IPOG	Interactive Process Optimization Guidance

IPP	Independent Power Producers
IPR	Small-Scale Mining Permit
IT-B2	Registered Importer of Hazardous Substances
ITB	Bandung Institute of Technology
JATAM	Mining Advocacy Network
JCOAL	Japan Coal Energy Center
JICA	Japan International Cooperation Agency
JOC	Joint Operation Contract
Kementerian PPN	Ministry of National Development Planning/National Development Planning Agency
Kg	Kilogram
KLHK	Ministry of Environment and Forestry
Km^2	Square kilometer
Kodam	Regional Military Command
KOH	Potassium Hydroxide
KPPM	Mercury Research and Monitoring Committee
KUMAK	Mercury Test Kit in Water and Cosmetics
KY	Judicial Commission
LED	Light-Emitting Diode
LFL	Linear Fluorescent Lamps
LFPR	Labor Force Participation Rate
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LPNK	Non-Ministerial Institutions
m	Meter
m3	Cubic meter
MA	Mercury Analyzer
MA	Supreme Court
mb	Millibar
MBOPD	Millions of Barrels of Oil Per Day
MDF	Marine Diesel Fuel
MIA	Minamata Initial Assessment
MK	Constitutional Court
Mo-gas	Motor Gasoline
MoA	Minister of Agriculture
MoCI	Ministry of Communication and Informatics
MoEC	Ministry of Education and Culture
MoEF	Ministry of Environment and Forestry
MoEMR	Ministry of Energy and Mineral Resources
MoF	Ministry of Finance
MoH	Ministry of Health
MoI	Ministry of Industry
MoIT	Ministry of Industry and Trade
MoM	Ministry of Manpower

MoPWPH	Ministry of Public Work and Public Housing
MoT	Ministry of Trade
MoTransp	Ministry of Transportation
MPR	People's Consultative Assembly
MRA	Moderated Regression Analysis
MRU	Mercury Recovery Unit
MSCF	Million Standard Cubic Feet
MSDS	Material Safety Data Sheet
MSMEs	Micro, Small and Medium Enterprises
MSW	Municipal Solid Waste
mt	Metric Tonnes
Muspika	District Leadership Meeting
MW	Megawatt
MWh	Megawatt-hour
NaOH	Natrium hidroxyde
NAP	National Action Plan
NCV	Net Calorific Values
NETL	National Energy Technology Laboratory
NGO	Non-governmental organization
NIB	Business Identification Number
NIC	Nippon Instrument Cooperation
Nm^3	Normal Cubic Meter
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
NRDC	Natural Resources Defense Council
NTB	Nusa Tenggara Barat
NTT	Nusa Tenggara Timur
ODF	Output Distribution Factor
OJK	Financial Services Authority
P-B2	Hazardous Substances Manufacturer
P3KLL	Center for Quality Research and Development and Environmental Laboratory
PA-B2	End Users of Hazardous Materials
PCC	Post- Combustion CO_2 Capture
PERS	Prosperous People's Gold Mining
PGE	PT Pertamina Geothermal Energy
PHE	Pertamina Hulu Energi (Company)
PHE ONWJ	Pertamina Hulu Energi Offshore North West Java
PHE TEJ	Pertamina Hulu Energi Tuban East Java
PI-B2	Hazardous Substances Import Approval
PIBIN	Indonesian Dry Battery Industry Association
PIC	Prior Informed Consent
PKK	Family Welfare Empowerment
PLN	State Electricity Company

PLTP	Geothermal Power Plant
PM	Particulate Matter
PN	National Priority
Polda	Regional Police
Polri	Indonesian National Police
Poltek	Polytechnic
POM	Drug and Food Control
ppb	Parts Per Billion
PPLI	Prasadha Pamunah Industrial Waste Company
ppm	Parts Per Million
PPP	Public Private Partnership
PROPER	Company Performance Rating Program
PRTR	Pollutant Release and Transfer Register
PSLH-LPPM ITB	Bandung Institute of Technology's Center for Environmental Studies
PT-B2	Hazardous Substances Registered Retailer
PT AEI	PT Arah Environmental Indonesia
PT PGEI	PT Panasonic Gobel Energy Indonesia
PT PLKK	PT Pengelola Limbah Kutai Kartanegara
PT PLN	PT Perusahaan Listrik Negara (Persero)
PT PRIA	PT Putera Restu Ibu Abadi
PT TJS	PT Tenang Jaya Sejahtera
PTWI	Provisional Tolerable Weekly Intake
PVC	Polyvinyl chloride
QAL	Quality Assurance Level
R&D	Research and Development
RAN-PPM	National Action Plan for Mercury Reduction and Elimination
RBC	Rotating Biological Contactor
RM	Rupiah Murni
RON	Research Octane Number
RPJMN	National Medium Term Development Plan
RRI	Radio of the Republic of Indonesia
SBSN	State Sharia Securities
SCR	Selective Catalytic Reactor
SDA	Spray Dry Absorber
SEML	PT Supreme Energi Muara Laboh
SIP	Specific International Program
SIUP-B2	Hazardous Substances Trading Business Permit
SKKMIGAS	National Strategic Projects and Upstream Oil & Gas Strategic Plans
SMGP	PT Sorik Marapi Geothermal Power
SNI	Indonesian National Standard
SO_2	Sulfur dioxide
SOL	Sarulla Operation Limited
SOP	Standard Operating Procedure

SPPL	Statement of Ability to Manage and Monitor the Environment
SUSENAS	National Socio-Economic Survey
TCLP	Toxicity Characteristic Leaching Procedure
TCLP-A	Toxicity Characteristic Leaching Procedure – Annex A
TCLP-B	Toxicity Characteristic Leaching Procedure – Annex B
TCLP-C	Toxicity Characteristic Leaching Procedure – Annex C
tekMIRA	Mineral and Coal Technology
TJ	Terajoules
TK-A	Total Concentration-Annex A
TK-B	Total Concentration-Annex B
TK-C	Total Concentration-Annex C
TNI	Indonesian National Army
TOR	Term of Reference
TSCF	Trillions of Standard Cubic Feet
UASB	Upflow Anaerobic Sludge Blanket
UKL-UPL	Environmental Management Effort and Environmental Monitoring Effort
UN	United Nations
UNAIR	Airlangga University
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESA	Surabaya State University
Unisba	Bandung Islamic University
UNITAR	United Nations Institute for Training and Research
Unsyiah	Syiah Kuala University
UR	Unemployment Rate
US	United States
USAID	United States Agency for International Development
USD	United States Dollar
USEPA	United States Environmental Protection Agency
UUD	Constitution
VCM	vinyl-chloride-monomer
VGF	Viability Gap Fund
WALHI	Indonesian Forum for the Environment
WHO	World Health Organization
WIUP	Mining Business Permit Areas
WIUPK	Special Mining Business Permit Area
wmt	Wet metric tonne
WP	Mining Area
WPR	Small-Scale Mining Areas
XRF	X-ray Fluorescence
y-on-y	year-on-year
YTS	Tambuhak Sinta Foundation

EXECUTIVE SUMMARY

Indonesia has ratified the Minamata Convention on Mercury through Law Number 1l of 2017 concerning Ratification of the Minamata Convention on Mercury. As a follow-up to the ratification, Indonesia issued Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (*Rencana Aksi Nasional Pengurangan dan Penghapusan Merkuri*, RAN-PPM). In addition, the Minister of Environment and Forestry Regulation Number P.81/Menlhk/Setjen/Kum.1/10/2019 has also been stipulated for the implementation of the RAN-PPM.

The activity "Development of Minamata Initial Assessment and National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia" is a collaboration between UNEP as the implementing agency and partners with the Ministry of Environment and Forestry, Republic of Indonesia (MoEF) as the executing agency with funding from the Global Environment Facility (GEF). Basel and Stockholm Conventions Regional Centre for Southeast Asia (BSCRC-SEA) have assisted MoEF in the implementation of this activity.

The expected outcome of this activity is the development of a Minamata Initial Assessment (MIA) and a National Action Plan (NAP) for the artisanal and small-scale gold mining (ASGM) sector and endorsed by the national government and key stakeholders facilitating early implementation Minamata Convention in Indonesia. Meanwhile, the objective of the activity is the early implementation of the Minamata Convention in Indonesia which contributes to the protection of human health and the environment from the risks posed by unintentional and intentional emissions and releases, and unsound use and management of mercury in Indonesia.

Mercury Inventory and Identification of Emissions and Release Sources

The individual mercury release sub-categories contributing the highest mercury releases to the atmosphere were gold (and silver) extraction with mercury amalgamation process, incineration of hazardous waste, electrical switches and relays with mercury, other non-ferrous metals extraction and coal combustion in coal-fired power plants.

The individual mercury releases sub-categories contributing the highest inputs of mercury were gold (and silver) extraction with mercury amalgamation process, gold extraction and initial processing by methods other than mercury amalgamation, electrical switches and relays with mercury, copper extraction and initial processing.

The origin of mercury in waste and wastewater produced in the country is mercury in products and materials. Waste fractions and wastewater do therefore not represent original mercury inputs to society (except for imported waste). Waste and wastewater may however represent substantial flows of mercury through society. The following were found to be the major flows of mercury with waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.

A summary of mercury inputs to society and mercury releases from all source categories present are shown in the tables below.

Table ES.1. **Summary of Mercury Inputs to Society**

Category no.	Source category	Estimated Hg input, Kg Hg/y, by life cycle phase (as relevant)		
		Production phase*1	Use phase	Disposal phase
5.1	**Main category - Extraction and use of fuels/energy sources**			
5.1.1	Coal combustion in large power plants		6,207	
5.1.2.1	Coal combustion in coal fired industrial boilers		2,511	
5.1.2.2	Other coal use		1	
5.1.3	Extraction, refining and use of mineral oil		949	
5.1.4	Extraction, refining and use of natural gas		19,740	
5.1.5	Extraction and use of other fossil fuels		-	
5.1.6	Biomass fired power and heat production		802	
5.1.7	Geothermal power production		367	
5.2	**Main category - Primary (virgin) metal production**			
5.2.1	Primary extraction and processing of mercury	-		
5.2.2	Gold and silver extraction with the mercury-amalgamation process	362,343		
5.2.3	Zinc extraction and initial processing	-		
5.2.4	Copper extraction and initial processing	32,079		
5.2.5	Lead extraction and initial processing	-		
5.2.6	Gold extraction and initial processing by other processes than mercury amalgamation	101,750		
5.2.7	Aluminum extraction and initial processing	8,296		
5.2.8	Extraction and processing of other non-ferrous metals	9,470		
5.2.9	Primary ferrous metal production	12,539		
5.3	**Main category - Production of other minerals and materials with mercury impurities**			
5.3.1	Cement production	4,336		
5.3.2	Pulp and paper production	891		
5.3.3	Lime production and light weight aggregate kilns	-		
5.3.4	Others minerals and materials			
5.4	**Main category – Intentional use of mercury as an auxiliary material in industrial processes**			
5.4.1	Chlor-alkali production with mercury-technology	300		
5.4.2	VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst	-		
5.4.3	Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst	-		
5.4.4	Other production of chemicals and polymers with mercury compounds as catalysts	-		
5.5	**Main category - Consumer products with intentional use of mercury**			
5.5.1	Thermometers with mercury		20.8	

Category no.	Source category	Estimated Hg input, Kg Hg/y, by life cycle phase (as relevant)		
		Production phase*1	Use phase	Disposal phase
5.5.2	Electrical and electronic switches, contacts and relays with mercury		36,953	
5.5.3	Light sources with mercury		773	
5.5.4	Batteries containing mercury		746	
5.5.5	Polyurethane with mercury catalysts		-	
5.5.6	Biocides and pesticides		-	
5.5.7	Paints		-	
5.5.8	Pharmaceuticals for human and veterinary uses		-	
5.5.9	Cosmetics and related products			
5.6	**Main category - Other Intentional products/process uses**			
5.6.1	Dental mercury-amalgam fillings		11	
5.6.2	Manometers and gauges		3,454	
5.6.3	Laboratory chemicals and equipment		13,197	
5.6.4	Mercury metal use in religious rituals and folklore medicine		-	
5.6.5	Miscellaneous product uses, mercury metal uses and other sources		-	
5.7	**Main category - Production of recycled metals**	-		
5.7.1	Production of recycled mercury ("secondary production)	-		
5.7.2	Production of recycled ferrous metals (iron and steel)	-		
5.7.3	Production of other recycled metals	-		
5.8	**Main category – Waste incineration**			
5.8.1	Incineration of municipal/			10
5.8.2	general waste			22,614
5.8.3	Incineration of hazardous waste			4,342
5.8.4	Incineration of medical waste			210
5.8.5	Sewage sludge incineration			3,200
5.9	**Main category - Waste deposition/landfilling and wastewater treatment**			
5.9.1	Controlled landfills/deposits			201
5.9.2	Diffuse deposition under some control			-
5.9.3	Informal local deposition of industrial production waste			-
5.9.4	Informal dumping of general waste			24,288
5.9.5	Wastewater system/treatment			4,343
5.10	**Main category - Cremation and cemeteries**			
5.10.1	Crematoria			53
5.10.2	Cemeteries			3,070

Catatan: *1: Tahap produksi meliputi produksi bahan baku.

Table ES.2. **Summary of Mercury Releases (Overleaf)**

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
5.1		**Source category: Extraction and use of fuels/energy sources**							
	5.1.1	Coal combustion in large power plants	y	5,370	-	-	-	-	837
	5.1.2.1	Coal combustion in coal fired industrial boilers	y	2,385	-	-	-	-	126
	5.1.2.2	Other coal use	y	1	-	-	-	-	-
	5.1.3	Mineral oils - extraction, refining and use	y	511	234	-	-	-	204
	5.1.4	Natural gas - extraction, refining and use	y	-	2,699	-	1,350	-	8,098
	5.1.5	Other fossil fuels - extraction and use	y	-	-	-	-	-	-
	5.1.6	Biomass fired power and heat production	y	802	-	-	-	-	-
	5.1.7	Geothermal power production	y	367	-	-	-	-	-
5.2		**Source category: Primary (virgin) metal production**							
	5.2.1	Mercury (primary) extraction and initial processing	n	-	-	-	-	-	-
	5.2.2	Gold (and silver) extraction with mercury amalgamation processes	y	102,223	130,235	129,885	-	-	-
	5.3.3	Zinc extraction and initial processing	n	-	-	-	-	-	-
	5.3.4	Copper extraction and initial processing	y	4,039	1,639	-	12,600	-	13,800
	5.3.5	Lead extraction and initial processing	n	-	-	-	-	-	-
	5.3.6	Gold extraction and initial processing by methods other than mercury amalgamation	y	4,070	2,035	91,575	4,070	-	-
	5.3.7	Aluminium extraction and initial processing	y	1,244	830	-	-	5,392	830
	5.3.8	Other non-ferrous metals - extraction and processing	y	9,470	-	-	-	-	-
	5.3.9	Primary ferrous metal production	y	-	-	3,135	9,404	-	-
5.3		**Source category: Production of other minerals and materials with mercury impurities**							
	5.3.1	Cement production	y	2,602	-	-	867	-	867
	5.3.2	Pulp and paper production	y	802	-	-	-	89	-
	5.3.3	Production of lime and light weight aggregates	n	-	-	-	-	-	-
5.4		**Source category: Intentional use of mercury in industrial processes**							
	5.4.1	Chlor-alkali production with mercury-technology	y	60	6	114	30	-	90
	5.4.2	VCM production with mercury catalyst	n	-	-	-	-	-	-
	5.4.3	Acetaldehyde production with mercury catalyst	n	-	-	-	-	-	-
	5.4.4	Other production of chemicals and polymers with mercury	n	-	-	-	-	-	-
5.5		**Source category: Consumer products with intentional use of mercury**							
	5.5.1,	Thermometers with mercury	y	4	6	4	-	6	-

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
	5.5.2	Electrical switches and relays with mercury	y	11,086	-	14,781	-	11,086	-
	5.5.3	Light sources with mercury	y	232	-	232	-	309	-
	5.5.4	Batteries with mercury	y	170	2	201	-	370	3
	5.5.5	Polyurethane with mercury catalysts	n	-	-	-	-	-	-
	5.5.6	Biocides and pesticides with mercury	n	-	-	-	-	-	-
	5.5.7	Paints with mercury	n	-	-	-	-	-	-
	5.5.6	Pharmaceuticals for human and veterinary uses	n	-	-	-	-	-	-
	5.5.9	Cosmetics and related products with mercury	y	-	1,765	93	-	-	-
5.6		**Source category: Other intentional product/process use**							
	5.6.1	Dental mercury-amalgam fillings	y	1	4	-	-	3	3
	5.6.2	Manometers and gauges with mercury	y	685	1,027	685	-	1,027	-
	5.6.3	Laboratory chemicals and equipment with mercury	y	-	4,355	-	-	4,355	4,487
	5.6.4	Mercury metal use in religious rituals and folklore medicine	n	-	-	-	-	-	-
	5.6.5	Miscellaneous product uses, mercury metal uses, and other sources	n	-	-	-	-	-	-
5.7		**Source category: Production of recycled metals ("secondary" metal production)**							
	5.7.1	Production of recycled mercury ("secondary production")	n	-	-	-	-	-	-
	5.4.2	Production of recycled ferrous metals (iron and steel)	n	-	-	-	-	-	-
	5.4.2	Production of other recycled metals	n	-	-	-	-	-	-
5.8		**Source category: Waste incineration**							
	5.8.1	Incineration of municipal/general waste	y	5	-	-	-	-	5
	5.8.2	Incineration of hazardous waste	y	15,830	-	-	-	-	6,784
	5.8.3	Incineration of medical waste	y	3,040	-	-	-	-	1,303
	5.8.4	Sewage sludge incineration	y	189	-	-	-	-	21
	5.8.5	Informal waste burning	y	3,200	-	-	-	-	-
5.9		**Source category: Waste deposition/landfilling and wastewater treatment**							
	5.9.1	Controlled landfills/deposits	y	199	2	-	-	-	-
	5.9.2	Diffuse disposal under some control	n	-	-	-	-	-	-
	5.9.3	Informal local disposal of industrial production waste	n	-	-	-	-	-	-
	5.9.4	Informal dumping of general waste	y	2,429	2,429	19,430	-	-	-
	5.9.5	Wastewater system/treatment	y	-	3,418	11	-	546	367
5.10		**Source category: Crematoria and cemeteries**							
	5.10.1	Crematoria	y	53	-	-	-	-	-
	5.10.2	Cemeteries	y	-	-	3,070	-	-	-
SUM OF QUANTIFIED RELEASES:				**171,066**	**145,550**	**243,695**	**28,321**	**23,184**	**37,825**

Policy and Regulatory Framework Assessment

Legislation governing mercury management in Indonesia already exists and includes regulations related to mercury in its life cycle, namely from sources originating from mining and mercury trading, use, waste from mercury emissions and releases, to contaminated land. In addition, it also covers aspects of financial resources, capacity building of stakeholders, exchange of information and increasing public awareness as well as supervision and law enforcement.

For policy and regulatory framework assessment, the following recommendations are proposed:

- In order to meet the criteria for hazardous substance storage set forth in GR Number 74 of 2001, regulations or technical guidance for the criterion for hazardous substance storage need to be issued.
- It is necessary to regulate and raise awareness as well as transfer technology for non-mercury operations by gold craftsmen.
- Specific arrangements are needed for the protection of workers' health and the environment in the activities of micro, small, and medium-sized companies (MSMEs) and gold craftsmen.
- It is required to create a special regulation for mercury waste treatment that does not contradict with GR Number 22 of 2021. One of the provisions of the mercury waste regulation is to define mercury waste storage as treatment activities, allowing mercury waste to be held for more than 365 days if specific requirements are met.
- Following the termination date in Annex B of the Convention, regulations and/or policies restricting the use of mercury or mercury compounds in the production process mentioned in Part I of Annex B (acetaldehyde) are required.
- In addition, rules and/or policies linked to mercury use limits in processes mentioned in Part II of Annex B to the Convention, as well as regulations and/or policies to prevent mercury use in industrial processes not controlled by the Minamata Convention, need to be developed.
- It is important to adopt regulations and/or policies prohibiting the use of mercury in all processes covered in Article 5 as defined in Annex B to the Convention by new facilities, besides chlor-alkali.
- It is necessary to stipulate regulations for activities that produce mercury emissions, in particular coal-fired boilers in the fertilizer, petrochemical and chemical industries, smelting and roasting processes used in the production of non-ferrous metals, waste incineration facilities and cement clinker production facility.
- It is necessary to improve the monitoring of the Ministry of Environment and Forestry on the obligation to report the results of monitoring the quality of wastewater, especially mercury parameters by industry.
- For industrial activities regulated by the Minamata Convention, it is proposed that MoEF add requirements for effluent, emission, sediment in fresh and marine water, and biota.
- In the case of ambient air, it must be tested/analyzed further in the laboratory for mercury and other trace elements.
- It is hoped that carrying out this action plan will necessitate additional funding through the APBN and the APBD on-top from available funds.
- It is necessary to increase knowledge on mercury impact to related industrial operations such as gold mining, electronics, and other businesses that employ mercury. The solution is to grant permits to individuals who are not licensed, as long as they do not use mercury and follow all existing laws and regulations.
- It is recommended that laws and regulations be enacted to reconcile the definition of hazardous chemicals as defined by GR Number 74 of 2001 with hazardous materials as defined by other relevant agencies regulations, including symbols, labels, and characteristics. If this is not possible, harmonization can be achieved by informing the public that the definition and scope of this agreement are truly the same in terms of symbols, labels, and qualities agreed upon by mutual consent.
- There needs to be a common guideline that aligns symbols and labels and the Material Safety Data Sheet (MSDS).

Institutional Framework Assessment

For the implementation of the Minamata Convention on Mercury, there are several laws and government regulations that mandate ministries or non-ministerial government agencies with roles, duties and functions in accordance with their respective authorities. In addition, other stakeholders involved include associations, non-governmental organizations (NGOs), universities and financial institutions.

For institutional framework assessment, the following recommendations are proposed:

A. Ministry of Environment and Forestry (MoEF):
- Human resources and finance for monitoring the varied environmental requirements issued by MoEF must be enhanced.
- It is anticipated that the Agency for the Assessment and Application of Technology (*Badan Pengkajian dan Pengembangan Teknologi*, BPPT) will work with the Center for Quality Research and Development and Environmental Laboratory to develop recommendations for procedures and monitoring instruments.
- The Center for Quality Research and Development and Environmental Laboratory is expected to consult with the Agency for the Assessment and Application of Technology (*Badan Pengkajian dan Pengembangan Teknologi*, BPPT) to develop guidelines for procedures and a monitoring toolkit to detect mercury concentrations in the environment.
- The provisions of the Convention must be implemented to prohibit the use of mercury in line with the Convention's elimination targets.
- MoEF needs to develop and disseminate guidelines on the effects of mercury on the environment and human health to the general public and local governments.
- As the focal point of the Convention, MoEF needs to propose the issuance of presidential instructions on ministerial management in implementing the convention.
- MoEF together with the Ministry of Trade and the Ministry of Industry need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.

B. Ministry of Trade (MoT):
- It is necessary to regulate the export trade system by taking into account the provisions and procedures stipulated in the Rotterdam Convention, the Minamata Convention, and GR 74 of 2001.
- MoT together with MoEF and MoI need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.
- MoT together with MoI needs to put further emphasis on the legal umbrella to prevent and overcome further mercury contamination (e.g., outreach of the law prohibiting mercury use, both its affirmation and amendment if necessary as well as strict sanctions).

C. Ministry of Industry (MoI):
- To fulfill the mercury phase-out target in industrial operations, it is required to expand research and development (R&D) into mercury substitution for mercury-free technology to replace the mercury use process.
- MoI together with MoEF and MoT need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.
- MoI together with MoT needs to put further emphasis on the legal umbrella to prevent and overcome further mercury contamination (e.g., outreach of the law prohibiting mercury use, both its affirmation and amendment if necessary as well as strict sanctions).

D. Ministry of Energy and Mineral Resources (MoEMR):
- It is hoped that the Directorate General of Mineral and Coal, MoEMR will issue a policy prohibiting the mining of cinnabar.
- In order to improve supervision of illegal miners, it is necessary to increase the capacity of human resources both in the government and local governments and districts/cities regarding non-mercury technology and procedures for carrying out effective and efficient supervision.

E. Ministry of Health (MoH):
- It is critical for health workers, such as doctors and nurses in community health centers, to understand mercury and its health effects, as well as prevention and treatment options. This is especially important in areas where mercury is expected to be exposed to the environment, such as at ASGM sites. Appropriate financing is required for this.
- A portable tool is needed to prove mercury contamination in the human body and the environment, so that it can be proven that it is contaminated and harmful to human health.
- A reference laboratory to detect mercury for human health and the environment is also required, with at least 1 (one) laboratory for 1 (one) district.
- Due to the difficulty in proving the symptoms of illness, the Social Security Administration (*Badan Penyelenggara Jaminan Sosial*, BPJS) has been unable to cover the costs of patients who have been exposed to mercury. It is therefore necessary to disseminate information about the risk of diseases caused by mercury more widely.
- It is necessary to conduct a study on the impact of mercury, especially on children, by conducting toxicological research, which includes testing the placenta of babies born to mothers with mercury levels in their blood, nails and hair exceeding the established standards.
- Studies in the fields of health and the environment must be reported to MoEF, which serves as a focal point for the Minamata Convention, and the Center for Quality Research and Development, as well as the Environmental Laboratory, in order for the Mercury Research and Monitoring Committee to analyze the results of these studies and predict the impact of mercury on human health and the environment.

F. Ministry of Manpower:
To improve the Ministry of Manpower's performance, it is required to raise its capacity and number of human resources, as well as provide enough funds. In addition, it is required that it has authority to mandate firms that use or may expose mercury to check mercury levels in their employees' bodies so that they can be treated early.

G. Ministry of Finance (MoF):
- It is necessary to increase the capacity of human resources of customs officers regarding the impact of mercury on the environment and human health. It is hoped that the budget allocation to the MoEF and the MoH for capacity building in handling mercury can be increased.
- Mercury-containing items that have been banned from usage must be reported to the Ministry of Finance c.q the Directorate General of Customs and Excise, and it is proposed that these products be assigned a Harmonized System (HS) number, making it easier for customs agents to track illegal imports.
- It is necessary to establish a standard operating procedure (SOP) regarding health quarantine on the transportation of mercury in the event of an accident that causes mercury spills.

H. Ministry of National Development Planning/ National Development Planning Agency (*Kementerian Perencanaan Pembangunan Nasional/Badan Perencanaan Pembangunan Nasional*, *Kementerian* PPN/Bappenas):
Kementerian PPN/Bappenas is expected to encourage the preparation of program plans at MOEF, MOH, and other relevant ministries to strengthen human resource capacity, supervision, mercury-free technology use, mercury waste handling, and mercury-contaminated land remediation, particularly in ASGM sites.

I. Ministry of Communication and Informatics (MoCI):
Under Presidential Instruction Number 9 of 2015 concerning Public Communication Management. MoCI can serve as a coordinator for the national public communication management. It can collaborate with the public relations in other ministries/agencies by utilizing all available resources within each ministry/agency to promote a particular issue.

J. National Drug and Food Control Agency (*Badan Pengawas Obat dan Makanan*, BPOM):
It is hoped that the BPOM will increase its supervision and increase capacity for its employees in the central government as well as provincial/regency/city governments.

K. Agency for Technology Assessment and Application (*Badan Pengkajian dan Penerapan Teknologi*, BPPT):
It is required to conduct studies to find mercury substitutes in many activities that use mercury to improve the performance of BPPT.

L. Ministry of Transportation:
In terms of transporting mercury and mercury waste, it is important to strengthen the capacity of human resources related to their roles to monitor mercury transportation incidents and to shorten the time it takes to give permits, with permits granted for at least 5 years.

M. Ministry of Agriculture:
- Awareness raising is needed for pesticide users, both those who use mercury and non-mercury containing pesticides, to securely place pesticides and equipment so that they do not have harm the environment or human health.
- Apart from counseling about the prohibition of using mercury-based pesticides, it is also important to supervise and enforce the law, as well as to handle mercury-based pesticide waste and obtain permission from the Ministry of Environment and Forestry to do so.

N. Indonesian National Police (*Kepolisian Republik Indonesia*, Polri):
The role of Polri is crucial in awareness raising, enforcing and taking legal action to support the reduction and elimination of mercury in Indonesia, therefore its role in this regard needs to be increased by collaborating with the Directorate General of Environmental and Forestry Law Enforcement, MoEF.

O. Local Government
Due to the importance of the local government's authority in dealing with mercury, it is necessary to obtain guidance and improvement for its human resources as well as financing to carry out its duties.

P. Associations, NGOs, Universities:
- Miner's groups and environmental and health NGOs play a critical role in monitoring, coaching, capacity building, and mercury-free technology for local government and regency/city human resources. Therefore, increased collaboration with the government, businesses, and the community is required.
- Universities play a critical role in numerous initiatives to manage mercury, as well as conducting the essential research to reduce mercury usage and exposure.

It is hoped that all stakeholders' cooperation would continue to improve.

Implementation Plan and Priorities for Action

Based on baseline and mercury inventory results and identification of mercury emissions and sources, policy, regulatory, institutional framework assessment, identification of at-risk populations and gender dimensions as well as awareness raising and trainings that has been carried out by various stakeholder institutions, as well as taking into account the main provisions of the Minamata Convention that need to be complied with by Parties and the RAN-PPM that has been issued, action plans are recommended for various articles of the Minamata Convention in accordance with the MIA drafting template from UNDP (2016).

The recommendations include priority levels, proposed actions/activities, responsible agencies and timeframe. The priority levels for each activity proposal/action consists of very high, high, medium, low and very low.

The recommendations for action plans with a very high priority level are as follows:

- Develop government regulations or presidential regulations regarding the ban on cinnabar mining in Indonesia.
- Law enforcement against illegal cinnabar mining.
- Law enforcement against Article 31 of GR 74/2001 concerning the obligation to submit reports, especially mercury stocks and individual mercury compounds that exceed 50 metric tonnes, as well as sources of mercury supply that produce stocks exceeding 10 metric tonnes per year, which are located within its territory.
- Tightening supervision of the export and import of mercury, especially at customs and must go through the red line.
- Products that contain mercury and have been banned from use need to be informed to the Ministry of Finance c.q the Directorate General of Customs.
- It is proposed to set a specific Harmonized System (HS) number for these products, so as to make it easier for customs officials to monitor illegal imports.
- It is necessary to set reduction and elimination targets for products that have not been regulated in the RAN-PPM such as switches and relays, etc., for this reason, it is necessary to include them during the review and revision of the RAN-PPM.
- For products listed in Annex A part I which have been included in the RAN-PPM but have not been detailed, it is necessary to set targets for their reduction and elimination in detail in accordance with the Convention.
- It is recommended that the government conduct an inventory of mercury sources from manufacturing activities and their reduction alternatives and the availability of their substitutes so that they can be harmonized with the Minamata Convention.
- For products listed in Annex B parts I and II that have not been included in the RAN-PPM, it is necessary to set targets for their reduction and elimination as well as their restrictions in detail in accordance with the Convention.
- Submit exemptions to the Minamata Convention Secretariat for products and processes in Annex A and Annex B that do not meet the reduction and elimination targets set out by the Convention. For Annex A, items such as batteries, switches and relays, lamps, barometers, hygrometers, manometers. For Annex B, items such as production of chlor-alkali, production of vinyl chloride monomer, sodium or potassium methylate or ethylate, production of polyurethane with a mercury-containing catalyst.
- Revising the Minister of Environment Regulation Number 23 of 2008.
- Simplification in granting permits for Small-Scale Mining Permit (*Izin Pertambangan Rakyat*, IPR) and Small-Scale Mining Areas (*Wilayah Pertambangan Rakyat*, WPR) with the availability of clear data and not overlapping with licensed gold mining data.
- Establish wastewater quality standards for mercury parameters for all significant sources of mercury release to water.
- Establish quality standards for mercury release to soil and establish mercury quality standards on land based on location designations, for example for industry, settlements and others.
- Develop technical guidelines for criteria for requirements for hazardous substances storage, including the definition of storage for hazardous substances and hazardous waste that must be distinguished. The guidelines should also include the definition of hazardous substances which includes the meaning of the definition of hazardous materials. In this guideline, it is necessary to stipulate "Environmentally Sound Intermediate Storage of Mercury", since in GR Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, the storage and or warehousing of hazardous waste is only considered possible for a period of 365 days.

Meanwhile, storage for mercury hazardous waste can be performed perpetually, until the necessary processing technology is obtained. In addition, mercury storage needs to be regulated so that mercury exposure to the environment can be prevented. MSMEs that produce mercury in remote areas need to be considered as well.

- Conduct an inventory of locations contaminated by mercury for remediation purposes.
- Propose that the RAN-PPM can be included in the National Medium-Term Development Plan with on-top funds from existing activity plans originating from the APBN and APBD. Ministries/agencies and Ministry of National Development Planning can accept activities from RAN-PPM and include them in the National Medium-Term Development Plan and in the blue book if foreign assistance is required.
- MoEF and related ministries/agencies develop proposals to multinational and bilateral funds for the implementation of the RAN-PPM and these are then proposed to Ministry of National Development Planning to be included in the blue book.
- Conduct an inventory and information system for data collection to facilitate reporting obligations to the Minamata Convention Secretariat (information is not scattered).

Conclusions and Recommendations

The following actions are proposed, taking into account the RAN-PPM, the Minamata Convention framework, and the conditions for mercury reduction and elimination in Indonesia:

1. In preparing the RAN-PPM, it is proposed that the recommended template table be adapted to meet with the Minamata Convention requirements, including the financing planning for carrying out the planned operations. The funding plan is to be made in accordance with the schedule. Following up on the implementation of Article 21 of the Convention, adapting the RAN-PPM to this template will make compliance and reporting to the Minamata Convention Secretariat easier.
2. The RAN-PPM is expected to also include a funding plan which is to be included in the National Mid-Term Development Plan as well as the Ministry of National Development Planning's blue book for programs that require foreign support. In this regard, MOEF in collaboration with ministries/agencies will develop a Terms of Reference and it will be proposed to the Ministry of National Development Planning to be included in the blue book. It is expected that the proposed funding will be in addition (on-top) to any funds that the ministries/agencies may receive.
3. The following are the proposed activities in order of priority:

Table ES.3. **Priority of Proposed Activities**

Priority	Number of Proposed Activities from Table 6.1 to 6.15
Very High	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 4.1, 4.2, 4.3, 5.3, 6.1, 7.1, 7.2, 9.1, 9.2, 10.1, 12.1, 13.1, 13.2, 17.21.10
High	5.1, 5.2, 9.4, 9.6, 9.7, 9.8., 11.1, 11.2, 11.3, 12.2, 12.3, 12.4, 14.1, 14.2, 14.3, 16.2, 16.3, 16.4, 16.5, 16.6, 17.21.1, 17.21.2, 17.21.3, 17.21.4, 17.21.5, 17.21.6, 17.21.7, 17.21.8, 17.21.9
Medium	7.3, 8.1, 8.2, 8.4, 9.3, 16.1, 17.21.4, 25.30.1
Low	8.3, 9.5
Very Low	-

4. It is proposed that the priority program of RAN-PPM be maintained when Covid-19 is passed in 2021, as proposed by MoEF in collaboration with other ministries/agencies.
5. It is expected that the local governments will develop Regional Action Plans as soon as possible, in conformity with the framework outlined in Minister of Environment and Forestry Regulation 81/2019.

6. Based on the identification of mercury sources, it is proposed that several other mercury sources that are not controlled under the Minamata Convention are monitored and if they show an increase they need to be included in the RAN-PPM.

7. In the import and export of mercury, it is necessary to consider the provisions stipulated in Article 3 of the Minamata Convention and the provisions in the Rotterdam Convention and clearer arrangements are needed in the revision of GR Number 74 of 2001 and the development of other implementing regulations.

8. The mining sector is involved in the extraction of non-renewable natural resources; therefore, it is hoped that the mining sector can become a trigger or generator for other sectors so that the economy is no longer dependent on mining.

9. With the amendment of Law No. 32 of 2009 through Law No. 11 of 2020 concerning Job Creation, the Environmental Permit was changed to a provision for environmental approval, however it needs to be ensured that mercury and mercury-containing tailings are still managed as hazardous waste in accordance with applicable laws and regulations, with reference to GRs No. 22 of 2010.

10. Considering that some of the data needed for the inventory are not yet available, it is hoped that regular monitoring of mercury emissions and releases, as well as the establishment of mercury emission standards, will be carried out for the types of activities regulated by the Minamata Convention as follows:
    - Extraction and use of fuel/energy sources;
    - Primary metal production;
    - Production of minerals and other materials with mercury impurities;
    - Intentional use of mercury in industrial processes;
    - Consumer products with intentional use of mercury;
    - Intentional use in other products/processes;
    - Waste incineration and burning;
    - Waste deposition/landfill and wastewater treatment;
    - Crematoriums and funerals.

INTRODUCTION

The Minamata Convention on Mercury is a global agreement to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. This convention was adopted in October 2013 in Japan and entered into force in 2017. Mercury is a global pollutant that is toxic, corrosive and persistent; moreover, the bioaccumulation of mercury causes serious harm to human health and the environment. Mercury occurs naturally in nature and is widely found in goods that are used daily. Thus, mercury is released into the air, soil and water from various sources.

Under the Minamata Convention, "Mercury" means elemental mercury (Hg(0), CAS No. 7439-97-6). "Mercury compound" means any substance consisting of atoms of mercury and one or more atoms of other chemical elements that can be separated into different components only by chemical reactions. "Mercury-added product" means a product or product component that contains mercury or a mercury compound that was intentionally added.

Controlling anthropogenic releases of mercury over its life cycle is a key factor in determining the obligations under the Convention. The main provisions of the Minamata Convention include the prohibition of new mercury mines, the phase-out of existing mines, the prohibition and reduction of the use of mercury in a number of products and processes, measures to control emissions to air and releases to soil and water and informal artisanal and small-scale gold mining (ASGM) regulation. The Minamata Convention also regulates the temporary storage of mercury and its disposal after it becomes waste, mercury-contaminated land and health problems (UNEP, undated). The definition of ASGM under the Minamata Convention is gold mining as conducted by individual miners or small enterprises with limited capital investment and production.

Indonesia has ratified the Minamata Convention on Mercury through Law No.11 of 2017 concerning Ratification of the Minamata Convention On Mercury. As a follow-up to the ratification, Indonesia issued Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (*Rencana Aksi Nasional Pengurangan dan Penghapusan Merkuri*, RAN-PPM). In addition, the Minister of Environment and Forestry Regulation Number P.81/Menlhk/Setjen/Kum.1/10/2019 has also been stipulated for the implementation of the RAN-PPM.

The activity "Development of Minamata Initial Assessment and National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia" is a collaboration between UNEP as the implementing agency and the Ministry of Environment and Forestry, Republic of Indonesia (MoEF) as the executing agency with funding from the Global Environment Facility (GEF). Basel and Stockholm Conventions Regional Centre for Southeast Asia (BSCRC-SEA) have assisted MoEF in the implementation of this activity.

The expected outcome of this activity is the development of a Minamata Initial Assessment (MIA) and a National Action Plan (NAP) for the artisanal and small-scale gold mining (ASGM) sector and endorsed by the national government and key stakeholders facilitating early implementation Minamata Convention in Indonesia. Meanwhile, the objective of the activity is the early implementation of the Minamata Convention in Indonesia which contributes to the protection of human health and the environment from the risks posed by unintentional and intentional emissions and releases, unsound use and management of mercury in Indonesia. In this MIA document, various action plans that have not been included in the RAN-PPM are also recommended to support the fulfillment of the provisions of the Minamata Convention.

The preparation of this MIA document involved many relevant stakeholders as can be seen in Annex I. Data and information were collected through desk studies, questionnaires, interviews and field visits. The consultation and review process with various stakeholders to obtain input for the MIA document was carried out through face-to-face meetings, workshops and focus group discussions as well as through written input for questionnaire responses. In view of the ongoing global corona virus disease (Covid-19) pandemic, meetings since March 2020 have also been held online.

The workshops and meetings that were held during the preparation of the MIA document are as follows:

- Inception Workshop "Development of Minamata Initial Assessment and Updating of National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia, " Jakarta, 4-5 December 2017.
- Focus Group Discussion "Development of Minamata Initial Assessment and Updating of National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia, " Jakarta, 8 May 2018.
- National Steering Committee Meeting "Development of Minamata Initial Assessment and Updating of National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia, Jakarta, 10 April 2019.
- Training for Survey Team of Minamata Initial Assessment (MIA) and National Action Plan for Artisanal and Small-Scale Gold Mining in Indonesia, Jakarta, 9 February 2020.

The MIA document consists of 6 (six) chapters which include the following information:

Chapter I contains information on the national overview including geography and population, political and economic profiles, economic sector profiles and environmental overview.

Chapter II contains information on inventory of mercury sources and releases in Indonesia which includes data and inventories on various sectors that are sources of mercury releases in Indonesia, stocks of mercury and/or mercury compounds and storage conditions, supply and trade of mercury and mercury-containing compounds including sources, recycling activities and quantity, mercury contaminated land and the impact of mercury on health and the environment.

Chapter III contains information on the policy, regulatory and institutional framework assessment. The laws and regulations governing mercury management in Indonesia include regulations related to mercury in its life cycle, in addition to covering aspects of financial resources, capacity building of stakeholders, information exchange and public awareness raising as well as monitoring and law enforcement. The institutional assessment covers the roles, duties and functions of various stakeholders in Indonesia in mercury management. This chapter also provides information on the various problems faced and their recommendations.

Chapter IV contains information on, among other things, the identification of populations at high risk of mercury exposure, the influence of gender on the health impact of mercury, as well as case studies on the health impacts of mercury in Indonesia. This chapter also contains the implications of the results of the study for Indonesia as a Party to the Minamata Convention.

Chapter V contains information on the involvement of various stakeholder institutions in efforts to increase public awareness which includes various awareness raising activities as well as workshops and training on mercury that have been carried out by various stakeholders in Indonesia. This chapter also includes recommendations for awareness raising and capacity building regarding mercury.

Chapter VI contains information on the implementation plan and priorities for actions, which include, among others, recommendations for compliance with the provisions in various articles in the Minamata Convention in accordance with the MIA drafting template from UNDP, 2016. The recommendations include priority levels, proposed actions/activities, responsible agencies and time frame.

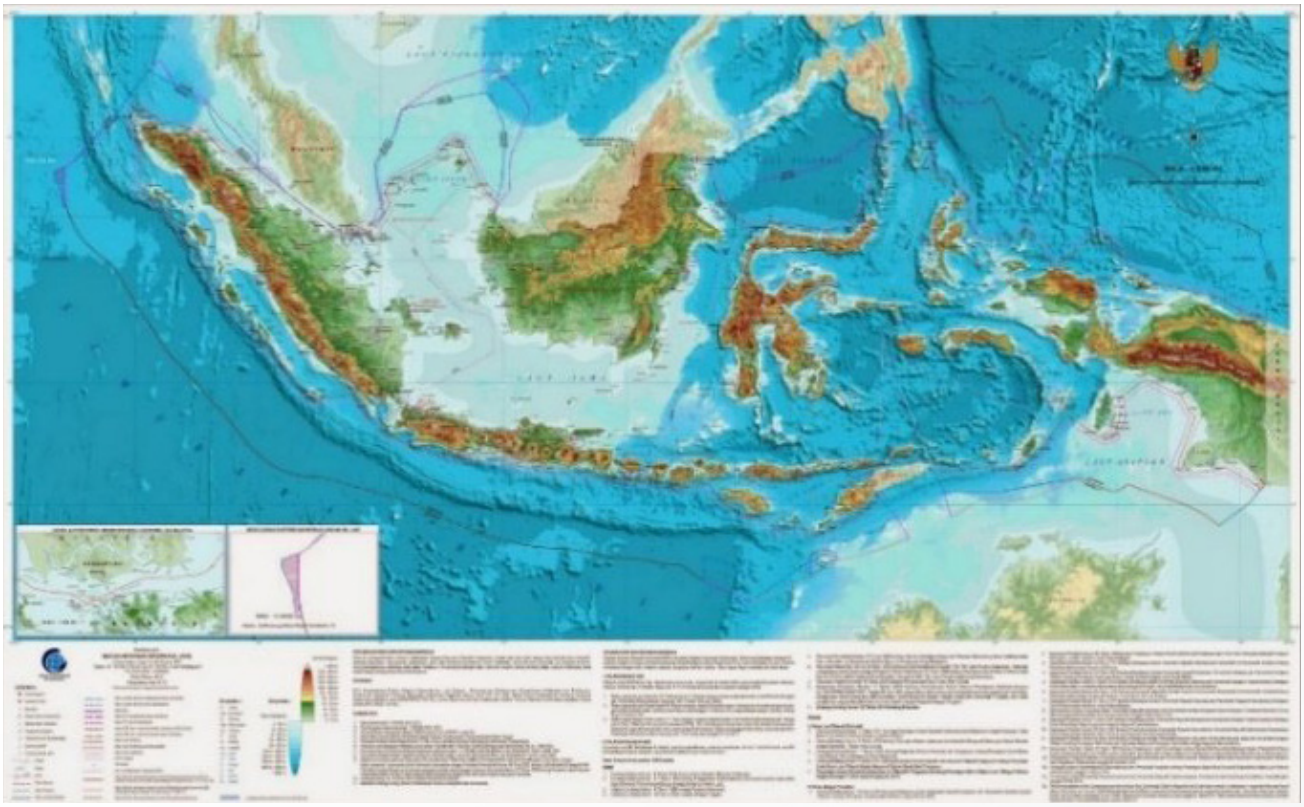
CHAPTER I
NATIONAL OVERVIEW/COUNTRY PROFILE

1.1. Geography and Population

1.1.1. Geography

Geographic location and area: Indonesia is located between 6º 04' 30" North Latitude and 11º 00' 36" South Latitude, and between 94º 58' 21" and 141º 01' 10" East Longitude and lies across the equator at 0º latitude. In terms of geographic location, Indonesia is located between the Asian Continent and the Australian Continent, and between the Indian Ocean and the Pacific Ocean. The total area of Indonesia is 1,916,906.77 km^2 with 16,056 islands (BPS-Statistics Indonesia, 2020a). Indonesia is a maritime country with a sea area larger than its land area. The total area of Indonesian waters is 6,400,000 km^2 and the exclusive economic zone (EEZ) is 3,000,000 km^2 with a long coastline of 108,000 km (Coordinating Ministry for Maritime and Investment Affairs, Republic of Indonesia, 2018). A map of Indonesia is shown in **Figure 1.1.**

Figure 1.1. **Map of Indonesia**



Source: Geospatial Information Agency, 2017

Climate: As a tropical country, Indonesia only has two seasons, namely the rainy season and the dry season, both of which are relative (Ministry of Tourism, Republic of Indonesia, 2019). In 2019, the average temperature in Indonesia ranged from 25.10-30.04° C and the average humidity was between 70.30-87.73%. The minimum amount of precipitation was 637.60 mm and the maximum was 4,072.70 mm. The number of rainy days ranged from 84-243 days and the duration of sunshine ranged from 33.69%-84.32%. The average atmospheric pressure ranged from 900.20 mb to 1,004.40 mb (BPS-Statistics Indonesia, 2020a).

Topography: The topography of the Indonesian territory, which has mountains, valleys, and many beaches, is extremely varied, adding to the variety of climatic conditions in the Indonesian territory, both according to space (region) and time. (BMKG, 2020).

Extreme elevation: The lowest point in Indonesia is the Indian Ocean (0 m) and the highest point is Puncak Jaya (5,030 m) (wikipedia.org).

Natural disasters: Geographically, Indonesia is an archipelago located at the junction of four tectonic plates, namely the Asian Continental plate, the Australian Continent, the Indian Ocean plate and the Pacific Ocean plate. In the southern and eastern parts of Indonesia, there is a volcanic belt (volcanic arc) that extends through the islands of Sumatra-Java-Nusa Tenggara-Sulawesi, whose sides are old volcanic mountains and lowlands which are partly dominated by swamps. This belt is very prone to disasters such as volcanic eruptions, earthquakes, tsunamis, floods and landslides (BNPB, n.d).

1.1.2. Population

In 2018, the total population in Indonesia was 268.1 million with an annual population growth rate of 1.15% and a life expectancy of 71.3 years (BPS-Statistics Indonesia, 2020a). The proportion of the population aged 0-14 years in 2035 is projected to be 21.5%, the proportion aged 15-64 years in 2035 is projected to be 67.9%, and those aged 65+ years in 2035 are projected to be 10.6% of the population (BPS-Statistics Indonesia, 2013).

The projection of the percentage making up the urban population is 60.0% in 2025 and 66.6% in 2035 (BPS-Statistics Indonesia, 2020b). Based on the Regulation of the Head of the Central Statistics Agency Number 37 of 2010 concerning the Classification of Urban and Rural Areas in Indonesia, urban is the status of an administrative area at the village/urban village level that meets the classification criteria for urban areas in terms of population density, percentage of agricultural households, and availabilities/access to urban facilities. According to Law Number 6 of 2014 concerning Villages, a village is a legal community unit that has territorial boundaries that are authorized to regulate and administer government affairs, the interests of local communities based on community initiatives, rights of origin, and/or recognized traditional rights and those respected in the government system of the Unitary State of the Republic of Indonesia.

The State Language is the Indonesian language as stated in the Basic Law of the Republic of Indonesia Year 1945. From 1991 to 2017 there has been mapping and verification of regional languages in Indonesia and the number is currently 652 regional languages, which can change over time (MoEC, 2018).

The literacy rate for those aged 15+ was 95.90% for urban and rural areas in 2019. In 2019, the highest education level attained by people aged 15+ was primary school or below (76,789,251 people), junior high school (43,052.786 people), high school (58,252,904 people) and college (19,816,836 people) (BPS-Statistics Indonesia, 2020a).

The total workforce in August 2020 was 138.22 million people, an increase of 2.36 million people compared to August 2019. In line with the increase in the size of the workforce, the Labor Force Participation Rate (LFPR) also increased by 0.24 percentage points. The unemployment rate (UR) in August 2020 was 7.07 percent, an increase of 1.84 percentage points compared to August 2019. The number of people who worked was 128.45 million people, a decrease of 0.31 million people from August 2019. The largest percentage increase was in the agricultural sector (2.23 percentage points). Meanwhile, the sector that experienced the largest decline was the manufacturing sector (1.30 percentage points) (BPS-Statistics Indonesia, 2020c).

1.2. Political and Economic Profile

1.2.1. Political Profile

Indonesia is a unitary state, in the form of a republic. The political system in Indonesia is based on Trias Politica principle or separation of legislative, executive, and judicative power. Legislative power is held by the People's Consultative Assembly (*Majelis Permusyawaratan Rakyat*, MPR) as the highest institution. The MPR membership changed after the amendment of the 1945 Constitution of the Republic of Indonesia (UUD 1945) during the period 1999–2004. MPR members are all the Indonesian House of Representative (*Dewan Perwakilan Rakyat*, DPR) members plus Regional Representatives Council (*Dewan Perwakilan Daerah*, DPD). DPR and DPD members are elected through a general election and appointed for a membership period of five-years.

The executive body consists of the president, the vice president, and the ministerial cabinet. In Indonesia, the ministerial cabinet follows the Presidential Cabinet system where every minister is responsible to the president. Since the reformation era and after the amendment of UUD 1945, the judicative power has been run by the Supreme Court, including the administrative arrangement of judges.

The government structure of the Republic of Indonesia period 2019–2024 consists of president, vice president, state supreme agencies, ministries, ministerial level institutions, and non-ministerial institutions (*Lembaga Pemerintahan Non Kementerian*, LPNK).

State supreme agencies consist of the People's Consultative Assembly (MPR), the House of Representatives (DPR), the Audit Board of the Republic of Indonesia (*Badan Pemeriksa Keuangan*, BPK), Supreme Court (*Mahkamah Agung*, MA), Local Councils (DPD), Constitutional Court (*Mahkamah Konstitusi*, MK), and Judicial Commision (*Komisi Yudisial*, KY). Ministries consist of the coordinating ministry and the departmental ministry (BPS-Statistics Indonesia, 2020a).

As of December 2019, there are 34 provinces in Indonesia, 416 regencies, 98 municipalities, 7,246 subdistricts, and 83,813 villages/urban villages (including Transmigration Settlement Units) (BPS-Statistics Indonesia, 2020a). Provinces are led by governors and regencies/cities are led by regents/mayors, while sub-districts are led by sub-district heads and villages by village heads. According to Law Number 23 of 2014 concerning Local Government, local governments have the authority over government affairs in their administrative areas including health and the environment. The duties and powers of the central government and local governments in health and environmental affairs are regulated more specifically in the Environmental Law and the Health Law. Law Number 23 of 2014 also regulates the division of authority between the central and local governments in spatial planning. Spatial planning is determined based on strategic environmental studies and criteria in Law Number 26 of 2007 concerning Spatial Planning and is regulated in more detail in provincial and regency/city regional regulations.

1.2.2. Economic Profile

Indonesia's economic growth in the first quarter of 2020 was 2.97% (year on year) and -2.41% (quarter-to-quarter). Gross Domestic Product (GDP) at current prices amounted to IDR 3,922.6 trillion. GDP growth by business sector for agriculture is 0.02%, mining and quarrying 0.43%, processing industry 2.06%, construction 2.90%, trade and repair 1.60%, and others 5.62%. Furthermore, in terms of the growth and contribution of Gross Regional Domestic Product (GRDP) by region, the highest contribution was made by Java Island which contributed to the Indonesian economy by 59.14% with a growth of 3.42% (BPS-Statistics Indonesia, 2020d).

The growth of large and medium manufacturing industries in 2019 increased by 4.01 percent compared to 2018. Production growth of large and medium manufacturing industries in Quarter IV-2019 increased by 3.62% (y-on-y) and production growth of micro and small manufacturing industries Quarter IV-2019 increased by 4.85% (y-on-y) relative to Quarter IV-2018 (BPS-Statistics Indonesia, 2020e). Indonesia's export value in March 2020 decreased 0.20% and imports decreased 0.75% compared to March 2019. In March 2020, total exports amounted to USD 14,093.5 million with oil and gas contributions of USD 673.9 million, and non-oil and gas USD 13,419.6 million, meanwhile total imports of USD 13,350.1 million with a contribution of USD 1,606.50 million for oil and gas and USD 11,743.6 million for non-oil and gas. Non-oil and gas exports were mostly to China, the United States, Japan and India and non-oil and gas imports were mostly from China, Japan, Thailand and Singapore (BPS-Statistics Indonesia, 2020f). Total coal exports in 2018 amounted to 356,394,687 tonnes, the highest being China (63,429 thousand tonnes), India (49,967 thousand tonnes) and Japan (23,081 thousand tonnes) (MoEMR, 2019). Meanwhile, mineral production, domestic sales and exports by commodity in 2014 are shown in the following table.

Table 1.1. **Mineral Production, Domestic Sales and Exports by Commodity in 2014**

No.	Commodity	Unit	Production	Domestic Sales	Export
1	Copper	ton	385,728.93	217,642.84	198,408.65
2	Copper concentrate	dmt	1,516,902.07	840,427.40	785,214.45
3	Gold	kg	69,645.47	20,819.40	59,758.44
4	Silver	kg	252,709.87	56,895.09	205,524.51
5	Tin metal	ton	34,701.56	n.a.	9,730.00
6	Bauxite	mt	3,095,519.56	n.a.	2,889,125.56
7	Nickel + cobalt in matte	ton	80,341.40	n.a.	79,477.75
8	Nickel ore	wmt	4,792,986.00	n.a.	3,865,572.00
9	Ferro nickel	ton Ni	16,923.00	n.a.	19,748.00
10	Iron sand	wmt	n.a.	n.a.	n.a.
11	Granite	ton	2,018,463.00	59,465.00	2,080,714.00
12	Iron ore	ton	1,154,230.71	-	1,154,230.71
13	Diamond	crt	n.a.	-	n.a.

Source: MoEMR, 2015

1.3. Economic Sector Profile

Based on the national inventory of mercury emissions and releases in Indonesia in 2021, the individual mercury release sub-categories contributing to the highest mercury releases into the atmosphere were gold (and silver) extraction by mercury amalgamation, electrical switches and relays with mercury, other non-ferrous metals extraction and coal combustion in coal fired power plants.

The individual mercury releases sub-categories contributing to the highest inputs of mercury were gold (and silver) extraction by mercury amalgamation, gold extraction and initial processing by methods other than mercury amalgamation, electrical switches and relays with mercury, and copper extraction and initial processing.

The origin of mercury in waste and wastewater produced in the country is mercury in products and materials. Waste fractions and wastewater do therefore not represent original mercury inputs to society (except for imported waste). Waste and wastewater may however represent substantial flows of mercury through society. The following were found to be the major flows of mercury with waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.

Data on gold production from the BGR Resources Databases shows that Indonesia produced 69 tonnes of gold from legal sources in 2014. In the same year, the data shows that a further 28 tonnes of gold were produced by approximately 300,000 ASGM workers. This estimate shows that ASGM gold production is equivalent to 41% of total gold production from legal sources. Some commentators estimate that gold production from ASGM is even equal to, or possibly greater than, total gold production from large-scale mining (Stähr & Schütte, 2016).

In 2014, according to the Ministry of Energy and Mineral Resources (MoEMR), Indonesia has suffered economic losses of up to IDR 38 trillion each year due to the activities of illegal gold miners. According to these calculations, ASGM gold production averaged 65 tonnes per year, resulting in losses of foreign exchange equivalent to IDR 32 trillion, lost royalties of IDR 1.2 trillion, and lost taxes worth IDR 4.8 trillion (Baihaqi, 2014).

The average price of crude oil in 2019 was USD 62.37 per barrel. Crude oil production in 2018 was 272,025 thousand bbl, exports of 25,716 thousand bbl and imports of 75,296 thousand bbl (MoEMR, 2020).

Total coal production in 2019 was 616,159,594 tonnes and coal energy consumption in 2019 was 167,412 thousand BOE. The retail price of coal in 2019 was IDR 179,000/BOE or USD 13/ BOE. Coal imports in 2018 amounted to 7,391,172 tonnes and exports amounted to 454,500,164 tonnes. The average export price for FOB coal in 2019 was USD 77.89/ton. Total coal sales to coal-fired power plants amounted to 98,550,260 tonnes (MoEMR, 2020).

1.4. Environmental Overview

The identification of current environmental and forestry conditions was carried out by study of air quality, water quality, forest and land condition, coastal and oceanic conditions, and biodiversity. As a result, air quality is found to be filled with pollutants which are dominated by NO_2, SO_2 and CO_2, which are mostly produced from motor vehicles. In terms of the chemical oxygen demand (COD) parameters, the quality standard has been exceeded in various regions. Domestic waste is the biggest contributor (60-90%) of river water pollution on the islands of Java and Sumatra. Forest fires are still a problem for Indonesia's forests and land, together with poor spatial planning, ultimately causing Indonesia's biodiversity to become vulnerable to extinction (MoEF, 2015).

According to the 2020-2024 National Medium-Term Development Plan which is stipulated by Presidential Regulation Number 18 of 2020, one of the development agendas or national priorities is to build up the environment, increase disaster resilience and responses to climate change. Its policy direction consists of improving the quality of the environment, increasing disaster and climate resilience and low carbon development.

The strategies for realizing the policy direction for improving the quality of the environment in the 2020-2024 RPJMN include: (1) prevention of pollution and damage to natural resources and the environment; (2) mitigation of pollution and damage to natural resources and the environment; (3) recovery of pollution and damage to natural resources and the environment; and (4) institutional strengthening and law enforcement in the field of natural resources and the environment. The strategies for overcoming pollution and damage to natural resources and the environment are carried out through the elimination and replacement of mercury, especially in artisanal and small-scale gold mining (ASGM) locations.

Regarding mercury management, the Government of Indonesia has affirmed its commitment to protecting its citizens from the dangers of mercury to health and the environment by ratifying the Minamata Convention on Mercury through Law Number 11 of 2017 concerning Ratification of the Minamata Convention on Mercury on 20 September 2017. This ratification is also an affirmation of Indonesia's commitment in achieving the Sustainable Development Goals 2015-2030.

As a follow-up to the ratification of the Convention, the Indonesian Government has currently issued Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Mercury Reduction and Elimination (*Rencana Aksi Nasional Pengurangan dan Penghapusan Merkuri*, RAN-PPM). The RAN-PPM contains strategies, programs and targets for the reduction and elimination of mercury. The RAN-PPM covers 4 (four) priority areas, namely artisanal and small-scale gold mining, manufacturing, energy and health. Mercury reduction and elimination targets in Indonesia are guided by the targets set in the Minamata Convention taking into account capabilities at the national level. For the implementation of the Presidential Regulation on the RAN-PPM, the Minister of Environment and Forestry Regulation Number P.81/MenLHK/Setjen/Kum.1/10/2019 has been issued.

CHAPTER II
MERCURY INVENTORY AND IDENTIFICATION OF SOURCES OF EMISSIONS AND RELEASES IN INDONESIA

2.1. Summary of Mercury Releases and Stockpiles

This inventory was developed in 2020. Data for the year 2019 have been used in the inventory, when available. For some data types, data from this year have not been available. The year for all data given is noted with the data in question in the relevant sections of this report.

This mercury release inventory was made with the use of the "Toolkit for identification and quantification of mercury releases" made available by the Chemicals Branch of the United Nations Environment Programme (UN Environment Chemicals). The Toolkit is available at UN Environment Chemicals' website: http://web.unep.org/chemicalsandwaste/what-we-do/technology-and-metals/mercury/toolkit-identification-and-quantification-mercury-releases

This inventory was developed using the Toolkit Inventory Level 2. The Toolkit methodology is based on mass balances for each mercury release source sub-category.

Results and Discussion

An aggregated presentation of the results for main groups of mercury release sources is presented in **Figure 2.1** (releases to air), **Figure 2.2** (releases to water), **Figure 2.3** (releases to land), and **Figure 2.4** (releases to by product and impurities), **Figure 2.5** (releases to general waste) and **Figure 2.6** (releases to specific treatment/disposal) and **Table 2.1** (summary of mercury inventory) below.

Figure 2.1. **Mercury Releases to Air**

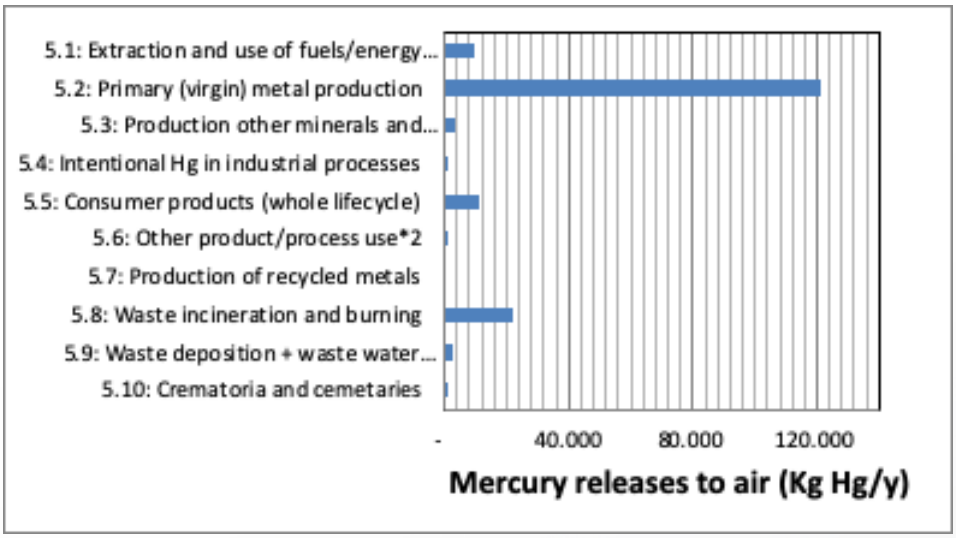


Figure 2.2. **Mercury Releases to Water**

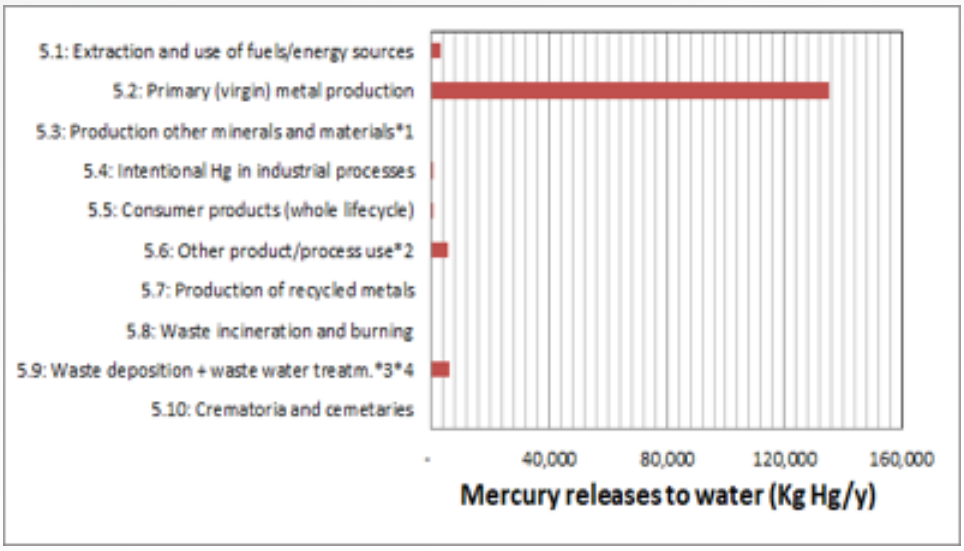


Figure 2.3. **Mercury Releases to Land**

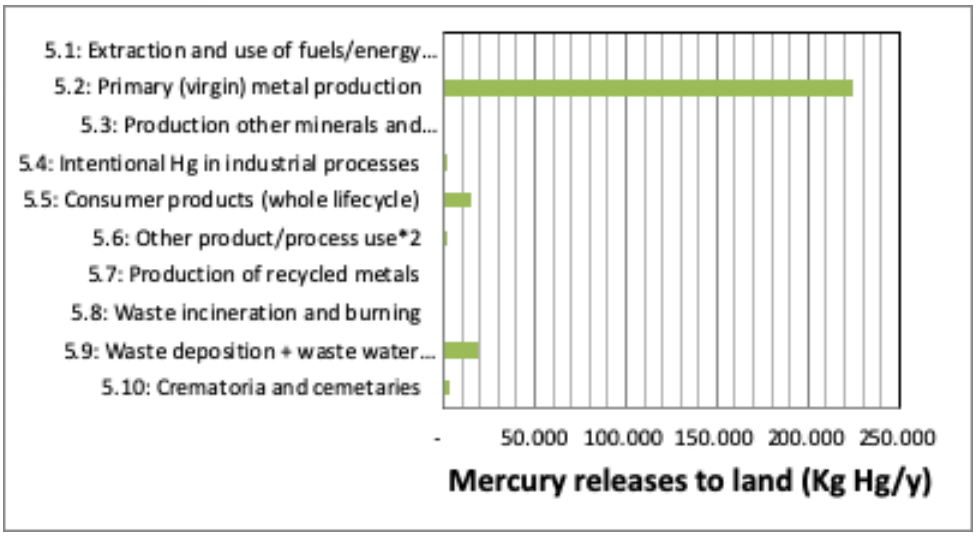


Figure 2.4. **Mercury Outputs to By-Products and Impurities**

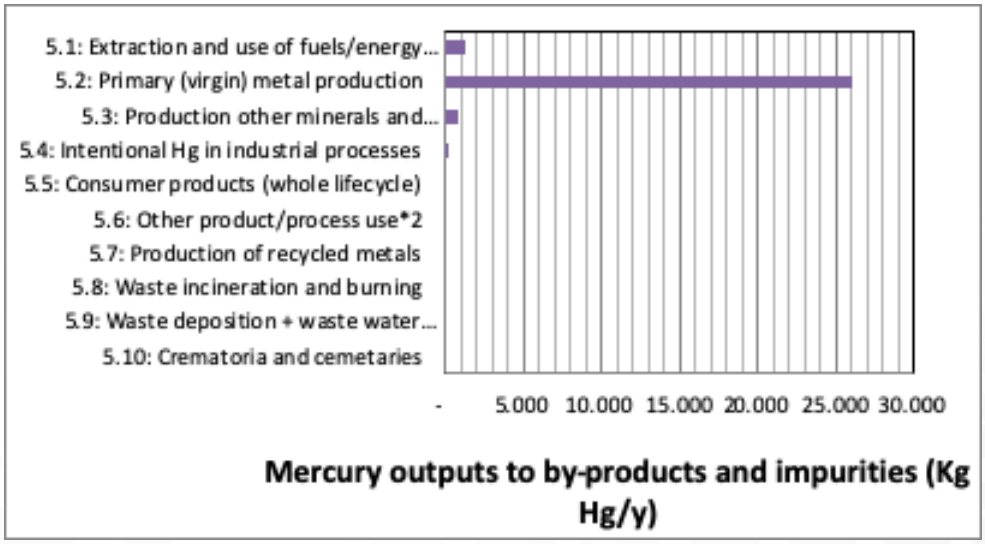


Figure 2.5. **Mercury Releases to General Waste**

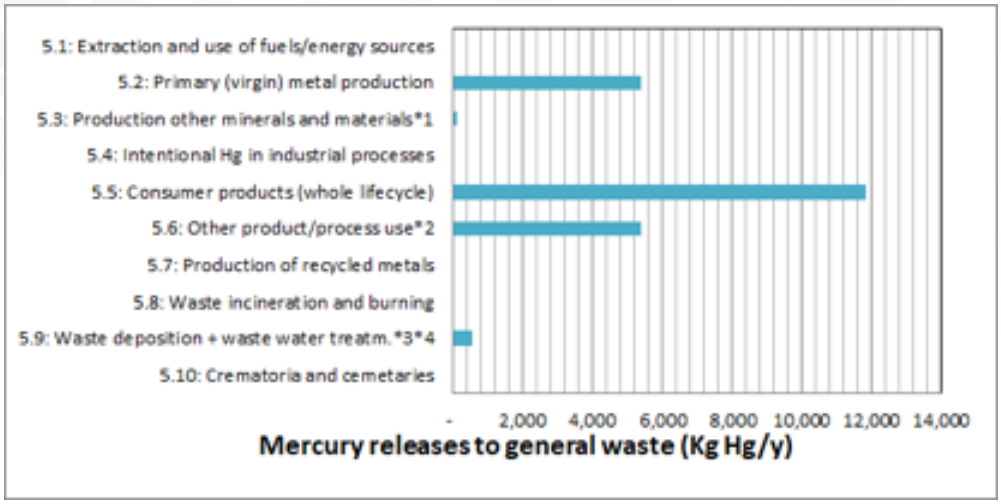


Figure 2.6. **Mercury Releases to Sector Specific Waste Treatment/Disposal**

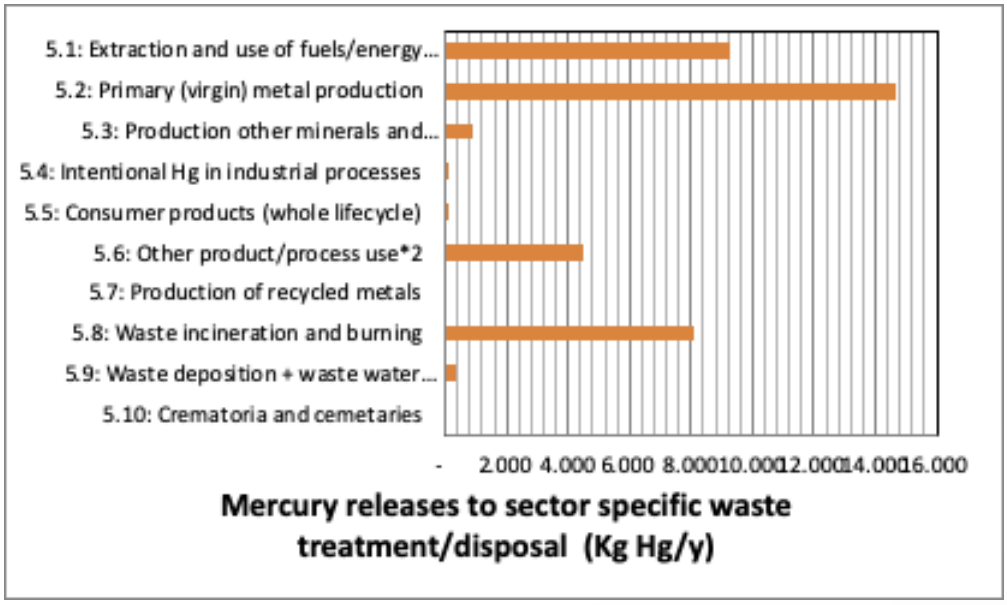


Table 2.1. **Summary of Mercury Inventory Results**

Source category	Calculated Hg output, Kg/y							Percent of total releases*3*4
	Air	Water	Land	By-products and impurities	General waste	Sector specific treatment / disposal	Total releases by source category	
5.1: Extraction and use of fuels/energy sources	9,434.8	2,933.5	-	1,349.7	-	9,264.8	22,983	3.5%
5.2: Primary (virgin) metal production	121,046.2	134,738.9	224,595.0	26,074.2	5,392.5	14,629.6	526,476	81.0%
5.3: Production of other minerals and materials with mercury impurities*1	3,403.7	-	-	867.3	89.1	867.3	5,227	0.8%
5.4: Intentional use of mercury in industrial processes	60.0	6.0	114.0	30.0	-	90.0	300	0.0%
5.5: Consumer products with intentional use of mercury (whole life cycle)	11,492.0	54.1	15,220.7	-	11,770.8	3.3	38,541	5.9%
5.6: Other intentional product/process use*2	685.4	5,386.7	684.9	-	5,385.6	4,490.3	16,633	2.6%
5.7: Production of recycled metals	-	-	-	-	-	-	-	0,0%
5.8: Waste incineration and burning	22,263.5	-	-	-	-	8,112.8	30,376	4.7%
5.9: Waste deposition/ landfilling and wastewater treatment*3*4	2,627.5	5,848.9	19,441.5	-	546.4	367.0	28,831	0.9%
5.10: Crematoria and cemeteries	53.1	-	3,069.8	-	-	-	3,123	0.5%
SUM OF QUANTIFIED RELEASES*3*4	171,066	145,550	243,695	28,321	23,184	37,825	649,642	100%

Notes: *1 Includes production of cement, pulp and paper, lime and light weight aggregates. *2 Includes dental amalgam fillings, manometers and gauges, lab chemicals and equipment, Hg use in religious rituals and folklore medicine, and miscellaneous product uses. *3: The estimated quantities include mercury in products which has also been accounted for under each product category. To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS. *4: The estimated input and release to water include mercury amounts which have also been accounted for under each source category. To avoid double counting, releases to water from wastewater system/treatment have been subtracted automatically in the TOTALS.

The individual mercury releases sub-categories contributing the highest mercury releases to the atmosphere were gold (and silver) extraction by mercury amalgamation process, incineration of hazardous waste, electrical switches and relays with mercury, other non-ferrous metals extraction and coal combustion in coal fired power plants.

The individual mercury releases sub-categories contributing the highest inputs of mercury were gold (and silver) extraction with mercury amalgamation process, gold extraction and initial processing by methods other than mercury amalgamation, electrical switches and relays with mercury, copper extraction and initial processing.

The origin of mercury in waste and wastewater produced in the country is mercury in products and materials. Waste fractions and wastewater do therefore not represent original mercury inputs to society (except for imported waste). Waste and wastewater may however represent substantial flows of mercury through society. The following were found to be the major flows of mercury within waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.

In this inventory, mostly default input factors were used for the estimation of mercury releases from general waste treatment and wastewater treatment. The default factors were based on literature data regarding mercury contents in waste and wastewater, and these data were only available from developed countries. The calculations made indicate that the default input factors for general waste and wastewater do not over-estimate the mercury releases from these sources.

Detailed presentation of mercury inputs and releases for all mercury release source types present in the country are shown in the following report sections.

The Toolkit spreadsheets used in the development of this inventory is available at Directorate of Hazardous Substances Management, MoEF.

Major point-sources of mercury releases identified are listed in each of the relevant source-sub-category sections below.

Data gaps and recommendations for follow-up

Major data gaps were the following:

- Information concerning the mercury content within materials and/or products are very limited, and many are unavailable for each of sub-categories.
- Due to the lack of data of mercury in materials and/or products, the material balance cannot be well established.
- Detailed information concerning types of specific materials and/or fuel use as well as types of controls to reduce mercury release in certain sub-categories are also limited.

Main priorities for further assessment [and/or actions]:

- Collect information of mercury content within materials and/or products for each of the sub-categories.
- The government should have a central data base for information regarding mercury content within the materials and/or products for each of the sub-categories.
- Planning for a survey for collecting data in line with the type of required data.

2.1.1. Mercury Release Source Type Present

Table 2.2 shows which mercury release sources were identified as present or absent in the country. Only source types positively identified as present are included in the quantitative assessment.

Table 2.2 **Identification of Mercury Release Sources in The Country; Sources Present (Y), Absent (N), and Possible but Not Positively Identified (?)**

Cat. no.	Source category	Source presence (y/n/?)
5.1	**Main category - Extraction and use of fuels/energy sources**	
5.1.1	Coal combustion in large power plants	Y
5.1.2	Other coal combustion	Y
5.1.3	Extraction, refining and use of mineral oil	Y
5.1.4	Extraction, refining and use of natural gas	Y
5.1.5	Extraction and use of other fossil fuels	Y
5.1.6	Biomass fired power and heat production	Y
5.1.7	Geothermal power production	Y
5.2	**Main category - Primary (virgin) metal production**	
5.2.1	Primary extraction and processing of mercury	N
5.2.2	Gold and silver extraction with the mercury-amalgamation process	Y
5.2.3	Zinc extraction and initial processing	N
5.2.4	Copper extraction and initial processing	Y
5.2.5	Lead extraction and initial processing	N
5.2.6	Gold extraction and initial processing by other processes than mercury amalgamation	Y
5.2.7	Aluminium extraction and initial processing	Y
5.2.8	Extraction and processing of other non-ferrous metals	Y
5.2.9	Primary ferrous metal production	Y
5.3	**Main category - Production of other minerals and materials with mercury impurities**	
5.3.1	Cement production	Y
5.3.2	Pulp and paper production	Y
5.3.3	Lime production and light weight aggregate kilns	N
5.3.4	Other minerals and materials	N
5.4	**Main category – Intentional use of mercury as an auxiliary material in industrial processes**	
5.4.1	Chlor-alkali production with mercury-technology	Y
5.4.2	VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst	N
5.4.3	Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst	N
5.4.4	Other production of chemicals and polymers with mercury compounds as catalysts	N
5.5	**Main category - Consumer products with intentional use of mercury**	
5.5.1	ThermometMain category - Other intentional products/process uses	Y
5.5.2	Electrical and electronic switches, contacts and relays with mercury	Y
5.5.3	Light sources with mercury	Y
5.5.4	Batteries containing mercury	Y
5.5.6	Biocides and pesticides	N
5.5.7	Paints	N
5.5.8	Pharmaceuticals for human and veterinary uses	N

Cat. no.	Source category	Source presence (y/n/?)
5.5.9	Cosmetics and related products	Y
5.6	**Main category - Other intentional products/process uses**	
5.6.1	Dental mercury-amalgam fillings	Y
5.6.2	Manometers and gauges	Y
5.6.3	Laboratory chemicals and equipment	Y
5.6.4	Mercury metal use in religious rituals and folklore medicine	N
5.6.5	Miscellaneous product uses, mercury metal uses and other sources	?
5.7	**Main category - Production of recycled metals**	
5.7.1	Production of recycled mercury ("secondary production)	N
5.7.2	Production of recycled ferrous metals (iron and steel)	N
5.7.3	Production of other recycled metals	N
5.8	**Main category – Waste incineration**	
5.8.1	Incineration of municipal/ general waste	Y
5.8.2	Incineration of hazardous waste	Y
5.8.3	Incineration of medical waste	Y
5.8.4	Sewage sludge incineration	Y
5.8.5	Informal waste burning	Y
5.9	**Main category - Waste deposition/landfilling and wastewater treatment**	
5.9.1	Controlled landfills/deposits	Y
5.9.2	Diffuse deposition under some control	N
5.9.3	Informal local deposition of industrial production waste	N
5.9.4	Informal dumping of general waste	Y
5.9.5	Wastewater system/treatment	Y
5.10	**Main category - Cremation and cemeteries**	
5.10.1	Crematoria	Y
5.10.2	Cemeteries	Y

2.1.2. Summary of Mercury Inputs to Society

Mercury inputs to society should be understood here as the amounts of mercury made available for potential releases through economic activity in the country. This includes mercury intentionally used in products such as thermometers, blood pressure gauges, fluorescent light bulbs, etc. It also includes mercury mobilized via extraction and use of raw materials which contains mercury in trace concentrations.

For waste categories, the “inputs” are calculated to show the distribution of mercury in waste through the different waste treatment activities and to calculate releases from these activities, though waste is not an original source of input mercury into society (except in the case of waste import). Waste “inputs” are marked in *italics*.

Table 2.3 **Summary of Mercury Inputs to Society**

Category no.	Source category	Estimated Hg input, Kg Hg/y, by life cycle phase (as relevant)		
		Production phase*1	Use phase	Disposal phase
5.1	**Main category - Extraction and use of fuels/energy sources**			
5.1.1	Coal combustion in large power plants		6,207	
5.1.2.1	Coal combustion in coal fired industrial boilers		2,511	
5.1.2.2	Other coal use		1	
5.1.3	Extraction, refining and use of mineral oil		949	
5.1.4	Extraction, refining and use of natural gas		19,740	
5.1.5	Extraction and use of other fossil fuels		-	
5.1.6	Biomass fired power and heat production		802	
5.1.7	Geothermal power production		367	
5.2	**Main category - Primary (virgin) metal production**			
5.2.1	Primary extraction and processing of mercury	-		
5.2.2	Gold and silver extraction with the mercury-amalgamation process	362,343		
5.2.3	Zinc extraction and initial processing	-		
5.2.4	Copper extraction and initial processing	32,079		
5.2.5	Lead extraction and initial processing	-		
5.2.6	Gold extraction and initial processing by other processes than mercury amalgamation	101,750		
5.2.7	Aluminum extraction and initial processing	8,296		
5.2.8	Extraction and processing of other non-ferrous metals	9,470		
5.2.9	Primary ferrous metal production	12,539		
5.3	**Main category - Production of other minerals and materials with mercury impurities**			
5.3.1	Cement production	4,336		
5.3.2	Pulp and paper production	891		
5.3.3	Lime production and light weight aggregate kilns	-		
5.3.4	Others minerals and materials			
5.4	**Main category – Intentional use of mercury as an auxiliary material in industrial processes**			
5.4.1	Chlor-alkali production with mercury-technology	300		
5.4.2	VCM (vinyl-chloride-monomer) production with mercury-dichloride (HgCl2) as catalyst	-		
5.4.3	Acetaldehyde production with mercury-sulphate (HgSO4) as catalyst	-		
5.4.4	Other production of chemicals and polymers with mercury compounds as catalysts	-		
5.5	**Main category - Consumer products with intentional use of mercury**			
5.5.1	Thermometers with mercury		20.8	
5.5.2	Electrical and electronic switches, contacts and relays with mercury		36,953	
5.5.3	Light sources with mercury		773	
5.5.4	Batteries containing mercury		746	

Category no.	Source category	Estimated Hg input, Kg Hg/y, by life cycle phase (as relevant)		
		Production phase*1	Use phase	Disposal phase
5.5.5	Polyurethane with mercury catalysts		-	
5.5.6	Biocides and pesticides		-	
5.5.7	Paints		-	
5.5.8	Pharmaceuticals for human and veterinary uses		-	
5.5.9	Cosmetics and related products		49	
5.6	**Main category - Other intentional products/process uses**			
5.6.1	Dental mercury-amalgam fillings		11	
5.6.2	Manometers and gauges		3,454	
5.6.3	Laboratory chemicals and equipment		13,197	
5.6.4	Mercury metal use in religious rituals and folklore medicine		-	
5.6.5	Miscellaneous product uses, mercury metal uses and other sources		-	
5.7	**Main category - Production of recycled metals**	**-**		
5.7.1	Production of recycled mercury ("secondary production)	-		
5.7.2	Production of recycled ferrous metals (iron and steel)	-		
5.7.3	Production of other recycled metals	-		
5.8	**Main category – Waste incineration**			
5.8.1	Incineration of municipal/general waste			10
5.8.2	Incineration of hazardous waste			22,614
5.8.3	Incineration of medical waste			4,342
5.8.4	Sewage sludge incineration			210
5.8.5	Informal waste burning			3,200
5.9	**Main category - Waste deposition/landfilling and wastewater treatment**			
5.9.1	Controlled landfills/deposits			201
5.9.2	Diffuse deposition under some control			-
5.9.3	Informal local deposition of industrial production waste			-
5.9.4	Informal dumping of general waste			24,288
5.9.5	Wastewater system/treatment			4,343
5.10	**Main category - Cremation and cemeteries**			
5.10.1	Crematoria			53
5.10.2	Cemeteries			3,070

Notes: *1: Production phase includes raw material production.

Note that the following source sub-categories made the largest contributions to mercury inputs to society: gold (and silver) extraction by mercury amalgamation process, gold extraction and initial processing by methods other than mercury amalgamation, electrical switches and relays with mercury, copper extraction and initial processing.

The origin of mercury in waste and wastewater produced in the country is mercury in products and materials. Waste fractions and wastewater do therefore not represent original mercury inputs to society (except for imported waste). Waste and wastewater may however represent substantial flows of mercury through society. The following

were found to be the major flows of mercury with waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.

2.1.3. Summary of Mercury Releases

In the **Table 2.4** below, a summary of mercury releases from all source categories present is given. The key mercury releases here are releases to air (the atmosphere), to water (marine and freshwater bodies, including via wastewater systems), to land, to general waste, and to sector-specific waste. An additional output pathway is "by-products and impurities" which designate mercury flows back into the market with by-products and products. See **Table 2.5** below for a more detailed description and definition of the output pathways.

Note that the following source sub-categories made the largest contributions to mercury releases to the atmosphere: gold (and silver) extraction with mercury amalgamation process, incineration of hazardous waste, electrical switches and relays with mercury, other non-ferrous metals extraction and coal combustion in coal- fired power plants.

Table 2.4 **Summary of Mercury Releases**

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
5.1	**Source category: Extraction and use of fuels/energy sources**								
	5.1.1	Coal combustion in large power plants	y	5,370	-	-	-	-	837
	5.1.2.1	Coal combustion in coal fired industrial boilers	y	2,385	-	-	-	-	126
	5.1.2.2	Other coal use	y	1	-	-	-	-	-
	5.1.3	Mineral oils - extraction, refining and use	y	511	234	-	-	-	204
	5.1.4	Natural gas - extraction, refining and use	y	-	2,699	-	1,350	-	8,098
	5.1.5	Other fossil fuels - extraction and use	y	-	-	-	-	-	-
	5.1.6	Biomass fired power and heat production	y	802	-	-	-	-	-
	5.1.7	Geothermal power production	y	367	-	-	-	-	-
5.2	**Source category: Primary (virgin) metal production**								
	5.2.1	Mercury (primary) extraction and initial processing	n	-	-	-	-	-	-
	5.2.2	Gold (and silver) extraction with mercury amalgamation processes	y	102,223	130,235	129,885	-	-	-
	5.3.3	Zinc extraction and initial processing	n	-	-	-	-	-	-

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
	5.3.4	Copper extraction and initial processing	y	4,039	1,639	-	12,600	-	13,800
	5.3.5	Lead extraction and initial processing	n	-	-	-	-	-	-
	5.3.6	Gold extraction and initial processing by methods other than mercury amalgamation	y	4,070	2,035	91,575	4,070	-	-
	5.3.7	Aluminium extraction and initial processing	y	1,244	830	-	-	5,392	830
	5.3.8	Other non-ferrous metals - extraction and processing	y	9,470	-	-	-	-	-
	5.3.9	Primary ferrous metal production	y	-	-	3,135	9,404	-	-
5.3	**Source category: Production of other minerals and materials with mercury impurities**								
	5.3.1	Cement production	y	2,602	-	-	867	-	867
	5.3.2	Pulp and paper production	y	802	-	-	-	89	-
	5.3.3	Production of lime and light weight aggregates	n	-	-	-	-	-	-
5.4	**Source category: Intentional use of mercury in industrial processes**								
	5.4.1	Chlor-alkali production with mercury-technology	y	60	6	114	30	-	90
	5.4.2	VCM production with mercury catalyst	n	-	-	-	-	-	-
	5.4.3	Acetaldehyde production with mercury catalyst	n	-	-	-	-	-	-
	5.4.4	Other production of chemicals and polymers with mercury	n	-	-	-	-	-	-
5.5	**Source category: Consumer products with intentional use of mercury**								
	5.5.1,	Thermometers with mercury	y	4	6	4	-	6	-
	5.5.2	Electrical switches and relays with mercury	y	11,086	-	14,781	-	11,086	-
	5.5.3	Light sources with mercury	y	232	-	232	-	309	-
	5.5.4	Batteries with mercury	y	170	2	201	-	370	3

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
	5.5.5	Polyurethane with mercury catalysts	n	-	-	-	-	-	-
	5.5.6	Biocides and pesticides with mercury	n	-	-	-	-	-	-
	5.5.7	Paints with mercury	n	-	-	-	-	-	-
	5.5.8	Pharmaceuticals for human and veterinary uses	n	-	-	-	-	-	-
	5.5.9	Cosmetics and related products with mercury	y	-	46	2	-	-	-
5.6	**Source category: Other intentional product/process use**								
	5.6.1	Dental mercury-amalgam fillings	y	1	4	-	-	3	3
	5.6.2	Manometers and gauges with mercury	y	685	1,027	685	-	1,027	-
	5.6.3	Laboratory chemicals and equipment with mercury	y	-	4,355	-	-	4,355	4,487
	5.6.4	Mercury metal use in religious rituals and folklore medicine	n	-	-	-	-	-	-
	5.6.5	Miscellaneous product uses, mercury metal uses, and other sources	n	-	-	-	-	-	-
5.7	**Source category: Production of recycled metals (“secondary” metal production)**								
	5.7.1	Production of recycled mercury ("secondary production”)	n	-	-	-	-	-	-
	5.4.2	Production of recycled ferrous metals (iron and steel)	n	-	-	-	-	-	-
	5.4.2	Production of other recycled metals	n	-	-	-	-	-	-
5.8	**Source category: Waste incineration**								
	5.8.1	Incineration of municipal/general waste	y	5	-	-	-	-	5
	5.8.2	Incineration of hazardous waste	y	15,830	-	-	-	-	6,784
	5.8.3	Incineration of medical waste	y	3,040	-	-	-	-	1,303

C	Sub-C	Source category	Exists? (y/n/?)	Calculated Hg output, Kg/y					
				Air	Water	Land	By-prod. +impur.	General waste	Sector spec. treatm./ dispos.
	5.8.4	Sewage sludge incineration	y	189	-	-	-	-	21
	5.8.5	Informal waste burning	y	3,200	-	-	-	-	-
5.9	**Source category: Waste deposition/landfilling and wastewater treatment**								
	5.9.1	Controlled landfills/ deposits	y	199	2	-	-	-	-
	5.9.2	Diffuse disposal under some control	n	-	-	-	-	-	-
	5.9.3	Informal local disposal of industrial production waste	n	-	-	-	-	-	-
	5.9.4	Informal dumping of general waste	y	2,429	2,429	19,430	-	-	-
	5.9.5	Wastewater system/treatment	y	-	3,418	11	-	546	367
5.10	**Source category: Crematoria and cemeteries**								
	5.10.1	Crematoria	y	53	-	-	-	-	-
	5.10.2	Cemeteries	y	-	-	3,070	-	-	-
SUM OF QUANTIFIED RELEASES:				171,066	145,550	243,695	28,321	23,184	37,825

Table 2.5 **Description of the Types of Results**

Calculation result type	Description
Estimated Hg input, Kg Hg/y	The standard estimate of the amount of mercury entering this source category with input materials, for example calculated mercury quantity in the amount of coal used annually in the country for combustion in large power plants.
Air	Mercury emissions to the atmosphere from point sources and diffuse sources from which mercury may be spread locally or over long distances by air masses; for example, from: ▸ Point-sources such as coal-fired power plants, metal smelters, waste incineration; ▸ Diffuse sources such as small-scale gold mining, and informally-incinerated toxic waste products such as fluorescent lamps, batteries, thermometers.
Water	Mercury releases to aquatic environments and to wastewater systems: Point sources and diffuse sources from which mercury will spread to marine environments (oceans), and freshwaters (rivers, lakes) including releases from: ▸ Wet flue cleaning systems from coal-fired power plants; ▸ Industry, households, etc., to aquatic environments; ▸ Surface run-off and leachate from mercury contaminated soil and waste dumps.

Calculation result type	Description
Land	Mercury releases to soil, the terrestrial environment: General soil and ground water. For example, releases from: ▸ Solid residues from flue gas cleaning on coal fired power plants used for gravel road construction; ▸ Uncollected waste products dumped or buried informally; ▸ Local un-confined releases from industry such as on-site hazardous waste storage/burial; ▸ Spreading of sewage sludge with mercury content on agricultural land (sludge used as fertilizer); ▸ Application on land, seeds or seedlings of pesticides with mercury compounds.
By-products and impurities	By-products that contain mercury, which are sent back into the market and cannot be directly allocated to environmental releases, for example: ▸ Gypsum wallboard produced from solid residues from flue gas cleaning on coal-fired power plants; ▸ Sulphuric acid produced from desulphurization of flue gas (flue gas cleaning) in non-ferrous metal plants with mercury trace concentrations; ▸ Chlorine and sodium hydroxide produced with mercury-based chlor-alkali technology; with mercury trace concentrations; ▸ Metal mercury or calomel as by-product from non-ferrous metal mining (high mercury concentrations).
General waste	General waste: also called municipal waste in some countries. Typically, household and institution waste where the waste undergoes a general treatment, such as incineration, landfilling or informal dumping or burning. The mercury sources to waste are consumer products with intentional mercury content (batteries, thermometers, fluorescent tubes, etc.) as well as high volume waste like printed paper, plastic, etc., with small trace concentrations of mercury.
Sector specific waste treatment /disposal	Waste from industry and consumers which is collected and treated in separate systems, and in some cases recycled. For example, ▸ Confined deposition of solid residues from flue gas cleaning on coal-fired power plants on dedicated sites. ▸ Hazardous industrial waste with high mercury content which is deposited in dedicated, safe sites. ▸ Hazardous consumer waste with mercury content, mainly separately collected and safely treated batteries, thermometers, mercury switches, lost teeth with amalgam fillings etc. ▸ Confined deposition of tailings and high-volume rock/waste from extraction of non-ferrous metals. The country-specific waste treatment/disposal method is described for each sub-category in the detailed report sections below.

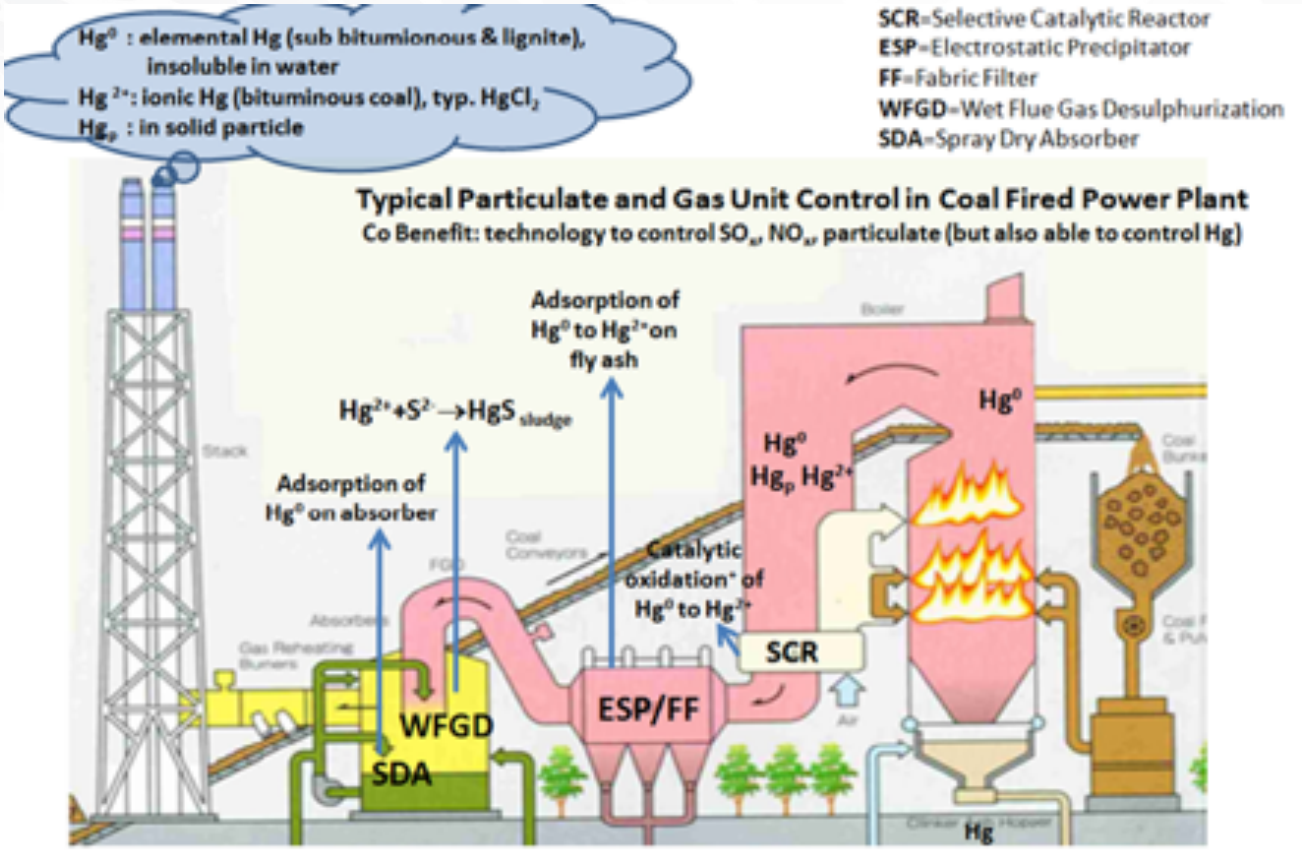
2.2. Data and Inventory on Extraction and Use of Fuels/Energy Sources

2.2.1. Coal Combustion in Power Plants

Fossil fuels such as coal naturally contain trace concentrations of mercury, and this mercury is released when the fuel is burned. Most of this mercury is released to the atmosphere, but some is captured by flue gas cleaning systems and ends up in residues from this system.

Large power plants presented in **Table 2.6** have various air pollution controls, but none are actually intended to capture Hg. As shown in **Figure 2.7**, at least a large power plant must install the electrostatic precipitators (ESP) for controlling the fly ash emissions to the air. Some power plants, especially the independent power producers, also install the Flue Gas Desulphurization (FGD), for controlling the SO_2 emission, as well as the Low NOx burner type boiler for reducing the NOx emission. Some Hg attached to the particles could also be captured within the ESP, while oxidized Hg^{2+} could react with S^{2-} in the FGD system.

Figure 2.7 **Hg Emissions from Large Coal Power Plants**



Source: The Department of Energy/National Energy Technology Laboratory (DOE/NETL) & the Electric Power Research Institute (EPRI)

Data description

There are Currently 141 active coal-fired power plants (CFPPs) in Indonesia as shown in **Table 2.6**, with various type of boilers, capacities, as well as air pollution control devices. According to the Electrify Supply Service Plan of the State Own Company (PT PLN), until 2028 coal use will still dominate the energy source (54.40%) for the electricity supply in Indonesia (MoEMR, 2018). However, with the improvement of the use of the renewable energy sources, PT PLN is capable of decreasing the coal use domination from 62.75% in 2019 to 54.40% in 2028.

Table 2.6 **Coal Fired Power Plants in Indonesia**

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
1	Subcritical - PCC	150	685,095	841,376	9.4	Electrostatic Precipitator (ESP)
2	Subcritical - PCC	150	702,956	932,212	9.4	Electrostatic Precipitator (ESP)
3	Subcritical - PCC	175	617,532	560,191	12.1	Electrostatic Precipitator (ESP), Limestone Injection

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
4	Subcritical - PCC	175	705,386	670,770	12.1	Electrostatic Precipitator (ESP), Limestone Injection
5	Subcritical - S	3.5	11,895	22,454	13.7	Electrostatic Precipitator (ESP), Cyclone
6	Subcritical - S	3.5	14,458	29,981	13.7	Electrostatic Precipitator (ESP), Cyclone
7	Subcritical - S	7	23,592	38,424	13.8	Fabric Filter (FF) / Baghouse Filter
8	Subcritical - S	7	23,767	38,432	13.8	Fabric Filter (FF) / Baghouse Filter
9	Subcritical - PCC	65	325,945	240,899	14.0	Electrostatic Precipitator (ESP)
10	Subcritical - PCC	65	325,945	242,226	14.4	Electrostatic Precipitator (ESP)
11	Subcritical - PCC	25	185,999	209,490	14.6	Electrostatic Precipitator (ESP)
12	Subcritical - PCC	25	185,651	207,131	14.6	Electrostatic Precipitator (ESP)
13	Subcritical - PCC	60	413,950	381,957	14.6	Electrostatic Precipitator (ESP), Limestone Injection
14	Subcritical - PCC	7.5	33,911	75,395	14.8	Electrostatic Precipitator (ESP)
15	Subcritical - PCC	7.5	33,911	75,395	14.8	Electrostatic Precipitator (ESP)
16	Subcritical - PCC	7.5	12,098	82,107	14.8	Electrostatic Precipitator (ESP)
17	Subcritical - FBC	12.5	47,856	83,196	14.8	Electrostatic Precipitator (ESP)
18	Subcritical - FBC	12.5	9,360	30,289	14.8	Electrostatic Precipitator (ESP)
19	Subcritical - FBC	24	145,681	242,988	14.8	Electrostatic Precipitator (ESP), Limestone Injection
20	Subcritical - FBC	25	1,476	2,471	14.8	Electrostatic Precipitator (ESP)
21	Subcritical - FBC	25	133,404	132,526	14.8	Electrostatic Precipitator (ESP)
22	Subcritical - FBC	30	184,800	213,725	14.8	None
23	Subcritical - FBC	30	177,000	187,600	14.8	None
24	Subcritical - S	12	52,096	64,260	14.8	Electrostatic Precipitator (ESP)
25	Subcritical - S	12	42,001	56,163	14.8	Electrostatic Precipitator (ESP)
26	Subcritical - FBC	110	396,051	349,193	14.8	Electrostatic Precipitator (ESP), Limestone Injection

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
27	Subcritical - S	16.5	72,660	72,496	14.8	Electrostatic Precipitator (ESP)
28	Subcritical - S	16.5	25,885	27,450	14.8	Electrostatic Precipitator (ESP)
29	Subcritical - FBC	110	348,171	325,594	14.8	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
30	Subcritical - S	22	45,565	63,344	14.8	Electrostatic Precipitator (ESP)
31	Subcritical - S	22	93,001	124,270	14.8	Electrostatic Precipitator (ESP)
32	Subcritical - FBC	110	291,416	256,810	14.8	None
33	Subcritical - FBC	110	290,539	229,559	14.8	None
34	Subcritical - FBC	110	432,009	380,752	14.8	Electrostatic Precipitator (ESP), Limestone Injection
35	Subcritical - FBC	110	335,092	275,320	14.8	Electrostatic Precipitator (ESP), Limestone Injection
36	Subcritical - PCC	125	638,646	439,413	14.8	Electrostatic Precipitator (ESP)
37	Subcritical - PCC	125	664,025	453,371	14.8	Electrostatic Precipitator (ESP)
38	Subcritical - PCC	135	441,915	328,701	14.8	Electrostatic Precipitator (ESP)
39	Subcritical - PCC	135	509,780	361,884	14.8	Electrostatic Precipitator (ESP)
40	Subcritical - S	7	17,694	24,140	14.8	Cyclone
41	Subcritical - PCC	200	507,181	368,385	14.8	Electrostatic Precipitator (ESP)
42	Subcritical - PCC	200	887,612	689,132	14.8	Electrostatic Precipitator (ESP)
43	Subcritical - FBC	55	138,057	150,988	15.1	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
44	Subcritical - FBC	55	137,128	147,076	15.1	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
45	Subcritical - FBC	60	174,458	177,148	15.2	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
46	Subcritical - FBC	60	197,820	197,318	15.2	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
47	Subcritical - S	7	40,794	24,265	15.6	Fabric Filter (FF) / Baghouse Filter

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
48	Subcritical - S	7	36,448	18,999	15.6	Fabric Filter (FF) / Baghouse Filter
49	Subcritical - PCC	300	2,359,066	1,428,234	15.6	Electrostatic Precipitator (ESP), Low NOx Burner
50	Subcritical - PCC	300	1,583,538	990,230	15.7	Electrostatic Precipitator (ESP), Low NOx Burner
51	Subcritical - FBC	100	384,013	355,829	15.8	Electrostatic Precipitator (ESP)
52	Subcritical - FBC	100	379,989	325,926	15.8	Electrostatic Precipitator (ESP)
53	Subcritical - FBC	110	432,826	329,772	15.9	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
54	Subcritical - FBC	110	474,634	364,426	15.9	Cyclone, Limestone Injection
55	Supercritical	660	4,270,183	2,480,145	15.9	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (Material Absorbant: Sea water), Low NOx Burner
56	Subcritical - FBC	30	349,001	175,157	15.9	Electrostatic Precipitator (ESP), Cyclone
57	Subcritical - FBC	30	333,139	167,196	15.9	Electrostatic Precipitator (ESP), Cyclone
58	Subcritical - S	8.1	24,787	32,802	16.0	Cyclone
59	Subcritical - S	8.1	30,031	37,261	16.0	Cyclone
60	Supercritical	660	3,490,569	1,968,487	16.0	Electrostatic Precipitator (ESP), Low NOx Burner
61	Subcritical - FBC	30	103,531	117,350	16.0	Electrostatic Precipitator (ESP)
62	Subcritical - FBC	30	116,176	131,854	16.0	Electrostatic Precipitator (ESP)
63	Subcritical - PCC	65	399,417	341,160	16.0	Electrostatic Precipitator (ESP)
64	Subcritical - PCC	65	264,018	239,282	16.0	Electrostatic Precipitator (ESP)
65	Subcritical - PCC	65	336,639	281,898	16.0	Electrostatic Precipitator (ESP)
66	Subcritical - PCC	65	470,189	400,762	16.0	Electrostatic Precipitator (ESP)
67	Subcritical - PCC	660	3,498,184	2,193,340	16.1	Electrostatic Precipitator (ESP)

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
68	Supercritical	660	4,167,579	2,680,375	16.2	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (Sea water)
69	Subcritical - FBC	112	471,010	397,542	16.2	Electrostatic Precipitator (ESP), Limestone Injection
70	Subcritical - FBC	112	421,427	320,802	16.2	Electrostatic Precipitator (ESP), Limestone Injection
71	Subcritical - PCC	615	4,443,336	2,358,002	16.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (Sea Water), Low NOx Burner
72	Subcritical - PCC	615	4,286,039	2,223,830	16.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System, Low NOx Burner
73	Subcritical - FBC	15	21,865	25,649	16.3	Electrostatic Precipitator (ESP)
74	Subcritical - FBC	15	79,319	91,219	16.3	Electrostatic Precipitator (ESP)
75	Subcritical - S	12	12,077	22,203	16.5	Cyclone, Flue Gas Desulphurization (FGD), Wet System
76	Subcritical - S	12	9,684	15,119	16.5	Cyclone, Flue Gas Desulphurization (FGD), Wet System
77	Subcritical - PCC	350	2,125,386	1,303,385	16.7	Electrostatic Precipitator (ESP)
78	Subcritical - PCC	315	2,263,915	1,385,055	16.7	Electrostatic Precipitator (ESP), Low NOx Burner
79	Subcritical - PCC	330	2,298,892	1,368,779	16.7	Electrostatic Precipitator (ESP), Low NOx Burner
80	Subcritical - PCC	330	2,151,713	1,261,330	16.8	Electrostatic Precipitator (ESP), Low NOx Burner
81	Subcritical - PCC	315	1,870,606	1,137,465	16.8	Electrostatic Precipitator (ESP), Low NOx Burner
82	Subcritical - PCC	330	1,984,945	1,163,863	16.8	Electrostatic Precipitator (ESP), Low NOx Burner
83	Subcritical - PCC	350	2,118,526	1,276,017	16.9	Electrostatic Precipitator (ESP)

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
84	Subcritical - PCC	315	2,023,875	1,242,808	16.9	Electrostatic Precipitator (ESP), Low NOx Burner
85	Subcritical - PCC	315	1,942,854	1,172,704	16.9	Electrostatic Precipitator (ESP), Low NOx Burner
86	Subcritical - PCC	315	1,688,736	1,028,746	16.9	Electrostatic Precipitator (ESP), Low NOx Burner
87	Subcritical - PCC	315	1,423,868	881,201	16.9	Electrostatic Precipitator (ESP)
88	Subcritical - PCC	110	388,067	353,049	16.9	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
89	Subcritical - PCC	110	320,293	272,588	16.9	Electrostatic Precipitator (ESP), Cyclone, Limestone Injection
90	Subcritical - PCC	350	1,847,052	1,218,125	17.0	Electrostatic Precipitator (ESP)
91	Subcritical - PCC	350	1,923,626	1,184,085	17.0	Electrostatic Precipitator (ESP)
92	Subcritical - PCC	350	1,613,897	1,059,367	17.0	Electrostatic Precipitator (ESP)
93	Subcritical - PCC	315	996,457	613,095	17.0	Electrostatic Precipitator (ESP)
94	Subcritical - PCC	400	2,520,673	1,503,272	17.3	Electrostatic Precipitator (ESP), Low NOx Burner
95	Subcritical - PCC	400	2,918,565	1,714,709	17.3	Electrostatic Precipitator (ESP), Low NOx Burner
96	Subcritical - FBC	10	14,690	19,856	17.4	Electrostatic Precipitator (ESP), Fabric Filter (FF) / Baghouse Filter, Limestone Injection
97	Subcritical - FBC	10	47,793	59,011	17.4	Electrostatic Precipitator (ESP), Fabric Filter (FF) / Baghouse Filter, Limestone Injection
98	Subcritical - FBC	30	116,684	116,886	17.5	Electrostatic Precipitator (ESP), Cyclone
99	Subcritical - FBC	30	113,108	112,289	17.5	Electrostatic Precipitator (ESP), Cyclone
100	Subcritical - FBC	16,5	102,466	104,797	17.7	Electrostatic Precipitator (ESP)
101	Subcritical - PCC	135	753,029	496,830	17.7	Electrostatic Precipitator (ESP)

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
102	Subcritical - PCC	135	786,759	524,784	17.7	Electrostatic Precipitator (ESP)
103	Subcritical - FBC	16.5	72,916	75,959	17.8	Electrostatic Precipitator (ESP)
104	Subcritical - PCC	625	2,909,645	1,830,276	17.9	Electrostatic Precipitator (ESP)
105	Subcritical - PCC	142	918,205	514,409	18.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System
106	Subcritical - PCC	142	929,006	516,766	18.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System
107	Subcritical - PCC	142	912,945	505,659	18.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System
108	Subcritical - PCC	400	2,824,468	1,582,035	18.4	Electrostatic Precipitator (ESP)
109	Subcritical - PCC	400	2,398,635	1,405,760	18.4	Electrostatic Precipitator (ESP), Low NOx Burner
110	Subcritical - PCC	400	2,942,460	1,740,864	18.5	Electrostatic Precipitator (ESP)
111	Subcritical - PCC	400	2,429,617	1,398,449	18.5	Electrostatic Precipitator (ESP), Low NOx Burner
112	Subcritical - PCC	300	1,772,610	1,020,556	18.6	Electrostatic Precipitator (ESP)
113	Subcritical - PCC	300	1,916,186	1,141,863	18.6	Electrostatic Precipitator (ESP)
114	Subcritical - FBC	115	37,898	60,094	18.7	Electrostatic Precipitator (ESP), Limestone Injection
115	Subcritical - PCC	7	14,501	18,922	18.7	None
116	Subcritical - PCC	7	21,640	28,327	18.7	None
117	Subcritical - PCC	65	24,754	17,674	18.7	None
118	Subcritical - PCC	65	291,891	216,489	18.7	Electrostatic Precipitator (ESP)
119	Subcritical - PCC	65	191,391	144,576	18.7	Electrostatic Precipitator (ESP)
120	Subcritical - FBC	115	27,391	32,874	18.9	Electrostatic Precipitator (ESP), Limestone Injection
121	Supercritical	660	4,613,206	2,513,957	19.0	Electrostatic Precipitator (ESP), Low NOx Burner

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
122	Subcritical - PCC	600	4,433,959	2,251061	19.1	Electrostatic Precipitator (ESP), Low NOx Burner
123	Subcritical - PCC	600	4,096,728	2,111,125	19.1	Electrostatic Precipitator (ESP), Low NOx Burner
124	Subcritical - PCC	600	4,315,393	2,206,517	19.2	Electrostatic Precipitator (ESP), Low NOx Burner
125	Subcritical - PCC	65	46,194	33,135	19.4	Electrostatic Precipitator (ESP)
126	Subcritical - PCC	610	4,328,693	2,084,167	19.4	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (Sea water), Low NOx Burner
127	Subcritical - FBC	135	595,323	405,083	19.4	Cyclone, Limestone Injection, Bag Filter
128	Subcritical - FBC	135	277,655	187,271	19.4	Fabric Filter (FF) / Baghouse Filter, Limestone Injection
129	Subcritical - PCC	610	4,418,896	2,091,294	19.6	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (sea water), Low NOx Burner
130	Subcritical - FBC	100	363,672	221,686	20.2	Fabric Filter (FF) / Baghouse Filter, Limestone Injection
131	Subcritical - FBC	100	406,387	232,724	20.2	Fabric Filter (FF) / Baghouse Filter, Limestone Injection
132	Supercritical	815	1,507,548	736,465	20.3	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (sea water), Low NOx Burner
133	Subcritical - PCC	721.8	4,152,863	1,754,766	21.4	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (limestone), Low NOx Burner

No.	Type of boiler	Capacity	Power net generation	Coal consumption	Coal net calorific value	Type of control unit
		MW	MWh	Tonnes/year	TJ/Gg	
134	Subcritical - PCC	721.8	5,292,720	2,234,870	21.5	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (limestone), Low NOx Burner
135	Subcritical - PCC	710	4,923,570	2,219,113	22.0	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (limestone), Low NOx Burner
136	Subcritical - PCC	710	5,151,254	2,288,434	22.0	Electrostatic Precipitator (ESP), Flue Gas Desulphurization (FGD), Wet System (limestone), Low NOx Burner
137	Subcritical - PCC	65	542,347	276,646	23.0	Fabric Filter (FF) / Baghouse Filter, Flue Gas Desulphurization (FGD), Dry System, Low NOx Burner
138	Subcritical - PCC	65	555,398	276,670	23.0	Fabric Filter (FF) / Baghouse Filter, Flue Gas Desulphurization (FGD), Dry System, Low NOx Burner
139	Subcritical - PCC	65	485,978	248,141	23.0	Fabric Filter (FF) / Baghouse Filter, Flue Gas Desulphurization (FGD), Dry System, Low NOx Burner
140	Subcritical - PCC	100	645,407	332,638	24.1	Electrostatic Precipitator (ESP)
141	Subcritical - PCC	100	500,158	269,692	24.1	Electrostatic Precipitator (ESP)
	Total	26,915	153,675,954	91,444,216		

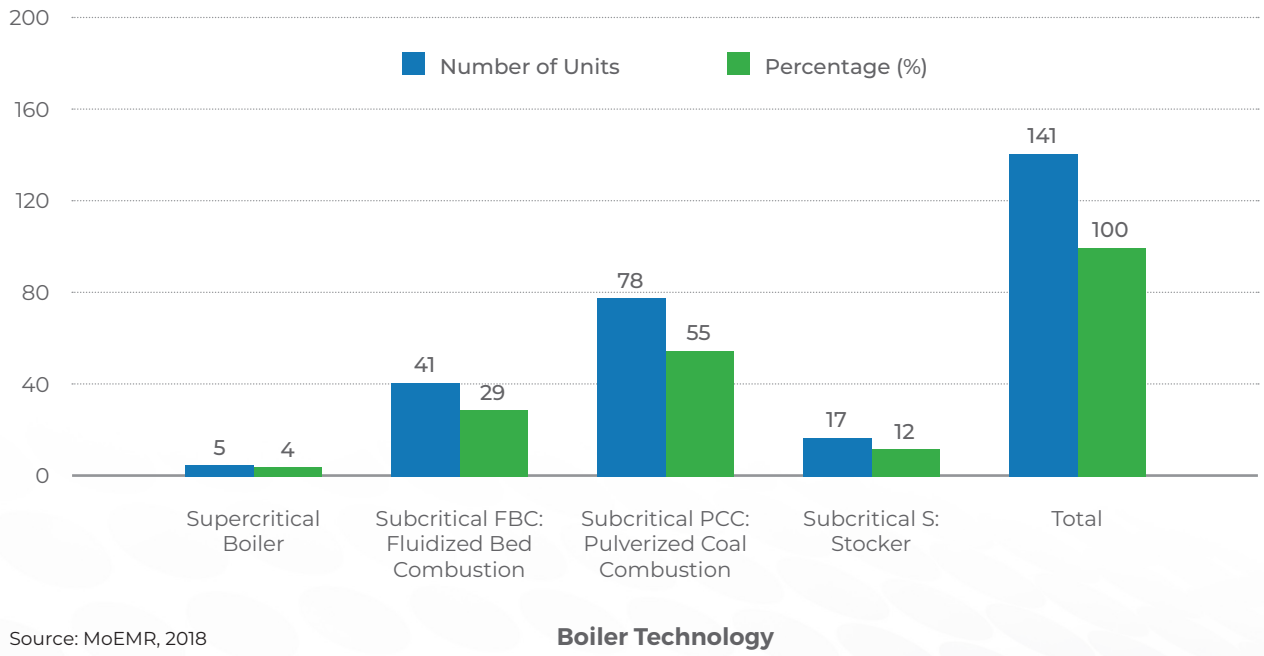
Source: MoEMR, 2018

Data also show that there are four types of boiler technologies in Indonesian CFPPs as depicted in **Figure 2.8**. The most advanced technology that is used in Indonesian CFPPs, the supercritical boilers, are only applied in 5 units out of 141 CFPPs (4% of the total number of units). Other CPPs use subcritical fluidized bed combustion (41 units, or 29% of the total number of units) and most CFPPs apply the subcritical pulverized coal combustion (78 units, 55% of the total number of units), and the rest of the CFPPs use subcritical stocker boiler (17 units or 12% of the total number of units).

Forty-three percent (43%) of the Indonesian CFPPs have capacity less than 100 MW, 40% have capacity between 100 and 400 MW, and only 17% (24 units) have capacity larger than 400 MW (see **Figure 2.9**). Only two types of coal as shown in **Figure 2.10**, the Lignitee with NCV between 9.4 and 17.4 TJ/Gg and sub-bituminous with NCV between 17.7 and 24.1 TJ/Gg are utilized in Indonesian CFPPs. None of the CPPs apply the coal wash process before using coal for the electricity generation.

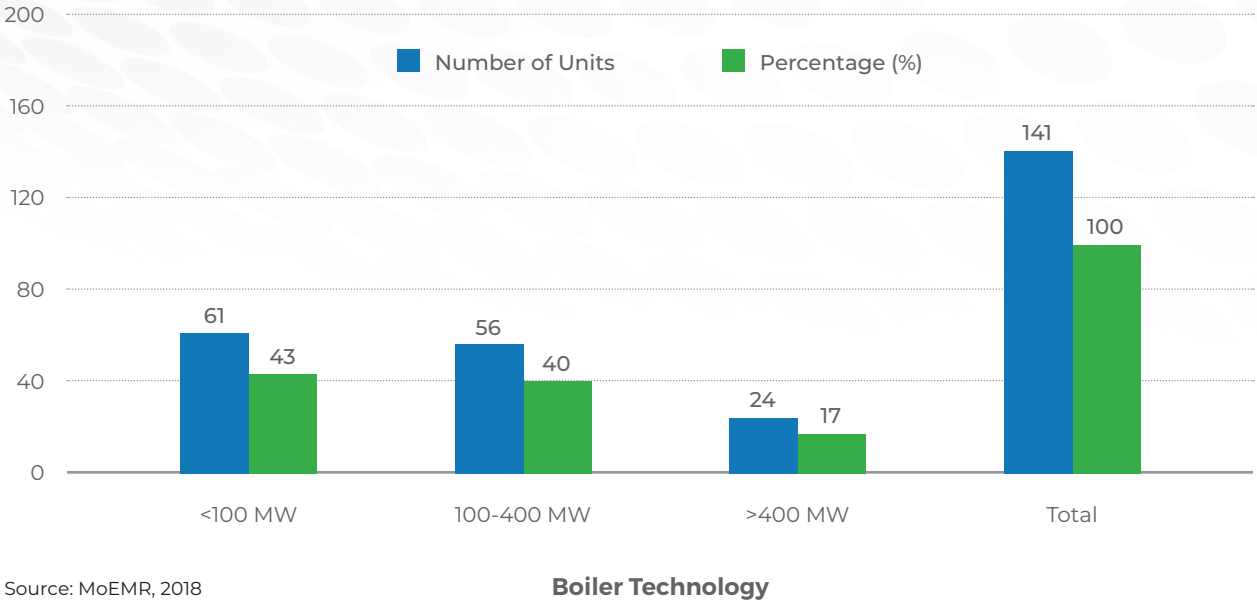
The type of air pollution control (APC) devices which are installed can be seen in **Figure 2.11**, classified based on the type of coal which is consumed by the CFPPs. About 65.7% of CFPPs which use Lignitee coal as the energy source, install level 1 APC (electrostatic precipitator, particulate scrubber or cyclone) or simple APC for reducing particulate emissions, 22% CFPPs install level 2 (fabric filter) APC, 8.1% CFPPs install level 3 (particulate control, spray drier adsorber or wet flue gas desulphurization) APC, 4.0% CFPPs does not have any APC devices, none of the CFPPs has level 4 (particulate matter control + flue gas desulphurization + selective catalytic reduction and level 5 (mercury specific filter) APC. For CFPPs which use sub-bituminous coal as the source of energy, 47.6% of them have level 1 APC, 38.1% have level 3 APC, 7.1% have level 2 APC, 7.1% have level 0 APC, and none of them have level 4 and level 5 APC.

Figure 2.8. **Boiler Technologies of Indonesian Coal Fired Power Plants (MoEMR, 2018)**



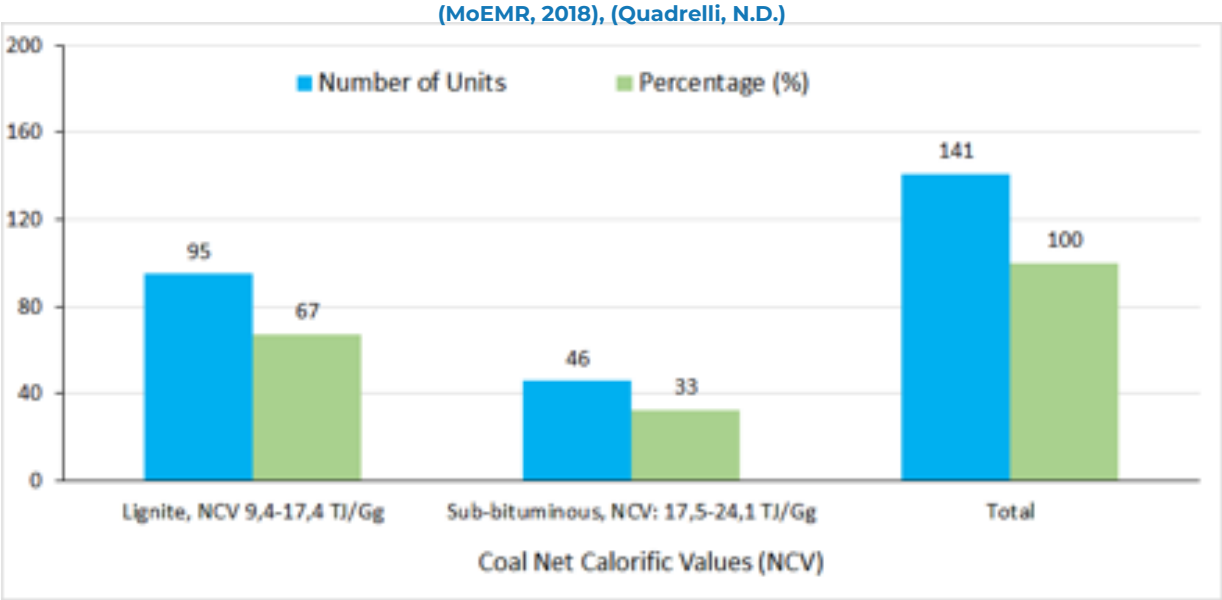
Source: MoEMR, 2018

Figure 2.9. **Boiler Capacities of Indonesian Coal Fired Power Plants**



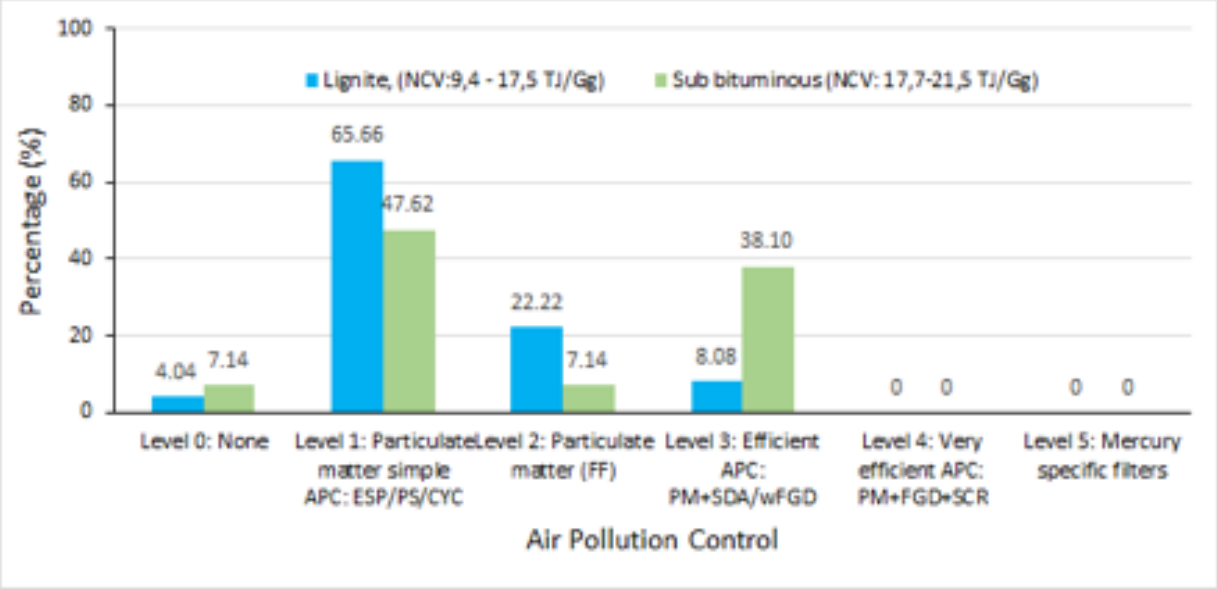
Source: MoEMR, 2018

Figure 2.10. **Coal Net Calorific Values (NCV) of Indonesian Coal Fired Power Plants (MoEMR, 2018), (Quadrelli, N.D.)**



Source : MoEMR, 2018 ; Quadrelli, n.d.

Figure 2.11. **Air Pollution Control Devices of Indonesian Coal Fired Power Plants (MoEMR, 2018), (UNEP, 2019)**

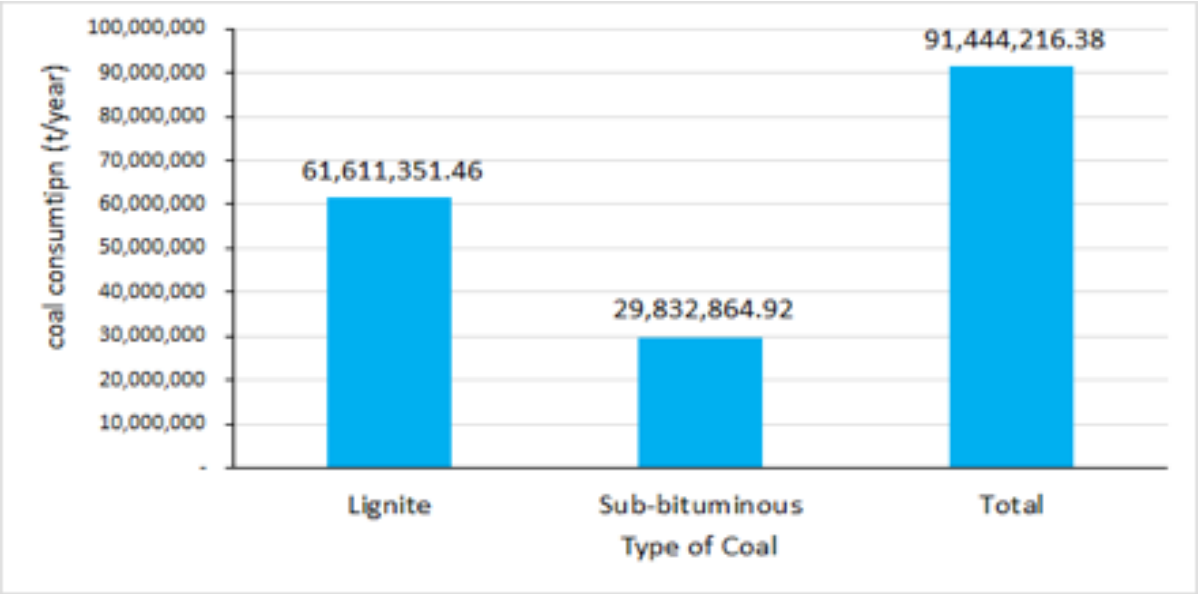


Source: MoEF, 2018; UNEP, 2019

Background calculations and approximations

According to data presented in **Table 2.6**, the total amount of coal which was consumed in 2018 was 91.4 million tonnes, with 61.7 million tonnes of lignitee coal (67.4%) and the rest, 29.8 million tonnes (32.6%) being sub-bituminous coal (see **Figure 2.12** below).

Figure 2.12. **Coal Consumption in 2019 (MoEMR, 2018)**



Source: MoEF, 2018

Based on the Handbook of Energy and Economic Statistics (MoEMR, 2019), the total coal consumption of the country in 2019 was 135,964,920 tonnes per year, or only 22.5% from the total coal production (605 million tonnes). About 77.5% of Indonesian coal was exported.

Coal consumption in CFPPs in 2019 increased to 96,798,644 ton, by using the similar comparison between lignite and sub-bituminous coal, the amount of lignite consumption in 2019 was 65,218,945 ton and sub-bituminous was 31,579,699 ton. These values were the activity data for level 2 inventory from coal combustion.

Since April 2019, the MoEF set a new regulation concerning the Emission Standards for Thermal Power Plants, where all CFPPs must comply to the requirement of a mercury emission standard of 0.03 m/ (at 25ºC, 1 atm, and 7% O_2) as the new parameter. However, not all of the active CFPPs have reported their mercury emissions yet, since there is still a transition time before the new MoEF regulation is to be completely enforced.

Table 2.7 shows the results of Hg emission measurements from 84 CFPP boilers owned by 46 companies. Other available data were the emission flowrates, the operating hours for a certain tiNm³me period, and the amount of coal that was consumed during that period. Data were classified according the type of coal consumed, i.e., the lignite with NCV between 9.4 and 17.6 TJ/Gg and/or the sub-bituminous coal with NCV between 17.7 and 24.1 TJ/Gg. The specific input factors for each of the boilers can be determined according to the following equation:

$$Hg\ emission\ rate = Hg\ emission\ concentration\ \frac{mg}{Nm^3} * gas\ flowrate\ \frac{Nm^3}{s} * operating\ hours\ \frac{hours}{period} * 3600\ \frac{s}{hours} * \frac{1}{1000}\ \frac{g}{mg} = \frac{g\ Hg}{period} \quad \text{Eq. 2-1}$$

$$Hg\ emission\ factor\ (release\ to\ the\ air) = \frac{Hg\ emission\ rate\ \frac{g\ Hg}{period}}{coal\ consumption\ \frac{t\ coal}{period}} = \frac{g\ Hg}{t\ coal} \quad \text{Eq. 2-2}$$

Based on the calculated values presented in **Table 2.7**, the mercury emission factor (emission release to the air) is 0.047 g Hg/ t coal for combustion of lignite coal, and 0.069 for combustion of sub-bituminous coal. In order to be able to determine the input factor for each of the coal type, calculation based on this data, information related to the output distribution factor from UNEP toolkit, and data of air pollution control device (**Figure 2.11**) were utilized to generate the specific input factor as describe in **Table 2.8**.

Table 2.7. **Measurement Data of Hg Emissions of Coal Fired Power Plants in Indonesia**

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
1	A	CFPP 1	744	86.54	0.015	3,476.831	0.0487	0.066	71,459	9.406	Lignite
		CFPP 2	744	103.83	0.024	6,674.359	0.0843		79,174	9.413	Lignite
2	B	CFPP 3	4,285	17.5	0.001	269.955	0.0007	0.004	388,885	12.13	Lignite
		CFPP 4	3,756	18.4	0.001	248.797	0.0008		297,438	12.13	Lignite
		CFPP 3	8,746	17.5	0.001	550.998	0.0007		793,743	12.13	Lignite
		CFPP 4	8,323	18.4	0.001	551.316	0.0008		659,099	12.13	Lignite
		CFPP 3	6,790	17.5	0.01	4,277.700	0.0069		616,226	12.13	Lignite
		CFPP 4	7,970	18.4	0.01	5,279.328	0.0084		631,145	12.13	Lignite
		CFPP 3	6,790	19.32	0.01	4,722.581	0.0077		616,226	12.13	Lignite
		CFPP 4	7,970	20.2	0.01	5,795.784	0.0092		631,145	12.13	Lignite
3	C	CFPP 5	486	12.81	0.0001	2.241	0.0002	0.000	14,191	14	Lignite
		CFPP 5	565	11.36	0.0001	2.311	0.0001		16,497	14	Lignite
		CFPP 5	590	19.87	0.0001	4.220	0.0002		17,227	14	Lignite
		CFPP 5	620	12.17	0.0001	2.716	0.0001		18,253	14.4	Lignite
		CFPP 5	656	11.1	0.0001	2.621	0.0001		19,313	14.4	Lignite
		CFPP 5	618	19.66	0.0001	4.374	0.0002		18,195	14.4	Lignite
4	D	CFPP 6	4,651	13.7	0.009	2,064.486	0.0442	0.044	46,733	14.8	Lignite
5	E	CFPP 7	8,590	131.79	0.0005	2,037.737	0.0082	0.008	248,363	14.8	Lignite
6	F	CFPP 8	6,165	36.73	0.001	815.186	0.0025	0.017	322,506	14.8	Lignite
		CFPP 9	5,974	41.68	0.001	896.387	0.0024		368,179	14.8	Lignite
		CFPP 8	6,165	32.21	0.02	14.297,375	0.0443		322,506	14.8	Lignite
		CPFF 9	5,974	31.45	0.01	6.763,763	0.0179		376,978	14.8	Lignite
7	G	CFPP 10	6,678	13.8	0.00103	341,716	0.0057	0.016	59,561	14.8	Lignite
		CFPP 10	8,400	12	0.01	3.628,800	0.0222		163,372	14.8	Lignite
		CFPP 11	4,348	18.8	0.0001	29,427	0.0008		38,780	14.8	Lignite
		CFPP 11	8,112	9.13	0.01	2.666,252	0.0169		157,771	14.8	Lignite
		CFPP 11	8,112	18.8	0.01	5.490,202	0.0348		157,771	14.8	Lignite
8	H	CFPP 12	1,285	547.91	0.0003	760,389	0.0113	0.014	67,344	14.8	Lignite
		CFPP 12	1,240	544.93	0.001	2.432,568	0.0408		59,656	14.8	Lignite
		CFPP 12	1,029	534.58	0.0004	792,119	0.0160		49,505	14.8	Lignite
		CFPP 12	569	354.29	0.0002	145,146	0.0049		29,820	14.8	Lignite
		CFPP 12	720	354.14	0.0002	183,586	0.0049		37,733	14.8	Lignite
		CFPP 12	971	345.86	0.0002	241,798	0.0048		50,888	14.8	Lignite
9	I	CFPP 13	8,760	3.73	0.01	1.176,293	0.0105	0.016	111,847	14.8	Lignite
		CFPP 13	8,760	7.32	0.01	2.308,435	0.0206		111,847	14.8	Lignite
10	J	CFPP 14	3,798	140	0.01	19.141,920	0.1570	0.157	121,935	15.18	Lignite
11	K	CFPP 15	6,707	22.39	0.008	4.324,888	0.2310	0.225	18,722	15.6	Lignite
		CFPP 16	6,133	23.87	0.008	4.216,168	0.2193		19,225	15.6	Lignite

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm³/s	mg/Nm³	gHg/period	gHg/ tcoal	gHg/tcoal$_{ave}$	t coal/ period	TJ/Gg	
12	L	CFPP 17	7,457	1,255.8	0.0002	6,742.440	0.0055	0.004	1,230,826	15.61	Lignite
		CFPP 17	4,465	1,262.9	0.0002	4,059.971	0.0055		736,977	15.61	Lignite
		CFPP 17	2,843	598	0.0002	1,224.082	0.0026		469,256	15.61	Lignite
		CFPP 17	8,460	906.26	0.0002	5,520.211	0.0040		1,396,378	15.61	Lignite
		CFPP 18	5,251	1,071.2	0.0002	4,049.907	0.0051		797,011	15.67	Lignite
		CFPP 18	3,048	1,210.3	0.0002	2,656.076	0.0057		462,634	15.67	Lignite
		CFPP 18	717	605	0.0002	312.325	0.0029		108,828	15.67	Lignite
		CFPP 18	8,460	867.91	0.0002	5,286.613	0.0041		1,284,081	15.67	Lignite
13	M	CFPP 19	5,197	205.78	0.001	3,849.979	0.0122	0.012	314,431	15.77	Lignite
		CFPP 20	6,977	260.2	0.001	6,535.495	0.0156		420,070	15.77	Lignite
		CFPP 19	5,387	172.34	0.001	3,342.224	0.0103		325,926	15.77	Lignite
		CFPP 20	5,910	191.56	0.001	4,075.631	0.0115		355,829	15.77	Lignite
		CFPP 19	5,387	187.86	0.001	3,643.207	0.0112		325,926	15.77	Lignite
		CFPP 20	5,910	193.73	0.001	4,121.799	0.0116		355,829	15.77	Lignite
14	N	CFPP 21	2,590	92.8	0.013	11,248.474	0.0862	0.042	130,535	15.85	Lignite
		CFPP 22	2,157	85.5	0.012	7,967.095	0.0768		103,790	15.85	Lignite
		CFPP 21	4,362	52.6998	0.0005	413.778	0.0019		219,844	15.85	Lignite
		CFPP 22	3,088	58.7153	0.0005	326.363	0.0022		148,588	15.85	Lignite
15	O	CFPP 23	5,862	756	0.0002	3,190.804	0.0017	0.002	1,859,074	15.85	Lignite
		CFPP 23	1,956	942.993	0.0002	1,328.036	0.0021		620,326	15.85	Lignite
16	P	CFPP 24	2,258	47.14	0.0001	38.319	0.0027	0.001	14,067	15.96	Lignite
		CFPP 25	3,376	60.89	0.0001	74.003	0.0005		136,379	15.96	Lignite
		CFPP 24	6,166	12.9	0.0001	28.635	0.0007		38,414	15.96	Lignite
		CFPP 25	6,512	12.9	0.0001	30.242	0.0001		263,062	15.96	Lignite
		CFPP 24	2,807	14.6	0.0001	14.754	0.0008		17,487	15.96	Lignite
		CFPP 25	3,151	14.6	0.0001	16.562	0.0001		127,290	15.96	Lignite
		CFPP 24	5,986	11.8	0.0001	25.429	0.0007		37,292	15.96	Lignite
		CFPP 25	4,410	11.8	0.0001	18.734	0.0001		178,149	15.96	Lignite
17	Q	CFPP 26	1,048	733	0.0005	1,382.731	0.0040	0.005	347,931	15.97	Lignite
		CFPP 26	2,184	1,029.85	0.0005	4,048.546	0.0056		725,077	15.97	Lignite
		CFPP 26	2,203	1,023.9	0.0006	4,872.208	0.0067		731,385	15.97	Lignite
18	R	CFPP 27	608	73.91	0.00038	61.474	0.0055	0.018	11,175	16	Lignite
		CFPP 27	650	61.63	0.0002	28.843	0.0023		12,303	16	Lignite
		CFPP 27	598	61.48	0.0002	26.471	0.0024		10,991	16	Lignite
		CFPP 27	744	182.28	0.0002	97.644	0.0069		14,082	16	Lignite
		CFPP 27	720	169.91	0.0023	1,012.935	0.0765		13,233	16	Lignite
		CFPP 27	744	162.05	0.0002	86.807	0.0062		14,082	16	Lignite
		CFPP 27	744	149.61	0.0002	80.143	0.0059		13,674	16	Lignite
		CFPP 27	696	677.93	0.0002	339.724	0.0266		12,792	16	Lignite
		CFPP 27	612	546.28	0.00026	312.927	0.0270		11,584	16	Lignite

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
19	S	CFPP 28	8,460	484.65	0.01	147,605.004	0.0525	0.040	2,812,486	16.05	Lignite
		CFPP 28	8,460	19.64	0.01	5,981.558	0.0021		2,812,486	16.05	Lignite
		CFPP 28	8,460	456.96	0.01	139,171.738	0.0495		2,812,486	16.05	Lignite
		CFPP 28	8,460	257.33	0.02	156,744.850	0.0557		2,812,486	16.05	Lignite
20	T	CFPP 29	2,184	475.43	0.005	18,690.104	0.0268	0.027	697,250	16.18	Lignite
21	U	CFPP 30	3,792	218	0.0045	13,391.827	0.0584	0.066	229,130	16.19	Lignite
		CFPP 31	3,408	226.26	0.0056	15,545.257	0.0756		205,681	16.19	Lignite
		CFPP 30	6,705	182.48	0.0037	16,297.398	0.0402		405,146	16.19	Lignite
		CFPP 31	5,058	250.71	0.0054	24,651.693	0.0808		305,263	16.19	Lignite
		CFPP 30	6,705	211.27	0.0092	46,916.644	0.1158		405,146	16.19	Lignite
		CFPP 31	5,058	226.25	0.0066	27,190.291	0.0891		305,263	16.19	Lignite
		CFPP 30	5,058	153.87	0.0037	10,366.616	0.0339		305,627	16.19	Lignite
		CFPP 31	5,058	151.41	0.0038	10,476.579	0.0343		305,263	16.19	Lignite
22	V	CFPP 32	7,285	14.6	0.03	11,486.988	0.0055	0.006	2,085,951	16.28	Lignite
		CFPP 33	6,956	15.4	0.03	11,569.219	0.0058		2,003,486	16.28	Lignite
23	W	CFPP 34	15,370	1,040.09	0.01	575,502.599	0.2083	0.096	2,762,205	16.68	Lignite
		CFPP 34	13,971	1,130.87	0.0001	5,687.779	0.0023		2,510,785	16.68	Lignite
		CFPP 34	11,043	1,345.12	0.0001	5,347.498	0.0027		2,002,588	16.86	Lignite
		CFPP 34	16,328	1,072.78	0.008	504,470.933	0.1704		2,960,994	16.86	Lignite
24	X	CFPP 35	3,446	572.05	0.008	56,772.988	0.0984	0.095	576,998	16.69	Lignite
		CFPP 35	7,565	543.09	0.008	118,324.104	0.0934		1,266,683	16.69	Lignite
		CFPP 36	7,990	541.28	0.008	124,555.023	0.0923		1,349,130	16.82	Lignite
25	Y	CFPP 37	25,202	1,313.09	0.01	1,191,329.790	0.2908	0.313	4,096,777	16.73	Lignite
		CFPP 37	19,269	1,456.47	0.01	1,010,329.935	0.3208		3,149,431	16.76	Lignite
		CFPP 37	24,081	1,444.56	0.01	1,252,312.177	0.3182		3,935,931	16.76	Lignite
		CFPP 37	25,148	1,480.29	0.01	1,340,147.985	0.3232		4,146,636	16.84	Lignite
26	Z	CFPP 38	2,154	288.32	0.0002	447.150	0.0014	0.026	329,843	16.87	Lignite
		CFPP 38	2,208	220.58	0.0022	3,857.362	0.0114		338,112	16.87	Lignite
		CFPP 38	1,982	382.57	0.015	40,945.702	0.1349		303,505	16.87	Lignite
		CFPP 38	2,184	188.1	0.0002	295.783	0.0009		334,437	16.87	Lignite
		CFPP 40	2,184	280.05	0.0002	440.373	0.0013		335,058	16.88	Lignite
		CFPP 40	378	303.47	0.0008	330.370	0.0057		57,991	16.88	Lignite
		CFPP 41	2,052	405.17	0.007	20,951.503	0.0631		332,073	16.88	Lignite
		CFPP 40	2,013	383.48	0.007	19,453.020	0.0630		308,824	16.88	Lignite
		CFPP 41	2,208	283.21	0.0002	450.236	0.0013		357,318	16.88	Lignite
		CFPP 40	2,108	222.6	0.0002	337.853	0.0010		323,399	16.88	Lignite
		CFPP 41	2,184	264.46	0.0002	415.858	0.0012		353,434	16.88	Lignite
27	AA	CFPP 42	2,208	22.5	0.0000009	0.161	0.0000	0.004	313,847	16.91	Lignite
		CFPP 42	4,368	20.22	0.014	4,451.376	0.0076	0.089	583,973	17.02	Lignite

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
28	AB	CFPP 44	3,625	15.2	0.001	1,986.210	0.0119	0.018	166,268	16.92	Lignite
		CFPP 45	4,079	209.5	0.001	3,076.382	0.0154		200,012	16.92	Lignite
		CFPP 44	389	305.9	0.001	428.382	0.0240		17,842	16.92	Lignite
		CFPP 45	686	302.8	0.001	747.795	0.0222		33,638	16.92	Lignite
29	AC	CFPP 46	6,772	596.249	0.01	145,360.736	0.1340	0.127	1,085,159	16.98	Lignite
		CFPP 47	1,264	531.721	0.01	24,195.432	0.1223		197,853	16.98	Lignite
		CFPP 48	1,297	532.782	0.01	24,876.657	01219		204,074	16.98	Lignite
		CFPP 46	1,440	532.782	0.01	27,619.419	0.1197		230,749	16.98	Lignite
		CFPP 48	7,156	511.768	0.01	131,839.625	0.1171		1,125,945	16.98	Lignite
		CFPP 47	6,616	621.72	0.01	148,078.783	0.1430		1,035,597	16.98	Lignite
		CFPP 48	5,692	512.83	0.01	105,085.021	0.1173		895,595	16.98	Lignite
		CFPP 46	5,315	599.43	0.01	114,694.936	0.1347		851,687	16.98	Lignite
		CFPP 47	5,152	622.36	0.01	115,430.354	0.1431		806,438	16.98	Lignite
		CFPP 48	3,811	538.471	0.01	73,876.067	0.1232		599,633	16.98	Lignite
		CFPP 46	4,363	529.428	0.01	83,156.197	0.1189		699,136	16.98	Lignite
		CFPP 47	4,188	543.69	0.01	81,971.054	0.1250		655,544	16.98	Lignite
30	AD	CFPP 49	2,184	440	0.0002	691.81	0.0015	0.001	449,433	17.29	Lignite
		CFPP 49	8,375	434	0.0002	2,617.020	0.0015		1,723,444	17.29	Lignite
		CFPP 49	2,070	812.475	0.0001	605.456	0.0014		42,974	17.29	Lignite
		CFPP 49	2,208	434	0.00007	241.485	0.0005		454,372	17.29	Lignite
		CFPP 50	3,060	441	0.0002	971.611	0.0016		618,823	17.3	Lignite
		CFPP 50	7,193	440	0.0002	2,278.742	0.0016		1,454,638	17.3	Lignite
		CFPP 50	1,371	783.367	0.0001	386.639	0.0014		277,257	17.3	Lignite
		CFPP 50	1,852	434	0.00007	202.550	0.0005		374,529	17.3	Lignite
31	AE	CFPP 51	7,288	23.26	0.0002	122.054	0.0018	0.002	66,902	17.408	Lignite
		CFPP 52	6,988	23.9	0.0002	120.250	0.0020		60,355	17.408	Lignite
32	AF	CFPP 53	3,898	94	0.0002	263.817	0.0037	0.004	71,427	17.4686	Lignite
		CFPP 53	1,372	93	0.0002	91.869	0.0037		25,140	17.4686	Lignite
		CFPP 53	6,825	99	0.0002	486.486	0.0039		125,061	17.4686	Lignite
		CFPP 53	5,545	96	0.0002	383.270	0.0038		101,606	17.4686	Lignite
	Average Hg input factor of lignite combustion							0.047			
33	AG	CFPP 54	741	120.71	0.00042	135.243	0.0144	0.090	9,391	17.7	Sub-bituminous
		CFPP 54	696	311.64	0.00149	1,163.459	0.1319		8,821	17.7	Sub-bituminous
		CFPP 54	740	140.73	0.00155	581.102	0.0620		9,379	17.7	Sub-bituminous
		CFPP 54	744	109.88	0.0002	58.861	0.0062		9,429	17.7	Sub-bituminous
		CFPP 54	385	310.12	0.00165	709.213	0.1453		4,879	17.7	Sub-bituminous

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
		CFPP 54	412	114.16	0.0002	33.864	0.0065		5,222	17.7	Sub-bituminous
		CFPP 54	717	175.18	0.0002	90.435	0.0100		9,087	17.7	Sub-bituminous
		CFPP 54	744	94.48	0.00016	40.489	0.0043		9,429	17.7	Sub-bituminous
		CFPP 54	744	206.03	0.009	4,966.477	0.5267		9,429	17.7	Sub-bituminous
		CFPP 55	744	116.52	0.0003	93.626	0.0108		8,648	17.79	Sub-bituminous
		CFPP 55	696	317.97	0.00037	294.781	0.0364		8,090	17.79	Sub-bituminous
		CFPP 55	744	124.73	0.00098	327.395	0.0379		8,648	17.79	Sub-bituminous
		CFPP 55	744	113.74	0.0002	60.928	0.0070		8,648	17.79	Sub-bituminous
		CFPP 55	450	321.01	0.0017	884.062	0.1690		5,230	17.79	Sub-bituminous
		CFPP 55	597	124.65	0.0002	53.580	0.0077		6,939	17.79	Sub-bituminous
		CFPP 55	647	84.64	0.0002	39.429	0.0052		7,520	17.79	Sub-bituminous
		CFPP 55	744	63.06	0.0007	118.230	0.0137		8,648	17.79	Sub-bituminous
		CFPP 55	744	194.37	0.007	3,644.204	0.4214		8,648	17.79	Sub-bituminous
34	AH	CFPP 56	1,440	85.004	0.0008	352.529	0.0039	0.022	90,720	18.3	Sub-bituminous
		CFPP 57	4,392	209.82	0.01	33,175.060	0.1176		282,049	18.3	Sub-bituminous
		CFPP 56	4,392	91.46	0.01	14,460.924	0.0523		276,697	18.3	Sub-bituminous
		CFPP 58	4,392	177.54	0.01	28,071.204	0.1002		280,224	18.3	Sub-bituminous
		CFPP 57	3,648	91.46	0.01	12,011.259	0.0513		234,270	18.3	Sub-bituminous
		CFPP 56	3,648	80.7	0.01	10,598.170	0.0461		229,825	18.3	Sub-bituminous
		CFPP 58	3,648	156.02	0.01	20,489.795	0.0880		232,754	18.3	Sub-bituminous
		CFPP 57	2,904	102.22	0.01	10,686.488	0.0573		186,492	18.3	Sub-bituminous
		CFPP 56	2,904	95.764	0.01	10,011.552	0.0547		182,953	18.3	Sub-bituminous
		CFPP 58	2,904	177.54	0.01	18,560.742	0.1002		185,285	18.3	Sub-bituminous
		CFPP 57	2,184	102.22	0.0008	642.956	0.0046		140,254	18.3	Sub-bituminous

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
		CFPP 56	2,184	95.764	0.0008	602.348	0.0044		137,593	18.3	Sub-bituminous
		CFPP 58	2,184	177.54	0.0008	1,116.712	0.0080		139,346	18.3	Sub-bituminous
		CFPP 57	1,440	91.46	0.0006	284.477	0.0031		92,475	18.3	Sub-bituminous
		CFPP 58	1,440	156.02	0.0008	647.046	0.0070		91,877	18.3	Sub-bituminous
		CFPP 57	744	91.46	0.0008	195.973	0.0041		47,779	18.3	Sub-bituminous
		CFPP 56	744	85.004	0.0008	182.140	0.0039		46,872	18.3	Sub-bituminous
		CFPP 58	744	156.02	0.0008	334.307	0.0070		47,470	18.3	Sub-bituminous
		CFPP 57	8,309	209.82	0.0008	5,020.976	0.0094		533,594	18.3	Sub-bituminous
		CFPP 56	8,398	91.46	0.0006	1,659.055	0.0031		529,077	18.3	Sub-bituminous
		CFPP 58	8,520	177.54	0.0008	4,356.406	0.0080		543,604	18.3	Sub-bituminous
		CFPP 57	7,565	102.22	0.0008	2,227.088	0.0046		485,816	18.3	Sub-bituminous
		CFPP 56	7,654	91.46	0.0008	2,016.100	0.0042		482,205	18.3	Sub-bituminous
		CFPP 58	7,776	156.02	0.0006	2,620.537	0.0053		496,134	18.3	Sub-bituminous
		CFPP 57	6,845	91.46	0.0008	1,803.006	0.0041		439,578	18.3	Sub-bituminous
		CFPP 56	6,934	80.7	0.0008	1,611.573	0.0037		436,844	18.3	Sub-bituminous
		CFPP 58	7,056	156.02	0.0008	3,170.526	0.0070		450,196	18.3	Sub-bituminous
		CFPP 57	6,101	102.22	0.0008	1,796.095	0.0046		391,799	18.3	Sub-bituminous
		CFPP 56	6,190	95.764	0.0008	1,707.204	0.0044		389,972	18.3	Sub-bituminous
		CFPP 58	6,312	177.54	0.0008	3,227.422	0.0080		402,726	18.3	Sub-bituminous
		CFPP 57	5,381	91.46	0.0008	1,417.381	0.0041		345,562	18.3	Sub-bituminous
		CFPP 56	5,470	85.004	0.0008	1,339.119	0.0039		344,612	18.3	Sub-bituminous
		CFPP 58	5,592	156.02	0.0008	2,512.696	0.0070		356,788	18.3	Sub-bituminous
		CFPP 57	4,637	112.98	0.0004	754.399	0.0025		297,783	18.3	Sub-bituminous
		CFPP 56	4,726	95.764	0.0006	977.574	0.0033		297,740	18.3	Sub-bituminous
		CFPP 58	4,848	138.84	0.0008	1,938.517	0.0063		309,318	18.3	Sub-bituminous

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
35	AI	CFPP 59	2,115	763.23	0.00064	3,719.189	0.0092	0.011	404,892	18.41	Sub-bituminous
		CFPP 59	8,322	827.21	0.0002	4,956.510	0.0031		1,593,148	18.41	Sub-bituminous
		CFPP 60	3,491	739.02	0.0002	1,857.542	0.0026		711,030	18.44	Sub-bituminous
		CFPP 60	5,840	681.39	0.0007	10,027.880	0.0084		1,189,463	18.44	Sub-bituminous
		CFPP 61	3,548	1,170.58	0.0002	2,990.317	0.0041		722,640	18.44	Sub-bituminous
		CFPP 61	1,981	1,117.59	0.0002	1,594.041	0.0040		403,481	18.44	Sub-bituminous
		CFPP 61	1,464	1,207.67	0.0007	4,455.433	0.0149		298,181	18.44	Sub-bituminous
		CFPP 61	2,072	1,294.62	0.0002	1,931.366	0.0046		422,015	18.44	Sub-bituminous
		CFPP 62	3,522	722.6	0.0032	29,318.368	0.0412		711,602	18.45	Sub-bituminous
		CFPP 62	6,728	818.19	0.001	19,817.216	0.0146		1,359,357	18.45	Sub-bituminous
		CFPP 63	3,350	870.43	0.0007	7,348.170	0.0110		666,376	18.46	Sub-bituminous
		CFPP 63	7,078	785.18	0.0008	16,005.612	0.0114		1,407,943	18.46	Sub-bituminous
36	AJ	CFPP 64	2,106	1,011.47	0.005	38,342.805	0.1361	0.233	281,709	18.62	Sub-bituminous
		CFPP 64	2,106	1,074.14	0.005	40,718.499	0.1445		281,709	18.62	Sub-bituminous
		CFPP 64	8,208	1,015.45	0.016	480,085.263	0.4171		1,150,912	18.62	Sub-bituminous
37	AK	CFPP 65	1,830	132.1	0.00007	60.919	0.0006	0.00003	105,947	18.67	Sub-bituminous
		CFPP 68	938	8.53	0.00007	2.016	0.00004		45,548	18.935	Sub-bituminous
38	AL	CFPP 66	1,841	167	0.0002	221.362	0.0041	0.002	53,555	18.7	Sub-bituminous
		CFPP 66	6,043	129	0.0001	280.637	0.0016		170,805	18.7	Sub-bituminous
		CFPP 67	6,043	146.52	0.0001	318.751	0.0019		168,722	18.7	Sub-bituminous
		CFPP 66	3,151	115.272	0.0001	130.760	0.0015		87,977	18.7	Sub-bituminous
		CFPP 67	3,648	142.56	0.0001	187.221	0.0018		101,853	18.7	Sub-bituminous
39	AM	CFPP 69	1,718	29.23	0.0005	90.391	0.0002	0.001	544,775	19.03	Sub-bituminous
		CFPP 69	1,737	34.2	0.005	1,069.297	0.0019		550,800	19.03	Sub-bituminous
		CFPP 69	2,195	39.3	0.005	1,552.743	0.0022		696,031	19.03	Sub-bituminous

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
40	AN	CFPP 70	2,978	735.89	0.0008	6,311.464	0.0078	0.008	812,041	19.13	Sub-bituminous
		CFPP 70	7,298	960.27	0.0003	7,568.694	0.0038		1,990,019	19.13	Sub-bituminous
		CFPP 71	2,764	896.56	0.001	8,921.131	0.0120		743,183	19.14	Sub-bituminous
		CFPP 71	7,207	928.43	0.0002	4,817.660	0.0025		1,937,814	19.14	Sub-bituminous
		CFPP 72	3,544	827.43	0.00101	10,662.250	0.0112		949,302	19.17	Sub-bituminous
		CFPP 72	6,354	1,040.87	0.0006	14,285.566	0.0084		1,701,994	19.17	Sub-bituminous
41	AO	CFPP 73	4,301	131	0.00008	162.268	0.0014	0.003	113,015	19.37	Sub-bituminous
		CFPP 73	2,184	170	0.0002	267.322	0.0047		57,388	19.37	Sub-bituminous
42	AP	CFPP 74	7,879	657.75	0.03	559,700.523	0.2686	0.269	2,084,109	19.38	Sub-bituminous
43	AQ	CFPP 75	4,700	180.39	0.01	30,521.988	0.1054	0.114	289,462	19.418	Sub-bituminous
		CFPP 76	4,156	180.39	0.01	26,989.230	0.1217		221,737	19.418	Sub-bituminous
		CFPP 76	5,523	180.39	0.01	35,866.583	0.1217		294,672	19.418	Sub-bituminous
		CFPP 75	6,812	180.39	0.01	44,237.400	0.1054		419,535	19.418	Sub-bituminous
		CFPP 76	1,885	180.39	0.01	12,241.265	0.1217		100,571	19.418	Sub-bituminous
		CFPP 75	268	180.39	0.01	1,740.403	0.1054		16,506	19.418	Sub-bituminous
		CFPP 76	2,903	180.39	0.01	18,852.198	0.1217		154,885	19.418	Sub-bituminous
		CFPP 75	2,304	180.39	0.01	14,962.268	0.1054		141,898	19.418	Sub-bituminous
44	AR	CFPP 76	7,298	191.49	0.01	50,309.785	0.1622	0.163	310,210	20.23	Sub-bituminous
		CFPP 76	5,129	192.34	0.01	35,514.427	0.1629		218,014	20.23	Sub-bituminous
		CFPP 77	1,141	173.28	0.01	7,117.649	0.1466		48,566	20.23	Sub-bituminous
		CFPP 77	5,468	206.88	0.01	40,723.914	0.1750		232,741	20.23	Sub-bituminous
		CFPP 77	5,468	197.47	0.01	38,871.575	0.1670		232,741	20.23	Sub-bituminous
45	AS	CFPP 78	7,560	20.6	0.03	16,819.488	0.0065	0.007	2,570,380	20.32	Sub-bituminous

No	Unit	CFPP	Operating time	Flowrate	Hg emission concentration	Hg emission rate	Hg input factor	Hg input factor, specific CFPP	Coal use	Coal net calorific value	Coal type
			hour/ period	Nm^3/s	mg/Nm^3	gHg/period	gHg/ tcoal	$gHg/tcoal_{ave}$	t coal/ period	TJ/Gg	
46	AT	CFPP 79	4,271	696.96	0.008	85,729.425	0.0846	0.041	1,012.839	21.4	Sub-bituminous
		CFPP 80	8,640	887.1	0.000027	744.994	0.0004		2,048.919	21.4	Sub-bituminous
		CFPP 80	7,858	1,026.62	0.0003	8,712.554	0.0047		1,863.473	21.4	Sub-bituminous
		CFPP 81	8,605	813.251	0.008	201,543.116	0.0988		2,040.619	21.4	Sub-bituminous
		CFPP 82	8,605	686.44	0.008	170,116.307	0.0749		2,270.043	21.52	Sub-bituminous
		CFPP 83	8,640	919.85	0.000034	972.774	0.0004		2,279.276	21.52	Sub-bituminous
		CFPP 83	8,441	886.04	0.0004	10,769.852	0.0048		2,226.779	21.52	Sub-bituminous
		CFPP 84	7,890	525.992	0.008	119,522.214	0.0574		2,081.422	21.52	Sub-bituminous
Average Hg input factor of sub-bituminous coal combustion								0.069			

Source: (MoEF 2020) (MoEMR, 2018)

Table 2.8. **Input Factor Determination for Sub Bituminous and Lignite Coal Combustion**

Type of emission control	Sub bituminous coal				Lignite coal			
	Emission factor to air: EF_{SB} = 0.069				Emission factor to air: EF_L = 0.047			
	Output distribution factor to air	% Type of unit control	Input factor	Proportion of input factor from each type of control	Output distribution factor to air	% Type of unit control	Input factor	Proportion of input factor from each type of control
	ODF	%	$IF=EF_{SB}/ODF$	IFp=IF*%				
Level 0: None	1	7.14	0.069	0.0049	1	4.04	0.047	0.0018
Level 1: Particulate matter simple APC: ESP/PS/ CYC	0.9	47.62	0.077	0.0365	0.98	65.66	0.0479	0.0315

Type of emission control	Sub bituminous coal				Lignite coal			
	Emission factor to air: EF_{SB} = 0.069				Emission factor to air: EF_L = 0.047			
	Output distribution factor to air	% Type of unit control	Input factor	Proportion of input factor from each type of control	Output distribution factor to air	% Type of unit control	Input factor	Proportion of input factor from each type of control
	ODF	%	$IF=EF_{SB}/ODF$	IFp=IF*%				
Level 2: Particulate matter (FF)	0.5	7.14	0.138	0.0098	0.95	22.22	0.0494	0.0111
Level 3: Efficient APC: PM+SDA/ wFGD	0.6	38.1	0.115	0.0438	0.8	8.08	0.0587	0.0047
Level 4: Very efficient APC: PM+FGD+SCR	0.75				0.8			
Level 5: Mercury specific filters	0.25				0.25			
	Input factor = $\Sigma_1^5 IF_p$			0.0951	Input factor = $\Sigma_1^5 IF_p$			0.049129

As comparison, a study of mercury emissions from coal fired power plants by BSCRC-SEA in 2017 stated that the minimum and maximum value of the mercury content of coal samples from 44 CFPP varied between 0.011 mg/kg and 0.23 mg/kg. The average value of mercury content of coal samples and considered as the input factor from this study was 0.056 mg/kg (g/t). The value of this input factor is typical to the lignite input factor from current calculations based on actual emissions data.

Data gaps and priorities for follow up

- There was no information available on the mercury content of coal that was used during the measurement of mercury emissions from each of the CFPP. The input factor was indirectly determined from each emission factor and default output distribution factor relevant to the installed air pollution control devices.
- The coal quality or characteristics usually fluctuates, because most of the CFPPs use combined coal which originates from several mining sites, single coal supplier was only applied in a few CFPPs.
- Since the GoI only set the new regulation No. 15/2019 for mercury emission standard from CFPPs in April 2019, limited data of emission concentrations has been available up to now. However, the mercury input factor in terms of g Hg/t coal from this sub sector had already been generated from 46 different units with 84 CFPPs out of 141 CFPPs. More refined data can be derived once all of the CFPPs have already conducted the mercury emission measurements.
- The emission standard regulation does not mention the speciation of Hg to be measured, therefore the mercury measurement was mostly conducted by using reference method 29 from the USEPA, the measurement of metals from stationary sources. Thermal power plants with capacity ≥25 MW, or with capacity <25 MW but using coal with sulfur content higher than 2% must install continuous emission monitoring systems (CEMS) for mercury measurement. However, up until the end of 2019, no power plants had installed CEMS for mercury measurement yet.

- Although there is no specific guideline regarding the installation, operation and maintenance of CEMS, as well as quality assurance and quality control of CEMS for measuring mercury issued by official standardization bodies in Indonesia such as the Indonesian National Standard (SNI), MoEF has already issued several important provisions which can be referred to within regulation No. 15/2019. The government has also pointed out that most commercial CEMS have their own requirements for calibration and maintenance. For example, in the European Union, the European Committee for Standardization has established the standard EN 14181 for the Quality Assurance of automatic monitoring systems. The EN 14181 is a relatively complex standard but can be simplified into two main parts, the Quality Assurance Level (QAL) and the Annual Surveillance Test (AST). The QAL1 deals with equipment certification to ensure that the equipment used is appropriate for mercury measurement; the QAL2 is a tool for calibration against standard methods, in this case related to the correct preparation of equipment at the emission source; and the QAL3 ensures the measurement range is within the predetermined limits, which indicates that the CEMS continues to function properly, finally the AST is an annual check tool to ensure the performance of the CEMS. If this CEMS for mercury measurement in power plant has been installed, more data measurement can be derived to refine the value of input factors as well as the output distribution factors.

Priorities for follow up

- Collect information on coal characteristic (especially for calorific values and mercury content) that was used during mercury emission measurement.
- Collect more information on mercury emissions, this information will be abundantly available when mercury-CEMS has already been installed by the CFPPs.

Summary of Inputs and Results

Summary of inputs and results of mercury released from coal combustion in large power plants is shown in **Table 2.9.**

Table 2.9. **Summary of Inputs and Results of Mercury Released from Coal Combustion in Large Power Plants**

Coal combustion (power plant)	Unit	Combustion of sub-bituminous coal				Combustion of sub lignite coal				Sum of releases to pathway from assessed part of life-cycle
		Type of control				Type of control				
		Level 0	Level 1	Level 2	Level 3	Level 0	Level 1	Level 2	Level 3	
Activity rate	t coal / year	31,579,699.46				65,218,945				
Input factor for phase	g Hg/ t coal	0.951				0.0491				
Calculated input to phase	kg Hg/y	214	1,430	214	1,144	129	2,104	712	259	
Output distribution factors for phase:										
▸ Air		1	0.9	0.5	0.6	1	0.98	0.95	0.8	
▸ Water										
▸ Land										
▸ Products										
▸ General waste treatment										

Coal combustion (power plant)	Unit	Combustion of sub-bituminous coal				Combustion of sub lignite coal				Sum of releases to pathway from assessed part of life-cycle
		Type of control				Type of control				
		Level 0	Level 1	Level 2	Level 3	Level 0	Level 1	Level 2	Level 3	
▸ Sector specific waste treatment			0.1	0.5	0.4		0.02	0.05	0.2	
Calculated outputs/releases to:										
▸ Air	kg Hg/y	214	1,287	107	686	129	2,062	676	207	5,370
▸ Water	kg Hg/y									
▸ Land	kg Hg/y									
▸ Products	kg Hg/y									
▸ General waste treatment	kg Hg/y									
▸ Sector specific waste treatment	kg Hg/y		143	107	458		42	36	52	837

2.2.2. Coal Combustion in Coal Fired Industrial Boilers and Other Coal Use

Data description

Coal combustion in coal fired industrial boilers

Coal combustion in coal fired industrial boilers usually exists in some industries which require steam or hot water, other heating processes and for generation of mechanical power and/or electricity. The first option for the industries is to utilize the energy source which is supplied by the State Electricity Company (*Perusahaan Listrik Negara*, PLN) and/or private power company. However, some industries might need extra energy for their own purposes which are related to their specific processes. Therefore, most of these industrial boilers are used for providing steam or heat purposes, not for electricity. According to the Ministry of Industry (2019), various industrial sectors use such boilers, such as the food and beverage industry, palm oil, pharmaceuticals, sugar, rubber, chemicals and petrochemicals, paper and pulp, health services such as electricity, clinics and also the tourism sector.

Other coal use

Coal is also used in coal processing plants to process coking coal, steam coal, sub-bituminous coal, and lignite to produce coke, blast furnace gas, and briquettes. Briquettes are the fuel produced by briquetting sub-bituminous coal, lignite, or peat through the process of carbonization or powdering. Briquettes are more convenient to use and are of better quality than the raw materials they are manufactured from. The product from this type of coal processing plant is then utilized by industry.

Background calculations and approximations

Coal combustion in coal fired industrial boilers

The amount of coal combusted in coal fired industrial boilers was derived from the Handbook of Energy and Economic Statistics of Indonesia (MoEMR, 2019), which was 39,151,543 tonnes. Since the mercury emission standard was only available for thermal power plants, there was no information available regarding the emissions of mercury from industrial boilers. However, the combustion process is similar to that in a coal fired power plant, therefore

the input factor from previous calculations of coal combustion in large power plants were used for this sub-category. However, the type of boiler used in this sub sector is different from the type of boiler used for the thermal power plants. Most of the coal fired boilers (thermal power plants) use the pulverized or fluidized boiler as depicted in **Figure 2.8**, while the simpler boiler type such as grate chain boilers are mostly utilized in industrial coal boilers
.

Other coal use

The amount of other coal use was also derived from the Handbook of Energy and Economic Statistics of Indonesia (MoEMR, 2019), which was 7,857 tonnes for coke and other processed coal (blast furnace gas, and briquette) production, and 7,717 tonnes for other coal combustion (combustion of coal products) in Industry.

Data gaps and priorities for follow up

Several data gaps for this sub sector can be identified as follows:

- The input factor from coal combustion in large power plants was applied for this source sub-category.
- There is no information available for the type of coal that is used in this sector, thus the assumption is that the coal type is similar to the coal combustion in large power plants.
- The emission standard of mercury from industrial coal boiler is also not regulated by the GoI, the mercury emission measurement from this sub-category is not available.
- Lack of information related to the air pollution control devices.

Priorities for follow up

- Collect information and/or conduct measurement on the characteristics of coal (calorific values and mercury content) used in this source sub-category.
- Collect information on the air pollution control devices that are used by this source sub-category.
- Collect information and/or measure the mercury content within the coal processing product (charcoal, coke).

Summary of inputs and results

Summary of inputs and results of coal combustion in coal fired industrial boilers and other coal use is shown in **Table 2.10.**

Table 2. 10. **Summary of Inputs and Results of Coal Combustion in Coal Fired Industrial Boilers and Other Coal Use**

Coal Combustion in Coal Fired Industrial Boilers and Other Coal	Unit	Coal Combustion in Coal Fired Industrial Boiler		Other Coal Use		Sum Of Releases to Pathway from Assessed Part of Life-Cycle
		Combustion Of Sub Bituminous Coal	Combustion Of Lignite Coal	Coal Processing Plant	Combustion Of Coal Product	
Activity rate	t coal/year	12,772,844	26,378,700	7,857	7,717	
Input factor for phase	g Hg/t coal	0.0951	0.0491	0.0491	0.0491	
Calculated input to phase	kg Hg/y	1,215	1,296	0.386	0.379	2,511.47
Output distribution factors for phase:						
▸ Air		0.95	0.95	1.00	1.00	
▸ Water		0.00	0.00	0.00	0.00	
▸ Land		0.00	0.00	0.00	0.00	
▸ Products		0.00	0.00	0.00	0.00	

Coal Combustion in Coal Fired Industrial Boilers and Other Coal	Unit	Coal Combustion in Coal Fired Industrial Boiler		Other Coal Use		Sum Of Releases to Pathway from Assessed Part of Life-Cycle
		Combustion Of Sub Bituminous Coal	Combustion Of Lignite Coal	Coal Processing Plant	Combustion Of Coal Product	
▸ General waste treatment		0.00	0.00	0.00	0.00	
▸ Sector specific waste treatment		0.05	0.05	0.00	0.00	
Calculated outputs/releases to:						
▸ Air	kg Hg/y	1,154.00	1,231.16	0.39	0.38	2,385.93
▸ Water	kg Hg/y	0.00	0.00	0.00	0.00	
▸ Land	kg Hg/y	0.00	0.00	0.00	0.00	
▸ Products	kg Hg/y	0.00	0.00	0.00	0.00	
▸ General waste treatment	kg Hg/y	0.00	0.00	0.00	0.00	
▸ Sector specific waste treatment	kg Hg/y	60.74	64.80	0.00	0.00	125.54

2.2.3. Mineral Oils - Extraction, Refining and Use

Data description

Extraction

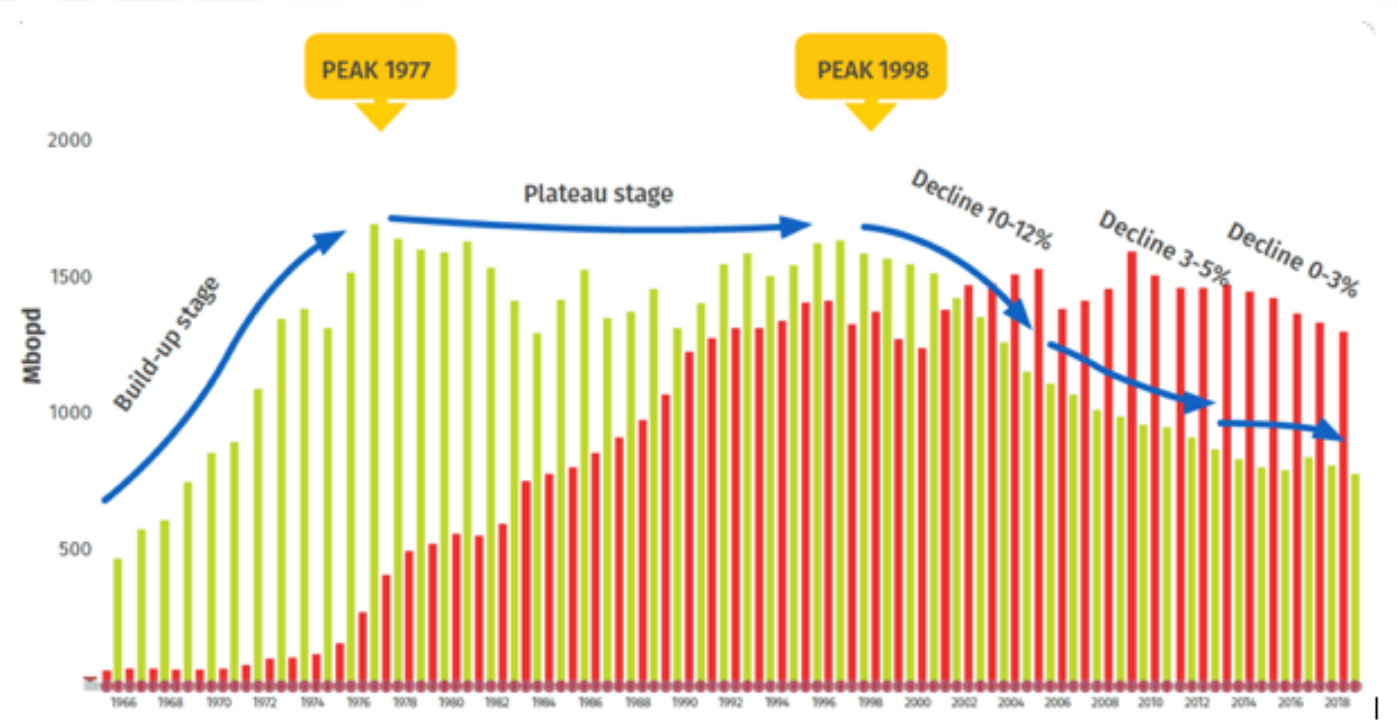
Indonesia has oil and gas reserve across almost the entire region from east to west of the territory as depicted in **Figure 2.13** (SKKMIGAS, 2020), with total reserve of 2.5 BSTB oil and 50 TSCF. To increase the status of resources to become proven resources, a massive exploration program is needed. Along with the increasingly mature oil fields and gas fields in Indonesia, no significant oil and gas reserves have been found yet, therefore efforts to hold back the pace of natural production decline is a challenge. Some of the main projects in Indonesia such as the Merakes Field (ENI Sepinggan B.V.), Field Masela (Inpex Masela Ltd.) and Jambaran Field Tiung Biru (Exxon Mobil Cepu Ltd.) are expected to increase the national oil and gas production. However, innovative activities and a new breakthrough that can have direct impact on increasing the production are required.

The Special Task Force for the Implementation of Upstream Oil and Gas Business Activities in Indonesia (SKKMIGAS, 2020) through their annual report, have presented the fluctuation of oil and gas extraction (production) in 2019 which can be seen in **Figure 2.14**. The average production of oil and gas throughout the year was 745.27 MBOPD (thousand-barrel oil per day) and 1,292 MBOPD respectively. Most of the national petroleum production is generated from old oil and gas fields that are experiencing a natural production decline of about 7-12% per year. To push down the overall natural production decline rate, various efforts have been done such as through intensification initiatives (among others were to increase seismic and enhanced oil recovery activities) as well as business expansion efforts by proposing new blocks for exploration to the Directorate General of Oil and Gas.

Figure 2.13. **Map of Indonesian Oil and Gas Reserves (SKKMIGAS, 2020)**

Source: SKKMIGAS, 2020

Figure 2.14. **National Oil and Gas Production 1966-2019 (SKKMIGAS, 2020)**



source: SKKMIGAS, 2020

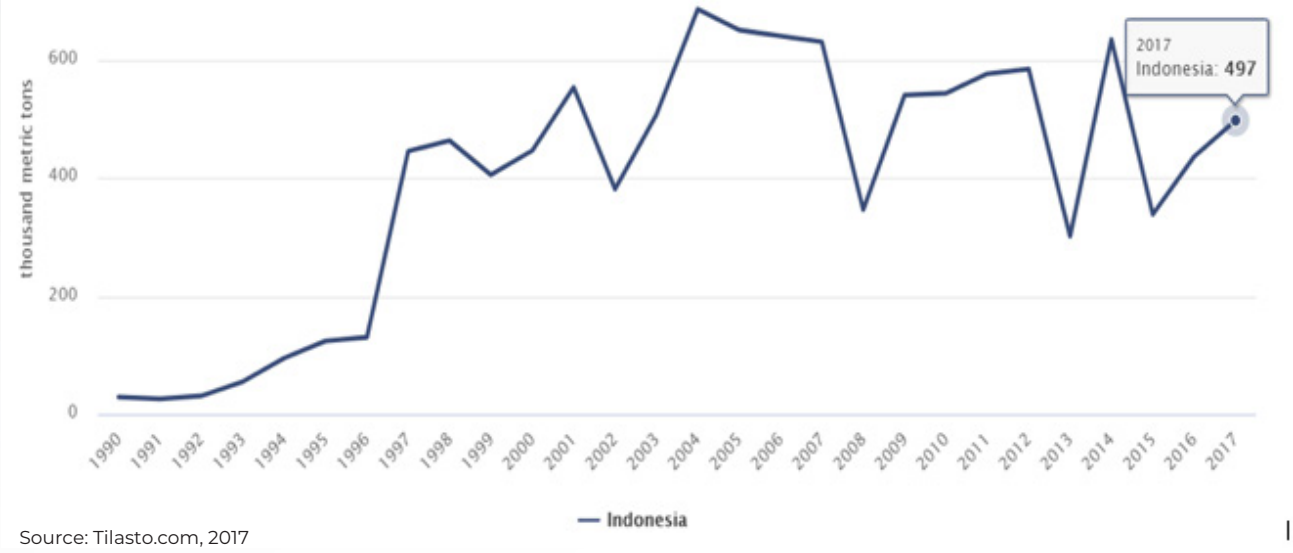
Refining

Indonesia's oil consumption is showing a steady upward trend due to a growing population, an expanding middle class and a growing economy, demand for fuel is increasing continuously. As domestic production cannot meet domestic demand, Indonesia imports about 75,296 thousand BOE crude oil, based on the Indonesia energy balance from the Handbook of Energy and Economic Statistics of Indonesia (MoEMR, 2019). Refinement of crude oil in 2019 was 334,963 thousand BOE, higher than the total production of 272,025 thousand BOE.

Use of heavy oil and petroleum coke:

Diesel Oil is a refinery product containing heavy gasoil. This type of fuel is obtained from the lowest fraction of crude oil distilled at atmospheric pressure, while the heavy gasoil is obtained from the vacuum residue of crude oil distilled at atmospheric pressure. On the market, diesel oil is divided into Gasoil CN 48 (diesel oil) and Industrial Diesel Oil (IDO). Fuel Oil (FO) is oil made from the distillation of residue. This type of fuel includes all kinds of residues including those from blending. FO has a viscosity of about 10 cSt at SOT. Its flash point is higher than SOT and its density is more than 0.9. Based on the handbook of energy (MoEMR, 2019), the amount of heavy oil which was consumed in 2019 was 333,792 m^3 of Gasoil CN 48, 62,200 m^3 of IDO, and 1,521,869 m^3 of IFO. The production of petroleum coke is shown in **Figure 2.15** below:

Figure 2.15. **Indonesia Petroleum Coke Production**



Source: Tilasto.com, 2017

The energy balance table from the Handbook of Energy and Economic Statistics (MoEMR, 2019) contains petroleum products used for energy, namely Avgas, Avtur, Mo-gas (Motor gasoline), Gasoil, Marine Diesel Fuel (MDF/IDO), Fuel Oil, and Kerosene.

- Avgas (aviation gasoline) is aircraft fuel that consists of light hydrocarbons distilling between 100°C and 250°C. The distilled product contains at least 20% of the volume at 143°C.
- Avtur is jet aircraft fuel which consists of hydrocarbon middle distillates having similar distillation and flash point characteristics as those of kerosene, with a maximum aromatic content of 20% of the volume. It has a freezing point of less than –47°C and octane number between 80–145 RON.
- Mo-gas is a light hydrocarbon used in the internal combustion engine of motorized vehicles (excluding aircraft). Mo-gas is distilled at a temperature between 35°C and 215°C and processed by Reformer, Catalytic Cracking, or Blending with aromatic fraction to achieve a high-octane number. In the Indonesian markets, three gasoline types are available, namely RON 88, RON 92, and RON 95.
- Diesel Oil is a refinery product containing heavy gasoil. This type of fuel is obtained from the lowest fraction of crude oil distilled at atmospheric pressure, while the heavy gasoil is obtained from the vacuum residue of crude oil distilled at atmospheric pressure. On the market, diesel oil is divided into Gasoil CN 48 (diesel oil) and Industrial Diesel Oil (IDO). Fuel Oil (FO) is oil made from the distillation of residue. This type of fuel includes all kinds of residues including those from blending.
- Kerosene is the fuel produced from crude oil distillation having volatility between the volatility of gasoline and that of gasoil. It has a distillation range between 150°C and 300°C, where a minimum of 65% of the volume is distilled at 250°C. It has specific gravity of 0.8 and flash point of over 38°C.
- These petroleum products were utilized in the power plant (17,549 thousand BOE), industry (26,685 thousand BOE), transportation (414,598 thousand BOE), household (2,871 thousand BOE), commercial (2,391 thousand BOE) and another sector (11,782 thousand BOE). Additional oil was in the form of biofuel, with total amount produced of 4,433 (thousand BOE). Overall, the total consumption of light oils was 480,309 thousand BOE.

Background calculations and approximations

Oil extraction is known to potentially cause significant releases of mercury and focus has increased on mercury releases from this sector in recent years. Mercury may be released to air, land or water during extraction, refining as well as through refinery products or by-products and various process wastes and sludges. Combustion of oil products releases mercury primarily to air in the form of air emissions. Generally, no air pollution abatement systems are used on oil combustion facilities (some large combustion units designed for oil use may have emission reduction equipment).

Extraction

The average production of oil throughout the year was 745.27 MBOPD or 272,025 thousand BOE (43,248,520 m^3) in 2019. Using the density of oil of 850 kg/m^3, the amount of oil extraction was approximately 36,761,242 tonnes.

The mercury content in Indonesian oil and gas data is still hard to find. However, some information was able to be taken from public documents such as environmental impact assessment documents of some recent activities related to oil and gas exploration and refinery in Indonesia. According to these documents, the specific product condensate and/or crude oil generically has mercury content up to 30 ppb (mg Hg/t). This value was set to become the input factor for this source sub-category.

Refining

The refinery of crude oil in 2019 was 334,963 thousand BOE or 53,254,863 m^3, using the density of oil of 850 kg/m^3, the amount of oil extraction was 45,266,634 m^3. The crude oil which goes to the refining process has approximately the same amount of mercury content as is within the crude oil (up to 30 ppb).

Use of heavy oil and petroleum coke:

Based on the handbook of energy (MoEMR, 2019), the amount of heavy oil which was consumed in 2019 was 333,792 m^3 of Gasoil CN 48, 62,200 m^3 of IDO, 1,521,869 m^3 of IFO. In this case, the total amount of heavy oil consumption was 1,917,862 m^3 or 1,630,183 tonnes (applying density of 859 kg/m^3). Adding the amount of petroleum coke consumption was 497,000 tonnes, the total amount of heavy oil and petroleum coke consumption in 2019 was 2,127,183 tonnes.

Since mercury is not defined in the standard and quality or specification of oil products, therefore there is no information available related to the mercury content within the petroleum products. For instance, the Decree of the Directorate General of Oil and Gas No. 3675K/24/DJM/2006 concerning the specification for diesel fuel does not contain mercury, but only other metals such as copper. The input factor from the UNEP toolkit was taken to calculate releases from this sector, which was 20 mg Hg/t combusted product.

Use of gasoline, diesel, light fuel oil, kerosene, LPG and other light to medium distillates

The total amount of light oil consumed in 2019 was 480,309 thousand BOE. Using the multiplier factor of 5.8275 (1 kilo litre to BOE), gave the amount of 82,421,107 m^3 or 65,936,885 tonnes (applying density of 800 kg/m^3). Part of 64,306,703 tonnes, there was the amount of heavy oil of 1,630,183 tonnes, therefore the final amount of light fuel consumption in 2019 was 64,306,703 tonnes.

Since mercury is not defined in the standard and quality or specification of oil products, therefore there is no information available related to this mercury content within the petroleum products. For instance, the Decree of the Directorate General of Oil and Gas No. 3675K/24/DJM/2006 concerning the specification for diesel fuel does not contain mercury, but other metals such as copper. The input factor from UNEP toolkit was taken to calculate release from this sector, which was 2 mg Hg/t combusted product.

Data gaps and priorities for follow up

Identified data gaps

Information related to mercury content during extraction, refining, as well as in other petroleum products was still difficult to find. The government should start to collect data from these sectors not only data related to the waste but also data related to mercury content within the raw materials and products.

Priorities for follow up

- Collect data of mercury content within the crude oil and petroleum products.

Summary of inputs and results

Summary of inputs and results of extraction, refining, and use of heavy oil and petroleum coke, and light to medium petroleum product (gasoline, diesel, light fuel oil, kerosene, LPG and other light to medium distillates) is shown in **Table 2.11.**

Table 2.11. **Summary of Inputs and Results of Extraction, Refining, and Use of Heavy Oil and Petroleum Coke, and Light to Medium Petroleum Product (Gasoline, Diesel, Light Fuel Oil, Kerosene, LPG and Other Light to Medium Distillates)**

Extraction, Refining, And Use of Oil	Unit	Extraction	Refining	Use Of Heavy Oil and Petroleum Coke	Use Of Light to Medium Petroleum Product	Sum Of Releases to Pathway from Assessed Part of Life-Cycle
Activity rate	t/year	36,761,242	45,266,634	2,127,183	64,306,703	
Input factor for phase	mg Hg/t	30	30	20	2	
Calculated input to phase	Kg Hg/y	1,103	1,358	42.5	128.6	948.5
Output distribution factors for phase:						
▸ Air		0.00	0.25	1	1	
▸ Water		0.2	0.01	0.00	0.00	
▸ Land		0.00	0.00	0.00	0.00	
▸ Products		0.00	0.00	0.00	0.00	
▸ General waste treatment		0.00	0.00	0.00	0.00	
▸ Sector specific waste treatment		0.00	0.15	0.00	0.00	
Calculated outputs/releases to:						
▸ Air	kg Hg/y		339.50	42.54	128.61	510.65
▸ Water	kg Hg/y	220.57	13.58			234.15
▸ Land	kg Hg/y					
▸ Products	kg Hg/y					
▸ General waste treatment	kg Hg/y		203.70			203.70
▸ Sector specific waste treatment	kg Hg/y		203.70			

2.2.4. Natural Gas Extraction, Refining and Use

Natural gas is a fossil fuel used for various purposes, especially combustion to produce electricity and heat. Like many other natural materials, natural gas contains small amounts of natural mercury impurities, which are mobilized to the biosphere during extraction, refining and combustion. The fate of the mercury content observed in natural gas is still poorly understood. This may be considered a major data gap in the description of mercury releases. In most countries, the gas delivered to consumers has been cleaned and contains - at that stage - only little mercury (UNEP, 2019).

Data description

Extraction/refining

As it has already been shown in **Figure 2.14**, the achievement of national gas production in 2019 reached 1,292 thousand BOPD (475,578 thousand BOE), and experienced a decrease in comparison to the level of production achieved in 2018. In 2019, there were several fields coming onstream such as the Benewangi Field (BOB BSP) in September 2019, Kedung Keris Field (Exxon Mobil Cepu Ltd) in November 2019, Gajah Putri Field, Bison Field and Field Iguana (Premier Oil) in November-December 2019, however, there are several fields that are no longer productive for economic reasons such as Kepodang Field (Petronas Muriah Ltd) in September 2019 and Akatara Square (Mandala Energy Lemang Ltd) in December 2019. Although in 2019 the rate of decline in production retained 3%-5% per year through development drilling activities, workover activities and activities on well care, yet a number of Fields targeted to contribute in the Year 2019 such as West Pangkah Field (Saka Pangkah Ltd), Randu Gunting Field (PHE Randu Gunting), Sidayu Field (Saka Pangkah Ltd), Field Source (PHE TEJ) and YY Field (PHE ONWJ) failed to contribute (SKKMIGAS, 2020).

Use of raw or pre-cleaned gas

According to the Handbook of Energy and Economic Statistics of Indonesia (MoEMR, 2019), only 380,634 thousand BOE of gas became the domestic primary energy supply, the rest of the raw natural gas was exported. The domestic uses of raw natural gas were 93,764 thousand BOE by power plants, 31,448 thousand BOE by own use and losses in primary energy production and transformation processes, 94,621 thousand BOE by various consumer industry, transportation, household, commercial, another sector. Additional gas consumption came from the use of 167 thousand BOE biogas by the industrial sector. In this case, the total amount of gas consumption was 220,000 thousand of BOE.

Use of pipeline gas (consumer quality)

The consumer quality gas was calculated from the amount of LPG and LNG domestic consumption. Most of the LPG in Indonesia was imported (48,715 thousand BOE). About 16,725 thousand BOE of LPG was produced from natural gas processing plants. The LNG was also derived from natural gas conversion. The industry sector consumed 959 thousand BOE LPG, households consumed 63,481 thousand BOE LPG, and the commercial sector consumed 1,758 thousand BOE LPG, or in total LPG consumption was 66,198 thousand BOE. The consumption of LNG was recorded at 1,574 thousand BOE by state owned power plants.

Background calculations and approximations

Extraction/refining

The average production of oil throughout the year was 475,578 thousand BOE in 2019, using the multiplication factor from MSCF to BOE of 0.1796, the amount of extracted gas was 2,647,985,900 MSCF. Appling the conversion factor 1 MSCF is equal to 28.32 m^3, the total amount of gas extraction/refining in 2019 would then become 74,982,610,508 Nm^3.

The mercury content varies considerably between different regions. It should be noted that it is unclear as to what extent the presented data sets represent regions with particularly high mercury content (UNEP, 2019). According to Muchlis (1981), Situmorang and Muchlis (1982) as cited in OilTracers (1999-2004), stated in the UNEP reference report and guideline (2019), the amount of mercury concentration in wellhead gas varied between 180-300 µg/Nm^3. The low end of this range was taken into account as the input factor because no further information could be found.

Use of raw or pre-cleaned gas

The total amount of raw gas usage was 220,000 thousand of BOE, using the multiplication factor from MSCF to BOE of 0.1796, the amount of extracted gas was 1,224,944,320.71 MSCF. Appling the conversion factor 1 MSCF is equal to 28.32 m^3, the total amount of gas consumption in 2019 would then become 34,686,560,413 Nm^3/year. The mercury content for this sector would be the same as the mercury content from extraction/refining activities, which is 180 µg/Nm^3.

Use of pipeline gas (consumer quality)

The total LPG consumption in 2019 was 66,198 thousand BOE. Using a multiplier factor of 1 ton LPG is equal to 8.5246 BOE, the amount of LPG consumption was 7,765,526 tonnes. Using the density of 1.898 kg/m^3, the volume of LPG gas was 4,091,425,530 Nm^3. The consumption of LNG was recorded at 1,574 thousand BOE by state own power plants. Using a multiplier factor of 1 ton LNG equals to 8.0532 BOE, the amount of LNG consumption was 195,450 tonnes. Using the density of 470 kg/m^3, the volume of LNG gas was 415,851.61 Nm^3. Adding all the gas volume from LPG and LNG consumption, the total value of gas in 2019 would be 4,091,841,381 Nm^3.

In the gas refinery plant, the raw gas from the feed receiving facility usually flows toward LNG trains, which has gas processing units such as Mercury Recovery Units (MRU), Acid Gas Absorption Units (AGRU), and, Gas Drying Units. The gas from the separator inlet flows to the Mercury Absorption Unit (MRU), where the mercury is removed to reach the specification of <0.01 µg/Nm^3. Mercury adsorption is usually carried out using a metal sulfide catalyst and this is replaced periodically according to the equipment lifetime design. The spent catalyst is usually sent to processing facilities abroad which have already been approved by the MoEF. Considering this information from the environmental impact assessment data, the input factor for gas consumer quality was set to be 0.01 µg/Nm^3.

Data gaps and priorities for follow up

Identified data gaps

Information related to mercury content during extraction/refining of gas as well as consumer quality gas was also still hard to find. The government should start to collect data from these sectors, not only data related to the waste of extraction/refining processes but also the mercury content within the raw materials and products.

Priorities for follow up

- Collect data on mercury content within the pre-cleaned gas and gas refining products.

Summary of inputs and results

Summary of inputs and results of extraction/refining, and use of raw gas and consumer quality gas is shown in **Table 2.12.**

Table 2.12. **Summary of Inputs and Results of Extraction/Refining, and Use of Raw Gas and Consumer Quality Gas**

Extraction, Refining, And Use of Raw Gas and Consumer Quality Gas	Unit	Extraction	Use Of Raw Pre-Cleaned Gas	Use Of Pipeline Gas (Consumer Quality)	Sum Of Releases to Pathway from Assessed Part of Life-Cycle
Activity rate	Nm^3/year	74,982,610,508	34,686,560,413	4,091,841,381	
Input factor for phase	µg Hg/t	180	180	0.01	
Calculated input to phase	Kg Hg/y	13,497	6,244	0.041	19,740.91
Output distribution factors for phase:					
▸ Air		0.1	0.1	1.0	
▸ Water		0.2	0.0	0.0	
▸ Land		0.0	0.0	0.0	
▸ Products		0.1	0.0	0.0	
▸ General waste treatment		0.0	0.0	0.0	
▸ Sector specific waste treatment		0.6	0.0	0.0	
Calculated outputs/releases to:					
▸ Air	kg Hg/y	1,349.69	6,244	0.041	7,593.73
▸ Water	kg Hg/y	2,699.37	0.00	0.00	2,699.37
▸ Land	kg Hg/y	0.00	0.00	0.00	0.00
▸ Products	kg Hg/y	1,349.69	0.00	0.00	1,349.69
▸ General waste treatment	kg Hg/y	0.00	0.00	0.00	0.00
▸ Sector specific waste treatment	kg Hg/y	8,098.12	0.00	0.00	8,098.12

2.2.5. Biomass-Fired Power and Heat Production

Data description

Biomass is a renewable, organic material-based fuel. Biomass includes firewood (wood, wood waste, charcoal), agriculture wastes (rice hulls, rice straw, palm fronds, coconut shell, etc.), urban solid waste, and industrial waste. The data of biomass consumption in the household sector has been calculated based on the approach of the National Socio-Economic Survey (*Survei Sosial Ekonomi Nasional*, SUSENAS) and the share of biomass use in the household sector.

According to the Handbook of Energy and Economic Statistics (MoEMR, 2019), the total amount of biomass used in 2019 was 61,393 thousand BOE, consisting of use by industry: 42,862 thousand BOE, by households 17,211 thousand BOE, and by the commercial sector 1,320 thousand BOE.

Background calculations and approximations

The total use of biomass in 2019 was 61,393 thousand BOE, using the multiplier of 1 tonne of biomass to BOE of 2.2979, the total weight of biomass would be 26,717,002 tonnes. Currently, there is no information available for the mercury content within biomass in Indonesia, therefore the suggested default input factor from UNEP toolkit level 2 was taken as the input factor from this sector (0.03 g Hg/t dry weight of biomass).

Data gaps and priorities for follow up

Similar to the previous data gaps for the fuel sector, information related to the mercury content within biomass is currently not available. The government should start collecting data from these sectors, not only data related to the waste from the combustion activities of this biomass, but also the mercury content data from within the raw materials.

Summary of inputs and results

Summary of inputs and results of extraction and use of other fossil fuels and biomass burning is shown in **Table 2.13.**

Table 2.13. **Summary of Inputs and Results of Other Fossil Fuels - Extraction and Use: Biomass Burning**

Extraction and Use of Other Fossil Fuels	Unit	Biomass burning	Sum of releases to pathway from assessed part of life-cycle
Activity rate	Nm^3/year	26,717,002	
Input factor for phase	g Hg/t (dry weight)	0.03	
Calculated input to phase	Kg Hg/y	802	802
Output distribution factors for phase:			
▸ Air		1.00	
▸ Water		000	
▸ Land		0.00	
▸ Products		0.00	
▸ General waste treatment		0.00	
▸ Sector specific waste treatment		0.00	
Calculated outputs/releases to:			
▸ Air	kg Hg/y	801.51	801.51
▸ Water	kg Hg/y	0.00	
▸ Land	kg Hg/y	0.00	
▸ Products	kg Hg/y	0.00	
▸ General waste treatment	kg Hg/y	0.00	
▸ Sector specific waste treatment	kg Hg/y	0.00	

2.2.6. Geothermal Power Production

Data description

Geothermal energy is energy produced from the magma inside the earth in volcanic areas. The hot high-pressure steam emitted from a production well-head can be utilized to propel a steam turbine in a geothermal power plant or be used directly for drying agricultural products.

Geothermal power in Indonesia is an increasingly significant source of renewable energy. As a result of its volcanic geology, Indonesia has 40% of the world's potential geothermal resources, estimated at 28,000 megawatts (MW). Although Indonesia generates 60% of its electricity from conventional thermal sources (coal, gas, and oil), it was the third-largest generator of geothermal power in 2019. Data from the Directorate General of Oil and Gas showed that the total power generated from geothermal power plants was 2,130.70 MW in 2019 as shown in **Table 2.14**.

Table 2.14. **Summary of Inputs and Results of Geothermal Power Plant Capacity in Indonesia (MoEMR, 2019)**

No.	Working Area	Location	Owner	Turbine Capacity	Total Capacity
1	PLTP Kamojang	West JAva	PT Pertamina Geothermal Energy (PGE)	1 × 30 MWe 2 × 55 MWe 1 × 60 MWe 1 × 35 MWe	235
2	PLTP Lahendong	North Sulawesi	PGE	4 × 20 MWe 2 x 20 MWe	120.0
3	PLTP Sibayak	North Sumatera	PGE	1 × 10 MWe 2 MWe (Monoblock)	12.0
4	PLTP Salak	West Java	PGE	3 × 60 MWe 3 × 65.6 MWe	376.8
5	PLTP Darajat	West Java	PGE	1 × 55 MWe 1 × 94 MWe 1 × 121 MWe	270.0
6	PLTP Wayang Windu	West Java	PGE	1 × 110 MWe 1 × 117 MWe	227.0
7	PLTP Dieng	Central Java	PT Geo Dipa Energy (GDE)	1 × 60 MWe	60
8	PLTP Ulubelu	Lampung	PGE	2 × 55 MWe 2 × 55 MWe	220.0
9	PLTP Ulumbu	NTT	PT PLN (Persero)	4 × 2.5 MWe	10.0
10	PLTP Mataloko	NTT	PT PLN (Persero)	1 × 2.5 MWe	2.5
11	PLTP Patuha	West Java	PT Geo Dipa Energy (GDE)	1 × 55 MWe	55
12	PLTP Sarulla	North Sumatera	PT PGE and Joint Operation Contract (JOC) Sarulla Operation Limited (SOL)	3 × 110 Mwe	330.0
13	PLTP Karaha	West Java	PGE	1 × 30 Mwe	30.0
14	PLTP Lumut Balai	West Java	PGE	1 × 55 MWe	55.0
15	PLTP Sorik Marapi	North Sumatera	PT Sorik Marapi Geothermal Power (SMGP)	1 × 42.4 Mwe	42.4
16	PLTP Muara Laboh	West Sumatera	PT Supreme Energi Muara Laboh (SEML)	1 × 85 Mwe	85.0
	Total				2,130.7

Source: MoEF, 2019

Background calculations and approximations

Data from the Handbook of Energy and Economic Statistics (MoEMR, 2019) recorded that the total energy production from geothermal in 2019 was 14,100 GWh, this was the value of activity data for the geothermal sector. The input factor for geothermal power plants was only published in a few publications as shown in **Table 2.15**, and it might not be suitable for Indonesia geothermal power plants. According to Robertson et.al. (1977), geothermal steam used for power production contains significant quantities of volatile mercury. Much of this mercury escapes to the atmosphere as elemental mercury vapor in cooling tower exhausts. Mercury emissions from geothermal power plants, on a per megawatt (electric) basis, are comparable to releases from coal-fired power plants.

Table 2.15. **Summary of Inputs and Results of Various Emission Factors for Geothermal Power Plants**

No.	Geothermal Power Plants	Emission factor	Unit	Source
1	Off gas ejectors	0.00075-0.02	g Hg/MWh	(US-EPA, 1997)
	Cooling tower exhaust	0.026-0.072	g Hg/MW	
2	Not specified	0.26-1.3. (default: 0.44)	g Hg/MWh	(EMEP/EEA, 2019)

The specific coal consumption for generating electricity is 0.3443 kg/kWh when utilizing coal with calorific value of 6,216 kJcal/kg (Bono et.al, 2017). The average calorific value of Indonesian coal according to **Table 2.6** was 16.8 TJ/Gg or 4,018.6 kcal/kg. The Hg input factor from coal fired power plants was calculated to be 0.049 g Hg/tonne coal (**Table 2.8**). By considering that mercury emissions from geothermal power plants, on a per megawatt (electric) basis, are comparable to releases from coal-fired power plants (Robertson et.al., 1977), the input factor for Hg emissions from geothermal plants can be approximated as follows:

- Correcting the coal comsumption per MWh based on the average value of coal calorific value:

$$\frac{6{,}216\ \frac{kcal}{kg}}{4{,}018.6\ \frac{kcal}{kg}} * 344.3\ \frac{kg\ Coal}{MWh} = 532.57\frac{kg\ Coal}{MWh} \qquad \text{Eq. 2-3}$$

- Determining the approximate value of the input factors for geothermal power plant emissions (to the air).

$$532.47\frac{kg\ Coal}{MWh} * 0{,}049\frac{g\ Hg}{1000\ kg\ Coal} = 0.026\frac{g\ Hg}{MWh} \qquad \text{Eq. 2-4}$$

Table 2.16. **Summary of Inputs and Results of Geothermal Power Production**

Geothermal power production	Unit	Geothermal power production	Sum of releases to pathway from assessed part of life-cycle
Activity rate	MWh/year	14,100,730.00	
Input factor for phase	g Hg/MWh	0.026	
Calculated input to phase	Kg Hg/y	367	367
Output distribution factors for phase:			
▸ Air		1.00	
▸ Water		0.00	
▸ Land		0.00	
▸ Products		0.00	
▸ General waste treatment		0.00	
▸ Sector specific waste treatment		0.00	
Calculated outputs/releases to:			
▸ Air	kg Hg/y	367	367
▸ Water	kg Hg/y	0.00	
▸ Land	kg Hg/y	0.00	
▸ Products	kg Hg/y	0.00	
▸ General waste treatment	kg Hg/y	0.00	
▸ Sector specific waste treatment	kg Hg/y	0.00	

2.3. Data and Inventory on Primary (Virgin) Metal Production

2.3.1. Gold and Silver Extraction by Mercury Amalgamation

Data description

At almost all ASGM sites, mercury is used to extract gold and then burned off. Large scale gold mining does not use mercury in their gold processing. In ASGM, mercury is added to gold-pans, sluice boxes, and ball-mills. From these processes, at least 10 grams of mercury per gram of gold will be released to the environment. Mercury vapor will stay in the atmosphere for 1.5 years and then travel to a place far from its source. Mercury released to water and soil is accumulated in fish and plants consumed by people (Ismawati, 2012).

There is a lot of information related to the use of mercury in Artisanal and Small-Scale Gold Mining (ASGM) sector in Indonesia, results from various projects, funded by the Government of Indonesia (GoI) mostly represented by Ministry of Environment and Forestry (MoEF), the Ministry of Energy and Mineral Resources, the Ministry of Health, international institutions (UNEP, USEPA, IPEN, etc.), Donor-Led Research Projects (from Canada, Australia, Denmark, German), NGOs, centers of research, and academic research. Most of the projects aimed to establish baseline data, raise community awareness on mercury hazards, map the impact of mercury on the environment and health and socio-economics around the ASGM locations, conduct research into appropriate non-mercury alternative technology, improve incomes, public health, and the environment of the vulnerable and marginalized men and women dependent on ASGM, and so on. The results of these projects contribute to the realization of the ultimate goal of the GoI for mercury phase out in the ASGM sector in 2025.

Information related to the amount of gold produced and mercury released to the environment is available from various sites. However, only limited information is available for the national scale estimation of gold production from this sector, as well as the amount of mercury released to the environment. Although there is a discrepancy in estimating the amount of gold produced from ASGM sectors by various institutions or researchers in Indonesia, it can be identified that there has been a decrease in gold production from 2010 to the current year. The Agency for the Assessment and Application of Technology (*Badan Pengkajian dan Penerapan Technology*, BPPT) in 2010 (Katadata.co.id, 2021) stated that production of gold from ASGM sector reached 64-120 t/year, almost similar to 65-130 tonnes/year according to Balifokus in 2011 (Ismawati, 2012). MoEF in 2017 stated that the gold production from this sector was about 80 tonnes/year (Tempo.Co, 2017), and in 2018 according to the business actors in mining sectors, ASGM contributed gold production of 105 t/year (Katadata.co.id, 2020). MoEF and BSCRC-SEA in 2019 estimated gold production as part of the Minamata Initial Assessment and National Action Plan for ASGM of 53.8 t/year from this sector (MoEF & BSCRC-SEA, 2019).

There are also various estimations concerning the amount of mercury released to the environment, due to the various activity data, in this case the gold production, as well as the various amounts of required mercury or the input factors for gold production using amalgamation techniques. **Table 2.17** contains a summary of the results of the previous and latest research in the Indonesian ASGM sector related to the type of ore and the mercury used to gold produced ratio (Hg:Au). The input factor summarized within the table might not have the same meaning from one researcher to another. For instance, research conducted in 2018-2019 by MoEF with Brawijaya University (UB) and ITB applied the UN toolkit for estimating mercury use and documenting practices in artisanal and small-scale gold mining. The input factor of Hg:Au (kg Hg added/ kg gold produced) was calculated only from amount of Hg evaporated/gold produced. The evaporated Hg only takes into account the mercury which is released to the air, but not to other pathways such as water and land. The input factor Hg:Au from these researchers varied between 1.3:1 to 11.71:1. Higher input factors Hg:Au of 18.38:1 and 21:1 were derived from Mallongi (Mallongi, Anwar et al., 2015) and Telmer (2007), which took into account the total release to the environment.

The type of input factor within the UNEP toolkit inventory level 1 and level 2 denotes the comparison between the amount of mercury added to the amount of gold produced. Multiplication of this input factor (kg Hg/kg gold produced) and activity data (kg gold produced) result in the total amount of mercury release to the environment. Furthermore, the amount of mercury emitted to the air, released to the land and water are calculated by applying the output distribution factor.

Table 2.17. **Summary of Type of Ore, Input Factor Hg:Au, and Location of ASGM in Indonesia**

No.	Type of ore	Hg:AU	Location/note	Source
1		6.875:1	Anggai, Tatelu, Penangan and Buwun Mas	(Planet Gold, 2020)
2	Primary gold deposits (hard rock):	10.0:1	Indonesia, gold produced: 38.3 t/year	(MoEF & BSCRC-SEA, 2019)
	Secondary gold deposits. (Alluvial and placer)	1.3:1	Indonesia, gold produced: 16.9 t/year	
			Indonesia, total gold produced: 55.2 t/year	

No.	Type of ore	Hg:AU	Location/note	Source
3		9.6:1 10:1	Kotabunan, East Bolaang Mongondow, Prov. North Sulawesi; Without retort	MoEF (2019)
4	Hard rock	4.49:1	Wonogiri	MoEF and ITB, 2018
	Hard rock	11.7:1	Dharmasraya	
	Alluvial ore	6.99:1		
	Hard rock	11.7:1	Kotawaringin Barat	
	Colluvial ore	4.49:1		
5		2.89:1, 2.17:1	Sekotong	MoEF and UB (2018)
		2.78:1, 3.44:1	Tobongan	
6	Hard rock	4.49:1	Pangku villaget, Nort Arut, West Kotawaringin Regency	MoEF (2018)
7	hard rock	11.72:1	Sembilan Koto, Dharmasraya, West Sumatera	MoEF (2018)
	Alluvial concentrates	6.99:1	Sitiung, Dharmasraya, West Sumatera	
8		3.64:1	Jendi Village, Wonogiri	MoEF (2018)
9	Whole ore amalgamation	18.38:1 (15.88 to tailing, 2.5 to atmosphere)	Buladu village. North Gorontalo Regency	(Mallongi et al, 2015)
10		4.49:1	Pangkut village, West Kotawaringan regency	Blacksmith Institute and Yayasan Tambuhak Sinta (2013)
11	Whole ore	20:1 (19 ke tailing, 1 ke atmosfer)	Kereng Pangi, Central Kalimantan	Telmer (2007)
	Alluvial concentrates	0.3:1 (Hg ke tailing)		
12.	Hard rock Kaolinite-Dickite	5.72:1	Lebakgedong District, Lebak Regency	MoEF & BSCRC-SEA (2021)
13.	Hard rock Galena, Pyrite, and Chalcopyrite.	15.57:1	Hutabargot District, Mandailing Natal Regency	MoEF & BSCRC-SEA (2021)
14.	Hard rock Kaolinite-Dickite	12.7:1	Karangjaya District, Tasikmalaya Regency	MoEF & BSCRC-SEA (2021)
15.	Hard rock Dacite-Porphyritic	6.2:1	Taliwang District, West Sumbawa Regency	MoEF & BSCRC-SEA (2021)
16.	Hard rock Chalcopyrite-Pyrite	6.99:1	Lolayan District, Bolaang Mongondow Regency	MoEF & BSCRC-SEA (2021)
17.	Hard rock Andesite, Dacite	63.2:1	Murung Raya Regency	MoEF & BSCRC-SEA (2021)

Balifokus estimates that approximately 190 tonnes of mercury are released to the environment (Dewi K. and Ismawati Y., 2012) per year. The Indonesian Community Miners Association (APRI) has claimed that there are about one million gold miners in Indonesia, and that they use about 3,500 tonnes of mercury per year. Marcello Veiga estimated that between 100 - 150 tonnes of mercury per year are released to the environment from ASGM in all of Indonesia as a result of the widely used whole ore amalgamation methods (Krisnayanti, 2018). MoEF and BSCRC-SEA estimates 345.5 t/year (see **Table 2.18**) metric tonnes of mercury per year is released to the environment from ASGM, this figure is based primarily on the magnitude of the releases at a number of very prominent sites in the country (MoEF & BSCRC-SEA, 2019). However, this table should be updated due to the differences in understanding on Hg:Au as described above.

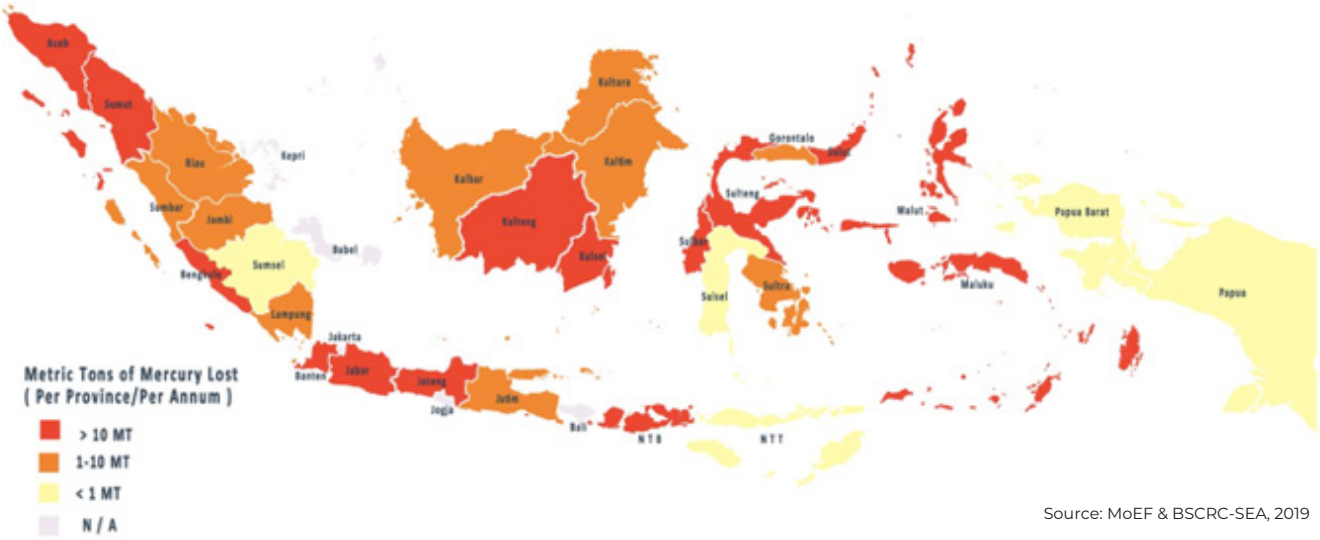
Table 2.18. **Mercury Use, Gold Production and Mercury Releases from ASGM in Indonesia**

No	Province	Gold production (t/year)	Hg release (t/year)	Input factor
1	Banten	3.60	36.00	10.0
2	Bengkulu	0.60	6.00	10.0
3	Gorontalo	1.20	8.09	6.8
4	Jambi	2.10	2.73	1.3
5	West Java	2.55	25.50	9.8
6	Central Java	1.95	19.50	9.8
7	East Java	0.36	2.03	5.0
8	West Kalimantan	3.45	4.49	1.3
9	South Kalimantan	1.95	12.98	6.5
10	Central Kalimantan	7.35	21.30	2.9
11	East Kalimantan	0.75	2.28	2.9
12	North Kalimantan	0.60	3.39	5.7
13	Lampung	0.60	4.70	7.8
14	Maluku	2.10	21.00	10.0
15	North Maluku	1.50	13.70	9.1
16	Nangro Aceh Darussalam	4.35	18.71	4.3
17	West Nusa Tenggara	3.60	33.39	9.3
18	North Nusa Tenggara	0.60	0.78	1.3
19	Papua	0.75	0.98	1.3
20	West Papua	0.15	0.20	1.0
21	Riau	0.75	2.28	2.9
22	West Sulawesi	1.35	12.20	8.7
23	South Sulawesi	0.6	0.78	1.3
24	Central Sulawesi	5.10	48.39	9.5
25	Southeast Sulawesi	0.60	2.09	3.5
26	North Sulawesi	2.55	25.50	9.8
27	West Sumatera	0.90	2.48	2.8
28	South Sumatera	0.45	0.59	1.2
29	North Sumatera	1.35	13.50	9.6
	Total	**53.8**	**345.5**	**6.3**

Source: MoEF & BSCRC-SEA, 2019

The national map below summarizes the level of mercury pollution from ASGM in each of the 29 affected provinces; using a relative scale of impacts that applies three orders of magnitude to the problems faced, according to the total quantity of mercury used[1] each year, as a result of ASGM activities within each province.

Figure 2.16. **Map of National Overview of Mercury Used in ASGM by Province**



Source: MoEF & BSCRC-SEA, 2019

Background calculations and approximations

Determining the representative activity data and input factor for the ASGM sector in Indonesia is a very challenging matter. The many differences among types of recorded data also reflect the various conditions within the ASGM sector especially as relates to the type of ore and amount of mercury use during gold extraction. There has been a decrease of mercury use as well as gold production since 2013 when the Government of Indonesia created the National Action Plan for the Elimination of Mercury Use in Gold Processing (RAN-PPM). The government action resulted in a higher price for mercury among the gold miners because mercury became harder to obtain. However, the rapid increase of the gold price from around IDR 500,000 in 2015 to IDR 900,000 in 2021 (Goldprice.org, 2021), once again triggered the production of gold from the ASGM sector.

In order to be able to have a site-specific input factor which represents current ASGM condition in Indonesia, as well as fulfil the type of input factor required by the UNEP toolkit, the raw data from MoEF (2018), Brawijaya University (2018), and Bandung Institute of Technology (2018) were collected and recalculated. Since not enough data were available for the amalgamation with retort category, only amalgamation without retorts were taken to generate the input factor and output distribution factor.

The input factor and output distribution factor are recalculated based on the formula described in eq. 2-5 until eq. 2-10. The total amount of Hg use is determined based on the amount of Hg added into the ball mills minus Hg recycled (Eq. 2-5) for amalgamation without retort.

[1] "Whereby "mercury used" denotes mercury lost to the environment"

$$\text{Hg use without retort (g)} = \text{Hg added (g)} - \text{Hg recycled (g)} \qquad \text{Eq. 2-5}$$

As it is shown in eq. 2-6, the correction factor (percent of gold purity) is applied for determining the gold extracted (g) with 100% purity (24K), since the gold from the miners is usually purified in the local gold shop. Although information related to the amount of Hg released from this gold purification process has not been available yet, the information of gold purity from the miners is used to approximate the real amount of extracted gold using amalgamation.

$$\text{Gold extraced (g, purity 100\%, 24 K)} = \text{gold purity (\%)} * \text{gold extraced (g)} \qquad \text{Eq. 2-6}$$

The input factor is then calculated based on the amount of gold extracted with 100% purity (24K) divided by the amount of Hg use. Using this input factor also means quantifying total amount of mercury which is released to the air, water, and land. However, there is no data available related to the amount of Hg left behind after miners burned the amalgam. Considering this fact, the amount of Hg left is neglected, and assumed that all Hg is burned by the miners during combusted the amalgam. The Hg input factor was calculated using the following equation:

$$\text{Hg input factor (Hg: Au)} = \frac{\text{Gold extracted}}{\text{Hg use (g)}} \qquad \text{Eq. 2-7}$$

The output distribution factor for quantifying the amount of Hg released to the air is able to be determined according to Eq. 2-8 for amalgamation without retort as follows.

$$\text{Hg output distribution factor to air, without retort} = \frac{\text{Hg burned (g)}}{\text{Hg use (g)}} \qquad \text{Eq. 2-8}$$

The amount of Hg released to the land and water can also be directly determined from the collected data as follows:

$$\text{Hg released to land and water (g)} = \text{Hg use (g)} - \text{Hg recycled (g)} - \text{Hg burned(g)} \qquad \text{Eq. 2-9}$$

The output distribution factor to land and water can then be calculated using Eq. 2-10.

$$\text{Hg output distribution factor to land and water, without retort} = \frac{\text{Hg released to land and water (g)}}{\text{Hg use (g)}} \qquad \text{Eq. 2-10}$$

Table 2.19 shows the results of calculation for input factor and output distribution factor for ASGM sector in Indonesia. The value of input factor Hg:Au (g Hg use/g gold produced) varied from 3.13:1 to 113.49:1 with average value of 19.08:1. Variations also represent the various conditions and types of ore available in Indonesia.

MoEF and BSCRC-SEA (2019) as shown in **Table 2.18** published activity data (gold production) and input factor (g Hg use/g gold produced) for 29 provinces in Indonesia and estimated that the amount of Hg release to the environment was about 345.5 t/year, much higher than the previous estimation from various research. The overall estimate was reached based on site-specific data which already included a geographic database. The result is considered to be a conservative estimate which is likely to increase as more detailed information emerges from in-depth field assessments. However, the value of the input factor is lower than recalculated values which were generated from similar studies. This might be due to the different perspective of calculating the input factor.

The activity data of gold production 53.8 t/year from MoEF and BSCRC-SEA (2019) which has already been determined by using in depth field assessment, is utilized for generating this level 2 inventory for the ASGM sector. About 50% of this data (26,900 t/year) is considered to have an input factor of 12.17 g Hg/g gold produced (**Table 2.19**) and 50% of this data (26,900 t/year) is considered to have an input factor of 1.3 g Hg/g gold produced. Using these values, the total amount of Hg release would be 367.058 t/year. The output distribution factors to the air, water and land (for whole ore) from **Table 2.19** were also applied to calculate mercury release to the air, water and land replacing the default input factor within the toolkit level 2.

Information related to the estimation of Hg release to environment from this sector are also available from an MoEF and BSCRC-SEA study in 2019. The ASGM locations are classified as extreme, very high, high, and low regarding Hg release to the environment. The total amount of Hg release to the environment was also estimated (345.5 t/year) However, very limited information is given concerning the type of ore (whole or concentrate) either from this MoEF and BSCRC-SEA study or from other available studies. The calculation of input factor in **Table 2.19** also gave various values from 2.66 to 79.44 (with average of 12.17 g Hg/g gold produced), and again no clear information concerning the type of ore (whole or concentrate).

Considering the variation of input factor derived from Table 2.19, unclear information related to the type of ore use, as well as results of discussion with local ASGM researchers, it was decided to split 50:50 percent between whole ore and concentrate. The input factor of 12.17 is considered as the input factor of Hg from whole ore, and 1.3 as the input factor for concentrate (default value from the toolkit), resulting estimation of 362.3 t per year. This would also approximate the estimate of Hg release.

Table 2.19. **Summary of Hg Use in Gold Amalgamation from ASGM in Indonesia**

Parameter	MoEF	BRAWIJAYA University				Institut Teknologi Bandung										Avg.	Min	Max
	2019	2018				2018												
	Kulon Progo	Sekotong		Tobongon		West Kotawaringin			Wonogiri				Dharmasraya					
	Yogyakarta	NTB		North Sulawesi		Central Kalimantan			Central Java				West Sumatera					
		1	2	1	2	1	2	3	1	2	4	5	D1	D2	D3			
Hg added (g)	7.22	1.223	675	2.438.00	3.842.60	34.82	38.42	28.36	7.50	5.00	5.20	7.30	89.62	87.52	84.76			
Hg & amalgam (g)	4.60	1.218	670	2.426.30	3.732.40	26.05	30.17	19.81	5.63	4.35	4.94	5.97	79.88	79.02	75.12			
Hg recycled (g)	4.40	1.215	667	2.425.00	3.727.41	19.65	25.05	13.83	3.91	3.05	3.50	4.01	77.42	71.02	70.12			
Amalgam (g)	0.30	3.18	3.17	1.51	4.29	6.40	5.12	5.98	1.30	1.30	1.44	1.96	2.46	8.00	5.00			
Gold extracted (g), certain purity	0.12	1.08	1.39	0.50	1.45	3.58	2.18	2.84	0.27	0.27	0.64	0.60	1.23	2.89	2.97			
Purity of gold extracted (%)	70	58	58	70	70	87	87	87	85	85	85	85	74	74	74			
Hg burned (g)	0.18	2.10	1.78	1.01	2.84	2.82	2.94	3.14	1.03	1.03	0.80	1.36	1.23	5.11	2.03			
Hg to land and water (g)	2.64	5.90	6.22	11.99	112.35	12.35	10.43	11.39	2.56	0.92	0.90	1.93	10.97	11.39	12.61			
Hg use = Hg added - Hg Recycled (g)	2.82	8.00	8.00	13.00	115.19	15.17	13.37	14.53	3.59	1.95	1.70	3.29	12.20	16.50	14.64			
Hg:Au, without retort = gold extracted /Hg use	23.50	7.41	5.76	26.00	79.44	4.24	6.13	5.12	13.30	7.22	2.66	5.48	9.92	5.71	4.93	12.17	79.44	0.00
Output distribution factor to air without retort = Hg burned/Hg use	0.06	0.26	0.22	0.08	0.02	0.19	0.22	0.22	0.29	0.53	0.47	0.41	0.10	0.31	0.14	0.23	0.53	0.02
Output distribution factor to land and water without retort = Hg to land and water/Hg use	0.94	0.74	0.78	0.92	0.98	0.81	0.78	0.78	0.71	0.47	0.53	0.59	0.90	0.69	0.86	0.77		
Total output distribution factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
= Hg burned/Hg use																		
Output distribution factor to land and water without retort																		
= Hg to land and water/Hg use																		
Total output distribution factor																		

Data gaps and priorities for follow up

For this sub-category, there are still data gaps and priorities for follow up which could be identified as follows:

- The uncertainty of activity data due to the possibilities that miners did not tell the truth about the amount of Hg they used and or the amount of gold that was derived. The situation due to covid-19 pandemic might have significantly influenced and increased the production of gold from ASGM, since the price of gold has increased steadily in recent years, touching the highest price in 2020.

Figure 2.17. **Ten Years of Gold Price in IDR Per Gram (Goldprice.org, 2021)**

Sumber: Goldprice.org, 2021

- The uncertainty for the type of ore which is used, either the whole ore or the concentrate ore, also has a great influence in the estimated amount of mercury release.
- The illegal use of mercury still plays the main role in the production of gold from ASGM. The Indonesian government has banned the trade and use of mercury and this caused the rise in price of illegal mercury. However, due to the rising price of gold, ASGM using mercury has still been a tempting source of economic activity.

Summary of inputs and results

Summary of inputs and results of gold and silver extraction with mercury amalgamation process is shown in **Table 2.20.**

Table 2.20. **Summary of Inputs and Results: Source Category: Primary (Virgin) Metal Production Gold (and Silver) Extraction with Mercury Amalgamation Processes**

Gold (and silver) extraction with mercury amalgamation processes	Unit	From whole ore	From concentrate	Sum of releases to pathway from assessed part of life-cycle
Activity rate	Gold produced, t/year	26,900	26,900	
Input factor for phase	kg Hg/kg gold produced	12.17	1.3	
Calculated input to phase	kg/year	327,373	34,970	362,343
Output distribution factors for phase:				
- Air		0.23	0.77	
- Water		0.385	0.12	
- Land		0.385	0.11	
- Products		0.00	0.00	
- General waste treatment		0.00	0.00	
- Sector specific waste treatment		0.00	0.00	
Calculated outputs/releases to:				
- Air	kg/tahun	75,295.79	26,926.90	102,222.69
- Water	kg/tahun	126,038.61	4,196.40	130,235.01
- Land	kg/tahun	126,038.61	3,846.70	129,885.31
- Products	kg/tahun	0.00	0.00	0.00
- General waste treatment	kg/tahun	0.00	0.00	0.00
- Sector specific waste treatment	kg/tahun	0.00	0.00	0.00

2.3.2. Other Metals

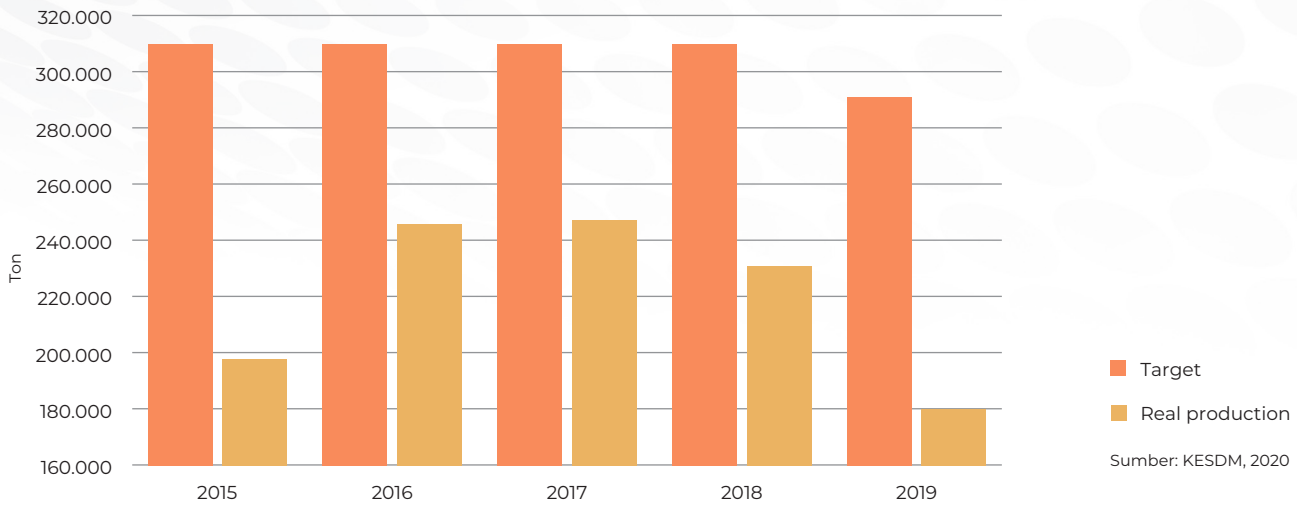
Data description

Copper extraction and initial processing

Copper, a red-orange metal that has been used in civilization since 8,000 BC, is one of the most important metals for modern industry. Copper is needed because of its ability to conduct heat and electricity; With its malleability, corrosion and high temperature resistance, recyclability, and the best electricity and heat transmission of all commercial metals, copper is highly used because it is used in the delivery and generation of electricity, as well as in all electrical equipment, including mobile phones and televisions.

PT Freeport Indonesia is the biggest copper concentrate producer in Indonesia, with total mining capacity of 300,000 tonnes per day. However, current production has declined to about 200,000 tonnes per day. The copper content within the copper whole ore (rock) ranges from 0.5 to 1.29% (the average is 1.06%). Since 2014, the Indonesian government has banned copper concentrate exports, and obliged the installation and use of copper smelters for domestic copper production. Currently, there are only two copper smelters in Indonesia, PT Smelting in East Java and PT Batutua Tembaga Raya in Maluku. The copper concentrate for the two smelters is supplied by PT Freeport Indonesia, PT Amman Mineral and PT Batutua Kharisma Permai with the total capacity of 1,000,000 tonnes/year. The rest of the copper concentrate can still be exported with a certain license from the government. According to the Statistics Central Agency the production of copper concentrate in 2019 was 1,697,725 tonnes (BPS, 2020g), while the real copper production was only 180,204 tonnes in 2019 (**Figure 2.18**).

Figure 2.18. **Production of Copper in Indonesia (MoEMR, 2020)**



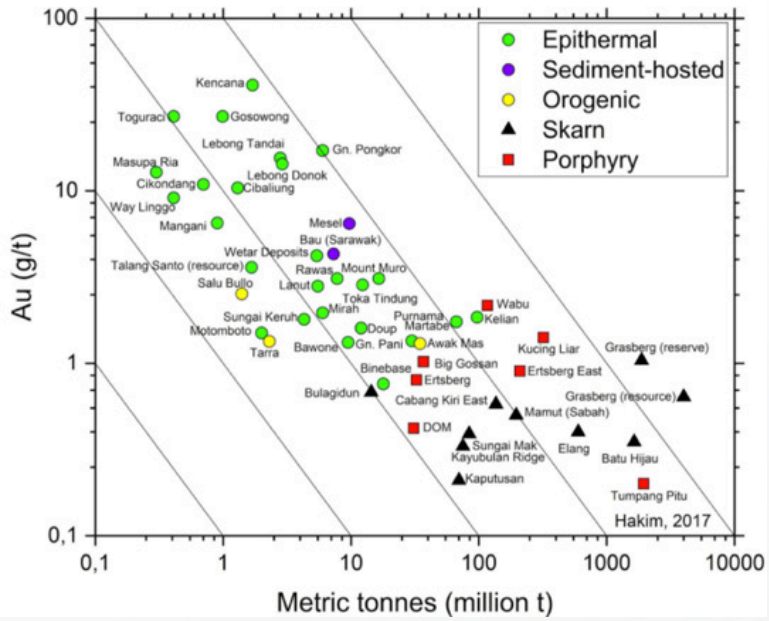
Sumber: KESDM, 2020

Gold extraction and initial processing by methods other than mercury amalgamation

Gold extraction processes can be significant sources of mercury releases, even if no deliberate mercury use (amalgamation) takes place. Industrial gold extraction is one of the largest sources of mercury releases among metal extraction activities in the Arctic countries (Maag, 2004). Both releases to land and the atmosphere may be significant. The extraction procedure for gold recovery involves several steps at temperatures high enough to thermally release mercury, as well as steps where significant amounts of solid or liquid residues which may contain mercury are produced and may be disposed of (UNEP, 2019).

Production of gold in Indonesia can be found in the national production statistics published by the Statistics Central Agency. The production of gold from the large-scale industry of gold mining uses gold extraction and initial processing by methods other than mercury amalgamation. The production in 2019 was approximately 108,977 kg (BPS, 2020g). The gold grade in Indonesia in a tonnage-grade diagram can be seen in Figure 2.19. The x-axis is the tonnage of the resource from the mine (in million tonnes), and the y-axis is the gold grade (in ppm or grams per tonnes). The green circle symbol represents epithermal gold, the purple circle represents gold within the hosted sediment, the yellow circle represents orogenic, triangular for skarn, and the red square is for porphyry. On average, gold content in gold ore in Indonesia is in the range 0.1 - 15 ppm, the size depends on the type of deposit (Yahya, 2015). Considering the various types of gold content within the ore, as well as considering the tonnage and grade diagram of various gold mines in Indonesia, the gold content is approximated to be 4 ppm.

Figure 2.19. **Tonnage and Grade Diagram of Various Gold Mines in Indonesia (Yahya, 2015)**



Sumber: Yahya, 2015

Aluminum extraction and initial processing

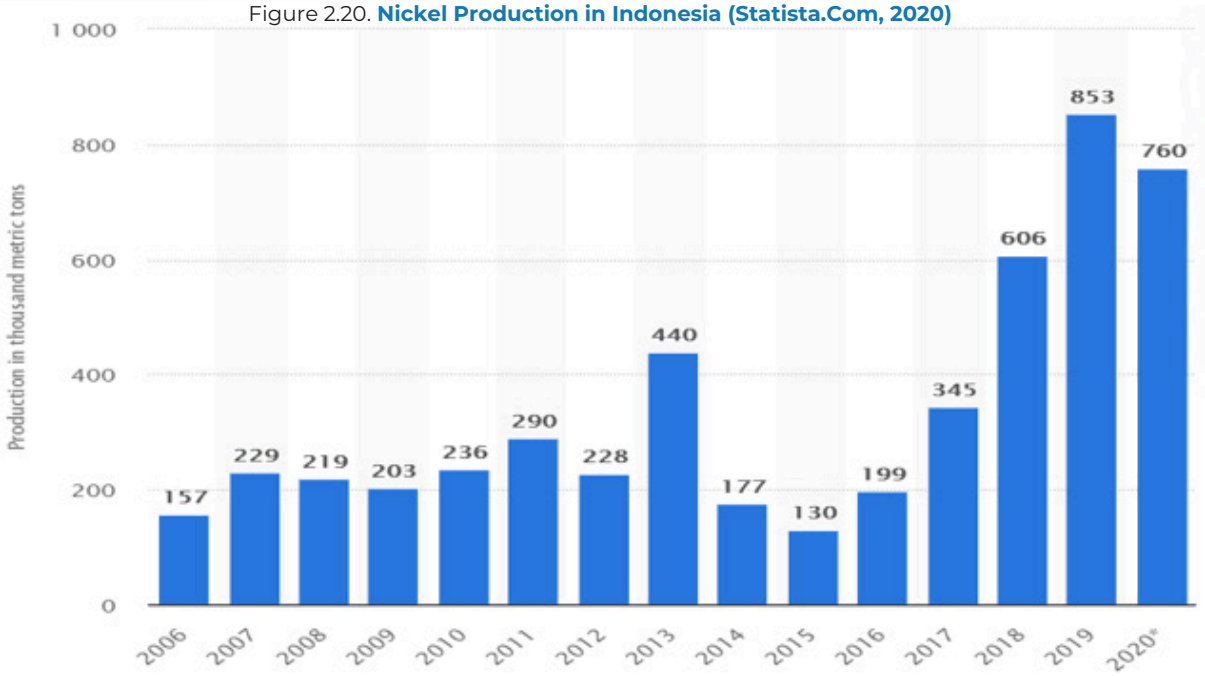
Aluminum ore, most commonly bauxite, is refined into aluminum oxide trihydrate (alumina) and then electrolytically reduced into metallic aluminum. In the process, feed ore and fossil fuels and hydrocarbon auxiliary materials are used, which may contain trace concentrations of mercury. The mercury may be released to the environment from aluminum processing, and it was recorded that 16,592,187 tonnes of bauxite had been processed in 2019 to produce alumina (BPS, 2020g).

Other non-ferrous metals - extraction and processing

Nickel production from nickel ore

Nickel ore mining in Indonesia according to the Statistics Central Agency (BPS, 2020g) produced 60,948,143.00 tonnes of nickel ore. The nickel content within the nickel ore is about 1.8-2% (BPPT, 2017). Using these values, the production of nickel in 2019 is approximately 926,412 tonnes. Other data are depicted in **Figure 2.20**, which also record the amount of nickel production in Indonesia.

Figure 2.20. **Nickel Production in Indonesia (Statista.Com, 2020)**



Sumber: Statista.Com, 2020

Tin production from tin ore

According to Statistics Indonesia (BPS, 2020g), the amount of tin concentrate production in 2019 was 86,947 tonnes/year.

Primary ferrous metal production

Iron production from iron sand in Indonesia was 2,507,786 tonnes in 2019. The amount of Iron (Fe) in natural sand in Mataram Indonesia can be seen in **Table 2.21.**

Table 2.21. **Iron Content in Natural Sand Mataram Indonesia**

Location	Natural sand (gram)	Magnetic material (gram)	Fe in magnetic material (mg/gram)	Fe in natural sand (mg/gram)
		measured		Calculated
Gading	50.11	42.80	10.57	9.03
Loang Baloq	50.03	46.78	12.82	11.99
Penghulu Agung	50.20	46.38	15.02	13.88
Ampenan	50.04	48.09	16.28	15.65

Source: Susilawati et.al, 2018

Background calculations and approximations

Copper extraction and initial processing

Mining/concentrating

The production of copper based on Statistics Indonesia (BPS, 2020g) data was 1,697,725 tonnes in 2019. The concentration of copper within the copper ore from environmental impact assessment data of copper ore expansion projects is about 1.29% (MoEF, 2020). Using these values, the amount of rock ore from mining/concentration production in 2019 was approximately:

$$\left(\frac{100}{1.29}\right) * 1{,}697{,}725\ \frac{tonne}{year} = 131{,}606{,}589\ \frac{tonnes}{year} \qquad \text{Eq. 2-11}$$

The amount of tailing from this mining activities would be:

$$131{,}606{,}589 * \left(\frac{100 - 1.29}{100}\right) = 129{,}908{,}864\ \frac{tonnes}{year} \qquad \text{Eq. 2-12}$$

The mercury content within the tailing is <0.012 – 0.02 or 1.06 mg/kg (MoEF, 2020), which is the input factor for mining/concentrating activities. All tailings would usually go to the tailing river/sedimentation site, in this case the output distribution factors are estimated to be 0.5 for water and 0.5 for land.

Production of copper from concentrates

Based on data from Statistics Indonesia (BPS, 2020g), the total production of copper concentrate in 2019 was 1,697,725 t. With the assumption that the available smelters processed 1 million tonnes of copper concentrate, the rest of the concentrate (697,725 t) was exported. There is no information available related to the concentration of mercury within the copper concentrate. The default input factor of 30 g Hg/t of concentrate used is applied for calculation of mercury release from this sector.

Gold extraction and initial processing by methods other than mercury amalgamation

As it has already been mentioned above, that on average, gold content in gold ore in Indonesia is in the range 0.1 - 15 ppm, the size depends on the type of deposit (Yahya, 2015). Considering the various types of gold content within the ore, as well as considering tonnage and grade diagrams of various gold mines in Indonesia, the gold content is approximated to 4 ppm. Therefore, the amount of gold ore used in 2019 for producing 108,977 kg of gold (BPS, 2020g) can be calculated as follows:

$$\frac{108{,}977\ \frac{kg}{year}}{0{,}004\ \frac{kg}{tonnes}} = 27{,}244{,}250\ gold\ ore\ \frac{tonnes}{year} \qquad \text{Eq. 2-13}$$

However, latest information from the Ministry of Energy and Mineral Resources (MoEMR, 2020), recorded that the amount of gold ore processed in 2019 was 18.5 million tonnes. This value was used as the activity rate for the toolkit.

The gold ore also contains mercury in various ranges. According to (Sumaryono, 2020), the mercury in gold ore content in Indonesia varies between 0.14-0.28 ppm. Higher content can also be found from previous research, i.e., 14, 15, 18, and 92 ppm (Sumaryono, 2020). Considering these various values for mercury content within the gold ore, the default input factor from UNEP toolkit of 5.5 ppm was taken as the input factor from this sector.

Aluminum extraction and initial processing

There is no data available for mercury content within the bauxite in Indonesia, the default input factor of 0.5 g Hg/t bauxite from UNEP toolkit level 2 was used for estimating mercury release form this sub sector.

Other non-ferrous metals - extraction and processing

Nickel production from nickel ore

According to Krivtsov A.I. and Klimenko N.G (1997), the average content of mercury in ore is 0.09 mg/kg; on the basis of estimated mercury flue gas emissions, 90% of the quantity of mercury is in raw materials being processed; with average specific emissions of 10.1 gram of mercury per 1 (one) tonnes of produced nickel (COWI, 2004).

Tin production from tin ore

The average content of tin in concentrates was approximately 50%. The content of mercury in tin concentrates varies within limits of 0.86 – 1.89 mg/kg, with an average value of approximately 1.3 mg/kg. A major part of the mercury sublimates from concentrates as early as in the frying stage; remaining mercury (approximately 5% of overall mass) is removed from the raw materials in the course of leaching and melting. As we noted above, an efficient dust arresting system is operated at Novosibirsky combined works. This permits us to assume that at least 60% of mercury contained in flue gases precipitates on filters of cleaning facilities together with dust. Thus, approximately 5 kg of mercury was emitted directly to atmosphere (COWI, 2004).

Primary ferrous metal production

Apart from quartz, the main mineral species identified in the raw sands and soil were calcite, fluorite and barite. The concentration of mercury ranged from 5 to 23 µg/g, and although it is distributed in different proportions as a function of size, thermal desorption profiles demonstrated that the mercury species present in the samples do not vary with the mercury concentration and the particle size. By means of thermal desorption (HgTPD), mercury oxide (HgO) was identified in beach sands, whereas mercury sulfide (HgS) was found in soil samples taken from the vicinity of the beach. Complementary methodologies foster the HgTPD conclusions and verify that mercury is present mostly in insoluble stable (HgS) or low-mobility (HgO) forms in the samples studied (Gallego et al., 2019).

Data gaps and priorities for follow up

Mercury data in the metal ore is difficult to find. The available data are usually in the form of mercury content within the effluent of water treatment facilities, in stream water, or in sediment. The information on mercury content within the ore is also important, when combined with the mercury data from the environment, the output distribution factors can be determined.

Summary of inputs and results

Summary of inputs and results of primary (virgin) metal production is shown in **Table 2.22.**

Table 2.22. **Summary of Inputs and Results: Primary (Virgin) Metal Production**

Other primary metal production	Unit	Copper extraction and initial processing		Gold extraction and initial processing by methods other than mercury amalgamation	Aluminium extraction and initial processing	Other non-ferrous metals - extraction and processing		Primary ferrous metal production	Sum of releases to pathway from assessed part of life-cycle
		Production of copper from concentrates			Alumina production from bauxite	Nickel production from nickel ore	Tin production from tin ore	Iron production from sand	
Activity rate		129,908,864 tailing t/y	1000,000 t Concentrate used/year	18,500,000 t gold ore used	16,592,187 Bauxite used, t/y	926,412 nickel produced, t/y	86,947 tin concentrate, t/y	2,507,786 iron sand, t/y	
Input factor for phase		0.016 g Hg/t tailing	30 g Hg/t concentrate	5.5 Gold ore used, t/y	0.5 g Hg/t bauxite	10.1 g Hg/t produced nickel.	1.3 mg Hg/kg tin concentrate	5 mg Hg/ kg natural sand	
Calculated input to phase	Kg Hg/y	2,079	30,000	27,244	8,296	9,357	113	12,539	89,627.61
Output distribution factors for phase									
- Air		0.50	0.10	0.04	0.15	1.00	1.00		
- Water		0.50	0.02	0.02	0.10				
- Land				0.90				0.25	
- Products			0.42	0.04				0.75	
- General waste treatment					0.65				
- Sector specific waste treatment			0.46		0.10				
Calculated outputs/releases to									
- Air	Kg Hg/thn	1,039.27	3,000.00	4,070.00	1,244.41	9,356.76	113.03	0.00	18,823.47
- Water		1,039.27	600.00	2,035.00	829.61	0.00	0.00	0.00	4,503.88
- Land		0.00	0.00	91,575.00	0.00	0.00	0.00	3,134.73	94,709.73
- Products		0.00	12,600.00	4,070.00	0.00	0.00	0.00	9,404.20	26,074.20
- General waste treatment		0.00	0.00	0.00	5,392.46	0.00	0.00	0.00	5,392.46
- Sector specific waste treatment		0.00	13,800.00	0.00	829.61	0.00	0.00	0.00	14,629.61

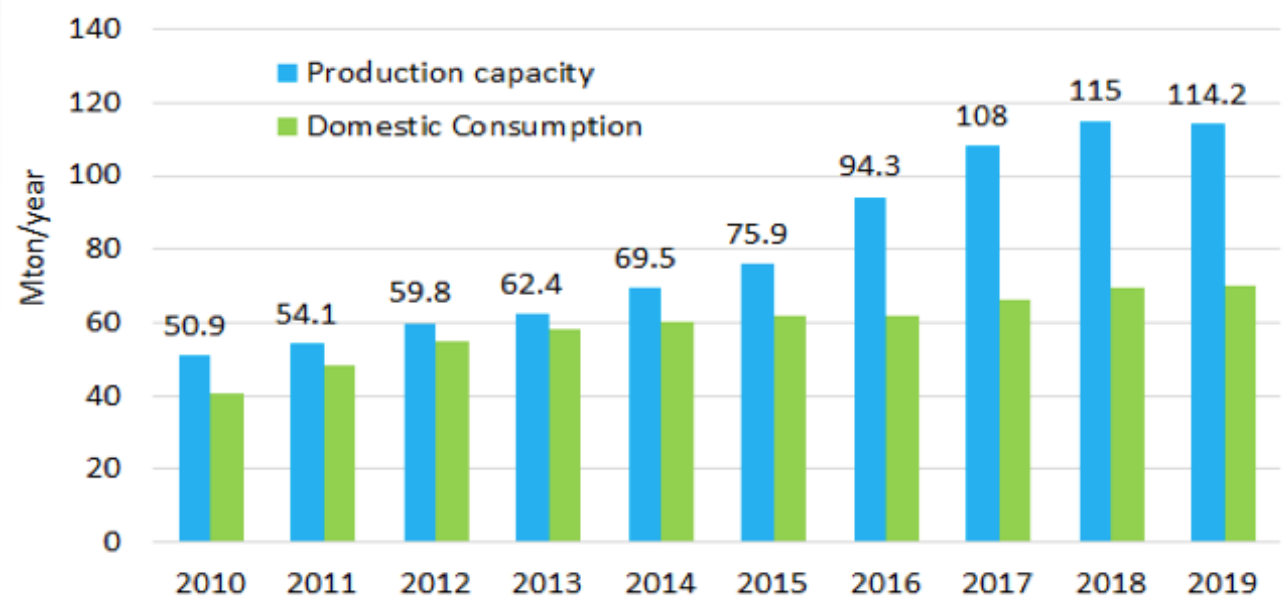
2.4. Data and Inventory on Production of Other Minerals and Materials with Mercury Impurities

2.4.1. Cement clinker production

Data Description

Domestic cement consumption in the last 10 years reached its highest growth in 2011, which was 17.7% with a volume of 48 million tonnes and at that time the national installed capacity was 54 million tonnes. From then on, existing cement producers continued expanding with additional installed capacity. In addition, new investors also began to construct new factories simultaneously (ASI, 2018). Indonesia was the second largest consumer amongst the Southeast Asian countries; however, per-capita consumption was only 195 kg, which was quite low compared to global and even regional standards. **Figure 2.21** shows the annual cement production and prediction from 2010 to 2019.

Figure 2.21. **Estimation of Cement Clinker Production in Indonesia**



Source: Resource Development Center, Ministry of Public Works (2019)

Co-Processing in cement kilns is a scientific, proven & established technology for disposing hazardous & other non-recyclable waste in an environmentally sustainable way. Due to its advantages in terms of combustion of waste & by having no residual left over, the cement kiln stands apart among the different methods of waste disposal like incineration, waste to energy and land filling.

Background calculations and approximations

The input factor for cement production was determined based on the amount of mercury emitted to the air, the amount of mercury content within the clinker (product), and the amount of mercury within the specific treatment/disposal.

The amount of mercury which was released to the air was calculated based on the point source emission data and cement plant operation data, with the general formula as described below:

$$Hg\ emission\ rate = Hg\ emission\ concentration\ \frac{mg}{Nm^3} * gas\ flowrate\ \frac{Nm^3}{s} * operating\ hours\ \frac{hours}{period} * 3600\ \frac{s}{hours} * \frac{1}{1000}\frac{g}{mg} = \frac{g\ Hg}{period} \quad \text{Eq.2-14}$$

$$Hg\ emission\ factor = \frac{Hg\ emission\ rate\ \frac{g\ Hg}{period}}{Cement\ produced\ \frac{t\ cement}{period}} = \frac{g\ Hg}{t\ cement\ produced} \quad \text{Eq. 2-15}$$

Table 2.23. **Calculation of Amount of Mercury Release to the Air from Cement Plants in Indonesia**

No	Company	Plant	Operating hours	Flowrate	Hg Concentration	Hg Emission rate	Hg input factor	Cement production	Plant capacity	Note
			hour/ period	Nm³/s	mg/Nm³	Hg/ period	g Hg/t cement	tonne/ period	tonne/ year	
1	A	P 1	6,781	80.19	0.02	39,151	0.034	1,161,130	1,500,000	Without co-incineration of waste
2		P2	7,983	69.81	0.02	40,125	0.029	1,366,952	1,500,000	
3		P2	4,400	98.812	0.03	46,955	0.062	753,425	1,500,000	
4		P2	4,400	64.5	0.03	30,650	0.041	753,425	1,500,000	
5	F	P14	1,621	253.704	0.03	44,415	0.133	333,082	1,800,000	
6		P14	1,621	324.28	0.001	1,892	0.006	333,082	1,800,000	
7		P14	1,621	252.75	0.001	1,475	0.004	333,082	1,800,000	
8		P14	1,621	252.75	0.001	1,475	0.004	333,082	1,800,001	
9		P14	1,621	303.62	0.001	1,772	0.005	333,083	1,800,002	
10	H	P19	1,621	147.6	0.004	3,445	0.010	337,708	1,825,000	
11		P19	1,621	14.7	0.005	429	0.001	337,708	1,825,000	
12		P19	1,621	103.18	0.0001	60	0.000	337,708	1,825,000	
13		P19	1,621	12.6	0.01	735	0.002	337,708	1,825,000	
Average value (set data 1)							0.026			
14	B	P3	1,621	143.087	0.002	1,670	0.004	462,614	2,500,000	
15		P4	1,621	153.419	0.0231	20,681	0.049	425,605	2,300,000	
16		P5	1,621	53.2866	0.011	3,421	0.031	109,177	590,000	
17		P6	1,621	38.1388	0.0125	2,782	0.025	109,177	590,000	

No	Company	Plant	Operating hours	Flowrate	Hg Concentration	Hg Emission rate	Hg input factor	Cement production	Plant capacity	Note
			hour/ period	Nm³/s	mg/Nm³	Hg/ period	g Hg/t cement	tonne/ period	tonne/ year	
18	C	P7	1,621	43.42	0.01	2,534	0.009	296,073	1,599,998	
19		P7	1,621	44.07	0.01	2,572	0.009	296,073	1,599,999	
20		P7	1,621	44.85	0.01	2,617	0.009	296,073	1,600,000	
21		P7	1,621	44.37	0.01	2,589	0.009	296,073	1,600,000	
22	D	P8	1,621	269.76	0.001	1,574	0.003	481,119	2,600,000	
23		P8	1,621	267.44	0.001	1,561	0.003	481,119	2,600,000	
24		P8	1,621	254.35	0.001	1,484	0.003	481,119	2,600,000	
25		P8	1,621	250.71	0.001	1,463	0.003	481,119	2,600,000	
26	E	P9	1,621	145.26	0.01	8,477	0.025	333,082	1,800,000	
27		P10	1,621	265.08	0.0046	7,116	0.009	769,050	4,156,000	
28		P11	1,621	31.53	0.0081	1,490	0.023	64,766	350,000	
29		P12	1,621	85	0.0035	1,736	0.007	232,787	1,258,000	
30		P13	1,621	129.39	0.00072	544	0.001	452,761	2,446,750	
31		P14	1,621	240.23	0.00033	463	0.001	576,787	3,117,000	
32		P10	1,621	226.09	0.0085	11,215	0.015	769,050	4,156,000	
33		P14	1,621	343.38	0.0094	18,836	0.033	576,787	3,117,000	
34		P9	1,621	124.82	0.0056	4,079	0.010	393,083	2,124,250	
35		P13	1,621	143.77	0.0035	2,936	0.006	452,761	2,446,750	
36		P11	1,621	20.81	0.0078	947	0.015	64,766	350,000	Without co-incineration of waste
37		P!2	1,621	102.02	0.0048	2,858	0.012	232,787	1,258,000	
38		P!3	1,621	56.01	0.0047	1,536	0.007	227,606	1,230,000	
39	G	P15	1,621	118.72	0.03	20,784	0.131	159,139	860,000	
40		P16	1,621	113.18	0.02	13,209	0.099	133,233	720,000	
41		P17	1,621	129.82	0.001	758	0.002	355,288	1,920,000	
42		P18	1,621	94.43	0.001	551	0.002	355,288	1,920,000	
43		P19	1,621	332.98	0.001	1,943	0.004	555,137	3,000,000	
44		P20	1,621	313.5	0.01	18,295	0.066	277,568	1,500,000	
45		P19	1,621	309.7	0.03	54,219	0.098	555,137	3,000,000	
46		P17	1,621	156.89	0.04	36,622	0.103	355,288	1,920,000	
47		P18	1,621	180.47	0.03	31,595	0.089	355,288	1,920,001	
48	I	P20	1,621	243.936	0.008	11,388	0.021	553,842	2,993,000	
49		P20	1,621	196.812	0.008	9,188	0.017	553,842	2,993,000	
50		P20	1,621	146.916	0.008	6,859	0.012	553,842	2,993,000	
51		P20	1,621	149.688	0.008	6,988	0.013	553,842	2,993,000	
52		P21	1,621	188.496	0.008	8,800	0.014	607,875	3,285,000	
53		P21	1,621	174.636	0.008	8,153	0.013	607,875	3,285,000	
54		P21	1,621	167.706	0.008	7,829	0.013	607,875	3,285,000	
Avera value (set data 2)							**0.025**			

According to mass balance analysis in Indonesian cement plants, the amount of mercury within the clinker was 0.006 g Hg /tonne clinker (MoI, 2014). Since Indonesian cement plants generally only use unit controls for particulates such as a fabric filter and an electrostatic precipitator, the amount of mercury content within the dust collected by this unit control would also be the same as 0.006 g Hg/ tonne clinker.

Table 2.24. **Input Factor Calculation for Cement Production without Waste Co-Incineration from Indonesian Cement Plants (g Hg /tonnes clinker)**

Note	Mercury emissions to the air	Mercury in product	Mercury in specific treatment	Total mercury emission and release
	Calculated data from Table 2.23	measured	Estimated, because using fabric filter/electrostatic precipitator	
Set data 1	0.026	0.006	0.006	0.038
Set data 2	0.025	0.006	0.006	0.037
Average	0.0255	0.006	0.006	0.0375

Due to the limited data on emissions from cement plants with co-incineration of waste, the input factor for incineration with alternative few and raw materials (AFR) was estimated based on a comparison of the default input factor within the toolkit. The input for cement plant production with co-incineration is about 1.36 times the incineration without AFR. Therefore, the input factor for cement production with co-incineration of waste from cement plant in Indonesia is 1.36*0.0375 which equals to 0.051 tonnes Hg/clinker produced.

To estimate the amount of clinker produced by co-incineration of AFR, the value of the national thermal substitution rate was applied, i.e., the proportionate heat substitution of traditional fossil fuel by using alternative fuels such as waste and biomass. Currently, the thermal substitution rate in the cement industry is 3.47% (MoI, 2019). Since the total amount of clinker production in 2019 was 114.2 m tonnes, the amount of cement produced by co-incineration AFR can be estimated as follows:

$$\frac{3.47}{100} * 114{,}200{,}000\ \frac{tonnes}{year} = 3{,}962{,}740\ \frac{tonnes}{year} \qquad \text{Eq. 2-16}$$

In this case, the total amount of clinker production without AFR was:

$$114{,}200{,}000\frac{tonnes}{year} - 3{,}962{,}740\ \frac{tonnes}{year} = 110{,}237{,}260\ \frac{tonnes}{year} \qquad \text{Eq. 2-17}$$

Data gaps and priorities for follow up

Identified data gaps

- The input factor in this study was determined by assuming all mercury emissions data is without AFR (co-incineration) implementation, because there is no accompanying description as to whether the emission was measured from cement plant with or without AFR.
- Direct information concerning the mass balance of mercury within the materials and products were not available.

- If the same method would be applied to refine input factor data, more data should also be collected for determining the emissions factor, as well as more detailed data related to the amount of mercury within the materials.
- Various input factors based on the fossil fuel utilization still cannot be developed using current available data.

Priorities for follow up

- Collect mercury content within materials and product in the process of cement production.
- Collect data of specific fossil fuel utilization and mercury emission data, along with information as to whether the plant implement incineration is with or without AFR.

Summary of inputs and results

Summary of inputs and results of cement clinker production is shown in **Table 2.25.**

Table 2.25. **Summary of Inputs and Results: Cement Clinker Production**

Cement clinker production	Unit	Cement clinker production /without co-incineration of waste	Cement clinker production /with co-incineration of waste	Sum of releases to pathway from assessed part of life-cycle
Activity rate		110,237,260	3,962,740	
Input factor for phase	t/y	0.0375	0.0511	
Calculated input to phase	Kg Hg/t	4,134	202	4,336.40
Output distribution factors for phase:				
▸ Air		0.6		
▸ Water				
▸ Land				
▸ Products		0.2		
▸ General waste treatment				
▸ Sector specific waste treatment		0.2		
Calculated outputs/releases to:				
▸ Air	Kg Hg/y	2,480.34	121.50	2,601.84
▸ Water	Kg Hg/y	0.00	0.00	
▸ Land	Kg Hg/y	0.00	0.00	
▸ Products	Kg Hg/y	826.78	40.50	867.28
▸ General waste treatment	Kg Hg/y	0.00	0.00	
▸ Sector specific waste treatment	Kg Hg/y	826.78	40.50	867.28

2.4.2. Pulp and Paper Production

Data description

In the pulp and paper industry, wood pulp is produced from raw wood via chemical or mechanical means or a combination of both. The source of input mercury is trace levels of mercury in the wood raw material, in fuels used for energy production, and - most likely - in the chemicals applied in the processes (NaOH, chloride, and possibly others). Atmospheric emissions from combustion processes, involving fossil fuels, bark and other wood wastes, and carbon containing process liquids (for chemicals recycling and energy production), disposal of solid wastes and aqueous releases from the processes are among the output pathways of mercury from pulp and paper manufacture. This source sub-category is a potential mercury release source of the type involving materials with very low mercury concentrations, but in very large quantities (UNEP, 2019).

Indonesia's pulp and paper industry are in the top 10 largest producers in the world. Indonesia's paper production capacity in 2019 was recorded at 16 million tonnes per year, while 11 million tonnes of pulp was produced per year (Adi, 2019). The domestic pulp and paper industry is expected to continue to grow this year. The Indonesian Pulp and Paper Association (APKI) projects the industry to grow by 5% in 2019. Moreover, market opportunities are still open and pulp and paper production capacity is increasing due to expansion. The Indonesian government continues to encourage the pulp and paper industry to use the latest technology, so the paper and pulp manufacturing process must prioritize efficiency and effectiveness in the sustainable use of resources.

Background calculations and approximations

According to Pulp and Paper Center (*Balai Besar Pulp dan Kertas*, BBPK) (BBPK, 2020), to produce 1 tonne of pulp, approximately 4.5 m^3 of wood is required. In Indonesia, acacia is the most used type of wood for making pulp. With a density of about 600 kg/m^3, the quantity of wood required for making 1 tonne of pulp is about 600 kg/m^3*4,5 m^3 =2700 kg. In this case, the amount of biomass for pulp production is approximately 11 million tonnes * 2.7 = 29.7 million tonnes of biomass. There is no data available for the content of mercury in the biomass that is used for pulp and paper production. For the assumption of the typical amount of mercury content within the biomass, the input factor from UNEP toolkit (0.03 g Hg/tonne dry weight of biomass) was utilized for the estimating the emissions and releases from pulp and paper production.

Data gaps and priorities for follow up

Both the activity data and the input factor for this sector must be updated. Direct specific information from the pulp and paper industry would be very useful for estimating the amount of biomass that is actually utilized for pulp and paper production. Measurement of the mercury content within various biomass raw materials for this sector should also be conducted to more precisely determined the specific input factor.

Summary of inputs and results

Summary of inputs and results in pulp and paper production is shown in **Table 2.26.**

Table 2.26. **Summary of Inputs and Results: Pulp and Paper Production**

Pulp and Paper Production	Unit	Pulp and paper production	Sum of releases to pathway from assessed part of life-cycle
Activity rate	Biomass, tonnes/year	29,700,000	
Input factor for phase	g Hg/tonnes dry weight of biomass	0.03	
Calculated input to phase	Kg/year		891
Output distribution factors for phase:			
▸ Air		0.9	
▸ Water		0.0	
▸ Land		0.0	
▸ Products		0.0	
▸ General waste treatment		0.1	
▸ Sector specific waste treatment		0.0	
Calculated outputs/releases to:			
▸ Air	Kg Hg/y		801.90
▸ Water	Kg Hg/y		0.00
▸ Land	Kg Hg/y		0.00
▸ Products	Kg Hg/y		0.00
▸ General waste treatment	Kg Hg/y		89.10
▸ Sector specific waste treatment	Kg Hg/y		0.00

2.5. Data and Inventory on Intentional Use of Mercury in Industrial Processes

2.5.1. Chlor-alkali production with mercury-technology

Data description, background calculations and approximations

In a mercury cell chlor-alkali facility, elemental mercury is used as a fluid electrode in an electrolytic process used for production of chlorine and sodium hydroxide (NaOH) or potassium hydroxide (KOH) from salt brine (the electrolysis splits the salt, NaCl). Hydrogen is also made as a byproduct. The process is sometimes referred to as the "mercury cell" process. The two other (non-mercury) methods are also used widely: the membrane process and the diaphragm process. Mercury is released to the environment with air emissions, water releases, in solid wastes and in products (such as NaOH). These releases can occur at various stages and locations of the process. The degree of release to each media (air, water, land), from various stages and release points in the process, is highly dependent on level of controls present, workplace/management practices, waste treatment/disposal procedures, and other factors (UNEP, 2019).

The production of caustic soda is very important, because it is one of the basic chemicals that have an important role in the production process of various industries. The need for NaOH in Indonesia is quite high and increase from year to year but the domestic production of NaOH has not been sufficient to fulfil the domestic need of caustic soda. Estimated requirement of NaOH in Indonesia by 2020 is estimated approximately 704,815.3 tonnes/year. Based on the Law of Republic Indonesia, No. 11 of 2017 concerning Ratification of the Minamata Convention on Mercury, the production of chlor-

alkali that utilizes mercury cells will be completely prohibited by 2025. Currently the chlor-alkali industry is shifting to other technologies such as membrane process and diaphragm process for chlorine and sodium hydroxide (NaOH) production. The chlor-alkali industry is the biggest consumer of industrial salt. This sector utilizes around 67% of total imported salt or 2.5 million. The chlor-alkali supplies the materials for paper and petrochemical industry, pharmacy industry, cosmetics industry as well as various food industries (Rini, 2018).

Currently there is still one chlor-alkali plant that still utilizes a mercury cell for chlorine and NaOH production, with a capacity of 3,000 tonnes/year. This industry is now trying to change its technology, otherwise it will be shut down by 2025. Since there is no information available concerning the input factor from this industry, the default input factor (100 g Hg/t Cl_2) from UNEP toolkit level 2 was used for calculating the mercury release.

Data gaps and priorities for follow up

Mercury release from this sector will be stopped by 2025. Special attention has been taken by the Indonesian government for implementation of Act of Republic Indonesia No. 11 of 2017 concerning Ratification of the Minamata Convention on Mercury for this sector. The mercury content per tonnes of Cl_2 produced is still unknown, direct measurement will give an accurate estimation of mercury release. However, since by 2025 this source sub-category will be completely shut down, it is not necessary to refine the mercury input factor.

Summary of inputs and results

Summary of inputs and results of intentional use of mercury in industrial processes is shown in **Table 2.27.**

Table 2.27. **Summary of Inputs and Results: Intentional Use of Mercury in Industrial Processes**

Intentional Use of Mercury In Industrial Processes	Unit	Chlor-alkali production with mercury-technology	Sum of releases to pathway from assessed part of life-cycle
Activity rate	t/y, Cl_2 produced	3,000	
Input factor for phase	g Hg/t Cl_2 produced	100	
Calculated input to phase	Kg/year	300	300
Output distribution factors for phase:			
▸ Air		0.20	
▸ Water		0.02	
▸ Land		0.38	
▸ Products		0.10	
▸ General waste treatment		0.00	
▸ Sector specific waste treatment		0.30	
Calculated outputs/releases to:			
▸ Air	Kg Hg/y	60.00	60.00
▸ Water	Kg Hg/y	6.00	6.00
▸ Land	Kg Hg/y	114.00	114.00
▸ Products	Kg Hg/y	30.00	30.00
▸ General waste treatment	Kg Hg/y	0.00	0.00
▸ Sector specific waste treatment	Kg Hg/y	90.00	90.00

2.6. Data and Inventory on Consumer Products with Intentional Use of Mercury

A large number of traditional products make use of mercury's characteristics in their function. The major product groups in which mercury is added intentionally are thermometers, fluorescent light bulbs, some battery types, some traditional types of electrical switches, and traditional manometers and pressure gauges. The consumption of these products is in a decline because of mercury's adverse effects on health and environment, and because electronic equipment for the same purposes but with smart features has gained increasing share of the market. The manufacture of mercury containing products may give rise to mercury releases to air, wastewater and production wastes. Publicly available mercury release data on such manufacture are scarce, and the estimation calculations here are based on a limited data base.

Data description

2.6.1. Thermometers with mercury

Mercury thermometers have traditionally been used for most medium temperature range measurements. Today, they are increasingly substituted by electronic and other thermometer types, but the degree of substitution probably varies among countries (UNEP, 2002).

2.6.2. Medical thermometers

Use and disposal

The Ministry of Health has stopped providing distribution permits for medical devices that still use mercury in Indonesia, such as thermometers and tensimeters or blood pressure meters, based on the Circular Letter of the Minister of Health Number HK.02.02/V/0720/2018 concerning the Determination of the Validity Period for Circulation of Medical Devices Containing Mercury which was issued on March 8 2018. Director General of Public Health, Ministry of Health of the Republic of Indonesia (*Kementerian Kesehatan*, Kemenkes), had carried out the removal and withdrawal of medical devices containing mercury, as part of the National Action Plan for Mercury Reduction and Elimination stipulated in Presidential Regulation No. 21/2019.

A questionnaire concerning the use and disposal of health equipment containing mercury (thermometer and sphygmomanometer) was circulated to health facilities (9,909 health centers and 2,820 hospitals) all over Indonesia over the period from January to August 2020 in order to identify the methods of use and disposal of such equipment. According to the questionnaire, there were still 6,033 mercury thermometer units in use in 2019-2020, and 20,537 units that were no longer in use but were kept in good condition. Also identified were 9,020 broken thermometers. The activity rate for these medical thermometers in the toolkit, including the use and disposal, was: 6,033+9,020=15,053 units.

2.6.3. Ambient air thermometer

Use and disposal

According to data from the National Committee of Accreditation in Indonesia, there are three types of accredited laboratories available in Indonesia, testing laboratories (1,263 labs), calibration laboratories (297 labs), and medical laboratories (80 labs). The use of ambient air thermometers in these laboratories is common but no specific survey has been conducted yet so as to identify the use and disposal of this type of thermometer. A previous study in 2010 predicted that at least 3 thermometers were available in each laboratory. Since the use of mercury thermometers has been prohibited, it was estimated that at least one thermometer might still have been in use in each laboratory in 2019.

2.6.4. Electrical switches and relays with mercury

Mercury has been used (and continues to be used) in a variety of electrical switches and relays. Mercury switches and relays will likely be present in this type of waste for years to come due to the very long service life of these items. This sub-category is a very diverse product group both in terms of the differences in applications, the mercury content and the life spans of the electrical components, and it may therefore take a substantial effort to estimate mercury releases from this sub-category. Recent studies in the US demonstrate that there are non-mercury alternative switches/relays that are comparable or superior to the mercury products with respect to cost and functionality for virtually all applications (Galligan et al., 2003, as cited by NRDC in comments to UNEP, 2005).

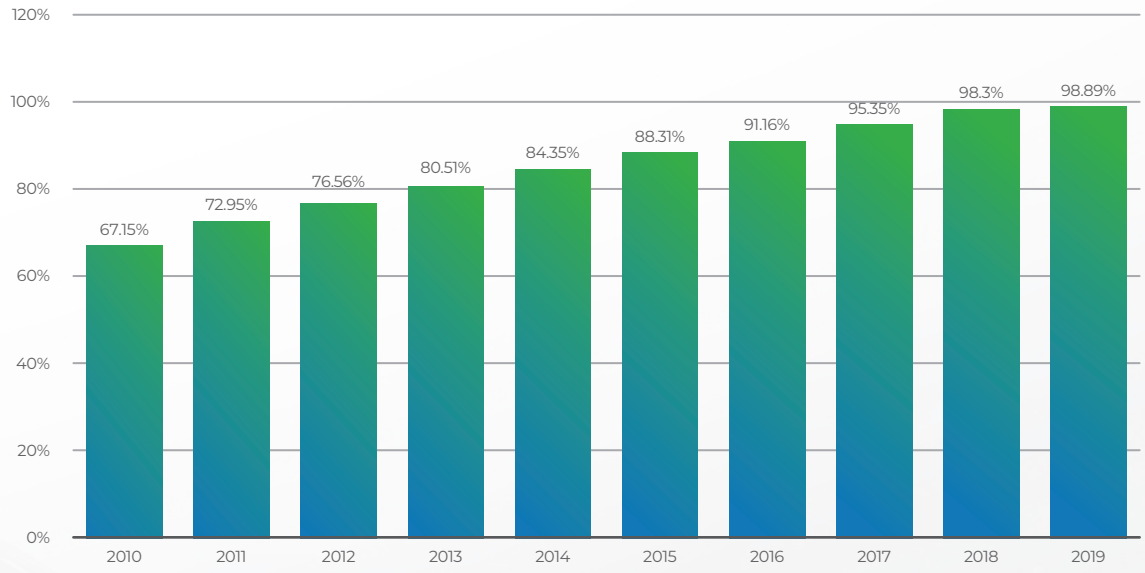
The primary use of elemental mercury in electrical apparatus manufacturing is in tilt switches, which are also known as "silent" switches. A mercury tilt switch is constructed by adding mercury into a glass tube containing metal wire contacts, and then sealing the tube. An out-side mechanical force or gravity activates the switch by moving the switch from a vertical to a horizontal position causing the mercury to flow from one end of the tube to the other, thus providing a conduit for an electrical current (UNEP, 2019).

Another type is the mercury thermostat probes, also known as flame sensors or gas safety valves. The metal probe consists of a metal bulb and thin tube attached to a gas-control valve. The mercury is inside the tube and expands or contracts to open and shut the valve. They are most commonly present as part of the safety valve that prevents gas flow if the pilot light is not lit in several types of gas-fired appliances, such as water heaters, furnaces, and space heaters. Mercury thermo fuses have been used in automatic coffee makers and irons (Skårup et al., 2003).

Use and disposal

Data related to the use and disposal of electrical switches and relays with mercury were not available. Therefore, the estimation of mercury release would rely on the estimation based on the number of inhabitants in Indonesia and the electrification rate (see Figure 2.22). The electrification rate refers to the percentage of people in a given area that have relatively simple, stable access to the electricity. Indonesian geography makes building and expanding the power supply a major challenge. The networks of countless islands in Indonesia need to be interconnected for a nationwide coverage. Currently, the archipelago has eight major power grids and around 600 smaller, isolated networks. Most of the networks are owned and operated by the state-owned electricity provider (PLN).

Figure 2.22. **Trend of Electrification Rate in Indonesia (Statista.Com, 2020)**



Sumber: Statista.Com, 2020

2.6.5. Lights sources with mercury

Use and disposal

Aperlindo has 42 members and 90 percent or 36 companies of the total membership are lamp importers. The rest are lamp manufacturers, a total of 6 companies that have light factories in Indonesia. The six lamp manufacturers in Indonesia, the Hori branded lamps are produced by PT Honoris Industry, a subsidiary of PT Multi Indocitra Tbk (MICE). Then the Light lamp are produced by PT Pancaran Indonesia, and the Focus lamp produced by PT Tjipto Langgeng Abadi. Aperlindo also estimated that the lamp production capacity in Indonesia about 20% of the total domestic demand (Arief, 2019).

For the domestic market, the number of lamp demands can be estimated based on the number of electricity customers. There are 69,702,979 electricity customers in 2019 (BPS, 2020h). If one customer used in average 8 lamps, there were approximately 557,623,832 lamps that were used in 2019. The domestic manufacturers were only able to supply 20% of the total consumption or 139,405,958 lamps, and the rest of the lamps were imported. According to Aperlindo (2020), the use of LED lamps in Indonesia increases, and it was recorded about 300 million lamps in 2019. The lowest number of lamps which are used in 2019 were the incandescent lamps (16,101,490 lamps), followed by the fluorescent tube lamps (48,304,469 lamps), and the compact fluorescent lamps (193,217,874 lamps). The types of lamps which release mercury are the fluorescent tube lamps and the compact fluorescent lamps.

2.6.6. Batteries with mercury

Production

According to reported data from local producer to MoI (2020), the amount of mercury used to produce batteries in 2019 was 326.1 kg. This was the last mercury stock which was available in the battery production, because the trade and the use of mercury had already been banned in Indonesia. The battery industry only utilized the latest stock which was still available. Currently they are still developing a cleaner battery which does not contain mercury.

Use and disposal

The lithium-ion battery is a type of rechargeable battery with high energy density and a high safety level. It is commonly used for portable electronic devices, power tools, and electric vehicles (EVs) (Mordor-Intelligence, 2019). This type of battery has undergone a tremendous transformation in their performance (MoEF, 2020). Indonesia has large deposits of nickel and cobalt and both nickel and cobalt are important raw materials in the lithium-Ion battery. Thus, the readily available raw materials in Indonesia are likely to drive the lithium-ion battery market in Indonesia. Although lithium-ion batteries do not contain mercury, cadmium or lead, the content of these batteries does include other heavy metals that can be problematical for the environment. In 2019, Indonesia set an ambitious target on the adoption of electric vehicles (EV) with 2.1 million e-motorcycles and 2,200 e-cars expected to take the road by 2025, which in turn is expected to drive the battery market (Mordor-Intelligence, 2019). Indonesia does however have the biggest reserves of nickel, and the country could provide the lowest EV battery manufacturing costs of any country in Asia (Chan, 2020). With automotive batteries currently equipped with warranties of five to eight years, end-of-life recycling will become big business in the not-too-distant future. In addition, the increasing volume of batteries becoming available for recycling in the medium term will reward investment in new recycling facilities and technological research that will increase the efficiency of material recovery and reduce costs, contributing to a circular economy (Nickel-Institute, 2021).

Most of battery production are shifting to an eco-friendly product, avoiding hazardous metals such as mercury and lead. PT Panasonic Gobel Energy Indonesia (PT PGEI) has a production capacity of 1 billion pieces of batteries, with installed production capacity of 1.3 billion per year, where 80% of these batteries are exported, and 20% (200,000,000 pieces) are for domestic consumption (Purba, 2015). This company contribute about 16% of domestic use which means that the total number of battery consumption in Indonesia approximately 100/16%*200,000,000 or equals to 1,250,000,000 pieces. Using this number, it can be predicted that the battery containing mercury would approximately about 1,250,000,000-200,000,000 = 1,050,000,000 pieces.

Although many companies have claimed that they are shifting to an eco-friendly product, the use of mercury containing battery are still possible, especially batteries from old production. The use of button cells was also possible since there are accessories such as watches, household appliances as well as children toys use this type of battery. Using data from previous inventory in 2015, it was estimated that 0.5 percent of inhabitants using the zinc-air button cells, while 20% of inhabitants using alkaline button cells. The weight of zinc-air button battery is 1.9 gram while alkaline type is 2.4 gram (Energizer, 2009). The weight of alkaline other than button cell shapes is about 11.5 gram.

2.6.7. Cosmetics and related products with mercury

Mercury has been used in skin lightening creams, soaps, and as preservatives in some eye cosmetics. Releases may occur during production, use and disposal of these products (UNEP, 2002 and COWI, 2002).

Use and disposal

The Drug and Food Monitoring Agency (BPOM) reported that there were 96 cases of illegal cosmetics circulation in 2019, worth IDR 185.5 billion (BPOM, 2019). The products such as lipsticks, whitening cream and face foundation contained dangerous substances including mercury. Most of these products were imported brands, and mainly circulated in Indonesia through the online shops. According to the online market research (Adilah, 2020), the price of these illegal products is cheaper than the legal products, approximately IDR 100,000 per package. If the package was assumed to be a 100-gram product, based on the total worth stated by BPOM, the weight of illegal cosmetics could reach more than:

$$\frac{185{,}800{,}000{,}000}{100{,}000}\ (item) * 100 \left(\frac{gram}{item}\right) * 10^{-6} \left(\frac{ton}{gram}\right) = 185{,}8\ ton \qquad \text{pers. 2-8}$$

Background calculations and approximations

Since there is no local specific information related to the content of mercury within the product, the input factors from UNEP were utilized to estimate the mercury release.

- For medical thermometers, the input factor was estimated to be 1 g Hg/item, while for ambient air thermometers, the input factor was chosen to be 3.5 g Hg/item.
- For electrical switches and relays with mercury, the input factor was approximated from the number of inhabitants (266,911,900 inhabitants in 2019) and electrification rates (98.8%), as well as the amount of mercury consumed per inhabitant per year (0.14 g/inhabitants).
- For light sources with mercury, the input factor for fluorescent tubes (double end) was 2 mg Hg/item, and for compact fluorescent lamp (CFL single end) was 2 mg Hg/item. Data for mercury content in CFL was derived from Gamatrindo (*Gabungan Industri Manufaktur Terpadu Indonesia* or Association of Indonesian Integrated Lighting Manufacturing Industry).
- For Batteries with mercury the input factor was 12 kg Hg/t product for zinc-air button cells, 5 kg Hg/t product, and 0.25 g Hg/t product for alkaline other than button cell shapes.
- And for cosmetics and related product with mercury, the input factor 0.262 kg Hg/t product according to the available data as presented in **Table 2.28**.

There was actually very little data on mercury content in the cosmetics and related products, as presented in **Table 2.28**. However due to the widespread and various types of illegal cosmetics in Indonesia, the low-end value from UNEP toolkit was taken to approximate the actually release.

Table 2.28. **Mercury Contents in Illegal Cosmetics and Related Product in Indonesia**

No	Mercury content	Unit	Source
1	0.391	kg/t	Polii, 2013
2	0.375	kg/t	
3	0.243	kg/t	
4	0.224	kg/t	Trisnawati dkk. 2017
5	0.188	kg/t	
6	0.1532	Kg/t	Nuradi, 2017
average	0.262	Kg/t	

Data gaps and priorities for follow up

Identified data gaps

The activity data for this sector must be updated, more surveys should be conducted to identify the real number of products with intentional use of mercury.

- Only medical thermometer data was derived from the direct survey to the health facilities all over Indonesia.
- Other data such as for ambient thermometers, electrical switches and relays with mercury, cosmetics and related products with mercury, as well as batteries, we still use estimation data.
- The content of mercury within each of the products is unknown. It is better to incorporate the identification of the production series or manufacturer, to track more information related to the mercury content.

Priorities for follow up

- Conduct survey for the use of ambient thermometer.
- Collect more accurate activity data of each type of battery production and use directly from the producers/manufacturer.
- Collect information related to the content of mercury within the thermometer, batteries, cosmetics and related products.

Summary of inputs and results

Summary of inputs and results of consumer products with intentional use of mercury is shown in **Table 2.29**.

Table 2.29. **Summary of Inputs and Results: Consumer Products with Intentional Use of Mercury**

Consumer products with intentional use of mercury	Unit	Thermometers with mercury		Electrical switches and relays with mercury	Light sources with mercury		Baterai Bermerkuri				Cosmetics and related products with mercury	Sum of releases to pathway from assessed part of life-cycle
		Medical thermometers	Ambient air thermometer		Fluorescent tubes (double end)	Compact fluorescent lamp (CFL single end)	Production	Zinc-air button cells	Alkaline button cells	Alkaline, other than button cell shapes		
Activity rate		15.053 Items/y	1640 Items/y	266,911,900 inhabitants	48,304,469 Items/y	193,217,874 Items/y	326 kg/y	2.5 t/y	128.1 t/y	11,446 t/y	185.8 t/y	
Input factor for phase		1 g Hg/item	3.5 g Hg /item		8 mg Hg/item	2 Mg Hg /item	1 /y	12 kg Hg/t	5 kg Hg/t	0.25 g Hg/t	0.262kg Hg/t	
Calculated input to phase	kg Hg/ thn	15.1	5.7	0.14 g/1000 inhabitants Electrification rate of 98,8%	386	386		30	641	2.86		
		20.8		36.953	773		326	674			48,7	38,796
Output distribution factors for phase:												
▸ Air		0.2		0.3	0.3		0.005	0.25				
▸ Water		0.3					0.005				0.95	
▸ Land		0.2		0.4	0.3		0.1			0.25	0.05	
▸ Products												
▸ General waste treatment		0.3		0.3	0.4		0.1			0.5		
▸ Sector specific waste treatment							0.01					
Calculated outputs/releases to:												
▸ Air	kg Hg/ thn	4.16		11,085.87	231.86		1.63			168.47		11,492.0
▸ Water		6.24					1.63				1,765.10	54.1
▸ Land		4.16		14,781.1	231.86		32.61			168.47	92.90	15,220.6
▸ Products												-
▸ General waste treatment		6.24		11,085.87	309.15		32.61			336.94		11,770.8
▸ Sector specific waste treatment							3.26					3.3

2.7. Data and Inventory on Other Intentional Product/Process Uses

Data description

2.7.1. Dental mercury-amalgam fillings

Dental amalgam fillings consist of an alloy of mercury, silver, copper and tin (typically about 44-51% mercury by weight). The alloy is typically supplied to the dentists either: 1) as pure mercury along with a powder mix of the other metals, which are weighed and mixed in an agitator in the clinic; or 2) as small capsules where mercury and the metal powder are present in the right formula and only need to be mixed (in the capsule before opening) in the clinic, prior to filling the cavity in the tooth (COWI, 2002).

The questionnaire concerning the use of mercury for dental amalgam fillings had been circulated in all of the health facilities in Indonesia (2019) to identify the amount of mercury use for dental amalgam. According to the questionnaire about 26,245.58 g mercury per year was utilized for this amalgam fillings.

2.7.2. Manometers and gauges with mercury

A questionnaire concerning the use and disposal of health equipment containing mercury (thermometer and sphygmomanometer) was circulated to health facilities (9,909 health centers and 2,820 hospitals) all over Indonesia over the period from January to August 2020 to identify the methods of use and disposal of such equipment. According to the questionnaire there were:

- 20,008 units of mercury sphygmomanometer-table type in use, and 24,498 were in broken condition.
- 4,254 units of mercury sphygmomanometer-standing type in use, and 176 were in broken condition.

Along with the implementation of the national action plan, 35,107 units of mercury sphygmomanometer-table type and 11,707 units of mercury sphygmomanometer-standing type were no longer in use and kept in good condition.

2.7.3. Laboratory chemicals and equipment with mercury

Mercury is used in laboratory instruments, reagents, preservatives, and catalysts. Some of this mercury is released to air, primarily through lab vents. However, most of the mercury may be released in wastewater or disposed of as hazardous waste or municipal waste. Mercury may have been substituted in some of the equipment and for some of the mentioned analytical methods. Some standard analyses seem, however, difficult to substitute in practice – even though substitutes are in many cases available - because standards are there to improve reproducibility of the analysis practices and therefore favor the well-known, and they are often also required in public regulation (UNEP, 2019).

Due to the various types of equipment and methods that might be implemented in every laboratory, there is no data that can be collected yet. However, the use of mercury in laboratory chemicals Indonesia is still apparent.

Background calculation and approximation

Dental mercury-amalgam fillings

The input factor was not applied for estimating mercury as dental mercury-amalgam fillings, since the amount of mercury was directly taken from the results of questionnaire which was circulated by BSCRC-SEA in 2019-2020.

Manometers and gauges with mercury

Since there was no specific information concerning the amount of mercury contained within the sphygmomanometer for either the table or the standing type, the input factor value from UNEP Toolkit was taken (lower end, 70 g Hg/item)

Laboratory chemicals and equipment with mercury

Specific information concerning laboratory chemicals and equipment with mercury are also not available. Preliminary default input factor is used, based on current consumption in the European Union i.e., 0.01 g Hg/inhabitant for laboratory chemicals and 0.04 g Hg/inhabitant for equipment with mercury.

Data gaps and priorities for follow up

Identified data gaps

The activity data for this sector must be updated, more surveys should be conducted to identify the real number of products with intentional use of mercury.

- Only sphygmomanometer data were derived from the direct survey to the health facilities all over Indonesia.
- Other data such as laboratory chemicals and equipment with mercury still use estimation data.
- The content of mercury within each of these products is unknown. It is better to incorporate the identification of the production series or manufacturer, to track more information related to the mercury content.

Priorities for follow up

- Conduct survey for the use of laboratory chemicals and equipment with mercury.
- Collect more accurate activity data of use and disposal of laboratory chemicals and equipment with mercury.
- Collect information related to the content of mercury within these products.

Summary of inputs and results

Summary of inputs and results of other intentional product/process is shown in **Table 2.30.**

Tabel 2.30 **Ringkasan Masukan dan Hasil: Penggunaan Produk/Proses Disengaja Lainnya**

Other Intentional Product/Process Uses	Unit	Dental mercury-amalgam fillings		Manometers and gauges with mercury		Laboratory chemicals and equipment with mercury		Sum of releases to pathway from assessed part of life-
		Preparations of fillings at dentist clinics	Use - from fillings in the mouth	Table-type	Standing type	Laboratory chemicals	Other laboratory equipment	
Activity rate				20,008 items use/y 24,498 items broke/y	4,254 items use/y 176 items broken/y			
Input factor for phase				70 g Hg/item	70 g Hg/item	0.01 g Hg/ inhabitant*inhabitants, with electrification rate: 98.89%	0.04 Hg/ y*inhabitant, with electrification rate: 98.89%	
Calculated input to phase	kg/thn	26.25	26.25	3,454		2,639.49	10,557.97	16,661.99
Output distribution factors for phase:								
▸ Air		0.02		0.2				
▸ Water		0.14		0.3		0.33	0.33	
▸ Land				0.2				
▸ Products								
▸ General waste treatment		0.12		0.3		0.33	0.33	
▸ Sector specific waste treatment		0.12				0.34	0.34	
Calculated outputs/releases to:								
▸ Air	Kg Hg/y	0.52		690.70				691.22
▸ Water	Kg Hg/y	3.67	0.52	1,036.06		871.03	3,484.13	5,395.41
▸ Land	Kg Hg/y			690.70				690.70
▸ Products	Kg Hg/y							-
▸ General waste treatment	Kg Hg/y	3.15		1,036.06		871.03	3,484.13	5,394.37
▸ Sector specific waste treatment	Kg Hg/y	3.15				897.43	3,589.71	4,490.29

2.8. Data and Inventory on Waste Incineration and Burning

Data description

2.8.1. Incineration of General/Municipal Waste

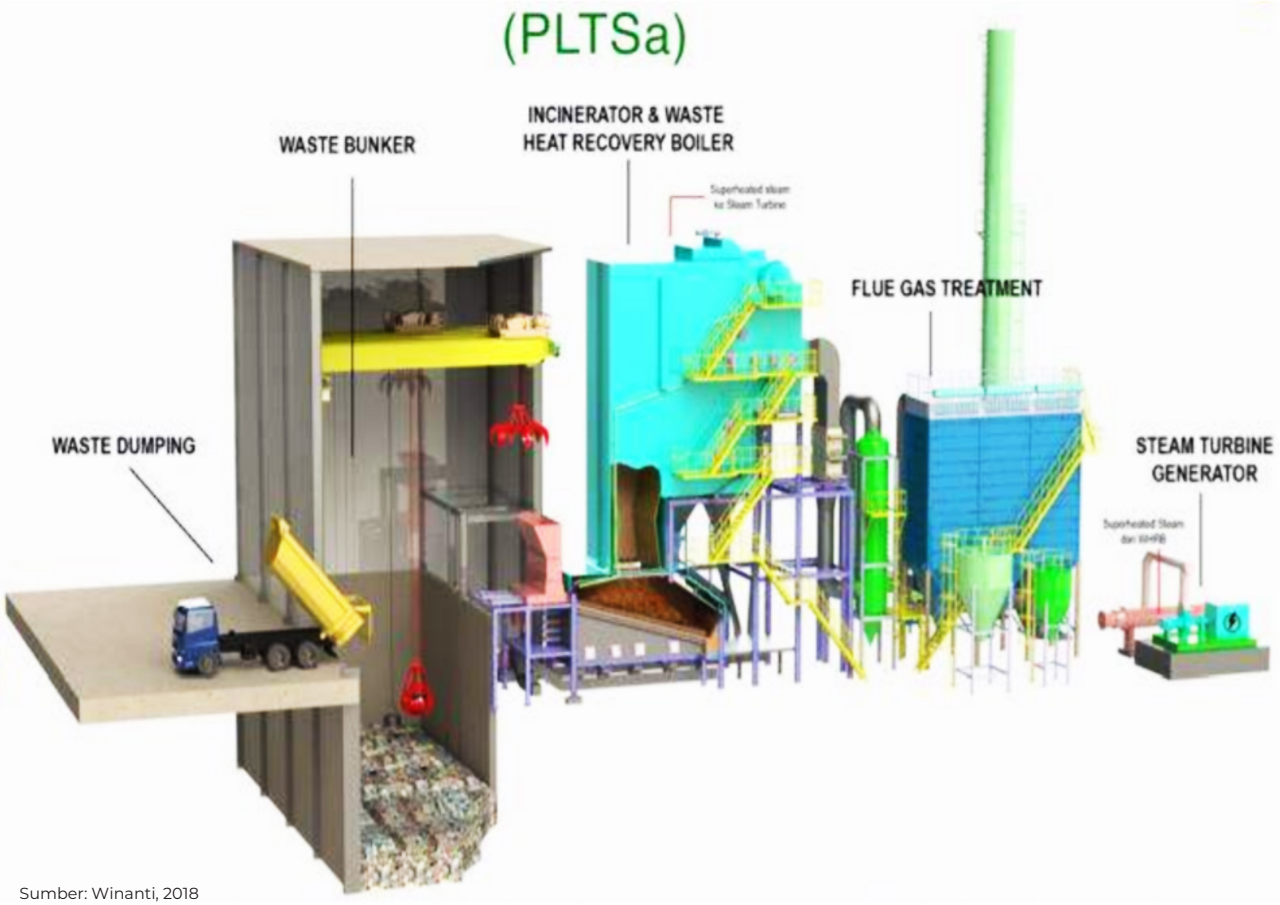
The mercury content in the general waste stream originates from three main groups of inputs: intentionally used mercury in discarded products and process waste;

1. Natural mercury impurities in high volume materials (plastics, paper, etc.) and minerals;
2. Mercury as a human-generated trace pollutant in high volume materials;
3. The mercury concentrations are directly dependent on the inputs of mercury to the waste.

Refuse or municipal solid waste (MSW) consists primarily of household garbage and other non-hazardous commercial, institutional, and non-manufacturing industrial solid waste (UNEP, 2019).

In Indonesia, there are two types of incineration of municipal waste, incineration in waste to energy plants, and informal incineration. The incineration of municipal waste in a waste to energy plant is considered to be one of the better solutions for the management of municipal waste, since the service periods of many landfills have ended and new places are relatively difficult to find. Waste to energy plants is also considered to be a good source of renewable energy and able to contribute to the development of renewable energy sources to fulfil the target of a renewable energy mix of 23% in 2025 in accordance with the government commitment in the Paris Agreement 2015. The Government has set up a pilot waste to energy plant in Bantar Gebang Bekasi city with a capacity of 100 tonnes per day (**Figure 2.23**). The plant started to operate on April 2019, and during the trial period, about 10,000 tonnes of waste was incinerated to produce electricity (Wartakotaalive.com, 2020).

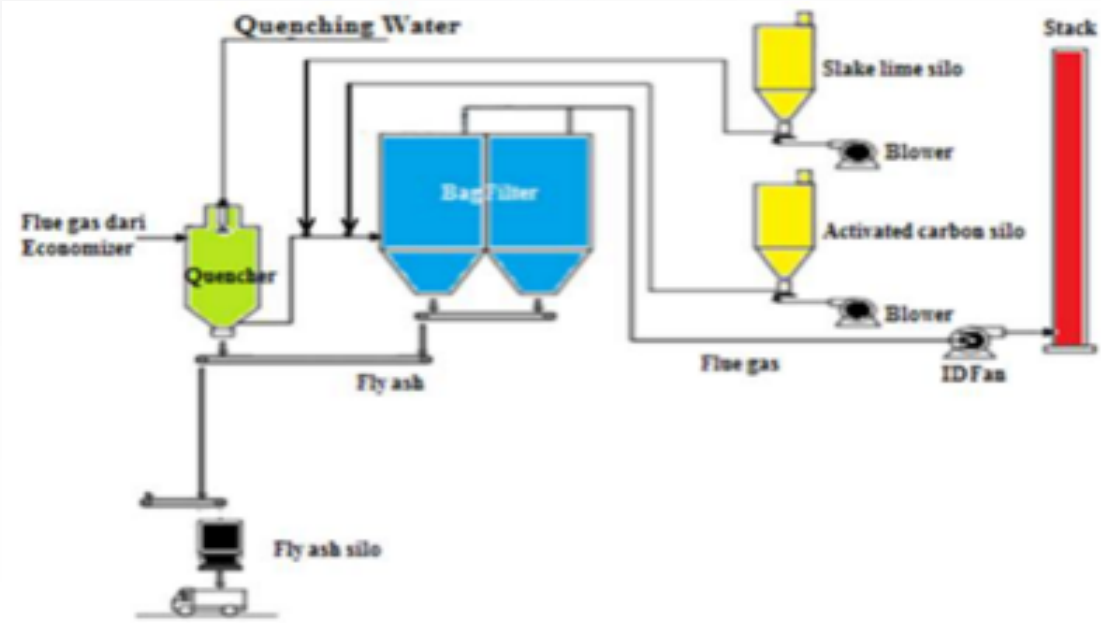
Figure 2.23. **Bantar Gebang Waste to Energy Plant (Winanti, 2018)**



Sumber: Winanti, 2018

This waste to energy plant was also equipped with air pollution control, quencher, dry scrubber and bag filter (**Figure 2.24**), wastewater treatment plant, ash management facilities, and instrumentation and control system.

Figure 2.24. **Air Pollution Control Devices in Bantar Gebang Waste to Energy Plant, Developed by BPPT (Winanti, 2018)**



Source: Winanti, 2018

The Indonesian government has set a target to build waste to energy plant in 12 cities from 2019 until 2022, and will be located in Jakarta (38 MW), Tangerang, South Tangerang (20 MW), Bekasi (9 MW), Bandung (29 MW), Semarang, Surakarta (10 MW), Surabaya (10 MW), Makassar (20 MW), Denpasar (20 MW), Palembang (20 MW) and Manado (20 MW). Surabaya will become the first city to build 10 MW waste to energy plant which consume around 1500-tonnes waste/day (Nurhasanah, 2020).

2.8.2. Incineration of Hazardous Waste, Medical Waste, and Sewage Sludge

Hazardous waste

The mercury content in the hazardous waste stream originates primarily from intentionally used mercury in discarded products and process waste. Some hazardous waste is incinerated as part of the treatment/disposal management. Hazardous waste refers to residues and wastes which contain hazardous materials in significant quantities. Generally spoken, all materials including consumer goods, which require special precautions and restrictions during handling and use, belong to this group. Any consumer goods, which are labelled to such an extent and have entered the waste stream, must be considered hazardous waste. These include solvents and other volatile hydrocarbons, paints and dyes, chemicals including pesticides and herbicides, pharmaceutical products, batteries, fuels, oils and other lubricants, as well as goods containing heavy metals. Also, all materials contaminated with these materials such as soaked rags or paper, treated wood, production residues, etc., are considered hazardous waste (UNEP, 2003).

Waste with high concentrations of mercury would generally not be suitable for incineration, and would preferably be sorted out of the hazardous waste before incineration and treated separately. In practice this may, however, not always be fully attained (UNEP, 2019).

The Government of Indonesia has set the regulation No 101/2014 concerning Hazardous Waste Management, which covers the definition of producers, collectors, transporters, and treatment facilities, and waste characteristics (including infectious waste or medical waste).

Medical waste

Medical waste includes infectious and non-infectious wastes generated by a variety of facilities engaged in medical care, veterinary care, or research activities such as hospitals, clinics, doctors' and dentists' offices, nursing homes, veterinary clinics and hospitals, medical laboratories, and medical and veterinary schools and research units. The mercury content in the medical waste stream originates primarily from intentionally-used mercury in discarded products and process waste. The mercury concentrations are directly dependent on the inputs of mercury to the waste.

Based on the source of the waste, medical waste form health facilities are considered to be hazardous waste based on the Government of Indonesia Regulation No. 101/2014 concerning Hazardous Waste Management. The Ministry of Environment and Forestry has further set up the Regulation No. P.56 /2015 concerning Methods and Technical Requirements for the Management of Hazardous and Toxic Waste from Health Service Facilities.

Sewage sludge

Sewage sludge is the product of any wastewater treatment process, regardless of its origin (e.g., wastewater from municipal, agricultural or industrial activities). The mercury concentrations are directly dependent on the inputs of mercury to the wastewater. If the concentrations of hazardous substances are low enough, the sludge may be spread on farmland as fertilizer in some countries. Otherwise, the sludge can either be incinerated (separately or by co-combustion in power plants, municipal waste incinerators, cement kilns etc.), be landfilled, or undergo other treatment like wet oxidation, pyrolysis, gasification, etc. (UNEP, 2019).

The sewage sludge from domestic wastewater treatment in Indonesia is usually used for plant fertilizer or for plant growing media. However, there is also sewage sludge from these domestic wastewater treatment systems that are incinerated. Currently there are only 23 wastewater treatment plants all over Indonesia, with the total capacity of 438,683 m^3/day (**Table 2.31**).

Table 2.31. **Domestic Wastewater Treatment Plants in Indonesia**

No.	Wastewater Treatment Plant	City	System	Total Capacity (m^3/day)
1	Pulo Brayan	Medan	UASB (Upflow Anaerobic Sludge Blanket) + Aerated Lagoon	10,000
2	Ajibata	Prapat	Aerated Lagoon	2,000
3	Setiabudi	DKI Jakarta	Aerated Lagoon	60,480
4	Bojongsoang	Bandung	Anaerobic, Facultative & Maturation Pond	243,000
5	Kesenden	Cirebon	Anaerobic, Facultative & Maturation Pond	7,033
6	Ade Irma	Cirebon	Anaerobic, Facultative & Maturation Pond	5,626
7	Gelatik	Cirebon	Anaerobic, Facultative & Maturation Pond	3,944
8	Rinjani	Cirebon	Anaerobic, Facultative & Maturation Pond	3,944
9	Sewon	Yogyakarta	Aerated Lagoon	15,500
10	Pucang Sawit	Surakarta	Aerob Facultative & Biofilter	9,504
11	Suwung	Bali	Aerated Lagoon	51,000
12	Margasari	Balikpapan	Extended Aeratin	800
13	HKSN	Banjarmasin	RBC	5,000
14	Pekapuran Raya	Banjar Masin	RBC	2,500

No.	Wastewater Treatment Plant	City	System	Total Capacity (m^3/day)
15	Lambung Mangkurat	Banjarmasin	RBC	1,000
16	Basirih	Banjarmasin	RBC	2,000
17	Tata Banua	Banjarmasin	RBC	2,000
18	Sungai Andai	Banjarmasin	RBC	3,000
19	Sultan Adam	Banjarmasin	RBC	2,000
20	Margasari	Balikpapan	Extended Aeration	800
21	Sukasari	Tangerang	Oxidation Ditch	2,700
22	Batam Center	Batam	Oxidation Ditch	2,852
23	Boulevard	Manado		2,000

Source: MoPWPH, 2014

The sewage sludge from industrial wastewater treatment is mostly incinerated, especially for the hazardous waste sewage sludge. The incineration can be done in the hazardous waste treatment facilities or as alternative fuel in cement plant for co-incineration process. According to the Decree of Directorate General of Pollution Control and Environmental Destruction No. SK53/2020 concerning Determination of Participants in the Assessment Program for Company Performance Ratings in Environmental Management for the 2019-2020 period, it was recorded that there were 2040 industries, and most of them have the wastewater treatment plant facilities.

2.8.3. Open Waste Burning on Landfills and Informally

Open waste burning is defined here as waste incineration undertaken at informal conditions, in barrels, containers, in landfills (of any kind) or on bare land, with no flue gas controls and diffuse spreading of incineration residues on land/landfill. If mercury is present in the waste, part of it will be released to air, and part of it will remain in incineration residues (including unburned and semi degraded waste) with a potential for additional subsequent mercury releases to air, ground water and surface waters (UNEP, 2019).

According to Indonesian Environmental Status in 2009, 69% was taken to landfill, 5% of generated waste was incinerated (Baqiroh, 2019). MoEF also pointed out that 55% of landfill are still open dumping type.

Background calculations and approximations

Incineration of general/municipal waste

In Indonesia, up to now, incineration of municipal waste in incinerator or in waste to energy plant only takes place in a pilot waste to energy plant in Bantar Gebang Bekasi city with maximum capacity of 100 tonnes per day, and in 2019 has combusted about 10,000 tonnes of municipal waste. More wastes to energy plants are going to be built in 12 different cities. However, there is no standard of mercury content of the municipal waste that can be used as energy source in a waste to energy plant. There is also no regulation related to the mercury content within the municipal waste. Since the municipal waste contain various type of waste, it is difficult to determine certain value of mercury content unless it is measured using representative samples. In this case, the default input factor from UNEP toolkit level 2 was utilized to estimate the mercury release.

Incineration of hazardous waste, medical waste, and sewage sludge

There are only 6 (six) hazardous waste treatment services available for incinerating hazardous waste (including medical waste from health facilities) in Indonesia (owned by the private sector and local government, see **Table 2.32**). By considering the safety factor processing capacity, as well as calculating various scenarios incinerator operating time in one day, an estimate of the current installed processing capacity is only 116 tonnes/day. This installed capacity is not sufficient to process medical waste from health facilities throughout Indonesia which produce at least 200 tonnes/day. A more complicated situation exists since health facilities are spread all over Indonesia, while most of the hazardous waste treatment facilities are located in Java (five facilities) and with one facility located in Kalimantan. In this case, it is necessary for the government of Indonesia to identify carefully the potential development of hazardous waste treatment facilities throughout Indonesia.

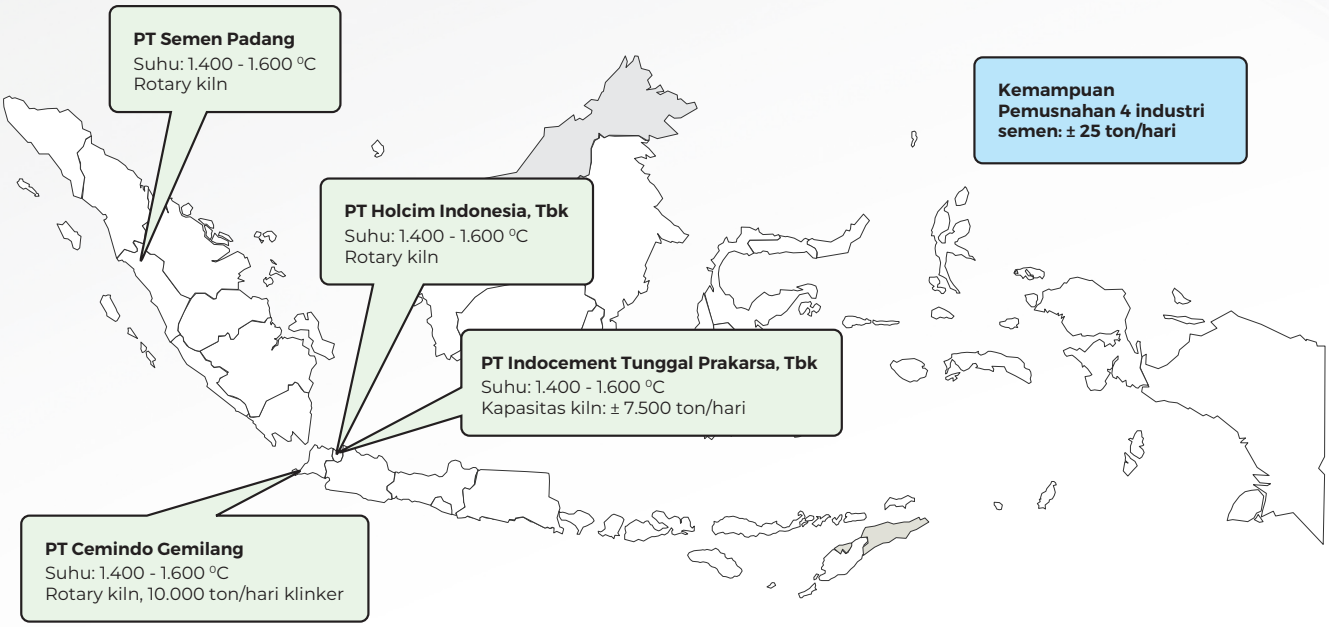
Table 2.32. **Available Hazardous Waste Treatment Facilities**

No.	Facility	Installed capacity	Expansion plan	Customer and coverage
1	PT Jasa Medivest	1 incinerator 12 tonnes/day	1 incinerator 12 tonnes/ day	West Java and East Java
2	PT Tenang Jaya Sejahtera (PT TJS)	1 incinerator 7.2 tonnes/day for solid hazardous waste and 2.400 l/day for liquid hazardous waste	4 incinerators with total cap. of 96 tonnes/day	West Java, Central Java, Jambi, and Padang
3	PT Putera Restu Ibu Abadi (PT PRIA)	2 incinerators, 16,8 tonnes/day for solid hazardous waste and 4,800 l/day for liquid hazardous waste	2 incinerators 24 tonnes/ day and 2 incinerators 48 tonnes/ day	East Java, Central Java, Bali, and West Nusatenggara
4	PT Wastec International	3 incinerators 36 tonnes/day, total 108 tonnes/day		West Java, Central Java, and East Java
5	PT Pengelola Limbah Kutai Kartanegara (PT PLKK)	1 incinerator, (500 kg/hour) or 12 tonnes/day)	1 incinerator in Balikpapan with capacity 800 kg/hour	East Kalimantan
6	PT Arah Environmental Indonesia (PT AEI)	2 incinerators, 12 tonnes/day	12 tonnes/ day	Solo, Central Java

Further information indicates that there will be five new hazardous waste treatment facilities (four owned by the private sector and one owned by the government) with total additional capacity of about 240 tonnes/day, located in Java, Batam, Riau (Sumatera Island), and Makassar (Sulawesi Island). In the long term, there will be continuous development of these facilities with an estimated capacity of 1,016 tonnes/day in Java, North Sumatra, South Sulawesi, and East Kalimantan. However, it is still a challenge for the government to develop medical waste treatment facilities in eastern Indonesia such as in Maluku and Papua, North Sulawesi, and Nusa Tenggara.

Due to the lack of hazardous waste facilities, the government of Indonesia has decided to launch hazardous waste emergency management, through the MoEF Decree SK. 176/2018 regarding the Handling of Hazardous and Toxic Waste from Health Service Facilities by Four Cement Plants (PT Indocement Tunggal Perkasa Tbk., PT Holcim Indonesia Tbk., PT Semen Padang and PT Cemindo Gemilang, see **Figure 2.25**).

Figure 2.25. **Hazardous Waste Emergency Management in Cement Plant Kilns (MoEF, 2018)**

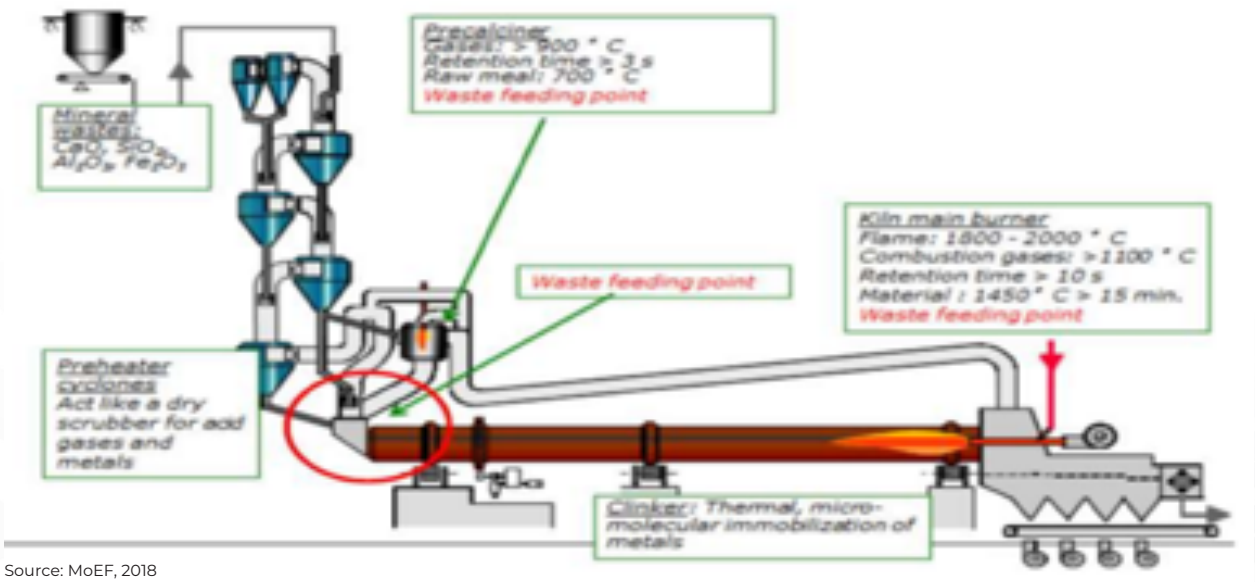


Source: MoEF, 2018

Destroying hazardous waste by using cement kiln facilities (Figure 2.26) is considered to be a safe and fast way to deal with the emergency conditions, due to the following reasons:

- The combustion temperature reaches 1,400 to 2,000°C.
- Have a continuous air quality monitoring device.
- Have a good waste feeder equipment system.
- Have good resources in emergency response and good risk analysis at all stages of handling.
- Implementing a Quality & Environmental Management System.
- Have a strict cement quality testing according to Indonesian standards as well international standards.

Figure 2.26. **Cement Kiln Process (MoEF, 2018)**



Source: MoEF, 2018

The Ministry of Environment and Forestry released the information on waste data in 2019 based on the letter No. ND.22/PKPLB3/MF/PLB.2/6/2020 on 17 June 2020 concerning the incineration of hazardous waste (excluded the medical and sludge waste), the medical waste and sludge waste as follows:

Table 2.33. **Amount of Incinerated Waste**

No	Type of incinerated waste	Tonnes	Source
1	Hazardous waste	942,238.15	MoEF, 2020
2	Medical waste	180,924.84	
3	Sewage waste	105,213.38	

As mentioned above, hazardous waste in Indonesia is mostly incinerated in cement kilns as a source of alternative fuels and materials (AFR). The Ministry of Environment and Forestry has set the regulation No. 18/2020 concerning the Utilization of Hazardous Waste. According to this regulation, the hazardous waste can be used as AFR with the following conditions:

- For alternative material in raw mill, maximum total concentration of mercury: 5 ppm.
- For alternative fuel in kiln or boiler, maximum total concentration of mercury: 1.2 ppm.

Although some measurements do indicate lower mercury concentrations within these alternative materials and fuels, there is no information available for the mercury content in sewage sludge and medical waste, therefore the input factors from UNEP toolkit level 2 were used to estimate these mercury releases.

Open waste burning on landfills and informally

Ministry of Environment and Forestry (MoEF) reported data of solid waste generation about 64,000,000 in 2019. According to Indonesian Environmental Status in 2009, 69% was taken to landfill, 5% of generated waste was incinerated (Baqiroh, 2019). MoEF also pointed out that 55% of landfill are still open dumping type. Therefore, the amount of waste which was burnt on landfills and informally approximately calculated as follow:

$$\frac{5}{100} * 64{,}000{,}000 \ \frac{ton}{year} = 3{,}200{,}000 \ \frac{ton}{year} \qquad \text{Eq. 2-19}$$

Similar to medical waste and sludge waste, there is no information available for mercury content in open waste burning, therefore the UNEP input factor was used to calculate the mercury release from this sector.

Data gaps and priorities for follow up

Identified data gaps

- Mercury content in municipal waste is difficult to determine since various types of waste may also have various mercury content.
- Using maximum standard of mercury content for hazardous waste may be overestimated.
- Data related to mercury content in the medical waste and sewage waste are not available.

Priorities for follow up

- Collect measured mercury information in the hazardous waste, medical waste, and sewage waste directly from the measurement results.

Summary of inputs and results

Summary of inputs and results of waste incineration and burning is shown in **Table 2.34.**

Table 2.34. **Summary of Inputs and Results: Waste Incineration and Burning**

Waste incineration and burning	Unit	Incineration of municipal/ general waste	Incineration of hazardous waste		Incineration of medical waste		Sewage sludge incineration	Open waste burning on landfills and informally	Sum of releases to pathway from assessed part of life-cycle
			PM reduc, simple ESP, or similar	Acid gas control with limestone (or similar acid gas absorbent) and downstream high efficiency FF or ESP PM retention	PM reduc, simple ESP, or similar	Acid gas control with limestone (or similar acid gas absorbent) and downstream high efficiency FF or ESP PM retention			
Activity rate		10,000 Waste incinerated, t/y	942,238 Waste incinerated, t/		180,925 Waste incinerated, t/y		105,213 t sludge incinerated/y (dry matter basis)	3,200,000 Waste burned, t/y	
Input factor for phase		1 g Hg/t waste incinerated	24 g Hg/t waste incinerated		24 g Hg/t waste incinerated		2 g Hg/t sludge incinerated	1 g Hg/t waste burned	
Calculated input to phase	Kg/ thn	10	11.307	11.307	2.171	2.171	210	3.200	12.473,72
Output distribution factors for phase:									
▸ Air		0,5	0,9	0,5	0,5	0,9	0,9	1	
▸ Water									
▸ Land									
▸ Products									
▸ General waste treatment									
▸ Sector specific waste treatment		0,5	0,1	0,5	0,5	0,1	0,1		
Calculated outputs/releases to:									
▸ Air	Kg Hg/y	5.00	10,176.17	1,130.69	1,954	1,085.55	189.38	3,200	9,731.77
▸ Water	Kg Hg/y								
▸ Land	Kg Hg/y								
▸ Products	Kg Hg/y								
▸ General waste treatment	Kg Hg/y								
▸ Sector specific waste treatment	Kg Hg/y	5.00	5,653.43	5,653.43	217	1,085.55	21.04		2,741.95

2.9. Data and Inventory on Waste Disposal, Deposition/Landfilling

Data description

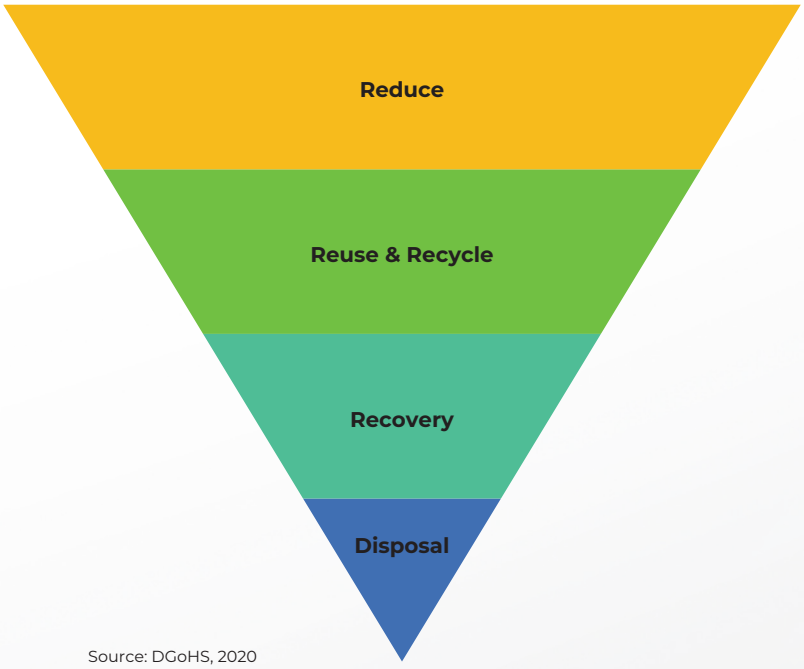
2.9.1. Controlled landfills/deposits

Throughout the history of any deposit/landfill, relatively small amounts of mercury are released annually from the deposit with outputs of water (leaching water and surface run-off), and with air to the atmosphere, because part of the mercury is slowly evaporating from the waste. The fate of the mercury released with water depends greatly on the presence and efficacy of the protective lining under the deposit and associated wastewater management. If the water is not collected and sent to wastewater cleaning, the mercury (and other substances) may contaminate the soil and groundwater under and around the deposit. If the water is sent to wastewater cleaning, the mercury will mainly follow the sludge fraction and go to land use or other fate, while the rest will follow the water discharge from the wastewater treatment (COWI, 2002).

According to Indonesian Environmental Status in 2009, 69% was taken to landfill, 5% of generated waste was incinerated (Baqiroh, 2019). MoEF also pointed out that 55% of landfills are still of the open-dumping type (Hendartyo, 2019). The Directorate General of Human Settlement has developed controlled landfills in 210 districts/cities and 3R-waste temporary transfer in 376 districts/cities, but these numbers are still not enough due to the fast growth of solid waste generation especially in the big cities (DGoHS, 2020).

It is not easy to build a new controlled landfill, since very limited space is available within municipal areas. Some of the existing controlled landfills are also no longer capable of accommodating municipal solid waste because their service period is nearly over. Improper management of landfills may cause the controlled landfills to become open-dumping systems, causing more environmental pollution. Efforts to reduce waste by development of integrated 3R-waste management (reduce, reuse, recycle) continues to be developed to reduce the amount of waste generation as shown in **Figure 2.27.**

Figure 2.27. **Strategy for Development of Solid Waste Management (DGoHS, 2020)**



Source: DGoHS, 2020

2.9.2. Informal dumping of general waste

Informal dumping of waste is defined as waste dumping undertaken under informal conditions with no safeguards to minimize releases of pollutants to the surroundings. If mercury is present in the waste, it represents a potential pathway for mercury releases to soil, air, ground water and surface waters. This waste disposal method may pose an immediate risk for the local community in which it takes place, because mercury (and other contaminants) may cause contamination of the local ground water.

In Indonesia, as stated before, almost 55% of existing landfills are still open-dumping landfills (Hendartyo, 2019). Since 2008, the government had actually prohibited the operation of open-dumping landfills by issuing Law Number 18 of 2008 concerning Waste Management which elaborates mechanism of waste management, by implementing sanitary landfills (controlled landfills). However, some of the built sanitary landfills (controlled landfills) also do not function properly. Generally, limited operational costs, unavailable national guidelines of sanitary landfill construction and operations, unavailable detailed regulation concerning the operation of sanitary landfills, a high increase of municipal waste generation due to a low community awareness of the sustainability of a controlled landfill (3R management program to reduce municipal waste still cannot be properly implemented) are the main causes of the less successful implementation of sanitary landfills in Indonesia.

2.9.3. Wastewater system/treatment

The most important factors determining releases of mercury from wastewater are the amount of mercury-containing wastes that are discharged to the system and the concentration of mercury in those wastes. Mercury content in wastewater mainly originates from the two source groups:

1. intentionally used mercury in products and processes (such as from dental amalgams, spillage from the manometers and other devices, and industrial discharges); and
2. atmospheric mercury washed out by precipitation that goes to wastewater systems (originating from both anthropogenic and natural sources).

As such, wastewater treatment is an intermediate mercury release source where mercury inputs from original mercury contamination is distributed on the output pathways water (with treated water), land through the application of sludge as fertilizer and air through sludge incineration and sludge application (UNEP, 2019).

Wastewater generation can come from domestic or industrial activities. The offsite system for domestic wastewater management treats the wastewater in wastewater treatment plants as illustrated in **Table 2.31**. The amount of wastewater generation from domestic sources can be estimated based on the size of the population and the amount of water use, and it can be assumed that 60 to 80% of the water use becomes wastewater.

The generation of industrial wastewater varies according to the type of industry as well as the operating capacity. However, the amount of generation cannot be easily predicted. The industrial wastewater is usually individually treated or sent to the centralized wastewater treatment plant located in an industrial area. According to the Decree of Directorate General of Pollution Control and Environmental Destruction No. SK53/2020 concerning Determination of Participants in the Assessment Program for Company Performance Ratings in Environmental Management for the 2019-2020 period, it was recorded that there were 2040 industries, and most of them have wastewater treatment plant facilities.

Background calculations and approximations

Controlled landfills/deposits

According to Indonesian Environmental Status in 2009, 69% was taken to landfill, 5% of generated waste was incinerated (Baqiroh, 2019). MoEF also pointed out that 55% of landfill are still open dumping type (Hendartyo, 2019). Therefore, the amount of waste which was treated in controlled landfills was about 45% of total amount of generated waste, approximately calculated as follows:

$$\frac{69}{100} * 64{,}000{,}000 \frac{ton}{year} * \frac{45}{100} = 19{,}872{,}000 \frac{ton}{year} \qquad \text{Eq. 2-20}$$

Informal dumping of general waste

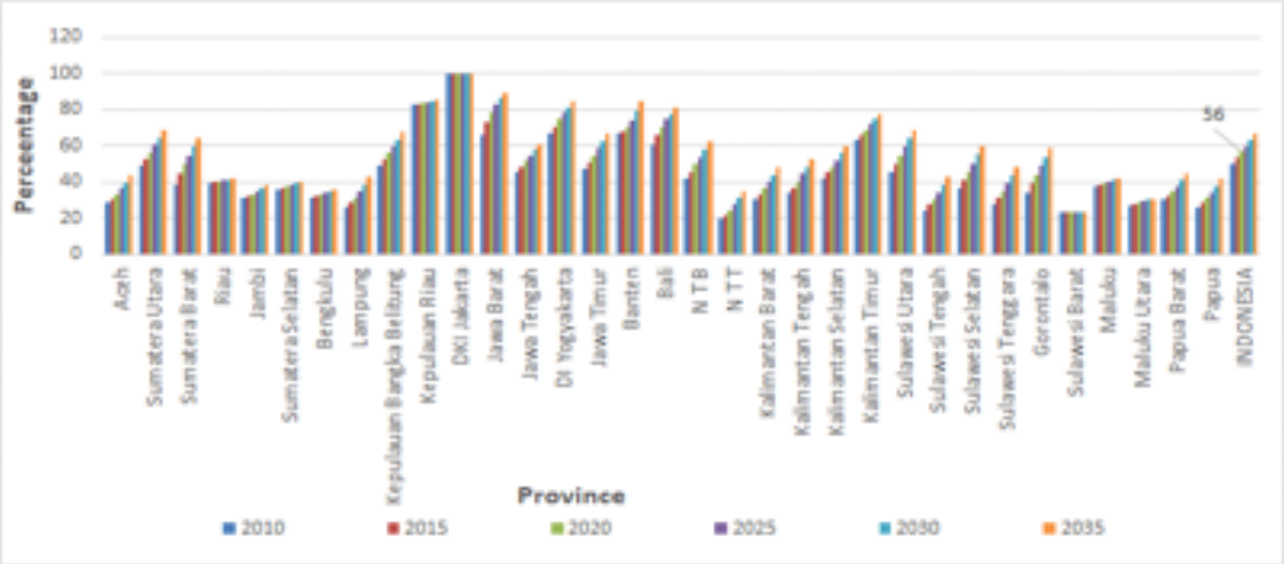
Based on data mentioned above, the approximate amount of general waste that was informally dumped in 2019 was as follows:

$$\frac{69}{100} * 64{,}000{,}000 \frac{ton}{year} * \frac{55}{100} = 24{,}288{,}000 \frac{ton}{year} \qquad \text{Eq. 2-21}$$

Wastewater systems/treatment

The amount of wastewater from domestic sources can be estimated based on the number of inhabitants and the water use. The average water use of urban households in Indonesia is 144 liters/person per day, while Indonesia's minimum basic needs are 70 liters/person/day (Ditjen Cipta Karya, 2016). Meanwhile, nationally in 2015, access to safe drinking water for households in Indonesia was 71.14 percent and this has continued to increase consistently until 2019 to 89.27%. Number of populations who lives in the city is about 56% of the total number of populations in Indonesia (see **Figure 2.28**) which also influence the calculation of total amount of wastewater generation in Indonesia.

Figure 2.28. **Percentage of Urban Population by Province**



Source: BPS, 2020

More than half of the households in Indonesia dispose of their wastewater into drains/ditches/rivers (57.42%), through earthen holes by 18.7%, and through reservoir wells by 1.67%. Only 1.28 %dispose of waste through wastewater treatment system and 10.26% through septic tanks (BPS, 2020).

Based on this information, the amount of domestic wastewater can be estimated as follows (assumption: 80% of water use become wastewater):

$$\left(266{,}911{,}000\ \text{penduduk} * 144\ \frac{\text{L}}{\frac{\text{hari}}{\text{orang}}} * 365\ \frac{\text{hari}}{\text{tahun}} * \frac{80}{100} * \frac{1}{1000}\ \frac{\text{m}^3}{\text{L}} * \frac{56}{100}\right)$$

$$+\left(266{,}911{,}000\ \text{penduduk} * 70\ \frac{\text{L}}{\frac{\text{hari}}{\text{orang}}} * 365\ \frac{\text{hari}}{\text{tahun}} * \frac{80}{100} * \frac{1}{1000}\ \frac{\text{m}^3}{\text{L}} * \frac{44}{100}\right)$$

$$= 8{,}685{,}441{,}344\ \frac{\text{m}^3}{\text{tahun}} \qquad \text{eq. 2-22}$$

The mercury content in wastewater effluent is rather hard to define, since there is no mercury standard for several industries in Indonesia (according to Ministry of Environment Regulation No. 15/2014). The followings are industries with no effluent mercury standard.

- Food processing industry such as: palm oil industry, tapioca industry, monosodium glutamate and inosine monophosphate industry, milk and dairy industry, soft drink industry, beer industry, fruit and vegetable industry, fish processing industry, seaweed processing industry, coconut processing industry, meat processing industry, soy processing industry, traditional medicine processing industry, farming industry, cooking oil industry, sugar industry, coffee industry, slaughterhouse industry.
- Other than food processing industry such as: metal plating and galvanizing industry, plywood industry, rayon industry, ceramic industry, acid terephthalate industry, polyethylene terephthalate industry, pulp and paper industry, lead acid battery industry, pesticide industry, fertilizer industry, ethanol industry, pharmacy industry, textile industry, rubber industry, tannery industry, detergent and vegetable oil product industry, cigarette industry, upstream petrochemical industry, hotel.

However, the regulation has set the effluent standard of mercury for wastewater various between 2 until 10 mg/m^3 for the following industries:

- electronic industry (2 mg/m^3), health facility (2 mg/m^3),
- caustic soda or Cl_2 industry (4 mg/m^3),
- dry battery industry (10 mg/m^3), paint industry (10 mg/m^3),
- other industries not stated within the regulation (2-5 mg/m^3).

Based on data of effluent standard as well as measurement results from representative industries as described in **Table 2.35**, the input factor is set to be 0.5 (low end of UNEP default input factor), since the measured mercury concentration never exceeds 0.5 mg/m^3.

Table 2.35. **Summary of Mercury Content in Wastewater from Industry**

No	Type of industry	Mercury content mg/m^3	Data information
1	Cooper and gold mining	<0.3	2019
2	Coal mining	<0.5	2016–2019
3	Others	0.01–0.5	2016–2019

Data gaps and priorities for follow up

- Activity data of industrial wastewater are still unknown, inventory related to this sector must be conducted.
- Mercury content in municipal waste is difficult to determine since various types of waste may also have various mercury content.
- Representative mercury content in wastewater treatment system is also still unknown, using standard value of mercury in wastewater may lead to an overestimate of mercury release.

Summary of inputs and results

Summary of inputs and results of waste disposal, deposition/landfilling is shown in **Table 2.36**.

Table 2.36. **Summary of Inputs and Results: Waste Disposal, Deposition/Landfilling**

Waste Disposal, Deposition/ Landfilling	Unit	Controlled landfills/ deposits	Informal dumping of general waste	Wastewater system/treatment			Sum of releases to pathway from assessed part of life-cycle
				No treatment; direct release from sewage pipe	Mechanical and biological (activated sludge) treatment; no land application of sludge	Mechanical and biological (activated sludge) treatment; 40% of sludge used for land application	
Activity rate		19,872,000 Waste landfilled, t/y	24,288,000 Waste dumped, t/y	8,685,441,344 Wastewater, m^3/y			
Input factor for phase		1 g Hg/t waste	1 g Hg/t waste	0.5 mg Hg/m^3 wastewater			
Calculated input to phase	Kg/y	19,872	24,288	2,493.59	1,793.54	55.587	28,831.43
Output distribution factors for phase:							
▸ Air		0.01	0.1				
▸ Water		0.0001	0.1	1	0.5	0.5	
▸ Land			0.8			0.2	
▸ Products							
▸ General waste treatment					0.3	0.15	
▸ Specific waste treatment					0.2	0.15	
Calculated outputs/releases to:							
▸ Air	Kg Hg/y	198.72	2,428.80				2,627.52
▸ Water	Kg Hg/y	1.99	2,428.80	2,493.59	896.77	27.79	5,848.94
▸ Land	Kg Hg/y		19,430.40			11.12	19,441.52
▸ Products	Kg Hg/y						0
▸ General waste treatment	Kg Hg/y				538.06	8.34	546.4
▸ Specific waste treatment	Kg Hg/y				358.71	8.34	367.05

Test of waste and wastewater default factors

In this inventory, most of the default input factors were used for the estimation of mercury releases from general waste treatment and wastewater treatment. The default factors were based on a literature survey of mercury contents in waste and wastewater, and these data were only available from developed countries. The following test of the results was performed to qualify the results for these sources.

The test made for general waste compares the calculated inputs from all four general waste sub-categories against the sum of general waste outputs from intentional mercury uses in products plus processes as follows, using data from the Inventory Level 2 spreadsheet:

If the sum of the calculated INPUTS to all general waste sub-categories is more than 2 times larger than the sum of WASTE OUTPUTS from intentional mercury uses in products plus processes, then the mercury flows to general waste sub-categories may be over-estimated, and that more detailed investigations may be needed on this issue.

In the IL2 spreadsheet the test was done as follows; tab "Level 2-Summary":

Is Input > 2*Output?

E62+E66+E68+E671) > 2*(J24 + ∑ (J37 to J56)).

10+3,200+201+24,288 2*(0+17,156)

27,699 < 34,313

The test made for wastewater compares the calculated inputs to wastewater treatment with the sum of outputs to water from intentional mercury uses in products plus processes as follows, using data from the Inventory level 2 spreadsheet.

In the IL2 spreadsheet the test was done as follows; tab "Level 2-Summary":

E72 > 2*(G24 + ∑ (G37 to G56))

4,343 2*(130,235+5,447)

4,343 < 271,364

The calculations made indicate that the default input factors for general waste and wastewater treatment does not necessarily over-estimate the mercury releases from these sub-categories.

2.10. Data and Inventory on Crematoria and Cemeteries

Data description

Cremation is a common practice in many societies to incinerate human corpses. Mercury is released during such cremation. Most of the mercury released is due to the presence of dental amalgam fillings that contain mercury. However, smaller amounts of mercury present in body tissues are also released during cremation. Crematoria furnaces are fired using oil or natural gas; some run-on electricity. Crematoria are usually located within cities and close to residential areas and normally, stacks are relatively low (UNEP, 2003).

A cemetery is an area where human corpses are buried. Mercury in the human body, primarily from dental amalgam fillings, will be released to the soil in the cemetery. In Indonesia, almost all corpses are buried. Cremation takes place in certain places, e.g., in Bali Island, where most of the people are Hindus, and when somebody died, their crops must be cremated in certain ceremony called Ngaben. The following is the information related to the number of people with their religion in Indonesia (**Table 2.37**), this data is utilized to estimate the number of people buried or cremated after their death.

Table 2.37. **Composition of Religion in Indonesia**

No	Religion	Percentage
1	Muslim	87.2
2	Christian - protestant	6.9
3	Christian - catholic	2.9
4	Hindu	1.7
5	Buddha	0.7
6	Khonghucu	0.05
7	Others	0.55

Source: Portal-Informasi-Indonesia, 2020

Background calculation and approximation

The crude death rate in 2019 is 6.5 per 1000 population (BPS, 2020), therefore the number of people died in 2019 were approximately:

$$66{,}911{,}900 * \frac{6{,}5}{1000} = 1{,}734{,}927 \text{ people} \qquad \text{Eq. 2-23}$$

Based on the data from Table 2.37, the number of people who were cremated after their death was approximately:

$$1{,}734{,}927 * \frac{1.7}{100} = 29{,}494 \text{ people} \qquad \text{Eq. 2-24}$$

And the rest is the number of people who were buried after their death was approximately:

$$1{,}734{,}927 - 29{,}494 = 1{,}705{,}434 \text{ people} \qquad \text{Eq. 2-25}$$

The amount of mercury in each corpse varies considerably and largely depends on the number of dental amalgam fillings, and to a lesser extent on the size of the fillings. In Denmark, the typical filling (as found in the mouth) contains from about 0.2 - 0.6 g of mercury; on average about 0.4 g mercury/ filling. The average mercury content of fillings of corpses in Denmark in 2001 was estimated at 4.1 g mercury per corpse (Skårup et al., 2003), nearly 100% was released to the atmosphere, as the crematoria are not equipped with emission controls (UNEP, 2019).

Since the amount of mercury release is determined by the amount of mercury which is used during the treatment of dental amalgam fillings, the ratio between number of dentists and number of populations must also be known. The ratio of dentists to the total population in Indonesia is still very low, i.e., 1:22000 (or 0.045:1000), while according to WHO the ideal number is 1:2000 (0.5:1000). This situation also led to data that DMFT (decayed, missing, and filled teeth) index is 4.6 which means 460 broken teeth/100 people (Jember-Univeristy, 2018). However, ratio standard between doctors and population has been set up in Ministry of Health Regulation No. 33/2015, that in 2019 the targeted ratio of 13 dentists per 100,000 population (0.13:1000). The default input factor from UNEP toolkit level 2 was applied to calculate mercury release from this sector.

Data gaps and priorities for follow up

Identified data gaps

There is no information on mercury content within the human corpses in Indonesia. Direct measurements of mercury content in the human corpses might also be inappropriate.

Priorities for follow up

- Updating data of ratio of dentists to the total population in Indonesia.
- Updating DMFT data to estimate number of broken teeth and filled with mercury amalgam.

Summary of inputs and results

Summary of inputs and results of cremation and cemeteries is shown in **Table 2.38.**

Table 2.38. **Summary of Inputs and Results: Cremation and Cemeteries**

Cremation & Cemeteries	Unit	Cremation	Cemeteries	Sum of releases to pathway from assessed part of life-cycle
Activity rate		29,494	1,705,434	
Input factor for phase	g Hg/corpse	4	4	
Calculated input to phase		53	3,070	3,123
Output distribution factors for phase:				
▸ Air		1		
▸ Water				
▸ Land			1	
▸ Products				
▸ General waste treatment				
▸ Sector specific waste treatment				
Calculated outputs/releases to:				
▸ Air	Kg Hg/y	53		53
▸ Water	Kg Hg/y			
▸ Land	Kg Hg/y		3,070	3,070
▸ Products	Kg Hg/y			
▸ General waste treatment	Kg Hg/y			
▸ Sector specific waste treatment	Kg Hg/y			

2.11. Stocks of Mercury and/or Mercury Compounds, and Storage Conditions

The widespread use of mercury in the ASGM sector is one reason for the proliferation of illegal mercury sales. Especially with the existence of the cinnabar mine in Indonesia, this has added to the supply of mercury. On the other hand, the Government of Indonesia conducts increasingly stringent supervision of the mercury trade, particularly in the ASGM sector. This is in line with the Presidential Instruction March 9 of 2017 regarding the Use of Mercury in Community Mining, Minister of Energy and Mineral Resources Decree No. 1827K/30/MEM/2018 concerning Guidelines for Implementing Good Mining Technological Rules, and Minister of Trade Regulation No. 47 of 2019 concerning the Third Amendment upon the Minister of Trade Regulation No. 44/M-DAG/PER/9/2009 on Procurement, Distribution and Combination of Hazardous Substances which reinforce the ban on the use of mercury for the ASGM sector.

Some examples of arrests by police of mercury dealers were carried out in Sidoarjo region, East Java Province. There were 414 kilograms of illegal mercury products found in the form of Gold brand packaging from Germany (Rinanda, 2019). In Manado, North Sulawesi Province, police foiled the trade of 6 illegal mercury jerry cans which are planned to be sold to ASGM locations in Tatelu, Minahasa Regency, North Sulawesi Province (CNN Indonesia, 2020). Arrests were also carried out by police in West Sumatra of mercury dealers and securing 157 bottles offered at a price of IDR 1,500,000 per bottle (Saputra, 2020). Throughout 2019, Yos Sudarso Port Regional Police, Ambon, Maluku, foiled the illegal shipment of 212 kilograms of mercury liquid and 89 kilograms of cinnabar ore which are the raw material for mercury (Herin, 2019).

In the health sector, the use and procurement of mercury-containing medical devices in all health care facilities has been prohibited for elimination until 2020, in accordance with Minister of Health Regulation Number 41 of 2019. The Ministry of Environment and Forestry has also issued Minister of Environment and Forestry Regulation Number P.27/Menlhk/Setjen/Kum.1/12/2020 to regulate the collection, temporary storage, transportation, storage at storage depots, treatment and/or export of the discarded mercury-containing medical devices. So far, mercury-containing medical devices that is no longer used is still stored in a special temporary storage in healthcare facilities to be futher withdrawn to storage depots which will be provided in each province.

Until now the Ministry of Environment and Forestry does not yet have a storage place for the confiscated or withdrawn mercury. In the meantime, the Ministry of Environment and Forestry in collaboration with the Agency for the Assessment and Application of Technology will develop prototype mercury storage devices to prevent the occurrence of evaporation of mercury in Mount Botak, Buru Regency, Maluku (Zulfikar, 2019).

2.12. Supply and Trade of Mercury and Mercury Containing Compounds, including Sources, Recycling Activities, and Quantities

Maps from UN Comtrade show an increase in mercury imports in Indonesia. In 2012, it was estimated that 300 tonnes of mercury entered Indonesia illegally. While imports recognized by the Government of Indonesia were only 2.5 tonnes. On the map of mercury trade in the world in 2004, mercury entering Indonesia was estimated to be around 30% illegal. Whereas in 2008, it was reported that almost 80% of the illegal mercury trade in the world entered Indonesia. As a result of the increased supply of mercury, the price of mercury decreased. In 2000 to 2005, the price of mercury was in the range of 1.2 to 1.3 million per kilo, while in 2005 the price of mercury fell to 0.6 to 0.8 million per kilo. With the decrease in mercury prices, it is suspected that there has been an increase in the amount of mercury used for mining activities. In 2010, with the cinnabar being mined, a significant price reduction occurred again, in the range of 0.2 to 0.3 million per kilo (DPR-RI, 2017).

In West Kalimantan, mercury allegedly enters from both the land and water routes. West Kalimantan's geographical location borders land and sea with Malaysia, making for many unofficial entrances along the border. Mercury is packaged in the form of flasks, which are then resold by the suppliers. In 2007, West Kalimantan Regional Police succeeded in rolling up an international mercury supplier syndicate (Pahlevy, 2018).

Indonesia's legal imports of mercury reached an average of 550 kilograms during 2011-2014 and were only limited to the industrial use of 2 (two) tubes of fluorescent lamps. During 2015-2016, according to the Ministry of Trade, no one submitted an application for mercury imports (BPHN, 2017).

In 2017, Balifokus published a highly definitive report entitled "Mercury Trade and Supply in Indonesia" in which it lists full details for 71 mercury traders that were found to be trading mercury actively online through websites, direct selling, delivery services, and online trading platform transactions. Cinnabar ore and mercury sales and marketing were also found to be conducted widely using the popular B-2-B e-commerce website, social-media platforms such as Alibaba, Facebook, Twitter, and Instagram (BaliFokus, 2017).

By 2016, global trade in mercury had shifted decisively. The export bans meant the center of gravity for mercury transferred from the Northern hemisphere to East Asia and South America. New routes from Mexico to Bolivia and Indonesia to Singapore were emerging. Meanwhile, since much of the mercury supply had previously originated from chlor-alkali industries in the United States and

European Union, which were no longer available, new sources of supply appeared, namely from new mercury mines (UNEP, n.d). Cinnabar is the most common source of mercury in nature and has been mined for thousands (Fritz, Maxson et al. 2016 as cited in IPEN, 2018). UNEP has noted that "Between 2011 and 2015, Indonesia and Mexico opened new mercury mines, in both cases before they had ratified the Minamata Convention." (Maxson, n.d).

For example, small-scale miners in Gunung Tembaga, West Seram, Maluku, can produce 40 kilograms of cinnabar every day. Even though it is artisanal mining, the results of the cinnabar mining in Iha Village by thousands of miners are fairly large. The selling price depends on the level in the range of IDR 100,000-135,000 per kilo (Kumparan, 2017).

In 2015, Balifokus reported that Indonesia exported 283,767 kg of mercury to 15 countries namely, China (211 kg), Eritrea (3,105 kg), Hongkong (105,053 kg), Malaysia (184 kg), Holland (36,896 kg), Papua New Guinea (25 kg), Poland (62 kg), Timor-Leste (450 kg), India (6,417 kg), Singapore (40,828 kg), Vietnam (19,175 kg), Switzerland (63,422 kg), Thailand (24 kg), Emirates (7,863 kg), and the USA (52 kg). Furthermore, Balifokus has reported that in 2015-2016, Indonesia became a mercury exporter (HS code 280540) to some countries, based on data obtained from the UN Comtrade database by searching for export notifications that Indonesia reported to trading partners in 2015 and 2016. Until now, in Indonesia there is no ban on mercury exports (as commodity with HS code 280540). (Balifokus, 2017).

In 2015-2016, Indonesia became a mercury exporter to some countries, mainly illegally, as the transaction are not recorded in the Central Bureau of Statistics report. The UN Comtrade data base indicates Indonesian exported 567 ton worth $ 5.2 million in 2015, and 1,360 ton worth $ 8.2 million in 2016. Indonesia is now ranked the world's largest mercury exporter. The estimate of additional domestic mercury trade is about 1,000 ton for $ 10 million. (Wollff, 2017).

Mercury sources from chlor-alkali production with mercury-technology is discussed in sub chapter 2.5.

2.13. Mercury Contaminated Sites

While mercury may exist naturally, there are several human activities done in Indonesia which cause mercury contaminated sites, i.e. artisanal and small-scale gold mining, mercury distillation from cinnabar, chlor-alkali facilities and oil and gas mining.

Mercury is still commonly used in ASGM in Indonesia for gold amalgamation. In areas with hard rock mining, miners send the mercury contaminated tailing to be processed further with cyanide in tanks. A study that was conducted in Kalirejo Village, Kulon Progo Regency, Central Java Province shows reveals mercury concentration in soil ranged from 0.30-22.51 mg/kg. This figure is above the quality standard of mercury contaminated soil in accordance with Government Regulation No. 101 of 2014 concerning Management of Hazardous and Toxic Waste Material with the established standard is 0.3 mg/kg (Banunaek, 2016).

A study conducted on ASGM site in Poboya Village, Palu City, Central Sulawesi Province, shows that the mercury content in the soil in open land has exceeded the critical threshold, where there is a point reaching 8.19 ppm. The high content of mercury at this point is presumably because it is so close to the amalgamation of gold processing. The mercury content at several other observation points in the open area is 1.26 ppm-2.6 ppm. At the location of rice fields and mixed plantations found points with mercury content in the range 2.17-2.65 ppm (Mirdat, 2013).

Another study, also carried out in Poboya, showed that the presence of mercury originated from mining activities both traditional mining using large drum carried out since 2007 as well as those using drum which has been ongoing since August

2009 until now. The highest mercury content in river water is 0.080 ppm, the lowest 0.005 ppm and the highest river sediment is 58,000 mg/kg, the lowest is 4,000 mg/kg. Then the mercury content in liquid waste is the highest activity of 0.040 ppm, the lowest 0.005 ppm and the highest solid waste (tailings) is 88.2 mg/kg, the lowest is 80.8 mg/kg. Mercury levels around combustion from five locations with different sampling distances between 45.5 mg/kg to 99.90 mg/kg. Partially the mercury metal content at some sample points has exceeded the maximum permissible concentration limit and holistically the condition is not safe and has exceeded the maximum concentration of water quality standards, sediment, liquid waste and solid waste as required. (Ruslan, 2010).

Ministry of Environment and Forestry (2018) has received reports from local environmental agencies with regard to sites contaminated with cyanide and mercury attributed to ASGM and cinnabar mining as in the table below.

Table 2.39. **Mercury Contaminated Land Inventory Data Recapitulation**

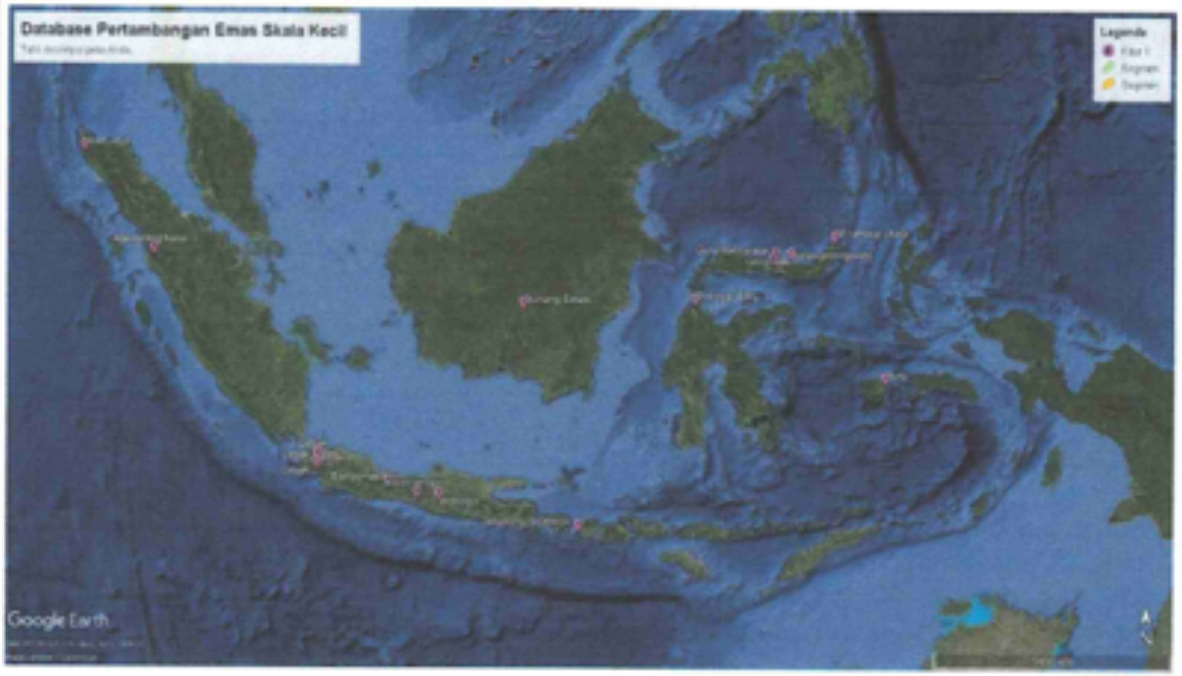
Location	Type of Hazardous Waste	Estimated Area of Contaminated Sites	Estimation Volume of Hazardous Wastes
Lebak Regency, Banten Province	Cyanide & mercury	6,803.71 m^2	2,564.65 m^3
Seram Barat Regency, Maluku Province	Mercury (from cinnabar mining)	200 ha	150 tonnes
North Bolaang Mongondow, North Sulawesi Province	Cyanide & mercury	N/A	N/A
North Minahasa Regency, North Sulawesi Province	Cyanide & mercury	7.5 ha	N/A
Gorontalo Province	Cyanide & mercury	60 ha	N/A

Source: Directorate of Contamination Remediation and Hazardous Wastes Emergency Response, MoEF, 2018

Map and Location of Mercury-Contaminated Land

Based on the results of the identification and inventory of land contaminated with hazardous waste, the area of land contaminated with hazardous waste in Indonesia was identified in 2014-2021 as ± 5,200,000 m^2. Around 14.94% of this land is contaminated with B3 waste from non-institutional activities (± 777,000 m^2) with a waste volume of ± 271,500 tonnes (already managed ± 25,000 tonnes), including mercury-contaminated land from the ASGM sector covering an area of ± 682,000 m^2 with an estimated total land area contaminated by mercury as much as 26,700 tonnes. Of this amount, 2,266.9 tonnes of mercury-contaminated land were recovered in Lebak Regency in 2019. The map and location of mercury-contaminated land in Indonesia can be seen in **Figure 2.29** and **Table 2.40.**

Figure 2.29. **Map of Mercury-contaminated Land in Indonesia**



Source: Directorate of Remediation of Contamination and Emergency Response of Hazardous Wastes, MoEF, 2021

Table 2.40. **Location of Mercury-Contaminated Land in Indonesia**

No.	Province	Regency	Waste Type	Note
1	Central Java	Banyumas Regency	B416 (tailing), mercury)	Babakan Village, Gumelar, Report of Local Enviromental Agency
		Wonogiri Regency	B416 (tailing), mercury)	Keloran Village, Report of Local Enviromental Agency
2	DIY Yogyakarta	Kulonprogo Regency	B416 (tailing), mercury)	Kalirejo Village, Report of Local Enviromental Agency
3	Banten	Lebak Regency	B416 (tailing), A302-7 (mercury sulphide waste)	Lebaksitu Village Location, FS and DED 2017
				Cimandiri Village Location, FS dan DED 2017
				Cikadu Village Location, FS and DED 2017
				Sukasari Village Location, FS and DED 2017
				Pasirgombong Village Location, FS and DED 2017
				Muncang Village Location, FS and DED 2017
				Girimukti Village Location, FS and DED 2017
				Ciladaeun Village Location, FS and DED 2018, has been remediated in 2,266.9 tonnes in 2019
4	North Sumatera	Mandailing Natal Regency	A2268 (mercury), B416 (tailing)	Hutabargot Village Location, Identification and Inventory Data
5	Central Kalimantan	Gunung Mas Regency	A2268 (mercury)	Identification and Inventory Data
6	Gorontalo	Gorontalo Regency	A2268 (mercury)	Bumela Village Location, Identification and Inventory Data
		North Gorontalo Regency	A2268 (mercury)	Ilangata Barat Village Location, Identification and Inventory Data

No.	Province	Regency	Waste Type	Note
7	North Sulawesi	Bolaang Mongondow Regency	A2268 (mercury)	Identification and Inventory Data
				Mopuya Village Location, Identification and Inventory Data
		North Minahasa Regency	A2268 (mercury)	Tatelu Village Location, Identification and Inventory Data
8	Central Sulawesi	Palu City	B416 (tailing), mercury and cyanide	Poboya Location, Identification and Inventory Data
9	Maluku	Buru Regency	B416 (tailing), A2268 (mercury)	Mount Botak Location, Delineation Study in 2019, FS Study in 2021
10	West Nusa Tenggara	West Lombok Regency	B416 (tailing), mercury and cyanide	Identification and Inventory Data

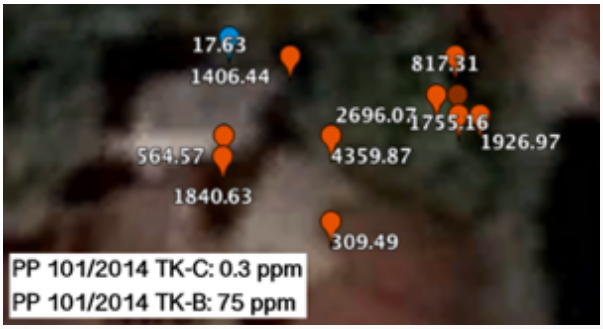
Source: Directorate of Contamination Recovery and Emergency Response to Toxic Hazardous Waste, MoEF, 2021

In 2018, the Ministries of Environment and Forestry did studies in collaboration with the Bandung Institute of Technology and the University of Brawijaya in ASGM sites in Wonogiri Regency, Central Java Province; Merangin Regency, Jambi Province; Dharmasraya Regency, West Sumatra Province; West Waringin City, Central Kalimantan Province; North Minahasa and East Bolaang Mongondow Regencies, North Sulawesi Province; and West Lombok Regency, West Nusa Tenggara Province. In these sites, where amalgamation is being practice to recover gold, the results show that mercury has contaminated air, soil and sediment. Elevated mercury concentration is found in plants, fish, and human (children and adults).

Mercury concentrations in ambient air in Wonogiri and Dharmasraya show measurement results of up to 50,000 ng/m^3, which means 50 times higher than WHO determined quality standards (1,000 ng/m^3). Fish samples taken from around ASGM locations in Wonogiri as well as plant samples from around ASGM locations in Wonogiri, Merangin, Dharmasraya, West Waringin City, North Minahasa, West Lombok, East Bolaang Mongondow were found to have mercury contents that exceeded safe limits (MoEF & ITB, 2018; MoEF & Unibraw; 2018).

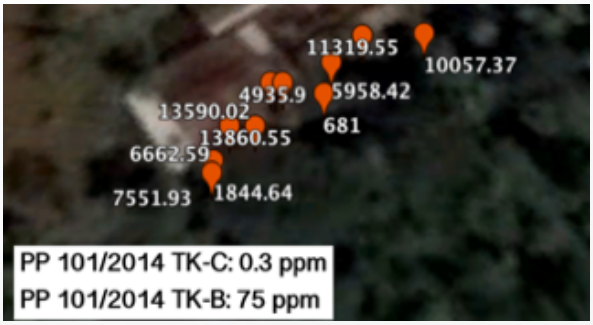
In 2016, the Ministry of Environment and Forestry, jointly with Pure Earth/Blacksmith Institute, did an environmental impact assessment in Parakan Salak Village and Bojong Genteng Village in Sukabumi Regency, West Jawa Province, where cinnabar is processed to produce mercury. The activities were commonly found in the house backyard and close to farming and plantation area (Pure Earth/Blacksmith Institute, 2016). The concentration of mercury in the soil as measured using a portable XRF device is as shown in **Figure 2.30** and **Figure 2.31**.

Figure 2.30. **Soil Sampling Using XRF Portable Device in Parakan Salak Village**



Source: Pure Earth/Blacksmith Institute, 2016

Figure 2.31. **Soil Sampling Using XRF Portable Device in Bojong Genteng Village**



Activities in oil and gas mining are identified to produce mercury as by-product. Without proper management, this will risk polluting the environment. One example is that which occurred in Hueng Village, North Aceh Regency, Nanggroe Aceh Darussalam Province, where local people found traces of mercury in the land that was once a rigger shop and civic mission clinic that served the local community owned by Exxon Mobil Oil Indonesia, Inc. With facilitation from the government, Exxon conducted a clean-up of 27 m^2 of mercury-contaminated land with a land volume of 47 m^3. The handling of mercury-contaminated soil is treated by sending it to a licensed B3 waste processor, PT Prasadha Pamunah Industrial Waste (PPLI). Exxon is required to provide monitoring reports after handling contaminated land (MoEF, 2012).

In order to implement RAN-PPM, Directorate of Contamination Remediation and Emergency Response on Hazardous Wastes, MoEF, has developed a program and provided funds to carry out several activities, including:

- Remediation of mercury contaminated land in Ciladaeun Village, Lebakgedong District, Lebak Regency in 2019 with the following implementation results:

Remediated land rea	3,014 m^2
Volume of contaminated soil remediated	1,720 m^3
Weight of contaminated soil remediated	2,2699.9 tonnes
Method of contaminated soil management	Stabilization/solidification and then landfilling in PPLI's landfill facility

- Development of a study on the remediation of mercury contaminated land in Lebak Regency, Banten Province;

  In 2019, the remediation of contaminated land in Lebak, Banten was carried out with the methodology of excavating, transportation and treatment to a licensed hazardous waste treatment service and landfilled using standard procedures. The processing cost in 2019 is around IDR 4 million/tonnes including transportation.

- In 2021, a large ex-gold mine has been restored in Mandor Subdistrict, Landak Regency, West Kalimantan Province. As a green open space, phytoremediation is used using plants that are not for consumption. To develop the community's economy, the context is integrated with tourism and crafts.

- Directorate of Remediation of Contamination and Emergency Response of Hazardous Wastes, MoEF plans to prepare a Feasibility Study (FS) Document for the Recovery of Mercury Contaminated Land in the Mount Botak Area, Waelata District, Buru Regency, Maluku Province in the 2021 fiscal year.

Identification and inventory have been carried out but it has not reached 50% of all contaminated land and many are still scattered. Part of this land is ASGM and some is not ASGM. Considering the large cost of excavating, transporting and treatment methodologies, other methodologies are also carried out by planting plants that can absorb mercury and are not consumption crops, including bamboo and banyan trees. People are warned not to not consume this plant and not to use it as animal feed.

Currently, there are still several spots of ex-mining land with ex-tailings waste with mercury concentrations reaching hundreds of ppm. However, most of the tailing wastes are extracted again for gold using mercury or cyanide, and dumped on community lands with an area many times that of these spots. The concentration is not too high, around > 0.3 ppm-30 ppm, but the amount is estimated to be more than 50% of the contaminated land.

For this reason, it is necessary to further think about handling these lands with relatively low mercury concentrations, which are around tens of ppm but have a large area and are large in number, given the high costs involved.

The RAN-PPM targets 4 (four) contaminated land locations for remediation. These locations are Sekotong, Poboya, Gunung Botak (replacing Palu which was hit by disaster) and Lebak (already done).

2.14. Impacts of Mercury on Human Health and Environment

Mercury is a persistent, bioaccumulative, toxic pollutant. A very important factor in the environmental impact of mercury is its ability to build up in organisms and up along the food chain. Although all forms of mercury can accumulate to some degree, methylmercury is absorbed and accumulates to a greater extent than other forms. Inorganic mercury can also be absorbed, but is generally taken up at a slower rate and with lower efficiency than is methylmercury. The biomagnification of methylmercury has a most significant influence on the impact on animals and humans (Green Facts, n.d). Mercury contamination is a significant public health and environmental problem because methylmercury easily enters the bloodstream and affects the brain (New Hampshire Dept. of Environmental Services, 2019).

Three forms of mercury have different toxicity and will impact human health in different ways with organic mercury as the most hazardous substance among all. In general, 75% of mercury exposure is attributed to elemental and inorganic mercury, in which mostly is associated to vapor inhalation and amalgam dental filling. Children and fetus are the most vulnerable population at risk to mercury exposure.

Some studies have shown that ASGM, which is said to be the biggest contributor of mercury emissions, has impacted the environment, i.e., in soil, water and air. A study that was done by Sumantri et al in Cisarua, Bogor Regency, in 2014, in an ASGM site found accumulation of mercury in 60% of miners that exceeds WHO threshold (2 ppm). A study that was done by Inswiasri and Haryoto Kusnoputranto in 2011 in Gunung Mas Regency, Central Kalimantan Province, found that the average mecury concentration in air exceeds WHO standard for residential area (1.0 – 2.0 mg/m^3) and working area (0.05 mg/m^3).

In 2013, BaliFokus Foundation conducted monitoring of mercury in ambient air in 10 hospitals in Bali and found higher mercury concentration in different area in different hospital. Dental clinic is one of those areas as mercury is stored in bottles although dental amalgam is no longer used. Indoor mercury concentration might also be derived from the practice of replacing dental amalgam fillings from patients. Other areas include emergency room with suspected mercury leakage from health equipment and the temporary mercury waste storage.

The Regency of Dharmasraya, in the Province of West Sumatra, is one area in which monitored through sampling both river-water and well-water. Data taken in 2015 to 2017 shows elevated mercury concentrations at sampling points in the Batang Hari River in 2016 (> 2.00 µg/l is the standard in accordance with Governors Regulation No.5/2008) (DIKPLD, 2016). However, a monitoring study done in 2018 shows that only 1 out of 15 public wells were in accordance with the Minister of Health Regulation No.492/2010 standard, while the remaining 14 were above the > 0.001 mg/l standard (MoH, 2018).

In studies conducted at several ASGM sites in the Provinces of East Kalimantan, Maluku, Southeast Sulawesi, and West Java, the Medicuss Foundation met miners who reported having muscle pain, headache, concentration problem, sleeping disorders, and some miners reported tremors in their hands (Medicuss, 2019).

The following results were reported by the Indonesian NGO's Medicuss and BaliFokus following a health survey conducted at ASGM sites:

- Medicuss found suspected mercury-intoxicated victims in all three ASGM locations studied: namely, Bombana, Sekotong, and Cisitu. Severe physical problems were noted in 28 children, including seizures, heavy salivation, congenital cataract, skin eruption, vision disorder, congenital deformities, deafness, impaired renal function, upper motor neuron disorder, hydrocephalus, delayed development, synostosis, muscle weakness, permanent shortening of muscles or joints, finger deformities, vitiligo, partial paralysis, ear malformation, epilepsy, cerebral palsy, and skin rashes. A few of these children lived in a neighborhood where the ambient air mercury level reached up to 21,985 ng/m^3 around their houses (Medicuss, 2015).
- Some mothers admitted that during their pregnancy, they stayed at home and helped their husbands taking care of the rod-mill operation. Almost every house in the Pangkal Jaya Village, Bogor Regency, has at least one sick family member (child or adult) with health problems (Ismawati et al, 2015).
- Out of 270 people studied (who all came from ASGM villages in Sekotong in West Lombok Regency for a free health check provided by BaliFokus) the results showed that 11% had symptoms of mercury intoxication (BaliFokus, 2015).
- Medicuss found that 37 out of 140 residents (26.4%) coming from the villages of Situmulya and Kujangsari in Cisitu in Lebak Regency (who sought treatment during activities carried out by Medicuss in collaboration with BaliFokus) were affected by mercury intoxication. In addition, they found that the impact of mercury intoxication generally arose only several years after exposure, when most workers had already gone back to their hometown (Medicuss, 2014).

In 2018, Brawijaya University conducted health tests of targeted respondents from mining communities. Samples of blood and urine showed that many of the respondents were already intoxicated, and physical tests showed detrimental health impacts caused mercury. Hair samples were taken from 36 respondents, and 27 of them showed concentrations above the reference level of 1.3 mg/kg. Likewise, for nail samples, 12 out of 38 respondents showed above 1.5 mg/kg (KLHK & UB, 2018).

For the development of the MIA and NAP ASGM documents, in 2020-2021, MoEF, BSCRC-SEA and the survey team conducted inventory, laboratory analysis of environmental samples and human biomonitoring activities in 6 (six) ASGM locations namely in Lebak Regency Banten Province, Tasikmalaya Regency West Java Province, Mandailing Natal Regency North Sumatra Province, Bolaang Mongondow Regency North Sulawesi Province, West Sumbawa Regency West Nusa Tenggara Province, and Murung Raya Regency Central Kalimantan Province. The result of Hg concentration in fish and biota in the 6 (six) regencies are shown in the table below.

Table 2.41. **Hg concentration in Fish and Biota in ASGM Locations in 6 (Six) Regencies**

No	Location (Regency)	Hg in fish and biota		
		Max Concentration (mg/kg)	Min Concentration (mg/kg)	Average Concentration (mg/kg)
1.	Lebak	0.383	0.015	0.175
2.	Mandailing Natal	6.20	0.22	1.43
3.	Tasikmalaya	0.542	0.025	0.193
4.	West Sumbawa	0.44	0.04	0.21
5.	Bolaang Mongondow	0.332	0.025	0.124
6.	Murung Raya	0.28	0.11	0.18

Source: MoEF & BSCRC-SEA, 2021

Note: BPOM Regulation No. 5/2018: Hg in fish 0.50 mg/kg

CHAPTER III.

POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORK ASSESSMENT

3.1. Policy and Regulatory Framework Assessment

3.1.1. Introduction

Indonesia has signed the Minamata Convention on Mercury and has ratified and promulgated the Law of the Republic of Indonesia Number 11 of 2017 concerning Ratification of the Minamata Convention on Mercury on 20 September 2017.

The policy of ratification of the Minamata Convention is based on the objectives of the Government of the State of Indonesia, as stated in the fourth paragraph of the Preamble to the Republic of Indonesia's 1945 Constitution, which protects the entire Indonesian nation and all of its people, promotes public welfare, educates the nation's life, and participates in the implementation of world order based on freedom, eternal peace and social justice. When it comes to the purpose of promoting general welfare, it can be viewed as the state's responsibility to improve the welfare of all citizens, one of which is the community's health status. Increasing the degree of public health can be implemented and fulfilled by carrying out a sustainable, comprehensive, targeted, and integrated health development which is an integral part of national development.

The government's health development program aims to improve community health as far as feasible while also maintaining the quality of Indonesia's human resources. The quality of the surrounding environment has a significant impact on public health and the quality of human resources. The right to a good and healthy living environment is guaranteed under Article 28 H paragraph (1) of the Republic of Indonesia's 1945 Constitution, which states: "Everyone has the right to live in physical and spiritual prosperity, to live in and have a good and healthy living environment, and to have the right to health services."

Mercury is regarded as a hazardous substance with adverse impact on health and the environment. Mercury is highly toxic, especially when metabolized into methyl mercury. It may be fatal if inhaled and harmful if absorbed through the skin. Around 80% of the inhaled mercury vapour is absorbed in the blood through the lungs. It may cause harmful effects to the nervous, digestive, respiratory, immune systems and to the kidneys, besides causing lung damage. Adverse health effects from mercury exposure can be: tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit and developmental delays during childhood (WHO, 2005).

The regulations of Law Number 32 of 2009 concerning Environmental Protection and Management in Chapter VII, which regulates the management of hazardous substances and hazardous waste, are amended by Law Number 11 of 2020 concerning Job Creation. The following are the goals of Law Number 32 of 2009: a. to protect the territory of the Unitary State of the Republic of Indonesia from pollution and/or environmental damage; b. to ensure the safety and health of human life; c. to ensure the survival of living things and the preservation of the ecosystem; d. to maintain environmental functions; e. to achieve harmony, synchronization and environmental balance. f. to ensure that justice is served for current and future generations; g. to ensure that the right to access the environment is respected and protected as part of human rights; h. to manage natural resources wisely; i. to achieve sustainable development; j. to foresee global environmental concerns.

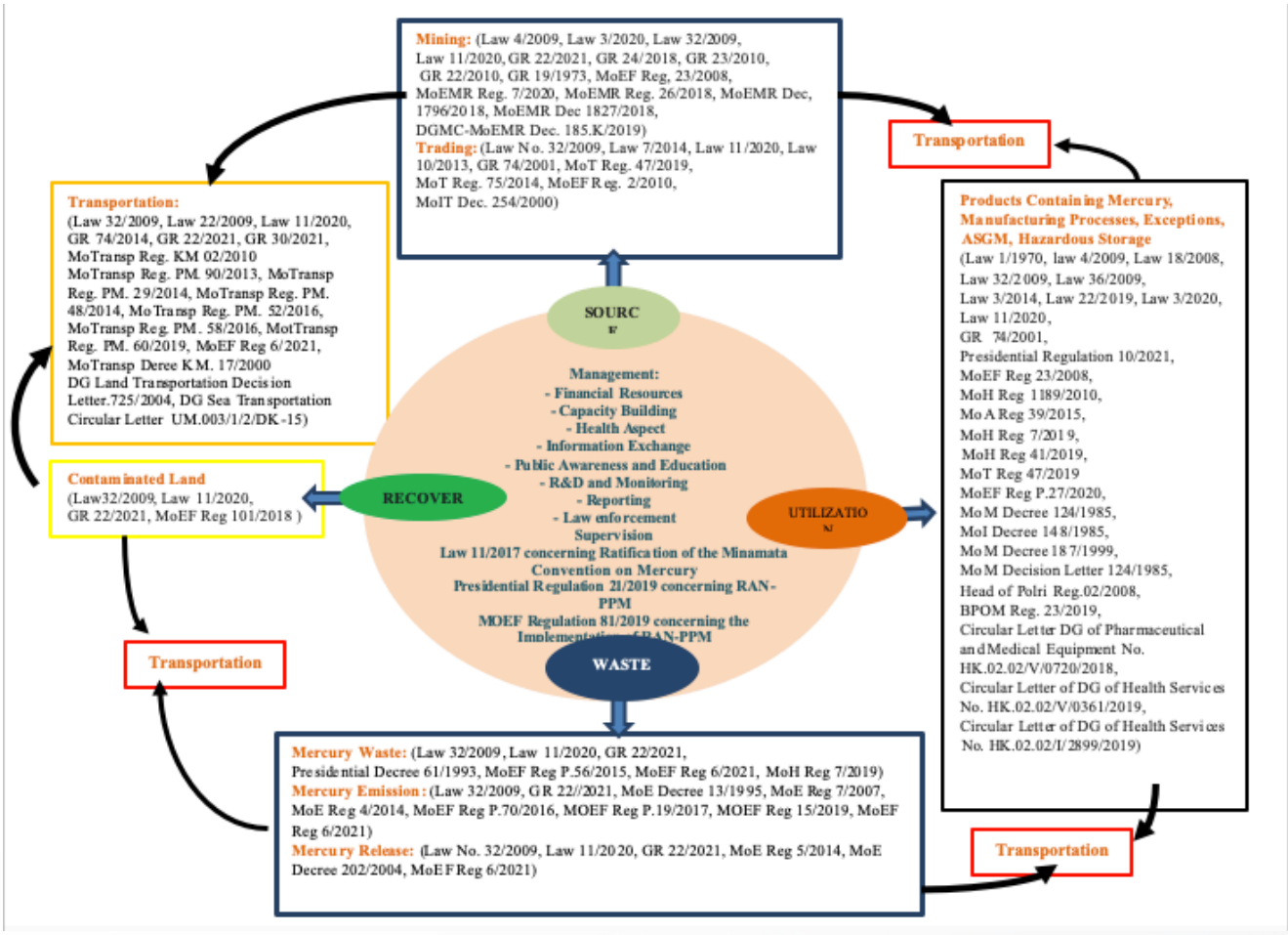
3.1.2. Indonesian Legislation Governing Mercury Management

The National Action Plan for Mercury Reduction and Elimination has been established through Presidential Regulation Number 21 of 2019 and its implementation is regulated in MoEF Regulation Number P.81/Menlhk/Setjen/Kum.1/10/2019. Mercury, which is widely used in ASGM business and/or activities, manufacturing, energy and health, has the potential to have a serious impact on health and the environment, necessitating mercury reduction and elimination efforts.

In addition, Presidential Regulation Number 18 of 2020 concerning the 2020-2024 RPJMN has also been stipulated which includes National Priority (PN) 6 Building the Environment, Improving Disaster Resilience, and Climate Change in PP 1: Improving the Quality of the Environment, especially the National Priority Project for Reduction and Elimination of Mercury.

Figure 3.1 depicts the laws and regulations governing mercury management in Indonesia according to its life cycle.

Figure 3.1. **Laws and Regulations Regulating Mercury Management in Indonesia According to Its Life Cycle**



With the laws and regulations governing mercury management in Indonesia, the country is expected to achieve the following target of the Sustainable Development Goals 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

3.1.2.1. Sources of Mercury

Under Article 3 of the Minamata Convention, mercury supply sources are mercury from mining, mercury stockpiles and mercury from decommissioning of chlor-alkali plants.

Primary Mercury Mining

Geologically, Indonesia, which is located in a volcanic region, has the potential to host cinnabar deposits, a mercury-bearing mineral. Mining of mineral resources is regulated in Law Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining which stipulates that the control of minerals and coal by the state is carried out by the central government (Article I paragraph (2)).

Law Number 3 of 2020 which amends the provisions of Article 6 paragraph (1) of Law Number 4 of 2020 in letters f to letter l states that the central government's authorities in the management of mineral and coal mining, among others, are as follows:

- Determine the Mining Area (*Wilayah Pertambangan*, WP) after being determined by the provincial government in accordance with its authority and in consultation with the House of Representatives of the Republic of Indonesia;
- Determine the Mining Business Permit Areas (*Wilayah Izin Usaha Pertambangan*, WIUP) Metal Minerals and WIUP Coal;
- Determine WIUP non-metallic mineral and WIUP ore deposits;
- Determine the Special Mining Business Permit Area (*Wilayah Izin Usaha Pertambangan Khusus*, WIUPK);
- Carry out WIUPK offers on a priority basis;
- Issue Business Licenses;
- Conduct guidance and supervision of the implementation of mineral and coal mining business activities carried out by the holder of a business license.

Law Number 3 of 2020 which amends Article 70 of Law Number 4 of 2009 confirms that every Small-Scale Mining Permit (*Izin Pertambangan Rakyat*, IPR) holder has an obligation to comply with laws and regulations in the field of mining safety, environmental management and comply with applicable standards and manage the environment together with the Minister who carries out government affairs in the field of Mineral and Coal Mining.

In Article 65 paragraph (1) of Law Number 4 of 2009 as amended by Law Number 3 of 2020, a business entity, cooperative, or individual company as referred to in Article 51, Article 54, Article 57, and Article 60 that conducts a mining business must fulfill administrative, technical, environmental and financial requirements. Further provisions regarding these requirements are regulated by a government regulation (Article 65 paragraph (2)).

Mining activities that have a significant impact on the environment are required to have an Environmental Impact Management Analysis as stated in Article 22 of Law no. 32 of 2009. Furthermore, Article 36 states that every business and/or activity that is required to have an Environmental Impact Management Assessment (*Analisis Mengenai Dampak Lingkungan*, AMDAL) or Environmental Management Effort and Environmental Monitoring Effort (*Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup*, UKL-UPL) must have an environmental permit. The environmental permit is issued based on the environmental feasibility decision as referred to in Article 31 or the UKL-UPL recommendation. Furthermore, the regulation is explained in Government Regulation (GR) Number 24 of 2018 concerning Electronically Integrated Business Licensing Services and GR Number 27 of 2021 concerning Environmental Permits.

With the enactment of Law Number 11 of 2020 concerning Job Creation or the Omnibus Law, several laws were revised including Law Number 32 of 2019. Several provisions related to Environmental Impact Management Analysis were revised and also Article 36 of Law Number 32 of 2019 regarding the obligation to have environmental permits was abolished. This environmental permit was changed to a provision for having an environmental approval which is included as the basis for granting a Business Licensing permit as stated in Articles 13, 21 and 22 of the Law on Job Creation. Furthermore, for the implementation of the Law on Job Creation, GR Number 22 of 2021 concerning the Implementation of Environmental Protection and Management has been stipulated which revoked GR Number 12 of 2012 concerning Environmental Permits. The hazardous waste management permit is removed and combined with the environmental approval. As for the permit and technical process for hazardous waste management, it refers to GR Number 22 of 2021. GR Number 24 of 2018 has been revoked with GR Number 5 of 2021 Implementation of Risk-Based Business Licensing.

Small-Scale Gold Mining (ASGM) concerns are regulated through the Minister of Environment Regulation Number 23 of 2008 concerning Technical Guidelines for the Prevention of Pollution and/or Environmental Damage Due to People's Gold Mining. These guidelines are in the process of being amended.

Law Number 3 of 2020 which amends the provisions of Article 158 of Law Number 4 of 2009 prohibits mining activities without a permit. The prohibition on the use of mercury for processing and refining gold is regulated in Attachment V to the MoEMR Decree No. 1827K/30/MEM/2018 concerning Guidelines for Implementation of Good Mining Engineering Standards. People's mining businesses are carried out in the form of IPR and WPR, in accordance with Article 20 of Law Number 4 of 2009 and Law Number 3 of 2020 which amends the provisions of Article 35 of Law Number 4 of 2009.

MoEMR Regulation Number 7 of 2020 regulates the procedures for granting territories, permits, and reporting on mineral and coal mining business activities. Minister of Energy and Mineral Resources No. 26 of 2018 regulates the implementation of good mining rules and supervision of mineral and coal mining including the implementation of reclamation and post-mining in mineral and coal mining business activities. Minister of Energy and Mineral Resources Decree Number 1796 of 2018 regulates guidelines for implementing applications, evaluating and issuing permits in the mineral and coal mining sector.

GR Number 22 of 2010 regulates mining areas. GR Number 23 of 2010 regulates the implementation of mineral and coal mining business activities. GR Number 19 of 1973 regulates the regulation and supervision of work safety in the mining sector. The Decree of the Director General of Mineral and Coal of the MoEMR Number 185.K/37.04/DJB/2019 is stipulated to provide technical instructions in the implementation of mining safety as well as the implementation, assessment, and reporting of the mineral and coal mining safety management system as well as a follow-up to the Minister of Energy and Mineral Resources Decree Number 1827 of 2018.

Data from MoEMR shows that until 2015 the Directorate General of Mineral and Coal had never issued a Production Operation Mining Permit for cinnabar or mercury commodities.

Mercury Stockpiles

Article 3 of the Minamata Convention requires Parties to endeavour to identify individual stocks of mercury or mercury compounds exceeding 50 metric tons, as well as sources of mercury supply generating stocks exceeding 10 metric tonnes per year, that are located within its territory.

Government Regulation Number 74 of 2001 in Article 31 obligates each person who conducts hazardous substances management to submit written reports on the hazardous management periodically at least every 6 (six) months to the responsible authority and authorized agency in their own task field with a copy to the Governor/ Head or Regent/Mayor.

Under the government regulation, hazardous substances management means activities which produce, transport, distribute, store, utilize and dispose of hazardous substances.

Mercury from Decommissioning of Chlor-Alkali Plants

The disposal process for the chlor-alkali industry, which has closed and transferred technology, is governed by GR Number 22 of 2021 concerning the Implementation Environmental Protection and Management.

Mercury Trading

In Article 58 of Law Number 32 of 2009, everyone who imports hazardous substances into the Unitary State of the Republic of Indonesia, produces, transports, circulates, stores, utilizes, disposes of, processes, and/or stockpiles hazardous substances is required to manage them.

Under this law, mercury is classified in GR Number 74 of 2001 as a hazardous substance the use of which is limited. As a result, mercury imports are governed by the MoT Regulation No. 47 of 2019 concerning the Third Amendment to the MoT Regulation No. 44/MDAG/PER/9/2009 concerning the Procurement, Distribution, and Supervision of Hazardous Substances, which states that mercury can only be imported by a company with a Business Identification Number (*Nomor Induk Berusaha*, NIB) that serves as a Producer Importer Identification Number (*Angka Pengenal Importir Produsen*, API-P) and an NIB that serves as a General Importer Identification Number (*Angka Pengenal Importir Umum*, API-U) and has obtained an Approval for the Import of Hazardous Substances (*Persetujuan Impor*).

Registration with the Ministry of Environment and Forestry is required for this purpose. This registration is only required once, until there is an amendment of GR Number 74 of 2001 which will be issued. Mercury which is classified as limited in use is inorganic mercury, alkyl mercury, alkyloxyalkyl mercury and aryl mercury.

Mercury is one of the hazardous substances listed in Attachment I, as defined in Article 2 paragraph (1) of MoT Regulation Number 75/M-DAG/PER/10/2014, which states:

1. Types of hazardous substances that are restricted in import, distribution and supervision consist of chemicals that endanger health and damage environmental sustainability as listed in Attachment I to this Ministerial Regulation;
2. The type of hazardous substances as referred to in paragraph (1) can be reviewed according to developments;
3. The type of hazardous material as referred to in paragraph (1) can only be used or utilized according to its designation;
4. Type hazardous material as referred to in paragraph (1) is prohibited from being used and utilized for food and food-related industries.

To export mercury compounds listed in Annex III of the Rotterdam Convention to other countries, it must be preceded by a notification from the authority of the country of origin to the authority of the country of destination and the country of transit (Prior Informed Consent, PIC procedure). Consent from the authority of the export destination country becomes the basis for the issuance or denial of export licenses from the authorized agency in the trade sector.

Meanwhile, to export mercury (elemental) [CAS: 7439-97-6, HS: 28054000], which is not listed in Annex III of the Rotterdam Convention, the authority of the country of origin must first submit a notification to the authority of the country of destination to convey information to the country of destination that mercury, whose use has been restricted in the country of origin, will enter the country of destination. Further provisions and procedures regarding the export of mercury (elemental) are regulated in the Rotterdam Convention, Article 3 of the Minamata Convention, and Article 7 of GR 74 of 2001.

Indonesian trade is founded on environmentally sound principles, according to Law Number 7 of 2014. Article 32 paragraph (1) also stipulates that environmental goods must be registered with the Minister of Trade, and the registration number must be shown on the items and/or packaging. The government may impose prohibitions or limits on trade in goods and/or services to preserve human health and safety as well as the environment, according to this law.

Technically, Indonesia has been regulating the trade and circulation of mercury since 2000, when the Minister of Industry and Trade issued Decree No. 254 of 2000 concerning the Trading System for the Import and Circulation of Certain Hazardous Substances, which includes mercury in the list of hazardous chemicals so that it will be included in the mechanism for regulating the import trade system including its circulation. The regulation has been amended several times, most recently through MoT Regulation Number 47 of 2019.

According to the MoT Regulation, hazardous substances obtained through imports for distribution can only be carried out by companies who have an NIB that serves as API-U. Each company that distributes hazardous substances mentioned in the said MoT Regulation must have a Hazardous Substances Trading Business Permit (*Surat Izin Usaha Perdagangan Bahan Berbahaya*, SIUP-B2) in order to distribute hazardous substances within the country (**Figure 3.2**). **Table 3.1** shows the different types of companies that can distribute hazardous substances under the MoT Regulation.

Table 3.1. **Categories of Companies That Can Distribute Hazardous Substances**

Company Category	Definition
Companies that have an NIB that serves as API-U	Companies that import hazardous substances for distribution/trading to other parties.
Registered Distributor of Hazardous Substances (*Distributor Terdaftar Bahan Berbahaya*, DT-B2)	A company appointed by a Hazardous Substances Manufacturer (*Produsen Bahan Berbahaya*, P-B2) and/or a company appointed by a company that has an the NIB that is serves as API-U, to carry out distribution.
Hazardous Substances Registered Retailer (*Pengecer Terdaftar Bahan Berbahaya*, PT-B2)	The company appointed by DT-B2 to distribute to PA-B2.
End Users of Hazardous Materials (*Pengguna Akhir Bahan Berbahaya*, PA-B2)	Industrial companies that use hazardous substances as raw/auxiliary materials to obtain added value, and/or business entities or institutions that use hazardous materials as auxiliary materials and/or research according to their designation, have permits and authorized agencies, and are not engaged in food processing.

Source: MoT Regulation Number 47 of 2019

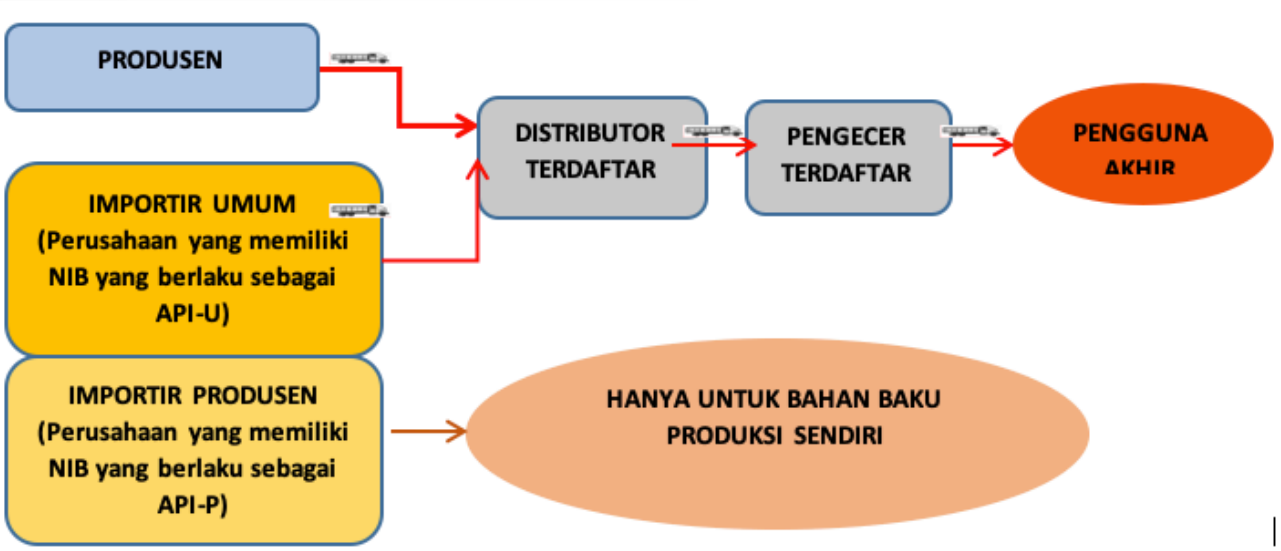
Specifically, for mercury type hazardous substances, the MoT Regulation explicitly regulates the prohibition of mercury imports for the gold mining industry and the distribution of mercury to end users engaged in the gold mining industry. Import procurement must be reported to the competent authority by a firm that has an NIB that serves as API-P and a company that has an NIB that serves as API-U and has obtained Hazardous Substances Import Approval (*Persetujuan Impor Bahan Berbahaya*, PI-B2). The distribution conducted by DT-B2, PT-B2, and PA-B2 must also be reported to the authorized institution.

In accordance with MoT Regulation Number 47 of 2019, companies with PI-B2 are required to submit reports on the implementation of hazardous substances imports, whether realized or not, to the Director General of Foreign Trade (*Direktur Jenderal Perdagangan Luar Negeri*, Dirjen Daglu), Director General of Consumer Protection and Trade Order (*Direktur Jenderal Perlindungan Konsumen dan Tertib Niaga*, Dirjen PKTN); Director General of Chemical, Pharmaceutical, and Textile Industry (*Direktur Jenderal Industri, Kimia, Farmasi dan Tekstil, Dirjen IKFT*), MoI; Deputy for Supervision of

Processed Food, BPOM; and the Director General of Solid Waste, Hazardous Waste, and Hazardous Substance Management, (*Direktur Jenderal Pengelolaan Sampah, Limbah, Bahan Beracun dan Berbahaya, Dirjen PSLB3*), MoEF.

Companies with an NIB that serves API-P as must submit a report on the realization on the use of hazardous substances to the Director General of Domestic Trade (*Direktur Jenderal Perdagangan Dalam Negeri*, Dirjen PDN); Dirjen IKFT, MoI; Deputy for Supervision of Processed Food, BPOM, and Dirjen PSLB3, MoEF. Companies with an NIB that serves as API-U must submit a report on the realization of the distribution of hazardous substances to DT-B2 to Dirjen PDN, Dirjen Daglu; Dirjen IKFT, MoI; Deputy for Supervision of Processed Food, BPOM, and Dirjen PSLB3, MoEF.

Figure 3.2. **Distribution Flow of Hazardous Materials based on the Regulation of the Minister of Trade of the Republic of Indonesia Number 47 of 2019 concerning the Third Amendment to the Regulation of the Minister of Trade Number 44/M-Dag/Per/9/2009 concerning the Procurement, Distribution and Control of Hazardous Materials**



In addition to the Minister of Trade Regulation above, the Rotterdam Convention, which has been ratified by Indonesia through Law Number 10 of 2013, regulates the trade in pesticides and chemicals that are prohibited and/or restricted in their use because they can have an impact on human health and the environment. This Convention aims to promote the sharing of responsibilities and cooperation among parties in conducting international trade in hazardous chemicals in order to protect human health and the environment from potential damage by exchanging information on the characteristics of hazardous chemicals and pesticides, setting up a decision-making process at the national level related to export-import policies and to disseminate the policies taken at the national level to other Parties. In this case, the Rotterdam Convention includes setting up PIC procedures and the exchange of information on chemicals in Annex III to the Convention as well as chemicals that have been banned and/or restricted in each Parties. The fifty-two chemicals in Annex III require PIC procedures in international trade, including regulating mercury compounds, including inorganic mercury, alkyl mercury, alkyloxyalkyl mercury and aryl mercury (excluding elemental mercury).

According to Minister of Environment Regulation Number 02 of 2010 concerning the Use of the Electronic System for Registration of Hazardous Substances within the framework of the Indonesia National Single Window at the Ministry of

Environment, all hazardous substances must be registered by the producer and/or importer, based on the provisions of Article 6 of GR Number 74 of 2001. Hazardous substances registration is submitted by the applicant using the hazardous substances registration form found in Attachment II to this GR, according to Article 6 paragraph (1). According to the MoEF's policy as the focal point for the Rotterdam Convention, the registration applicant must attach a hazardous substances notification approval letter from the MoEF for hazardous substances categorized as hazardous substances that are limited to use in accordance with applicable laws and regulations.

The Ministry of Industry (MoI) is currently working on a MoI Regulation Concerning Procedures for Providing Recommendations for the Import of Hazardous Substances for Non-Pharmaceutical Industries, which will require every industry importing hazardous substances (mercury included) to have a Recommendation Letter for Importing Hazardous Materials from MoI as one of the requirements for obtaining approval for the import of hazardous substances from MoT based on the based on MoT Regulation Number 47 of 2019 concerning the Third Amendment of MoT Regulation Number 44/M-DAG/PER/9/2009 concerning the Procurement, Distribution and Supervision of Hazardous Substances For the time being, Minister of Trade Regulation Number 47 of 2019 governs rules and policies aimed at identifying mercury stocks and sources.

It is recommended that the trade regulation for mercury is based on provisions and procedures under the Rotterdam Convention, Minamata Convention and GR Number 74 of 2001.

3.1.2.2. Mercury Use

Mercury is still widely used in a variety of activities, such as mercury-containing products, manufacturing processes, and ASGM as mentioned in Article 4, 5 and 7 of the Minamata Convention. Illegal gold miners also use mercury to purify gold from tailings waste. The laws and regulations governing mercury use are outlined here.

Law Number 3 of 2014 concerning Industry accommodates environmental management into the concept of green industry and the Minister of Industry will oversee the industry's compiance in meeting environmental standards.

Law Number 32 of 2009 also stipulates in Article 58 that the use of hazardous substances must be managed.

Law Number 4 of 2009 concerning Mineral and Coal Mining states that minerals and coal must be managed in a sustainable and environmentally sound manner.

The government, local governments, and the community ensure the availability of healthy environment and does not represent a health risk (Law Number 36 of 2009 concerning Health Article 163). This law also establishes what constitutes a healthy environment.

It is regulated in Law Number 36 of 2009 concerning Health Article 104 regarding the security of pharmaceutical preparations and medical devices that are held to protect the public from the dangers caused by the use of pharmaceutical preparations and medical devices that do not meet the quality, safety, efficacy/benefit requirements.

With the enactment of Law Number 11 of 2020 concerning Job Creation, several provisions in Law Number 3 of 2014, Law Number 32 of 2009, Law Number 3 of 2020, Law Number 4 of 2009 and Law Number 36 of 2009 have been amended.

Law Number 18 of 2008 concerning Waste Management does not specifically regulate mercury but solid waste must be managed properly and in accordance with regulations. In addition, burning solid waste without using environmentally sound technology is prohibited, thereby reducing the release of mercury.

Inorganic mercury, alkyl mercury, alkyloxyalkyl mercury, and aryl mercury are all classified as hazardous substances with limited use. Packages must carry hazardous-characteristics labels and symbols, and their storage is governed by GR No. 74 of 2001. The definition of hazardous substances storage is defined in Article 1 of this GR, which is the technique of placing hazardous substances activities to maintain the quality and quantity of hazardous substances and/or prevent hazardous substances from having adverse impact on the environment, human health, and other living creatures. According to paragraph 1 of Article 18, each hazardous substance storage location must have a sign and label. The hazardous chemicals storage space referred to in paragraph (1) must meet the requirements for the building's location and structure, according to paragraph (2). Paragraph (3) clarifies that the criteria for hazardous substances storage requirements referred to in paragraph (2) must be further specified by a Decree of the Head of the responsible agency.

The operations of the industrial sector are governed by the Industry Law No. 3 of 2014. Article 77 of this Law emphasizes that in realizing a green industry, the government shall formulate policies, strengthen institutional capacity, standardize and provide facilities. The regulation on the use of mercury or mercury compounds and control of mercury emissions is one of the government's references in preparing green industry standards that contain provisions on raw materials, auxiliary materials, energy, production processes, products, company management and waste management (Law on ratification of the Minamata Convention). Technically, the implementation of Law Number 3 of 2014 is regulated in the MoI Decree Number 148 of 1985 concerning Safeguarding of Hazardous Substances in Industrial Companies. The industry is fully responsible for the management of hazardous substances starting from procurement, storage, processing, packaging, and transportation to distributors.

Regarding regulations and or policies related to the prohibition of new facilities to use mercury in all processes under Article 5 as stipulated in Attachment B to the Convention, in Presidential Regulation Number 44 of 2016 concerning List of Business Fields Closed and Business Fields Open with Conditions in the Investment Sector, the chlor-alkali manufacturing industry with a mercury process is included in Annex I as a List of Closed Business Fields. With the issuance of Presidential Regulation Number 10 of 2021 about the Investment Business Field, which is the implementation of Law Number 11 of 2020, Presidential Regulation Number 44 of 2016 was revoked, and the chlor-alkali industry was removed from the list of closed business fields.

The regulation governing the commodity of medical devices is found in the MoH Regulation No. 1189 of 2010 Concerning Production of Medical Devices and Household Health Supplies. As stated in Article 16 of this regulation, production of medical devices and household health supplies must use raw materials that meet the quality, safety and usefulness requirements and related to the use of radioactive substances, must be produced in accordance with the provisions of laws and regulations concerning permits for the use of radioactive substances.

Related to Article 4 of the Minamata Convention on mercury-added products, RAN-PPM contains strategies, activities and reduction target for batteries and lamps of 50% from baseline condition in 2018 in year 2030. Mercury reduction is a gradual mercury restriction effort in activities of mercury distribution, mercury use and mercury emission and release control.

Mercury-containing medical devices may only be distributed or marketed in Indonesia until December 31, 2018, according to the Circular Letter of Director General of Pharmaceutical and Medical Equipment No. HK.02.02/V/0720/2018 concerning the Determination of Validity Period of Distribution License and Distribution of Mercury-Containing

Medical Devices. In addition, The Circular Letter of the Director General of Health Service Number HK.02.02/V/0361/2019 governs the requirement for healthcare facilities to have a temporary storage for hazardous waste at the healthcare facility, and the Circular Letter of the Director General of Health Service Number HK.02.02/V/0361/2019 governs the elimination and withdrawal of mercury medical devices.

The Ministry of Health (MoH) has also stipulated MoH Regulation No. 41 of 2019 concerning the Elimination and Withdrawal of Mercury Medical Devices in Healthcare Facilities for all mercury medical devices that can be substituted with alternative materials that are friendly to human activities and the environment. If any remain in circulation, they must be withdrawn, destroyed, or re-exported in compliance with applicable laws and regulations.

HS codes for mercury-containing thermometers and sphygmomanometers in Indonesia are listed under the Minister of Trade Regulation Number 12 of 2020 concerning Goods Prohibited for Import under Ex 9025.11.00 for mercury-containing thermometers and Ex 9018.90.90 for mercury-containing sphygmomanometers.

It is further regulated in MoEF Regulation Number P.27/MenLHK/Setjen/Kum1/12/2020 for the management of medical devices waste containing mercury, namely thermometers, sphygmomanometers, and dental amalgams from healthcare facilities that are not broken and mercury is not spilled.

MoH Regulation Number 7 of 2019 concerning Hospital Environmental Health regulates the chemical quality standard of water for hemodialysis at 0.0002 mg/liter.

In accordance with BPOM Regulation Number 23 of 2019 concerning Technical Requirements for Cosmetic Ingredients, mercury and its compounds are included in Annex V as a List of Prohibited Substances in Cosmetics.

Law Number 22 of 2019 concerning Sustainable Agricultural Cultivation Systems in Article 76 states that pesticides to be circulated within the territory of the Republic of Indonesia must be registered, meet quality standards, ensured their effectiveness, be labeled and must take into account public health and environmental sustainability. Mercury and mercury compounds are included in the active ingredients which are prohibited for all areas of pesticide use according to Annex II. Minister of Agriculture (MoA) Regulation Number 39/Permentan/SR.330/7/2015. The use of topical biocides and antiseptics containing mercury has also been banned.

The import, distribution and use of mercury for ASGM is not allowed in MoT Regulation Number 47 of 2019, Article 17.

MoEF Regulation Number 23 of 2008 concerning Technical Guidelines for the Prevention of Pollution and/or Environmental Damage Due to People's Gold Mining confirms that community gold mining activities carried out through mining activities in primary gold deposits and secondary gold deposits and their processing activities have the potential to reduce environmental quality due to pollution and/or environmental damage. Therefore, the guidelines for the government and local governments in providing guidance to business actors and/or ASGM activities as regulated in this ministerial regulation need to be implemented to prevent pollution and/or environmental damage due to ASGM activities. Article 5 highlights that the prevention of contamination and/or damage to mining activities is accomplished, among other things, by avoiding the use of mercury or cyanide. Article 6 paragraph (1) also confirms that the prevention of pollution from gold processing activities is carried out by minimizing the use of mercury or cyanide, storing mercury in a closed place, avoiding direct sunlight, being at room temperature and under the water surface at least 1 cm (submerged) for extraction and for amalgamation must use a retort system,

carried out in a special place equipped with a stack with a height of at least 2 meters higher than the roofs of houses around the site. The water in the settling pond must then be treated to meet quality standards before being discharged into rivers and/or marshes, and the abandoned mining pits must be backfilled.

Indonesia has a legislative framework for workplace safety and health, which is governed by Law No. 1 of 1970 on Occupational Safety. This law applies to all workplaces and highlights the necessity of primary prevention.

Law Number 36 of 2009 concerning Health states that occupational health efforts are aimed at protecting workers so that they can live healthy lives free from health problems and adverse impacts caused by work. These occupational health efforts cover workers in the formal and informal sectors and apply to everyone other than workers who are in the workplace environment. The government establishes occupational health requirements (Article 164).

Technical requirements for the utilization of hazardous substances can be found in the Minister of Manpower Decree No. 124/M/SK/4/1985 Handling, Processing, Transport, and Storage of Hazardous Chemicals. The control of hazardous compounds in the workplace is regulated by Ministerial Decree KEP. 187/MEN/1999. Article 4 of this Ministerial Decree governs the creation and delivery of material safety data sheets and labeling.

The Decree of the Minister of Manpower Number: KEP. 187/MEN/1999 regulates the control of hazardous chemicals in the workplace. The preparation and delivery of material safety data sheets and labeling is regulated in Article 4 of this Ministerial Decree.

The Regulation of the Head of the National Police of the Republic of Indonesia Number 2 of 2008 regulates the supervision, control, and security of commercial explosives (Article 9).

In order to meet the criteria for hazardous substance storage set forth in GR Number 74 of 2001, regulations or technical guidance for the criterion for hazardous substance storage need to be issued.

Given the widespread use of mercury by micro, small, and medium-sized companies (MSMEs) with gold craftsmen, it is necessary to regulate and raise awareness as well as transfer technology of non-mercury operations by gold craftsmen. For this reason, specific arrangements are also needed for the protection of workers' health and the environment in this activity. Some goldsmiths, as we all know, are already adopting ecologically friendly technologies. This needs to be publicized so that other craftsmen can learn from it.

It is necessary to formulate regulations and/or policies prohibiting the use of mercury or mercury compounds in the production process listed in Part I of Annex B (acetaldehyde) following the termination date in Annex B of the Convention. In addition, it is also necessary to formulate regulations and/or policies related to restrictions on the use of mercury in processes listed in Part II of Annex B to the Convention as well as regulations and/or policies to prevent mercury from being used in industrial processes that are not regulated in the Minamata Convention.

It is necessary to develop regulations and or policies related to the prohibition of new facilities to use mercury in all processes under Article 5 as defined in Annex B to the Convention, other than chlor-alkali.

3.1.2.3. Mercury Pollution

Law Number 32 of 2009 does not specifically regulate mercury, but under GR Number 22 of 2021 which is the implementation of Law Number 11 of 2020, mercury is included in Annex IX, Table 3. Hazardous Waste List from General Specific Sources: waste containing/contaminated with mercury can be sourced from the type of chloro-alkali process industry (excluding salt purification carried out in salt fields) which comes from the source of waste from the caustic soda production process using the

mercury cell method and the chlorine production process using the electrolysis method of mercury cells process with hazard categories of level 1 (mercury content >10 ppm) and level 2 (mercury content > 0.3 ppm and < 10 ppm). Attachment XI of the GR confirms the quality standards for toxic characteristics through the toxicity characteristic leaching procedure (TCLP) for the determination of the category of hazardous waste, mercury (Hg) of (TCLP-A) 0.3 mg/L (dry weight basis) and (TCLP-B) 0.05 mg/L (dry weight basis).

Article 285 paragraph (1) of this GR stipulates that each person who generates hazardous waste is required to store hazardous waste. To be able to store hazardous waste, each person as defined in Article 285 paragraph (1) must fulfill the following requirements:

a. a hazardous waste storage standard that is integrated into NIB for Hazardous Waste Producers from businesses and/or activities that are required to have Statement of Ability to Manage and Monitor the Environment (*Surat Pernyataan Kesanggupan Pengelolaan dan Pemantauan Lingkungan Hidup*, SPPL), and/or

b. technical details of hazardous waste storage contained in the environmental approval for hazardous waste generators from businesses and/or activities that are required to have AMDAL or UKL-UPL and government agencies that produce hazardous waste (Article 285 paragraph (3)).

If the name of the hazardous waste stored, the location of the storage area, and/or the design and capacity of the hazardous waste storage facility change, the business identity number or environmental approval must be updated.

NIB or environmental approval must be changed in the event of a change to the requirements for the name of the hazardous waste stored, the location of the storage area and/or the design and capacity of the hazardous waste storage facility.

Article 286 regulates the standards for a hazardous waste storage facility, including the site, facilities, and equipment for handling emergency situation.

According to Article 296 paragraph (1) letter b, the duration of time for temporary storage of hazardous waste is as follows:

1. 90 (ninety) days since the hazardous waste was generated for hazardous waste generated at a rate of 50 kg (fifty kilograms) per day or more;
2. 180 (one hundred and eighty) days since the hazardous waste was generated for hazardous waste produced at a rate of less than 50 kg (fifty kilograms) per day for category 1 hazardous waste;
3. 365 (three hundred and sixty-five) days since the hazardous waste was generated for hazardous waste generated at a rate of less than 50 kg (fifty kilograms) per day for category 2 hazardous waste from unspecific source and general specific source; or
4. 365 (three hundred and sixty-five) days since the hazardous waste was generated for category 2 hazardous waste from special specific sources.

The guidelines on the storage of mercury waste also take into account all relevant guidelines developed under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Indonesia has ratified the Basel Convention through Presidential Decree Number 61 of 1993.

Utilization of hazardous waste by hazardous waste utilizers is regulated in GR Number 22 of 2021 Article 315-341.

The Decree of the Head of the Environmental Impact Management Agency (*Badan Pengendalian Dampak Lingkungan*, Bapedal) Number Kep-03/Bapedal/09/1995 which regulates the technical requirements for hazardous waste treatment have been revoked by the MoEF Regulation Number 6 of 2021 concerning Procedures and Requirements for Hazardous Wastes Management, which regulates the procedures and requirements for: a) determination of hazardous waste status, b) hazardous waste reduction, c) hazardous waste storage, d) hazardous waste collection, e) hazardous waste transportation, f) hazardous waste utilization,

g) hazardous waste treatment, h) hazardous waste disposal, i) hazardous waste dumping; j) hazardous waste transboundary movement and k) application and issuance of technical approvals and Operational Feasibility Letter for hazardous waste management.

Hazardous waste treatment is a process to change the characteristics and composition of hazardous waste in order to render it harmless and/or non-toxic. The technical requirements for hazardous waste treatment include physics and chemistry, stabilization/solidification and incineration.

Furthermore, MoEF Regulation No. P.56/Menlhk-Setjen/2015 concerning Procedure and Technical Requirement for Hazardous Wastes Management from Healthcare Facilities provides guidelines for hazardous waste generators from health care facilities in managing hazardous waste generated, including mercury-containing medical devices.

Management of medical hazardous waste includes the following stages:

a. hazardous waste reduction and segregation;
b. hazardous waste storage;
c. hazardous waste transportation;
d. hazardous waste treatment;
e. Hazardous waste burial; and/or
f. Hazardous waste landfill.

It is important to develop procedures for treating mercury waste that meet environmental criteria and are located at the source of the mercury waste, especially at MSME scale and for those in remote places. According to the Minamata Convention, mercury waste must be treated by storing it under conditions that are safe for human health and the environment. Because the definition of mercury waste storage under GR Number 22 of 2021 is limited to a maximum of 365 days, it is required to create special regulations for processing mercury waste that do not contradict with GR Number 22 of 2021. Based on Annex IX Table 1 GR Number 22 of 2021, waste/products containing mercury are categorized as category 1 from non-specific sources with waste code A105d. If it is generated at a rate of more than 50 kg/day, it can be stored for up to 90 days, and if it is produced at a rate of less than 50 kg/day, it can be stored for up to 180 days. One of the provisions of the mercury waste regulation to be developed is to define mercury waste storage as a treatment effort, allowing mercury waste to be held for more than 365 days if specific requirements are met.

Currently, the Minister of Health Regulation Number 7 of 2019 concerning Hospital Environmental Health has set the standard for soil chemical quality related to public health, which is 75 mg/kg for mercury. Meanwhile, standards for mercury waste in soil based on environmental quality are not yet available so it is necessary to determine them by taking into account the designation of locations such as industrial, residential, commercial, agricultural, and others.

Mercury Emissions

Mercury is released as a result of a variety of activities. Air emission quality standards for mercury have been established for a variety of operations, including hazardous waste incinerators and boilers, which are governed by the MoEF Regulation Number 6 of 2021 to be 0.2 mg/Nm.

The MoEF has issued MoEF Regulation Number P.15/Menlhk/Setjen/Kum.1/4/2019 concerning The Emission Quality Standard for Thermal Power Plants, including a mercury emission quality standard of 0.03 mg/Nm^3 for coal-fired power plants. This law also mandates that coal-fired emission sources be monitored using the Continuous Emissions Monitoring System (CEMS), which includes criteria for mercury monitoring, measurement, and reporting.

The mercury emission quality limit for biomass boilers has been set at 5 mg/m^3 by Minister of Environment Regulation Number 7 of 2007 concerning the Emission Quality Standard for Immobile Sources for Steam Boilers. The mercury emission quality requirement for coal-fired steam boilers is not covered by this Minister of Environment regulation. Article 6, this rule establishes technical criteria for gas stack, as well as gas emission testing and reporting.

The mercury emission quality level for immovable sources has been regulated by Minister of Environment Decree No. KEP.13/MENLH/3/1995, which is 10 mg/m³ for types of activities other than iron and steel industry, pulp and paper, coal-fired power plant, and cement industry. This decree requires the manufacture of emission stack, technical requirements for measuring instruments for monitoring and reporting of emission monitoring results for the four industries mentioned above.

Minister of Environment Regulation No. 4 of 2014, in Annex V regulates the Emission Quality Standards for Immovable Sources for Mining Activities.

MoEF Regulation Number P.70/MENLHK/SETJEN/KUM.1/8/2016 establishes mercury emission quality standards for business and/or thermal waste processing activities for household waste and household-like waste that does not contain hazardous substances, hazardous waste, glass, poly vinyl chloride (PVC), and aluminum foil with a maximum recommended limit of 3 mg/Nm³. This regulation requires the use of CEMS and its monitoring and reporting.

MoEF Regulation Number P.19/MENLHK/SETJEN/KUM.1/2/2017 concerning Emission Quality Standards for Cement Industry and/or Activities establishes mercury emission quality standards for cement industry activities that use refuse-derived fuel (using household waste and/or household-like waste) of 0.2 mg/Nm³ and those who utilize hazardous waste of 0.2 mg/Nm³.

In smelting activities, compliance with emission quality standards is one of the technical requirements that must be met, and is taken into consideration in the assessment of the Company Performance Rating Program (*Program Penilaian Peringkat Kinerja Perusahaan*, PROPER). The emission quality standards that must be met refer to the permit owned by the company conducting the smelting. Currently, business activities that are required to have emission quality standards for mercury parameters are the smelting of lead and copper.

Industrial performance monitoring is focused on the industry's obligation to comply with all required regulations including mercury testing, which is determined based on available standards. The main focus of monitoring is compliance with mercury quality standards, rather than quantifying the amount of mercury discharged.

In terms of mercury emission quality standards, it is necessary to stipulate regulations for activities that produce mercury emissions, in particular coal-fired boilers in the fertilizer, petrochemical and chemical industries, smelting and roasting processes used in the production of non-ferrous metals, waste incineration facilities and cement clinker production facilities.

Mercury Releases

MoEF Regulation Number 6 of 2021 sets the quality standard for wastewater treatment activities, which is 0.002 mg/l. Meanwhile, the TCLP for determination of hazardous waste standards prior to landfilling for mercury is 0.05 mg/L and the quality standard for leachate is 0.002 mg/L.

Meanwhile, Minister of Environment Regulation No. 5 of 2014 regulates wastewater quality standards to implement the provisions of Article 20 paragraph (2) letter b of Law Number 32 of 2009, as amended by Law Number 11 of 2020, relating to the management of wastewater quality standards as a reference for local governments and businesses. Especially in the electronics industry with a mercury (Hg) threshold of 0.002 mg/l, the caustic soda or chlorine industry with a mercury (Hg) threshold of 0.004 mg/l (0.012 gram/tonnes), dry battery industry of 0.01 mg /l and 0.015 mg/kg (alkaline-manganese), 0.01 mg/l and 0.0025 mg/kg (carbon-zinc), paint industry at 0.01 mg/l (0.005 gr/m³), service industry health of 0.002 mg/l and other industries with a mercury threshold of 0.002 mg/l (class I) and 0.005 mg/l (class II).

The Minister of Environment Regulation Number 10 of 2006 determines wastewater quality standards for Vinyl Chloride Monomer and Poly Vinyl Chloride industrial activities, although it does not address mercury parameters.

Attachment II of Minister of Environment Decree No. 202 of 2004 determines the wastewater quality standard for businesses and or mining activities of gold and copper ore.

In addition to the quality standard value of wastewater for mercury, mercury concentration in receiving water bodies according to water-body segmentation or zone is also a consideration for industrial wastewater management. Mercury quality standards based on segmentation or zones of water-bodies are regulated in GR Number 22 of 2021, namely for river and similar water quality standards and lake water and the like, with class 1 of 0.001 mg/L, class 2 (0.002 mg/L), class 3 (0.002 mg/L) and class 4 (0.005 mg/L). The determination of water class is regulated in Article 113 of this GR.

It is necessary to improve the monitoring by MoEF on the obligation to report the results of monitoring the quality of wastewater, especially the mercury parameters, from industry.

It is proposed that MoEF add requirements for effluent, emission, sediment in fresh and marine water, and biota for industrial activities regulated by the Minamata Convention,

In the case of ambient air, it must be tested/analyzed further in the laboratory for mercury and other trace elements.

3.1.2.4. Contaminated Land

In Article 54 paragraph (1)-paragraph (3) of Law Number 32 of 2009, the recovery of contaminated land, including mercury contamination, is governed as follows:

Remediation of contaminated land, including contamination by mercury is regulated in Law Number 32 of 2009 in Article 54 paragraph (1)-(3), as follows:

1. Anyone who pollutes and/or destroys the environment is obligated to restore environmental functions.
2. The restoration of environmental functions as referred to in paragraph (1) is carried out in stages, as follows:
   a. cessation of pollution sources and cleaning of pollutant elements;
   b. remediation;
   c. rehabilitation;
   d. restoration; and/or
   e. other ways in accordance with the development of science and technology.
3. Further provisions regarding procedures for restoring environmental functions as referred to in paragraph (2) shall be regulated in a GR.

GR Number 22 of 2021, as the implementation of Law Number 11 of 2020, regulates the restoration of environmental functions in Articles 415-427. Article 421 describes the standard values for the identification of pollutant substances as listed in Annex XIII, where for mercury TCLP-A 0.3 mg/L and total concentration-A (TK-A) 300 mg/kg, TLCP-B 0.05 mg/L and TK-B 75 mg/kg; TCLP-C 0.02 mg/L and TK-C 0.3 mg/kg. The provisions for this quality standard value are explained in Article 421, as follows:

a. If the pollutant concentration is greater than TCLP-A and/or the total concentration of A, the soil must be managed in accordance with Category 1 Hazardous Waste Management;
b. If the pollutant concentration is equal to or less than TCLP-A and/or the total concentration of A, and greater than TCLP-B and/or the total concentration of B, the soil must be managed in accordance with Category 2 Hazardous Waste Management;
c. If the pollutant concentration is equal to or less than TCLP-B and/or the total concentration of B, and greater than TCLP-C and/or the total concentration of C, the soil must be managed in accordance with non-hazardous waste management;
d. If the pollutant concentration is equal to or less than TCLP-C and/or the total concentration of C, the soil can be used as base layer.

MoEF Regulation No. 101 of 2018 provides guidance for the remediation of land contaminated with hazardous waste, including mercury. A Presidential Regulation is currently being drafted to expedite the remediation of ex-mining open access land that must be expedited.

A complete list of laws and regulations pertaining to mercury management in Indonesia can be seen in **Annex II**.

3.1.2.5. Financial Resources

Presidential Regulation Number 113 of 2020 concerning Details of the State Budget for Fiscal Year 2021 was issued in accordance with Law Number 9 of 2020 concerning the State Budget.

Consideration for the elimination and substitution of mercury, especially in ASGM locations, is included in the 2020-2024 National Medium Term Development Plan, taking into account Covid-19, it is hoped that mercury will remain a priority given the commitment of the Indonesian government to reduce and eliminate the use of mercury.

There is currently no specific domestic financial mechanism in place to support the implementation of the Minamata Convention, particularly actions related to RAN-PPM. Until the present date, the State Revenue and Expenditure Budget has been the exclusive source of funding for hazardous substance activities in Indonesia (*Anggaran Pendapatan dan Belanja Negara*, APBN).

For the implementation of the Minamata Convention, especially the implementation of activities in Presidential Decree No. 21 of 2019, several ministry directorates do not have special programs or funding. Several other ministry directorates with funding from the State Budget have prepared programs and carried out activities for the implementation of the presidential regulation.

Apart from the APBN, the Center for Quality Research and Development and Environmental Laboratory (P3KLL)-MoEF received funding programs from the World Bank and UNDP for the implementation of baseline data collection and institutional capacity building in 2017-2020. MoH, specifically the Directorate of Environmental Health, received a grant from the Minamata Convention's Specific International Program (SIP) for a participatory approach activity for ASGM communities in controlling the impact of mercury exposure in the years 2020-2021.

In the future, the Ministry of National Development Planning (*Kementerian/Badan Perencanaan Pembangunan Nasional*, Bappenas) will push for the implementation of a Public Private Partnership (PPP) mechanism. In order to assess a project's feasibility, the government can provide Viability Gap Fund (VGF) funds, among other things, to finance especially the handling of medical hazardous waste in each province and integrated hazardous waste in the four major islands outside Java.

Currently, the elimination and substitution of mercury, especially in ASGM locations, is part of the strategy to realize the policy direction for improving the environmental quality in the 2020-2024 National Medium Term Development Plan.

Mercury reduction and elimination activities are pollution prevention and control efforts that are included in environmental business activities that can be financed from green bonds.

Mercury reduction and elimination activities can be sourced from loans (green bonds) as regulated, among others, in the Financial Services Authority (*Otoritas Jasa Keuangan*, OJK) Regulation No. 60/POJK.04/2017 concerning Issuance and Requirements for Environmentally Friendly Debt Securities and OJK Regulation No. 51/POJK.03/2017 concerning the Implementation of Sustainable Finance for Financial Service Institutions, Issuers and Public Companies.

To achieve the target of the 2020-2024 National Medium Term Development Plan related to hazardous substances and hazardous waste as well as RAN-PPM and the Regional Action Plan for Mercury Reduction and Elimination, it is necessary to develop financing potential other than the APBN and the Regional Budget (*Anggaran Pendapatan Belanja Daerah*, APBD) such as grants, State Sharia Securities (*Surat Berharga Syariah Negara*, SBSN), Indonesian Environmental Fund Management Agency, Corporate Social Responsibility (CSR), and others. The Regional Action Plan for Mercury Reduction and Elimination prepared by the local

government is expected to be incorporated into the Regional Medium-Term Development Plan, Regional Government Work Plan and Work Plans for Regional Apparatus Work Units, making it a priority in planning and budgeting.

It is proposed that after dealing with Covid-19, carrying out these action plans can be financed through the APBN and the APBD on-top from the available funds.

3.1.2.6. Stakeholder Capacity Building

The aforementioned institutions have held trainings for local governments, health clinics, and the general public, but the scope remains limited to licensed ASGMs, despite the fact that the number of unlicensed ASGMs is larger. In addition, in related industrial operations such as gold mining, electronics, and other businesses that use mercury, information of the effects of mercury is still lacking. The solution is to grant permits to those who are not licensed, as long as they do not use mercury and follow all existing laws and regulations.

3.1.2.7. Information Exchange and Public Awareness

Law Number 14 of 2008 regulates the disclosure of public information and its implementation is regulated in GR Number 61 of 2010. Furthermore, Presidential Instruction Number 9 of 2015 governs public communication management.

Environmental information is governed under Law Number 32 of 2009, as amended by Law Number 11 of 2020. GR Number 22 of 2021 as the implementation of Law Number 11 of 2020 also regulates environmental approvals, and includes the obligation to report water pollution control activities, air and hazardous waste management. To encourage companies to comply with environmental laws and regulations through incentives and disincentives, MoEF has a PROPER program. In addition, the Minister of Environment Regulation Number 03 of 2014 also governs the company's performance rating program in environmental management.

Regarding health information and education, it is regulated in Law Number 36 of 2009 as amended by Law Number 11 of 2020. Health information systems are regulated in GR Number 46 of 2014. MoH Regulation Number 56 of 2016 also includes outreach strategies and advocacy for the impact of mercury on health to the wider community including its monitoring and evaluation.

As a Party to the Basel Convention, Indonesia is obligated to fulfill reporting obligations which include, among other things, the impact of hazardous waste on health and the environment. Currently, Indonesia is also developing a Pollutant Release and Transfer Register (PRTR) roadmap, which is a national or international database or inventory that shows the amount of a chemical and its pollutants released into environmental media (water, air, soil) as well as those that are processed or disposed of and even in a product. This PRTR data can then be made available to the general public.

3.1.2.8. Supervision and Law Enforcement

According to the laws and regulations in the environmental sector, supervision of hazardous substances and hazardous waste including mercury is carried out by the supervisors of MoEF, provincial/regency/city governments. As for the import of hazardous substances and hazardous waste, including mercury, this is carried out by customs officers by checking the suitability of goods and documents. In the mining process, according to Law No. 4 of 2009 as amended by Law No. 3 of 2020, the supervision is carried out by mining inspectors.

According to Law Number 32 of 2009, integrated law enforcement involving civil servant investigators, the police, and the prosecutor's office can be carried out against perpetrators of environmental crimes under the coordination of the Minister responsible for the environment.

Under Law Number 11 of 2020, there are changes to several provisions regarding criminal sanctions in Law Number 32 of 2009. Further administrative sanctions are regulated in GR Number 22 of 2021.

Several activities have been carried out for the supervision and legal action of ASGM, among other things. MoEF in collaboration with the local government and the police closed and prosecuted the illegal ASGM in Mount Botak in 2018.

Under the Minister of Trade Regulation Number 47 of 2019 regarding supervision, it can be done either together or separately. Article 13 of this regulation explains that companies that have obtained PI-B2 are required to submit reports on the implementation of hazardous substances imports, whether realized or not realized to the Director General of Foreign Trade electronically through the http://inatrade.kemendag.go.id page; Directorate General of Consumer Protection and Trade Order the Director General of Chemical, Pharmaceutical, and Textile Industry, Ministry of Industry; the Deputy for Supervision of Processed Food Materials, BPOM; and the Director General of Solid Waste, Hazardous Waste and Hazardous Substances Management, MoEF.

Under the Minister of Trade Regulation 47 Number 2019 regarding supervision, it can be carried out either together or separately. Article 13 of this regulation explains that companies that have obtained PI-B2 are required to submit reports on the implementation of hazardous substances imports, whether realized or not realized to Dirjen Daglu electronically through the http://inatrade.kemendag.go.id page, Dirjen PKTN; Dirjen IKFT, MoI; Deputy for Supervision of Processed Food, BPOM and Dirjen PSLB3, MOEF.

Companies with NIB that serves as API-P are required to submit reports on the use of hazardous substances to Dirjen PDN electronically via the http://sipt.kemendag.go.id page, Dirjen IKFT, MoI; Deputy for Supervision of Processed Food, BPOM and Dirjen PSLB3, MoEF.

Companies with NIB that serves as API-U are required to submit reports on the realization of hazardous substances distribution to DT-B2 Dirjen PDN via the http://sipt.kemendag.go.id page; Dirjen Daglu via the http://inatrade.kemendag.go.id page; Dirjen IKFT, MoI; Deputy for Supervision of Processed Food, BPOM and Dirjen PSLB3, MoEF.

In Article 14 it is explained that DT-B2 must submit reports electronically through the http://sipt.lcemendag.go.id page to Dirjen PDN regarding hazardous substances acquisition from PB-2 and/or companies that have an NIB that serves as API-U and its distribution, with a copy to Deputy for Supervision of Processed Food, BPOM; Dirjen IKFT, MoI; Head of Provincial Agency where the company and hazardous substances distribution area are located and Dirjen PSLB3, MOEF.

PT-B2 is obligated to submit a report on the hazardous material data which it distributes to the Head of the Provincial Agency with a copy to Dirjen PDN; Deputy for Supervision of Processed Food, BPOM; Dirjen IKFT, MoI; Dirjen PSLB3, MoEF and Head of Regency/City Agency where the company is located.

PA-B2 is obligated to submit a report on data on hazardous materials acquisition to the Head of the local Regency/City Agency with a copy to Dirjen PDN; Deputy for Supervision of Processed Food, BPOM; Dirjen IKFT, MoI; Head of Provincial Agency and Dirjen PSLB3, MOEF.

Currently the Directorate of Domestic Trade, particularly the Directorate of Basic Goods and Important Goods, approves permits from business actors for licensing as a registered distributor; however, there is no mercury because it is prohibited by MoT Regulation from being distributed by IT-B2, DT-B2, or retailers. For business actors to obtain permits, inspection is first carried out at the warehouse, inspecting the packaging condition, and ensuring that it is only packaged for DT-B2. After inspection, an official report will be issued which is a requirement to become DT-B2 or a registered retailer.

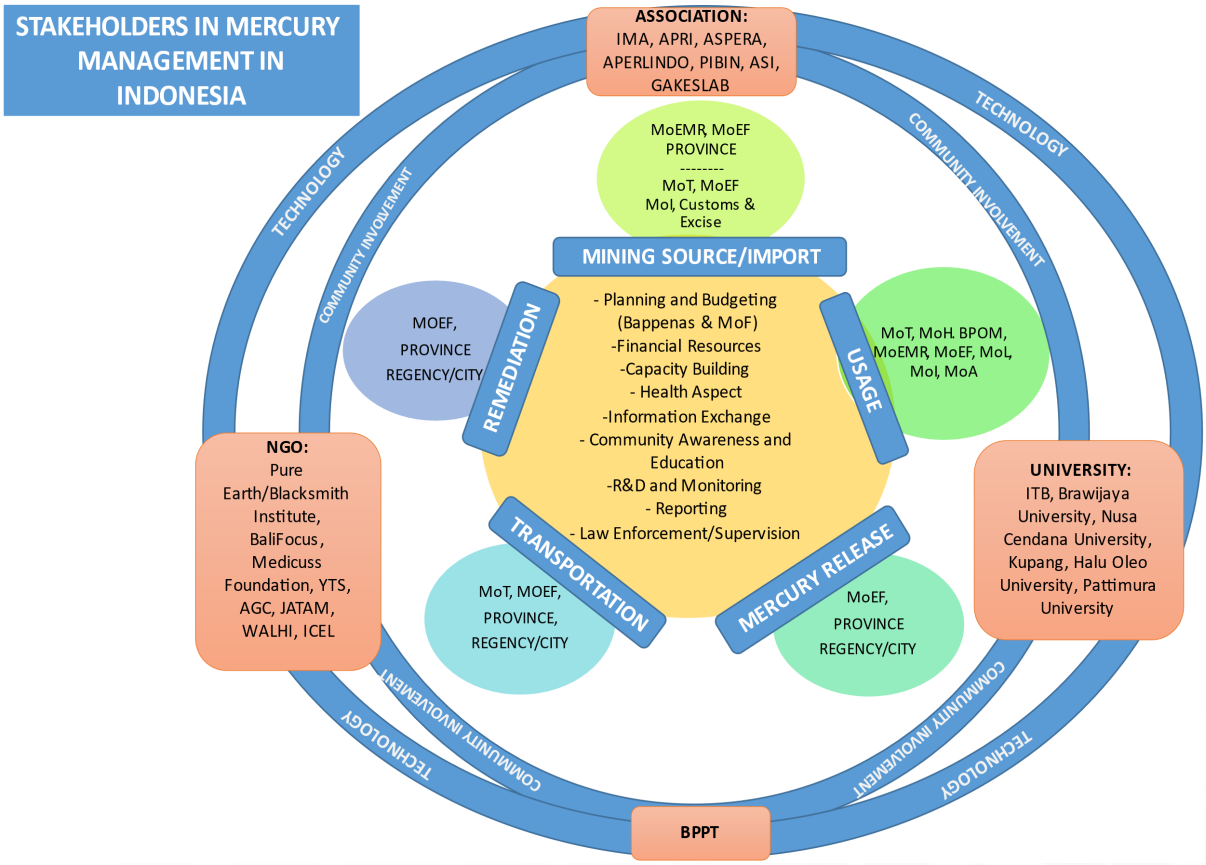
It is recommended to develop laws and regulations to harmonize the definition of hazardous substances in accordance with GR Number 74 of 2001 with hazardous substances according to the regulations of other relevant agencies, including symbols and labels and characteristics. If this is not possible, then harmonization can be achieved by informing the public that the definition and scope of this regulation is actually the same in terms of symbols and labels and characteristics established by mutual agreement. There needs to be a common guideline that aligns symbols and labels and the Material Safety Data Sheet (MSDS).

3.2. Institutional Framework Assessment

The duties and functions of ministries in Indonesia are as regulated in Presidential Regulation No. 68 of 2019 concerning the Organization of State Ministries. In addition to the Presidential Regulation, there are several government laws and regulations that mandate ministries or non-ministerial government agencies for specific activities.

Figure 3.3 shows the role and cooperation relationship among stakeholders in the implementation of mercury management in Indonesia.

Figure 3.3. **Role and Cooperation Among Stakeholders in Implementation of Mercury Management in Indonesia**



For the implementation of the Minamata Convention on Mercury, there are several government laws and regulations that mandate ministries or non-ministerial government agencies as in the following. In addition, other stakeholders involved include associations, non-governmental organizations (NGOs), universities and financial institutions.

A. Ministry of Environment and Forestry (MoEF)

The Ministry of Environment and Forestry is the focal point for the Minamata Convention and is appointed by the President given the objective of the Convention is to protect human health and the environment from anthropogenic mercury emissions and releases. MoEF is delegated to sign and develop a national implementation plan for the Minamata Convention. This authority is as mandated by Law Number 32 of 2009 in Article 63 paragraph (1) letter h as amended by Law Number 11 of 2020. MoEF coordinates and carries out control of pollution and/or environmental damage and in paragraph (1) letter k, stipulates and implement policies regarding hazardous substances, waste and hazardous waste. In addition, this authority is also regulated in GR Number 74 of 2001 and GR Number 22 of 2021. The function and organization of MoEF is regulated in MoEF Regulation Number: P.18/MENLHK-II/2015 Chapter IX concerning Management of Solid Waste, Waste and Hazardous Substances.

The following are the roles and functions of the MoEF:

1. Focal points for the Minamata Convention, Basel Convention, and Rotterdam Convention;
2. Coordinator for the Minamata Convention NAP;
3. Receive hazardous substance registration applications, including mercury, from producers and or importers (GR 74/2001 Article 6);
4. Receive and approve notification of limited use hazardous substance exports, including mercury (GR 74/2001 Article 7);
5. Receiving and providing answers to notifications of hazardous waste imports that are limited to use within a period of no later than 30 working days from the date of receipt of the notification request (GR 74/2001 Article 8);
6. To regulate the procedures and requirements for: a) determination of hazardous waste status, b) hazardous waste reduction, c) hazardous waste storage, d) hazardous waste collection, e) hazardous waste transportation, f) hazardous waste utilization, g) hazardous waste treatment, h) hazardous waste disposal, i) hazardous waste dumping; j) hazardous waste transboundary movement and k) application and issuance of technical approvals and Operational Feasibility Letter for hazardous waste management (MoEF Regulation 6/2021);
7. To specify procedures for packaging, labeling, and giving symbols for hazardous waste, in more detail, Minister of Environment Regulation Number 14 of 2013 regulates symbols and labels for hazardous waste;
8. Provide technical approval for hazardous waste management for hazardous waste collection activities on a national scale (GR 22/2021 Article 302) and an Operational Feasibility Letter (GR 22/2021 Article 307);
9. Issue recommendations for the transportation of hazardous waste (GR 22/2021 Article 312);
10. Issuing technical approvals for hazardous waste management for hazardous waste utilization activities (GR 22/2021 Article 319) and Operational Feasibility Letters (GR 22/2021 Articles 323, 324, 335, 336);
11. Issue technical approvals for hazardous waste management for hazardous waste treatment activities (GR 22/2021 Article 348) and Operational Feasibility Letters (GR 22/2021 Articles 352, 353, 363, 364);
12. Issue a technical approval for hazardous waste management for B3 waste landfilling activities (GR 22/2021 Article 373) and an Operational Feasibility Letter (GR 22/2021 Article 387);
13. Issue hazardous waste management technical approvals for hazardous waste dumping activities (GR 22/2021 Article 397);
14. Receive reports from manufacturers on hazardous waste reduction (GR 22/2021 Article 284);
15. Issue hazardous waste export recommendations (GR 22/2021 Article 408);
16. Receive hazardous waste notification for transit purposes (GR 22/2021 Article 409);

17. Approval or rejection of hazardous waste notification submitted to the Minister of Environment and Forestry.

Given the MoEF's extensive role and function, it is also required to enhance human resources and finance for monitoring the varied environmental requirements issued by MoEF.

In the RPJMN 2020-2024, MoEF is the executing agency for the following activities:

- construction of a mercury research laboratory and environmental metrology in Banten Province (funding indication of IDR 74 billion);
- additional laboratory equipment for testing water and mercury quality throughout Indonesia (funding indication of IDR 137.3 billion);
- construction of mercury-free gold processing facilities in licensed ASGM (25 units) in 24 provinces (funding indication of IDR 70.1 billion).

MOEF has launched the Center for Quality Research and Development and Environmental Laboratory (P3KLL) as a national mercury center. The tools for analyzing mercury in P3KLL are as follows:

a. Nippon Instrument Cooperation (NIC) MA-3000 for analysis of solids, biota and water samples. With thermal desorption accessories for ambient air sample analysis.
b. Mercury Analyzer Hg 5000, for analysis of water, solids and biota samples.
c. Nippon Instrument Cooperation (NIC) MA 3 SOLO for solids analysis.

Activities in Presidential Regulation Number 21 of 2019 concerning RAN-PPM which have been implemented can be seen in **Table 3.2**.

Table 3.2. **Activities in Presidential Decree No. 21/2019 that have been Implemented by the Ministry of Environment and Forestry**

No.	Activities	Matrix	Time	Location	Funding source
1	Baseline data collection	River water, land	2017	Romang Island, Southwest Maluku Regency, Maluku	APBN
2	Baseline data collection	Rice, soil, water, plants, biota, river water	2018	▸ Sukabumi Regency, West Java ▸ Sukabumi Regency, West Java ▸ Tasikmalaya Regency, West Java ▸ Lebak Regency, Banten	APBN
3	Baseline data collection	Air, soil, water, plants, biota, river water, hair, blood, socioeconomic	2018	▸ Wonogiri Regency, Central Java ▸ Merangin Regency, Jambi ▸ Dharmasraya Regency, West Sumatra ▸ West Kotawaringin Regency, Central Kalimantan ▸ West Lombok Regency, West Nusa Tenggara ▸ East Bolaang Mongondow Regency, North Sulawesi ▸ North Minahasa Regency, North Sulawesi	APBN
4	Baseline data collection	River water, land	2018	Botak Mountain, Buru Island, Maluku	APBN
5	Baseline data collection	Hair, socioeconomic	2019	Sukabumi, West Java	APBN
6	Baseline data collection	Rice, soil, water, plants, biota, river water	2019	▸ Kulon Progo Regency-Yogyakarta, ▸ Pacitan Regency, East Java ▸ East Bolaang Mongondow Regency - North Sulawesi	APBN
7	Baseline data collection	Rice, soil, water, plants, biota, river water	2020	▸ Bogor Regency, West Java ▸ Sukabumi Regency, West Java ▸ Tasikmalaya Regency, West Java ▸ Bandung Regency, West Java	APBN

No.	Activities	Matrix	Time	Location	Funding source
8	Baseline data collection	Air, soil, water, plants, biota	2020	▸ Tatelu, North Minahasa, North Sulawesi ▸ Mandor, West Kalimantan ▸ Sekotong, West Lombok	World Bank
9	Institutional Capacity Building	-	2020	▸ Manado ▸ Gorontalo ▸ Pekanbaru ▸ Yogyakarta ▸ Mataram ▸ Ternate	UNDP GOLD-ISMIA

Based on the MoEF Decree Number 340 of 2018, the Mercury Research and Monitoring Committee (Komisi Penelitian dan Pemantauan Merkuri, KPPM) was established.

The KPPM Secretariat is P3KLL-MoEF, which is proposing the construction of a mercury laboratory and environmental metrology through SBSN scheme for Fiscal Year 2020. This progress is in line with the 6th national priority, particularly the priority program for increasing environmental quality in the National Medium-Term Development Plan for 2020-2024. Its scope includes the construction of a 1,006 m² mercury laboratory building and a 1,109 m² environmental metrology building, as well as the acquisition of equipment, facilities, and infrastructure to support a mercury laboratory and environmental metrology. The objectives and benefits include the provision of mercury laboratory facilities and environmental metrology in accordance with SNI ISO/IEC 17025:2017, the development of an Indonesian mercury research and monitoring network, and support for the 2030 National Action Plan for Mercury Reduction and Elimination. The construction of this laboratory is expected to serve as a center of excellence to evaluate the performance of laboratories in the regions thus helping to strengthen them.

MoEF has also carried out remediation of mercury-contaminated land in Lebak Regency, Banten in 2019 and plans to prepare a Feasibility Study (FS) Document for the Recovery of Mercury Contaminated Land in the Mount Botak Area, Waelata District, Buru Regency, Maluku Province in the 2021 fiscal year.

In order to facilitate monitoring of mercury in the environment (air, water, soil), a toolkit is needed to detect mercury concentration in the environment. For this reason, P3KLL-MoEF is expected to consult with the Agency for the Assessment and Application of Technology (*Badan Pengkajian dan Pengembangan Teknologi*, BPPT) to develop guidelines for the procedures and monitoring tools.

The provisions of the Convention must be implemented to prohibit the use of mercury in line with the Convention's elimination targets in order to supervise the use of mercury and mitigate its impacts on the environment and human health, which pose significant hazards that are difficult to overcome.

MoEF needs to develop and disseminate guidelines on the effects of mercury on the environment and human health to the general public and local governments.

As the focal point of this Convention, MoEF needs to propose the issuance of a presidential instruction on ministerial management in implementing the convention.

MoEF together with the Ministry of Trade and the Ministry of Industry need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.

MoEF already has an ecolabel system in place to recognize products with environmental performance that meets national environmental standards.

MoEF is up against a number of challenges, among others things, high expenses owing to the widespread distribution of ASGM in Indonesia, as well as the specific conditions of each location, which necessitate a distinct approach. The local government and the general population still lack awareness of the risks of mercury. The implementation of the mercury proficiency test has not been carried out due to technical problems. As indicated in Presidential Regulation 21/2019 activities c.3.1.1.4, a proficiency test is required. Lack of data/information about mercury waste sources, production, and activities, as well as the dangers of using mercury from the mining process to the manufacturing process. Hazardous waste treatment technology is limited for mercury. The handling of mercury in coordination with the Directorate of Hazardous Substances, MOEF, needs to be improved in order to carry out integrated activities within MOEF and other relevant agencies. There is a need for an integrated policy between relevant stakeholder agencies such as MoEF and MoEMR in regulating environmental aspects of ASGM activities.

B. Ministry of Trade (MOT)

The mandate for import, export and product trading activities is stipulated by Law Number 7 of 2014 concerning Trade. The scope of trade regulation is explained in Article 4 of the Law. Several provisions in Law Number 7 of 2014 have been amended by Law Number 11 of 2020.

The export and import of mercury are regulated by GR Number 74 of 2001 in Article 7 paragraph (3) and Article 8 paragraph (3) and explained in detail in MoT Regulation Number 47 of 2019.

Under Article 3 paragraph (1) of this MoT Regulation, it is explained that companies wishing to import hazardous materials as referred to in Article 2 paragraph (1) must obtain recognition as PI-B2 from the Minister. The Minister can mandate the issuance of PI-B2 to Dirjen Daglu.

Under Law Number 7 of 2014 Article 32 paragraph (1) letter a, producers or importers who trade goods related to security, safety, health, and the environment are required to register the traded goods with the Minister of Trade.

The import of mercury trash is restricted under Law No. 11 of 2020 on Job Creation, which modifies the rules of Law No. 32 of 2009 on Environmental Protection and Management Article 69. Exporting countries are obligated to apply for notification if hazardous waste, in this case mercury waste, enters the Republic of Indonesia as a transit destination to the importing country (Article 408 of GR Number 22 of 2021).

Customs officers and local governments need to possess the knowledge on supervision of hazardous waste/mercury waste being disposed of into Indonesian territory. In addition, it is necessary to establish cooperation with neighboring countries.

While the import trade system for mercury as a commodity has been regulated, the export trade system for mercury as a commodity has not. For this reason, it is necessary to regulate the export trade system by taking into account the provisions and procedures stipulated in the Rotterdam Convention, the Minamata Convention, and GR 74 of 2001.

The MoT together with the MoEF and the MoI need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.

The MoT together with the MoI needs to put further emphasis on the legal umbrella to prevent and overcome further mercury contamination (e.g., outreach of the law prohibiting mercury use, both its affirmation and amendment if necessary as well as strict sanctions).

C. Ministry of Industry (MoI)

Based on Presidential Regulation Number 107 of 2020 concerning the Ministry of Industry, the task of the MoI is to carry out government affairs in the industrial sector to assist the President in administering the state government.

Law Number 3 of 2014 concerning Industry accommodates environmental management into the concept of a green industry that harmonizes industrial development with the preservation of environmental functions and provides benefits to the community. The Minister of Industry prepares and sets green industry standards (Article 79).

Regarding mercury management, it is stated in Law Number 11 of 2017 concerning Ratification of the Minamata Convention on Mercury that regulating the use of mercury or mercury compounds and controlling mercury emissions is one of the government's references in preparing green industry standards that contain provisions regarding raw materials, auxiliary materials, energy, production processes, products, company management and waste management.

According to Article 2 of the Minister of Industry's Decree No. 148/M/SK/4/1985 concerning the Safeguarding of Toxic and Hazardous Materials in Industrial Companies, the MoI requires that industrial companies be fully responsible for hazardous substance management, starting from procurement in factories, storage, processing, packaging, and transportation to the distributor, in order to avoid unwanted negative impacts. Mercury is listed in the attachment to the list of hazardous substances in the MoI Decree.

Based on Article 2 of the Decree of the Minister of Industry No. 148/M/SK/4/1985 concerning Safeguarding Toxic and Hazardous Materials in Industrial Companies, the Ministry of Industry requires industrial companies to be fully responsible for hazardous substances management starting from procurement in factories, storage, processing, packaging and transportation to the distributor to avoid unwanted negative impacts, as a result of the use of Toxic and Hazardous Materials. Mercury is included in Article 3 paragraph (2) of MoT Regulation Number 47 of 2019. MoI issues a recommendation as one of the requirements for non-pharmaceutical companies that will apply to obtain PI-B2 to import mercury type hazardous substances to the Minister of Trade. The Minister can mandate the issuance of PI-B2 to the Director General of Foreign Trade.

MoI has developed several technical guidelines, namely Technical Guidelines for Controlling Mercury Emissions for Smelting and Roasting Activities in the Non-Ferrous Metal Industry, Technical Guidelines for Controlling Mercury Emissions in the Cement Industry Sector, Guidelines for Controlling Mercury Emissions from Coal-Fired Boilers in Power Plant and Industry and Technical Guidelines for Mercury Use in the Lamp.

The obstacle faced is lack of available programs and funds for the implementation of the Minamata Convention on Mercury, in particular the implementation of activities in Presidential Decree No. 21 of 2019 concerning RAN-PPM.

To fulfill the mercury phase out target in industrial activities, it is necessary to develop research and development (R&D) into mercury substitution for mercury-free technology.

The MoI together with the MoEF and the MoT need to conduct more in-depth case studies on areas with high concerns regarding mercury contamination.

The MoI together with the MoT needs to put further emphasis on the legal umbrella to prevent and overcome further mercury contamination (e.g., outreach of the law prohibiting mercury use, both its affirmation and amendment if necessary as well as strict sanctions).

D. Ministry of Energy and Mineral Resources (MoEMR)

The authority of the MoEMR in mineral and coal mining is based on Law No. 3 of 2020, which amended Law No. 4 of 2009 Article 6 as follows:

1) The central government in the management of mineral and coal mining, is authorized to:
   a. Establish a national mineral and coal management plan;
   b. Establish a national mineral and coal policy;
   c. Establish laws and regulations;

d. Establish national standards, guidelines, and criteria;
e. Conduct mining investigations and research in all mining legal areas;
f. Determine the WP after being determined by the provincial government in accordance with its authority and in consultation with the House of Representatives-Republic of Indonesia;
g. Determine Metal Mineral WIUP and Coal WIUP;
h. Determine non-metallic mineral WIUP and rock WIUP;
i. Determine WIUPK;
j. Carry out WIUPK offers on a priority basis;
k. Issue a Business License;
l. Conduct guidance and supervision of the implementation of mineral and coal mining business activities carried out by the holder of a Business License;
m. Establish production, marketing, utilization and conservation policies;
n. Establish policies for cooperation, partnership, and community empowerment;
o. Manage and determine non-tax state revenue from mineral and coal mining business results;
p. Manage geological information, information on potential mineral and coal resources, as well as mining information;
q. Conduct guidance and supervision of reclamation and post-mining;
r. Carry out the preparation of the national level mineral and coal resource balance;
s. Develop and increase the added value of mining business activities;
t. Improve the capacity of the central government apparatus and the provincial government in implementing mining business management;
u. Set the benchmark price for metallic minerals, certain types of non-metallic minerals, radioactive minerals, and coal;
v. Perform the management of mining inspectors; and
w. Managing mining supervisory officers;

2) The authority of the central government as referred to in paragraph (1) is carried out in accordance with the provisions of the legislation.

(3) The central government sets limits on the investment value or the percentage of share ownership of foreign investment business entities engaged in mining.

The Directorate General of Mineral and Coal, MoEMR has provided guidance on legal mining activities and has carried out data collection and dissemination in unlicensed areas. Currently in licensed areas there are 233 illegal ASGM points.

It is hoped that the Directorate General of Mineral and Coal, MoEMR will issue a policy prohibiting the mining of cinnabar to prevent the use of mercury. However, based on Law Number 4 of 2009 concerning Mineral and Coal, this is not possible for MoEMR because the Law is not limited to certain commodities. Until now, no permit from the central or local government has been issued to mine primary mercury or cinnabar because it is included in the negative list. MoEMR Decree No. 1827 of 2018 Annex V prohibits the use of mercury in gold processing. In order to improve supervision of illegal miners, it is necessary to increase the capacity of human resources both in the government and local governments, regarding non-mercury technology and procedures for carrying out effective and efficient supervision.

Directorate of Electricity Engineering and Environment, Directorate General of Electricity, MoEMR encourages business actors in the electricity sector to reduce mercury emissions from coal-fired power plant operational activities.

The obstacles faced by the Directorate General of Electricity in implementing the Minamata Convention are as follows:

- There is a need for support in the preparation of BAT/BEP to control mercury emissions from coal-fired boilers at power plants in 2025, as stated in activity b.1.1.1. Presidential Decree Number 21 of 2019 on RAN-PPM.

- Coordination with local governments, because so far activities in the energy priority sector are directly related to electricity business actors and are not related to local governments, while in activity b.2.21 of Presidential Regulation Number 21 of 2019 it is stated that coordination with ministries/agencies and local governments is carried out once a year.

E. Ministry of Health (MOH)

The Minister of Health has a mandate based on Law no. 36 of 2009 concerning Health, in which the government, local governments and communities ensure the availability of a healthy environment that does not pose a health risk (Article 163).

A healthy environment is free from elements that cause human health problems, including hazardous chemicals, polluted water, polluted air and contaminated food (Article 163). In addition, MoH regulates environmental health quality standards in the form of maximum permissible levels of chemicals, including mercury. This is in accordance with GR Number 66 of 2014 concerning Environmental Health. This GR regulates efforts to protect the public from the dangers of medical devices that do not meet the requirements for safety, quality and benefits, as outlined in GR Number 72 of 1998 concerning Safeguarding of Pharmaceutical Preparations and Medical Devices (Article 2). The regulation concerning the licensing of medical equipment production facilities for Household Health Supplies is based on the MoH Regulation Number 1189/MENKES/PER/VIII/2010 concerning the Production of Medical Devices and Household Health Supplies.

Meanwhile, MoH Regulation Number 1190/MENKES/PER/VIII/2010 regulates the Circulation Permit of Medical Devices and Household Health Supplies (Article 5). MoH has stipulated the MoH Regulation Number 57 of 2016 concerning the National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020. The purpose of this action plan is to provide a reference for the central government, local governments and other stakeholders in the form of concrete steps that must be implemented on an ongoing basis in order to control the risks and impacts of mercury on health.

MoH stipulates Circular Letter No. HK.02.02/V/0720/2018 concerning Determination of Validity Period of Distribution License and Distribution of Mercury-Containing Medical Devices states that medical devices containing mercury may only be circulated or traded in Indonesia until December 31, 2018. In addition, MoH has also issued Circular Letter of the Directorate General of Health Services Number HK.02.02/V/0361/2019 concerning the Obligation to Have a Temporary Hazardous Waste Storage Place in Healthcare Facilities and Circular of the Director General of Health Services Number HK.02.02/I/2899/2019 concerning Elimination and Withdrawal of Mercury-Containing Medical Devices. MoH has also stipulated MoH Regulation Number 41 of 2019 concerning Elimination and Withdrawal of Mercury-Containing Medical Devices in Healthcare Facilities for all mercury medical devices that can be substituted with alternative materials that are friendly to human activities and the environment.

Furthermore, MoH has also established Guidelines for Controlling Health Impacts Due to Mercury Exposure in 2017 with the objective to provide the same information to officers at public health centers throughout Indonesia, totaling around 10,000. These guidelines are aimed to approach the community in ASGM to change people's behavior towards the use of mercury in processing rocks into gold to minimize the risk of mercury to public health.

The Directorate of Environmental Health, MoH already has equipment for public health centers cadres to detect the impact of mercury during field visits.

The distribution permit for drugs and medical devices containing mercury is determined by the Directorate General of Pharmacy and Medical Devices, MoH.

Under MoH policy, hospitals and public health centers must obtain accreditation in which one of the requirements is that the hazardous waste they generate must be managed properly. In addition,

MoH has a Healthy Community Movement (*Gerakan Masyarakat Hidup Sehat*, GERMAS) program that started in 2017 and has been widely publicized, one of which is the risk of mercury exposure to human health.

The MoH also stipulates MoH Regulation Number 70 of 2016 concerning Standards and Requirements for Health in the Industrial Work Environment as well as MoH Regulation Number 56 of 2016 concerning the Implementation of Occupational Disease Services. The healthcare facilities are governed by GR Number 47 of 2016.

The following are some of the challenges faced by the MoH, particularly the Directorate of Environmental Health in implementing the Minamata Convention:

- The number of mercury medical devices still in use and that have been stored because they are no longer used has not been recorded properly, nor in any detail, in all districts/cities;
- The ability of health facilities in replacing mercury medical devices varies, some are already 100% substituted, some are making gradual substitutions, while the target of Presidential Regulation Number 21 of 2019 is the elimination of 100% by the end of 2020;
- Mechanisms for withdrawal of mercury medical devices, especially from health facilities in remote areas and communities, do not yet exist.
- The use of mercury devices, namely the sphygmomanometer, is difficult to abandon because it is still considered more accurate than its digital replacement.
- Transportation for the withdrawal and removal of mercury medical devices from health service facilities, particularly public health centers, to storage depots is currently unavailable.
- The elimination of mercury medical devices has been implemented in health care facilities in almost all regions; the issue is when the mercury medical devices will be withdrawn, and the withdrawal mechanism is currently unavailable.

Considering that mercury has such a negative impact on human health, it is critical for health workers, such as doctors and nurses in public health centers, to increase their knowledge about mercury and its health effects, as well as prevention and treatment options. This is especially important in areas where people are expected to be exposed to mercury in the environment, such as at ASGM sites. Appropriate financing is required for this.

A portable tool is needed to prove mercury contamination in the human body and the environment, so that mercury contamination can be proven and to help show that it is harmful to human health. The tool can be further used in the relevant local agencies. A reference laboratory to detect mercury for human health and the environment is also required, with at least 1 (one) laboratory per district.

To provide an interim solution to the problem faced by the Social Security Administration (*Badan Penyelenggara Jaminan Sosial*, BPJS) which is unable to cover the cost of treating patients who have been exposed to mercury, it is necessary to disseminate more information about the risk of diseases caused by mercury, and more widely.

Often the symptoms of the health effects of mercury are similar to those of nervous disorders, such as cramps and loss of balance. For this reason, it is necessary to conduct further study on the impacts of mercury, especially on children, by conducting toxicological research, which includes testing the placenta of babies born to mothers with mercury levels in their blood, nails and hair exceeding the established standards.

Studies in the field of health and the environment that have been carried out need to be reported to MoEF as a focal point for the Minamata Convention and P3KLL to be able to analyze the results of these studies by involving KPPM to predict the impact of mercury on human health and the environment.

The Ministry of Health currently has a mercury working group in almost all units including the Directorate General of Health Services and the Directorate General of Pharmacy and Medical Devices, which are both related to BPOM.

F. Ministry of Manpower (MoM)

The Ministry of Manpower is responsible for carrying out government affairs in the field of labour to assist the President in administering the state government, as regulated in Presidential Regulation Number 95 of 2020 concerning the Ministry of Manpower.

Article 3 of Law Number 1 of 1970 concerning Occupational Safety stipulates the safety requirements, including providing workers with personal protective equipment and obtaining harmony between the workforce, work tools, environment, work methods and processes.

The Ministry of Manpower issues guidelines on the role of the workforce for hazardous substances management activities in accordance with Chapter V of GR Number 74 of 2001 concerning Occupational Safety and Health Article 22 paragraph (4).

Based on the Minister of Manpower Decree Number 187 of 1999 concerning Control of Hazardous Chemicals in the Workplace, MoM requires employers or administrators who use, store, utilize, produce and transport hazardous chemicals to control hazardous chemicals to prevent occupational accidents and diseases. The control of these hazardous chemicals includes the provision of material safety data sheets and labels and appointments of Chemical Occupational Health and Safety officers and experts. The list of information contained in the provision of the MSDS has also been set out in the Attachment to this from the Minister of Manpower.

In the MoM Decree Number 187 of 1999, in Attachment II, there is a form in which the chemical company/industry is required to report any chemical substances in the company to the local agency, which will be followed up by the service supervisor if hazardous substances are present, and then a head decree will be issued. The agency then explains the level of danger, whether medium or large.

The MoM has stipulated MoM Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment. The MoM Regulation also contains the mercury threshold value as well as the company's obligation to carry out periodic workforce inspection. If during these inspections something is discovered in the workforce, a special inspection is conducted. Presidential Regulation Number 7 of 2019 also addresses occupational diseases.

To improve the MoM's performance, it is necessary to increase its capacity and number of human resources as well as provide adequate funding. In addition, it is necessary that it has the authority to require companies that use and or may expose mercury to check mercury levels in their employee's bodies so that they can be treated early.

G. Ministry of Finance (MoF)

Presidential Regulation Number 57 of 2020 concerning the Ministry of Finance in Article 4 explains the task of the Ministry of Finance, namely to carry out government affairs in the field of state finances to assist the President in administering state government.

In accordance with the mandate of Article 8, Law Number 17 of 2003 concerning State Finances, one of the tasks of the Minister of Finance is to prepare a draft APBN, a draft amendment to the State Budget and to ratify budget implementation documents. In the explanation of Article 11 paragraph (5), the environment is included in the details of state spending by function. In Annex II, MoF Regulation Number 102 of 2018 concerning Budget Classification, the Minister of Finance specifies the activities of developing a hazardous waste system for the Central Government as one of the Function Classification Codes in determining the budget amount for environmental functions.

The Minister of Finance stipulates the general guidelines as well as the allocation of special allocation funds for the environmental sector every year.

In terms of mercury management, the MoF is one of the lead agencies within INSW, which is a government-created national system that allows for a single and synchronous submission of data and information as well as single decision-making to issue customs permits and production of goods. Thus, industries or manufacturers that wish to import hazardous substances can register them through INSW.

It is necessary to increase the capacity of human resources of customs officers regarding the impact of mercury on the environment and human health. It is hoped that the budget allocation to the MoEF and the MOH for capacity building in handling mercury can be increased.

Mercury-containing products that have been banned from usage need to be informed to the Ministry of Finance c.q. the Directorate General of Customs and Excise, and it is proposed that these products be assigned a Harmonized System (HS) number, making it easier for customs agents to track illegal imports.

It is necessary to establish a standard operating procedure (SOP) regarding health quarantine on the transportation of mercury in the event of an accident that causes mercury spills.

H. Ministry of National Development Planning/ National Development Planning Agency (*Kementerian/Badan Perencanaan Pembangunan Nasional*, Kementerian PPN/ Bappenas)

The Ministry of National Development Planning (Kementerian PPN/Bappenas) has the task of carrying out government affairs in the field of national development planning to assist the President in administering the state government, as regulated in Presidential Regulation Number 65 of 2015 concerning the Ministry of National Development Planning.

GR Number 55 of 2005 concerning the Balancing Fund, Article 64 has mandated Kementerian PPN/ Bappenas together with the Technical Minister to monitor and evaluate the utilization and technical implementation of activities funded from the Special Allocation Fund. In addition, in the context of the Special Allocation Fund policy, Kementerian PPN/Bappenas is responsible for formulating the policy direction of the Special Allocation Fund in the Government Work Plan.

Laboratory equipment is one of the menus in the Special Allocation Fund for Physical Environment. This menu consists of two details, namely laboratory equipment for testing water quality and laboratory equipment for testing mercury. Water quality laboratory equipment is for priority watersheds and mercury laboratory equipment is for areas with ASGM.

In the planning of the Special Allocation Fund for the 2021 Fiscal Year, there is a policy focusing on priority locations. As fewer areas become priority locations, it is hoped that the allocations from the Special Allocation Fund will become larger and more optimal in assisting problem-solving in the regions, especially on the environment. Details of the Special Allocation Fund for the physical environment, and the menu for environmental laboratory equipment for water and mercury quality is shown in the following table.

Table 3.3. **Special Allocation Fund for Physical Environment Menu for Environmental Laboratory Equipment (Water Quality and Mercury)**

Year	Receiving Area	Allocation (IDR)
2018	84	22,127,080,250
2019	266	47,010,493,550
2020	63	27,401,036,000
2021	14	24,708,185,000

Source: Kementerian PPN/Bappenas, 2021

The 2021 Government Work Plan for mercury management was established by Presidential Regulation Number 86 of 2020 as updated with Presidential Regulation Number 122 of 2020 concerning Updating of the 2021 Government Work Plan. The reduction and elimination of mercury is a priority project in the 2021 Government Work Plan, with a target of 10% (5 tonnes) mercury removal from the 2019 baseline as much as 50 tonnes in 180 districts/cities in 30 provinces and the construction of 10 units of mercury-free gold processing facilities in licensed ASGM, with MoEF as the implementing institution. According to the 2020-2024 National Medium-Term Development Plan, the mercury reduction target for 2024 is 20% (10 tonnes). The amount of hazardous waste managed in 2024 has been targeted at 126.49 million tonnes.

One of the details of the strategic priority projects (major projects) in the 2020-2024 National Medium Term Development Plan is the construction of hazardous waste treatment facilities, with one of the targets being the establishment of integrated hazardous waste treatment facilities in 4 (four) regions, namely Sumatera, Sulawesi, Kalimantan and East Java.

It is expected that Kementerian PPN/Bappenas will encourage the preparation of program plans at MoEF, MoH and relevant ministries to increase human resource capacity, supervision, use of mercury-free technology and handling mercury waste as well as mercury-contaminated land remediation, especially in ASGM locations.

I. Ministry of Communication and Informatics (MoCI)

The related regulation is Presidential Instruction Number 9 of 2015 on Public Communication Management. The Ministry of Communication and Informatics can serve as a coordinator for the national public communication management under this Presidential Instruction. It can collaborate with the public relations in other ministries/agencies by utilizing all available resources within each ministry/agency to promote a particular issue.

J. National Drug and Food Control Agency (Badan Pengawas Obat dan Makanan, BPOM)

According to Article 2 of Presidential Regulation Number 80 of 2017, the National Agency of Drug and Food Control (BPOM) is a non-ministerial government agency tasked with carrying out

government tasks in the field of drug and food supervision in accordance with the provisions of laws and regulations. Drugs and Food as referred to in paragraph (1) consist of drugs, medicinal ingredients, narcotics, psychotropics, precursors, addictive substances, traditional medicines, health supplements, cosmetics, and processed food. BPOM reports to and is accountable to the President through the minister in charge of health-related government matters. BPOM is led by the Head. According to Article 3 of this Presidential Decree, BPOM has specific functions including: the preparation and determination of norms, standards, procedures, and criteria in the field of supervision before circulation and supervision during circulation, implementation of control of drugs and food before circulation and supervision during circulation, implementation of legal action against violations of the provisions of laws and regulations in the field of drug and food control.

In accordance with BPOM Regulation Number 23 of 2019 concerning Technical Requirements for Cosmetic Ingredients, mercury and its compounds are included in Annex V as a List of Prohibited Substances in Cosmetics.

For the pharmaceutical, cosmetic, food and food packaging industries, BPOM issues a recommendation which is one of the requirements for companies that will submit an application to obtain PI-B2 to import hazardous substances mercury type to the Minister of Trade in this case the Director General of Foreign Trade. This is regulated in Article 3 paragraph (2) of the Minister of Trade Regulation Number 47 of 2019.

The maximum limit for mercury in processed food is regulated in BPOM Regulation Number 5 of 2018 concerning the Maximum Limit of Heavy Metal Contamination in Processed Food, which is 0.5 mg/kg for fish and fishery products (except for processed predatory fish such as tuna, marlin 1.0 mg/kg).

It is hoped that the BPOM will increase its supervision and increase capacity for its employees in the central government as well as provincial/ regency/city governments.

K. Agency for Technology Assessment and Application (*Badan Pengkajian dan Penerapan Teknologi*, BPPT)

BPPT is a Non-Departmental Government Institution that reports directly to the President, based on Presidential Decree No. 103 of 2001 concerning the Position, Duties, Functions, Authorities, Organizational Structure, and Work Procedures of Non-Departmental Government Institutions as has been amended several times, most recently by Presidential Regulation Number 145 of 2015. BPPT has the task of carrying out government duties in the field of assessment and application of technology in accordance with the provisions of applicable laws and regulations.

To support the National Action Plan for ASGM, BPPT in collaboration with its partners is initiating the establishment of the Indonesian Center for Artisanal Mining (INCAM), which includes research and technology center as well as training center.

In response to Law Number 11 of 2017 concerning the ratification of the Minamata Convention and to fulfill the National Action Plan for the elimination of mercury use in community gold mining in 2014–2018, BPPT has carried out various activities, including collaborating with MoEF which was appointed as the national program focal point, in designing technology on a pilot scale project of non-mercury gold processing. A pilot plant for non-mercury gold processing has been constructed in Lebak Regency, in cooperation with Lebak Regency government. BPPT has provided training and demonstrations on non-mercury gold processing in several ASGM locations.

BPPT plans to prepare detailed engineering designs in four other ASGM locations to support MoEF in the construction of the same pilot plant, as well as to construct a non-mercury gold processing pilot plant in ASGM groups in the WPR Kulon Progo, Yogyakarta. In addition, BPPT and MoEF are planning to construct non-mercury gold processing facilities in 14 (fourteen) regencies.

To improve the performance of BPPT in creating non-mercury technology, it is necessary to conduct studies to find mercury substitutes in various activities that use mercury.

L. Ministry of Transportation (MoTransp)

The Ministry of Transportation has the authority to issue business permits in the field of hazardous waste transportation after receiving recommendations for hazardous waste transportation from MoEF (GR Number 22 of 2021 Article 313). The Minister of Transportation receives a copy of the report on the implementation of the hazardous waste transportation from the transporter which is submitted to the Minister of Environment and Forestry (Article 314).

As stated in GR Number 74 of 2014 concerning Road Transportation, MoTransp has the authority to regulate hazardous substances transportation as referred to in Article 88 of the GR. Several provisions in this GR have been revoked and replaced by GR Number 30 of 2021 concerning the Implementation of Traffic and Road Transport Field which is the implementation of the Law on Job Creation, including licensing provisions.

Furthermore, under MoTransp Regulation Number PM 60 of 2019 concerning the Implementation of the Transportation of Goods by Motor Vehicles on the Road, the Minister of Transportation regulates the requirements for motorized vehicles to transport dangerous goods and procedures for their transportation.

The Director General of Land Transportation specifies in the Decree of the Director General of Land Transportation Number: SK.725/AJ.302/DRJD/2004 provisions regarding transportation of hazardous substances by road which regulates the general requirements and special requirements for hazardous substances transportation vehicles according to the type and characteristics of hazardous substances being transported. It is also regulated in terms of drivers and assistant drivers, hazardous substances transportation traffic, operating procedures for hazardous substances transportation vehicles, hazardous substances transportation approval, and the obligations of transporters, owners and or persons in charge of hazardous substances and their supervision. The Director General and officials authorized to issue transportation business permits shall operate a hazardous substances transportation management information system.

The Minister of Transportation regulates the procedures for loading, compiling, transporting, and unloading goods, including hazardous substances and hazardous waste by train through MoTransp Regulation Number PM 48 of 2014 which was amended by MoTransp Regulation Number PM 52 of 2016. In Article 7, specifically for hazardous substances and hazardous waste transportation, it must be accompanied by a permit from the Minister after obtaining a recommendation from the competent agency. Transportation of goods by carriage especially for hazardous substances and hazardous waste must be equipped with special symbols or labels for hazardous substances and hazardous waste and safety facilities in accordance with the types and characteristics of goods according to laws and regulations (Article 30). The Director General coordinates with the authorized agency to carry out guidance activities in the loading, preparation, transportation, and unloading of hazardous substances and hazardous waste as referred to in this Ministerial Regulation. The Director General approves goods stations and special places for hazardous substances and/or hazardous waste unloading activities.

Under MoTransp Regulation Number PM 90 of 2013 which is amended by MoTransp Regulation Number PM 58 of 2016, the Minister of Transportation enforces provisions regarding the safety of transporting dangerous goods by aircraft, which is overseen by the Director General of Civil Aviation. This provision includes classification, restrictions on the transportation of dangerous goods, packaging, labeling and marking, as well as education and training for personnel in charge of handling dangerous goods transportation.

The Minister of Transportation uses the "International Maritime Dangerous Goods (IMDG) Code" and its supplements as guidelines for handling hazardous materials/goods in shipping activities in Indonesia. More information can be found in the attachment to MoTransp Decree Number Km 17 of 2000, which has been amended by MoTransp Regulation Number 2 of 2010.

The Director General of Sea Transportation issues a letter of approval for hazardous waste transportation for ships that have met the requirements for hazardous waste transportation as outlined in the MoTransp Regulation Number 29 of 2014 concerning Maritime Environmental Pollution Prevention. Furthermore, the Director General of Sea Transportation regulates the transportation of hazardous waste for Indonesian-flagged ships in the Circular Letter of Directorate General of Sea Transportation Number UM. 003/1/2/DK-15.

In terms of transporting mercury and mercury waste, it is important to strengthen the capacity of human resources related to their duties to monitor mercury transportation incidents and to shorten the time for granting permits, with permits granted for a longer period of at least ± 5 years.

M. Ministry of Agriculture (MoA)

According to GR Number 7 of 1973 concerning Supervision of the Circulation, Storage and Use of Pesticides Article 2, any person or legal entity is prohibited from using pesticides that are not registered and/or obtained a permit from the Minister of Agriculture. The Minister of Agriculture will further regulate the procedure for applying for registration and permits after receiving a recommendation from the Pesticide Commission, which consists of various ministries and experts. Furthermore, through MoA Regulation Number 107/Permentan/SR.140/9/2014, the Minister of Agriculture regulates the supervision of pesticides, namely a series of inspection activities on the procurement, production, distribution, storage, use and destruction of pesticides in order to ensure their quality and effectiveness, not to disturb human health and safety and environmental sustainability.

The Minister of Agriculture stipulates that mercury and mercury compounds are included in the active ingredients and pesticide additives as prohibited pesticides in Annex II. MoA Regulation Number 39/Permentan/SR.330/7/2015.

To increase public knowledge, awareness raising is needed for pesticide users, both those who use mercury and non-mercury containing pesticides, to securely place pesticides and equipment so that they do not have harm the environment or human health.

Apart from being responsible for counseling about the prohibition of using mercury-based pesticides, it is necessary to supervise and enforce the law as well as to handle mercury-based pesticide waste and obtain permission from MoEF to handle it.

N. Coordinating Ministry for Maritime and Investment Affairs, Coordinating Ministry for Economic Affairs, Cabinet Secretariat

The development of the RAN-PPM also involves the Coordinating Ministry for Maritime and Investment Affairs, the Coordinating Ministry for Economic Affairs and the Cabinet Secretariat and the implementation of each activity is coordinated with the relevant coordinating ministry.

O. Indonesian National Police (*Kepolisian Republik Indonesia*, Polri):

The duties and authorities of Polri are regulated in Law Number 2 of 2002 concerning the Indonesian National Police as amended by Law Number 11 of 2020. The main task of Polri is to maintain public security and order, enforce the law and provide protection and services to the community.

Regarding mercury, Polri has carried out various awareness raising activities on the dangers of mercury to public health in illegal ASGM locations. In addition, awareness raising on the prohibition of misuse and distribution of chemical substances was also carried out among the public (see **Annex III**). Polri has succeeded in thwarting various attempts by home industries to manufacture illegal mercury, smuggle and sell mercury, including illegal mercury exports.

Polri has also succeeded in arresting the perpetrators of illegal cinnabar mining and processing and selling of the mercury raw material. In 2020, the Maluku Regional Police closed the cinnabar mine at Gunung Tembaga, Seram Island, Maluku, which is the largest mercury raw material mining location in Indonesia.

The role of Polri is crucial in awareness raising, enforcing and taking legal action to support the reduction and elimination of mercury in Indonesia, therefore its role in this regard needs to be increased by collaborating with the Directorate General of Environmental and Forestry Law Enforcement, MoEF.

P. Local Government

Local governments have the authority to carry out concurrent government affairs as mandated in Law Number 23 of 2014 concerning Local Government. Concurrent government affairs that are handed over to the regions become the basis for implementing regional autonomy. According to Article 12, government affairs under regional authority include, among others, the environment, health, agriculture, energy and mineral resources and trade and industry. Furthermore, in the Law on Job Creation, several provisions in Law Number 23 of 2014 have been amended, among others regarding the division of concurrent government affairs between the central government and local governments.

Law Number 11 of 2020 which amends the provisions of Law Number 32 of 2009 Article 59 states that hazardous waste management is mandatory for business permits or approval from the central government or local governments. The central government or local government is required to include environmental requirements that must be met and obligations that must be complied with by hazardous waste managers in business licensing or approval from the central government or local governments. Furthermore, Law Number 11 of 2020 which amends the provisions of Article 63 paragraphs (2) and (3) of Law Number 32 of 2009 regulates the duties and authorities of the provincial government and regency/city government in accordance with the norms, standards, procedures and criteria set by the central government.

In the case of management of mercury which is classified as a hazardous substance under GR Number 74 of 2001 concerning Hazardous Substances Management, the provincial government in accordance with Article 28 paragraph 2 states that "in certain cases, the supervisory authority over hazardous substances management as referred to in paragraph 1 can be delegated to the affairs of province/regency/city". Meanwhile, according to Article 31 of this GR, the province/regency/city receive reports from everyone who carries out hazardous substances management activities on a regular basis at least every 6 months.

In the event of an accident, according to Article 25 letters (c) and (d), the regency/city government receives reports of accidents and/or emergencies. In Article 26 it is stipulated that the local regency/city government apparatus, after receiving a report on the occurrence of an accident and/or emergency due to hazardous substances as referred to in Article 25 letter c, is obliged to immediately take the necessary countermeasures.

In certain cases, supervision of hazardous substances management can be delegated to the affairs of the province/regency/city after the transfer of the supervisory authority determined by the responsible agency (MoEF) in accordance with Article 28 paragraph 2 and the Governor/Regent/Mayor and the head of the competent agency, may increase public awareness of the potential impacts that will arise on the environment, human health and other living creatures as a result of hazardous substances management activities (Article 32).

In waste management, under Article 301 paragraph (1) Article 302 paragraph (1) and Article 302 paragraph (3) and Article 307 GR Number 22 of 2021, the Governor accepts applications and issuing and/or rejecting technical approvals and Operational Feasibility Letters for hazardous waste collection activities at provincial scale and Regent/Mayor at regency/city scale.

Provincial/regency/city governments are responsible for handling and training in emergencies due to the release of hazardous waste into the environment as stipulated by GR Number 22 of 2021 Article 437-440. Provincial/regency/city governments in accordance with their respective authorities initiate and lead the implementation of emergency management as stipulated in Articles 445 and 446. For the supervision of hazardous waste management as stipulated in Article 492-494, the provincial/regency/city governments supervise the permits granted in accordance with their respective authorities. The administrative sanctions are in the form of written warnings, government coercion, administrative fines or freezing and/or revocation of business licenses according to their authority (Article 505-509 of GR Number 22 of 2021)

The central government has the authority to regulate the management of hazardous substances and hazardous waste, the provincial government regulates the collection of hazardous waste on a provincial scale and the regency/city government regulates temporary storage for hazardous waste generators from businesses and/or activities mandatory of SPPL and hazardous waste collection at regency/city level.

As for mining activities, pursuant to Law Number 3 of 2020, the provisions of Article 9 paragraph (2) of Law Number 4 of 2009 are amended to mining areas determined by the central government after being determined by the provincial government in accordance with its authority and in consultation with the House of Representatives - Republic of Indonesia.

The authority of local governments in health matters is regulated by Law Number 36 of 2009 concerning Health, whereas their authority in agricultural matters is regulated by Law Number 22 of 2019 concerning Plant Cultivation Systems. Furthermore, Law Number 7 of 2014 regulates the authority of local governments in trade affairs and in industrial affairs is regulated by Law Number 3 of 2014. Several provisions in Law Number 36 of 2009, Law Number 22 of 2019 and Law Number 7 of 2014 have been amended by the enactment of Law No. Number 11 of 2020 concerning Job Creation.

The local government's authority in dealing with mercury is very strategic, therefore it is necessary to obtain guidance and improvement of its human resources as well as funding to carry out its duties.

Q. Associations

Associations related to mining Indonesia, among others, are The Indonesian Mining Association (IMA), the Indonesian People's Miner Association (*Asosiasi Penambang Rakyat Indonesia*, APRI) and the People's Mining Association (*Asosiasi Pertambangan Rakyat*, ASPERA).

IMA has made efforts, including approaches to civil servant investigators to curb illegal coal and gold mines in Indonesia that use hazardous substances such as mercury.

APRI's mercury-related activities have included working with the MoEF and Forestry on surveys and inventories of ex-mining open land across Indonesia, as well as hosting an International People's Mining Conference in 2016 that drew over 1,000 miners and representatives from ten countries, initiating (through a negotiation process) collaboration with a number of parties, including universities, the TEKMIRA Research and Development Center, business associations, banks, and a number of other private parties. Furthermore, the APRI is collaborating with TekMIRA and the Energy and Mineral Resources Agency of West Java Province to find the most efficient processing method using mercury-free and environmentally friendly technology and equipment to achieve a maximum recovery rate of more than 90%. The APRI announced in 2018 that it would no longer use mercury in gold mining activities.

Manufacturing industry associations related to mercury in Indonesia include the Indonesian Electric Lighting Industry Association (APERLINDO), the Indonesian Dry Battery Industry Association (PIBIN), the Indonesian Cement Association (ASI) and the Association of Medical and Laboratory Equipment Companies in Indonesia (GAKESLAB Indonesia).

R. Non-Governmental Organizations (NGOs)

Several NGOs in Indonesia are involved in mercury management, including among others, BaliFokus, Pure Earth/Blacksmith Institute, Medicuss Foundation, Tambuhak Sinta Foundation (YTS), Artisanal Gold Council (AGC), Mining Advocacy Network (*Jaringan Advokasi Tambang*, JATAM), Indonesian Forum for the Environment (*Wahana Lingkungan Hidup Indonesia*, WALHI), and Indonesian Center for Environmental Law (ICEL).

The following are some of the activities carried out by these NGOs:

- Environmental advocacy related to mercury;
- Project development of national and regional approaches to environmentally friendly mercury management projects in Southeast Asia;
- Mercury monitoring for several environmental parameters in several hotspots and areas in collaboration with local stakeholders and reported to relevant authorities as information for policymakers;
- Mercury-free health care initiatives;
- Development of mercury inventory and trade in ASGM in Southeast Asia;
- Awareness raising to the community about the dangers of mercury;
- Research on the impact of mercury on health and the environment in various ASGM locations by testing blood, hair and urine samples and by measuring mercury concentrations in the air;
- Mercury Free Technology Activities for ASGM and Mercury Contamination Activities from ASGM, including training for traditional gold miners using mercury-free methods and conducting remediation (clean-ups);
- Educational programs and community projects to prevent the release of toxic mercury used in gold mining into the environment.

S. Universities

Various universities in Indonesia have collaborated in capacity building and provided knowledge for activities carried out by associations, NGOs, government and local governments related to mercury management. Activities carried out include research and studies related to mercury, among others, mapping the impact of mercury on the environment, health and socio-economy around ASGM locations conducted by the Bandung Institute of Technology (*Institut Teknologi Bandung*, ITB) and Brawijaya University in collaboration with MoEF in 2018. In this activity, samples were taken and tested in the laboratory as well as interviews and health checks for miners in 8 (eight) ASGM locations to determine the impact of mercury on health and the environment.

For the preparation of MIA-NAP ASGM documents, in 2021, MoEF in collaboration with the Bogor Agricultural Institute (*Institut Pertanian Bogor*, IPB) carried out mapping activities on the impact of mercury on the environment, health and socio-economy around ASGM areas in 6 (six) locations. In this activity, samples were taken and tested in the laboratory as well as interviews and health checks for miners.

In addition to the government, there have also been collaborations between universities and associations related to mining in Indonesia, including the collaboration between the APRI and the University of Nusa Cendana Kupang (East Nusa Tenggara), Halu Oleo University (Kendari Southeast Sulawesi) and Pattimura University (Ambon Maluku).

Miner's associations and environmental and health NGOs play a critical role in monitoring, coaching, capacity building and mercury-free technology for local government and regency/city human resources. Therefore, it is necessary to further enhance cooperation with the government, companies and the community.

Universities play a critical role in numerous initiatives to manage mercury, as well as conducting the essential research to minimize mercury usage and exposure. It is hoped that all stakeholders' cooperation would continue to improve.

T. Financial Resources (State Budget and Expenditure Revenue, Regional Budget and Expenditure Revenue, Banking, Domestic and Foreign Donors)

The financial resources for the implementation of mercury reduction and elimination can be financed by APBN and APBD. Bappenas have included in the RPJMN 2020-2024 the following activities:

- construction of a mercury research laboratory and environmental metrology in Banten Province (funding indication of IDR 74 billion);
- additional laboratory equipment for testing water and mercury quality throughout Indonesia (funding indication of IDR 137.3 billion);
- construction of mercury-free gold processing facilities in licensed ASGM (25 units) in 24 provinces (funding indication of IDR 70.1 billion).

Activities related to mercury can also be financed through the Ministry of Finance, related ministries/agencies, Special Allocation Fund, SBSN, local governments (provincial governments and city/regency governments), domestic and foreign donors, including grants, corporate social responsibility (CSR) activities from industry, the Global Environment Facility (GEF), the United States Agency for International Development (USAID), Asian Development Bank (ADB), World Bank, Japan International Cooperation Agency (JICA), the Danish International Development Agency (DANIDA) and/or other alternative funding.

Allocation of State Budget of MoEF for ASGM and mercury management activities can be seen in the following table.

Table 3.4. **Allocation of State Budget of MoEF for ASGM and Mercury Management Activities**

Fiscal Year	Work Unit	Output	Target	Allocation (Thousand Rupiahs)	Note
2018	Directorate of Hazardous Substances Management	Elimination of Mercury Use	7 locations	IDR 39,291,400	*Rupiah Murni* (RM)
2019	Directorate of Hazardous Substances Management	Elimination of Mercury Use	3 locations	IDR 9,100,000	*Rupiah Murni* (RM)
2020	Directorate of Hazardous Substances Management	Provision of mercury-free gold treatment facility in ASGM locations	5 unit	IDR 12,000,000	▸ *Rupiah Murni* (RM) ▸ There is budget refocusing for Covid-19 countermeasures becoming IDR 5,611,586,000 with 1 target unit
2020	P3KLL	Construction of Mercury Laboratory and Environmental Metrology	1 unit	IDR 73,990,000	SBSN
2021	Directorate of Hazardous Substances Management	Construction of mercury-free gold treatment facility in ASGM locations	2 unit	IDR 3,600,000	▸ *Rupiah Murni* (RM) ▸ There is budget refocusing for Covid-19 countermeasures becoming IDR 2,718,100,000 with 1 target unit (Refocusing 2)
2022	Directorate of Hazardous Substances Management	Construction of mercury-free gold treatment facility in ASGM locations	2 unit	IDR 3,950,000	▸ *Rupiah Murni* (RM) ▸ Data record per 16 August 2021

Souce: Kementerian PPN/Bappenas, 2021

CHAPTER IV.
IDENTIFICATION OF POPULATIONS AT RISK AND GENDER DIMENSIONS

4.1. Identification of At-risk Populations and Gender Dimensions

The population at risk and gender dimensions are identified by taking into account the possibility of people who are at high risk of mercury exposure, namely those who work in an activity that produces or uses mercury, their families, people who live in the area around the source of mercury pollution, and even consumers who eat, for example, fish and rice, which contain mercury.

In Indonesia, some gynecologists advise pregnant patients not to eat seafood that is thought to be contaminated with mercury and not to use cosmetics that contain various main chemical compounds of mercury to avoid significant adverse impacts to the developing fetus. According to the Secretariat of the Basel Convention, Rotterdam Stockholm (BRS), from the point of view of chemicals and waste, biological factors influence the effects or impacts received due to exposure to chemical compounds and waste. It has been explained that women are more biologically sensitive, because women have times or periods such as adolescence, pregnancy, breastfeeding, and menopause where they are more susceptible to exposure to chemicals that have a major impact on their health.

Exposure to environmentally hazardous compounds, particularly in industrialized countries, can have an impact on men's reproductive health. More than 76 percent of infertility cases in men are caused by environmental factors connected to the usage of pesticides.

Exposure to different hazardous chemicals by pregnant women can have major implications for their children. Chemicals transported during complete development, for example, can result in birth abnormalities as well as childhood and adult disorders. An increasing number of pollutants (including mercury) and chemicals have been shown to provide multi-generational and transgenerational effects (BRS Secretariat, 2019).

According to the national inventory of mercury releases in Indonesia in 2021, the individual mercury releases sub-categories contributing the highest mercury releases to the atmosphere are gold (and silver) extraction using mercury amalgamation processing, incineration of hazardous waste, electrical switches and relays with mercury, other non-ferrous metals extraction and coal combustion in coal-fired power plants.

The individual mercury release sub-categories contributing the highest inputs of mercury are gold (and silver) extraction using mercury amalgamation in processing, gold extraction and initial processing by methods other than mercury amalgamation, electrical switches and relays with mercury, copper extraction and initial processing.

The origin of mercury in waste and wastewater produced in the country is mercury in products and materials. Waste fractions and wastewater do therefore not represent original mercury inputs to society (except for imported waste). Waste and wastewater may however represent substantial flows of mercury through society. The following were found to be the major flows of mercury with waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.

According to data from the MoEMR in 2017, ASGM locations can be found in 32 provinces and 197 regencies/cities, with an estimated 850 ASGM hotspots spread out throughout (MoEF and UB, 2018). In 2010, there were around 900 vulnerable zones with related groups of more than 250,000 miners, including women and children, and more than 1,000,000 individuals who relied on the mining industry for a living (Balifokus, 2015). According to more recent data from the National Inventory

Study conducted by MoEF and BSCRC-SEA (2019), it is estimated that there are 179,200 gold miners actively involved in ASGM in Indonesia. The figure below depicts the distribution of ASGM activity locations throughout Indonesia.

Figure 4.1. **Distribution of ASGM Activity Locations in Indonesia**

Source: MoEMR, 2016

Mercury imports in 2011-2014 totaled 550 kg per year and were limited to the industrial use of two fluorescent tube lamps, whereas no mercury import applications were submitted to the Ministry of Trade in 2015-2016. The use of mercury in ASGM, on the other hand, is significantly high. This mercury comes from Indonesia and is derived from cinnabar mining and processing. According to the Academic Paper of the Bill on Ratification of the Minamata Convention on Mercury, mercury levels in the air are measured at a maximum of 999 μg/m^3 and an average of 102.07 μg/m^3, while mercury levels in the soil are measured at a maximum of 5,100 ppm and an average of 1,827.64 ppm at the cinnabar processing location in Parakansalak Village, Sukabumi Regency. In Bojong Genteng Village, mercury levels in the air reached a maximum of 39.6 μg/m^3 and an average of 8.82 μg/m^3, while mercury levels in the soil reached a maximum of 11,300 ppm and an average of 6,981 ppm.

The table below shows the results of health sampling in Parakansalak Village.

Table 4.1. **Results of Health Sampling in Parakansalak Village**

Sample	Mercury Level	
	Hair mg/L	Nails (ppm)
1	9.57	2.657
2	9.31	1.765
3	5.70	2.062
4	56.18	16.302
5	13.39	
6	4.18	
Average	16.38	5.70
Quality standards (IPCS)	1 – 2 microgram/L	
Quality standards (WHO)	1 – 2 mg/kg	

Source: Directorate of Hazardous Substances Management, MoEF, 2016

According to research findings from the Bandung Institute of Technology's Center for Environmental Studies (*Pusat Studi dan Lingkungan Hidup dan Lembaga Penelitian dan Pemberdayaan Masyarakat Institut Teknologi Bandung*, PSLH-LPPM ITB) and MoEF in 2018, the results of PTWI (Provisional Tolerable Weekly Intake) calculations and comparisons of quality standards based on SNI:7387 2009 in various locations in Merangin Regency are as follows:

- Only one respondent exceeded the quality standard (5 µg/kg BW for total mercury) in Pangkalan Jambu District, while three others were near to the PTWI quality standard;
- Some respondents exceeded the quality standard (5 µg/kg BW for total mercury) in Sungai Manai District, and almost all of the respondents were close to the quality standard;
- Some respondents exceeded the quality standard (5 µg/kg BW for total mercury) in Tabir Barat District;
- In Batang Masumai District, none of the respondents exceeded the quality standard (5 g/kg BW for total mercury).

All of the miners (adult respondents) had mercury contents in their urine that are above the WHO quality standard of 5 µg/g creatinine (WHO, 2008). The concentration of mercury in the urine of non-miners (adult responders) was largely (20 persons) above the WHO quality standard, with only two people falling below it.

The study found that 25 adult miners had mercury concentrations in their nails that were near to the quality limit (WHO, 2008) of 1.6 µg/g, and the rest of 19 persons were above the quality standard. Twenty-two adult (22) respondents (non-miners) had a mercury concentration in their nails, 13 of whom exceeded the WHO quality standard and the rest were near to it.

For the mercury concentration in the hair of adult miners, only 3 persons were higher than the quality standard, 3 persons lower than the quality standard, and 19 times lower than the quality standard (WHO, 2008). For the mercury concentration in the hair of 22 adult respondents (non-miners); 6 persons were above the WHO quality standard of 2 µg/g, while the rest were below it.

Table 4.1 shows the average result of sample analysis of nails and hair of cinnabar miners in Parakansalak Village. The average mercury concentration for 6 samples of hair was 16.38 mg/L with the highest concentration of 56.18 mg/L and the lowest of 4.18 mg/L. The average mercury concentration for 4 samples of nail was 5.70 ppm with the highest concentration of 16.302 ppm and the lowest of 1.765 ppm.

The results of the study for the concentration of mercury in the urine of the 49 children in Merangin Regency, 43 children exceeded the WHO quality standard which is 5 µg/g creatinine and the rest (6 children) were below it. Mercury concentration in blood of 49 children all exceeded the WHO quality standard which is 2 µg/L and there was 1 (one) extreme data which is 333.333 µg/L.

The table below shows mercury concentration in urine, hair and nails in adult and children's respondents in study location of Merangin Regency.

Table 4.2. **Results of Mercury Concentration Measurement in Urine of Adult Respondents in Study Location of Merangin Regency**

No.	Gender	Age (year)	Height (cm)	Weight (kg)	Address (Village)	Address (District)	Occupation		Creatinine Concentration in Urine (mg/dl)	Hg Concentration in Urine (µg/g creatinine)
01.	M	40	165	70	Bungo Tanjung	Pangkalan Jambu	Miner		387.26	6.46
02.	M	35	165	66	Bungo Tanjung	Pangkalan Jambu	Miner		141.74	17.64
03.	M	37	169	74	Bungo Tanjung	Pangkalan Jambu	Miner		264.53	9.45
04.	M	38	160	48	Bukit Perentak	Pangkalan Jambu	Miner	Farmer	284.97	8.77
05.	M	28	165	66	Bukit Perentak	Pangkalan Jambu	Miner		295.86	8.45
06.	M	33	160	62	Bukit Perentak	Pangkalan Jambu	Miner		119.12	14.69
07.	M	36	160	52	Bukit Perentak	Pangkalan Jambu	Miner		205.65	8.51
08.	M	42	152	42	Bukit Perentak	Pangkalan Jambu	Miner		125.25	15.97
09.	M	39	75	160	Bukit Perentak	Pangkalan Jambu	Miner		94.68	15.84
10.	M	42	150	63	Baru	Pangkalan Jambu	Rubber farmer		113.5	22.03
11.	M	43	160	68	Baru	Pangkalan Jambu	Entrepreneur		191.53	11.75
12.	M	53	171	75	Bungo Tanjung	Pangkalan Jambu	Civil servant		218.54	11.44
13.	M	31	167	84	Sungai Pinang	Sungai Manau	Miner		225.25	9.99
14.	M	35	160	57	Sungai Pinang	Sungai Manau	Miner		104.6	71.7
15.	F	39	159	67	Sungai Pinang	Sungai Manau	Miner		290.41	51.65
16.	M	46	170	71	Sungai Pinang	Sungai Manau	Miner		132.3	18.9
17.	M	50	153	48	Sungai Pinang	Sungai Manau	Miner		234.03	32.05
18.	F	29	152	60	Sungai Pinang	Sungai Manau	Miner		143.6	17.41
19.	F	35	149	63	Sungai Pinang	Sungai Manau	Miner		85.67	29.18
20.	F	24	151	57	Sungai Pinang	Sungai Manau	Miner		138.69	16.22
21.	M	31	162	78	Sungai Pinang	Sungai Manau	Miner	Village Staff	245.65	30.53
22.	M	28	162	60	Sungai Pinang	Sungai Manau	Miner	Head of Village	66.92	37.36
23.	F	33	159	67	Sungai Pinang	Sungai Manau	Miner		175.16	57.09

No.	Gender	Age (year)	Height (cm)	Weight (kg)	Address (Village)	Address (District)	Occupation		Creatinine Concentration in Urine (mg/dl)	Hg Concentration in Urine (µg/g creatinine)
24.	F	32	152	70	Sungai Pinang	Sungai Manau	Miner		97.19	51.45
25.	F	37	147	51	Sungai Pinang	Sungai Manau	Miner		209.78	11.92
26.	F	29	140	58	Muara Kibul	Tabir Barat	Miner		145.57	34.35
27.	F	49	142	51	Muara Kibul	Tabir Barat	Miner		169.6	147.41
28.	F	42	148	45	Muara Kibul	Tabir Barat	Miner		207.8	36.09
29.	F	40	154	69	Muara Kibul	Tabir Barat	Rubber farmer		191.3	11.76
30.	F	33	148	50	Muara Kibul	Tabir Barat	Village staff	Perangakt Desa	89.42	19.57
31.	F	43	146	55	Muara Kibul	Tabir Barat	Housewife		261.28	3.83
32.	F	41	148	82	Muara Kibul	Tabir Barat	Farmer		150.56	9.96
33.	F	36	148	74	Muara Kibul	Tabir Barat	Housewife		287.87	6.08
34.	M	37	160	59	Muara Kibul	Tabir Barat	Rubber farmer		220.48	11.33
35.	M	58	154	55	Muara Kibul	Tabir Barat	Rubber farmer		178.9	11.18
36.	M	49	154	50	Muara Kibul	Tabir Barat	Diesel delivery		159.41	15.68
37.	M	49	157	67	Muara Kibul	Tabir Barat	Construction labourer		108.61	9.21
38.	M	50	159	55	Muara Kibul	Tabir Barat	Rubber farmer		150.74	8.29
39.	F	32	155	68	Muara Kibul	Tabir Barat	Teacher		140.55	17.79
40.	F	33	148	61	Muara Kibul	Tabir Barat	Teacher		121.76	16.43
41.	F	34	144	60	Titian Teras	Batang Masumai			162.31	7.7
42.	F	32	134	59	Titian Teras	Batang Masumai	Farmer		194.39	51.44
43.	F	26	149	39	Titian Teras	Batang Masumai	Housewife		74	16.89
44.	F	35	163	75	Titian Teras	Batang Masumai	Shop owner	Housewife	125.08	59.96
45.	F	33	148	50	Titian Teras	Batang Masumai	Housewife		167.77	1.49
46.	F	49	141	51	Titian Teras	Batang Masumai	Farmer		125.81	7.95
47.	F	32	144	52	Titian Teras	Batang Masumai	Farmer	Housewife	28.21	44.31
								Avg	**171.35**	**24.15**

Table 4.3. **Results of Mercury Concentration Measurement in Nails and Hair of Adult Respondents in Study Location of Merangin Regency**

No.	Gender	Usia (tahun)	Age (Year)	Residency duration (Year)	Occupation		Working duration (Year)	Hg Concentration in Nail (µg/g)	Hg Concentration in Hair (µg/g)
01.	M	40	Pangkalan Jambu	40	Miner		6	2.43	0.53
02.	M	35	Pangkalan Jambu	35	Miner		2	7.46	0.72
03.	M	37	Pangkalan Jambu	37	Miner		5	1.67	2.12
04.	M	38	Pangkalan Jambu	38	Miner	Farmer	5	3.92	0.53
05.	M	28	Pangkalan Jambu	8	Miner		3	5.61	0.2
06.	M	33	Pangkalan Jambu	10	Miner		9	13.51	0.73
07.	M	36	Pangkalan Jambu	10	Miner		10	6.21	1.64
08.	M	42	Pangkalan Jambu	42	Miner		4	1.79	7.93
09.	M	39	Pangkalan Jambu	15	Miner		8	3.69	1.18
10.	M	42	Pangkalan Jambu	Na	Miner		Na	0.75	0.76
11.	M	43	Pangkalan Jambu	Na	Miner		Na	8.3	Na
12.	M	53	Pangkalan Jambu	Na	Rubber farmer		Na	13.79	3.01
13.	M	31	Sungai Manau	31	Village staff		5	0.82	0.16
14.	M	35	Sungai Manau	35	Housewife		10	1.01	0.83
15.	F	39	Sungai Manau	39	Farmer		7	1.43	0.91
16.	M	46	Sungai Manau	22	Housewife		22	9.17	1.21
17.	M	50	Sungai Manau	50	Rubber farmer		8	11.36	9.67
18.	F	29	Sungai Manau	9	Rubber farmer		8	1.11	0.64
19.	F	35	Sungai Manau	35	Diesel delivery		3	10.1	1.47
20.	F	24	Sungai Manau	8	Construction labourer		8	5.95	0.44
21.	M	31	Sungai Manau	8	Rubber farmer	Village Staff	8	3.86	0.39
22.	M	28	Sungai Manau	29	Teacher	Head of Village	9	7.19	1.77
23.	F	33	Sungai Manau	33	Teacher		18	2.43	0.37

No.	Gender	Usia (tahun)	Age (Year)	Residency duration (Year)	Occupation		Working duration (Year)	Hg Concentration in Nail (µg/g)	Hg Concentration in Hair (µg/g)
24.	F	32	Sungai Manau	32			23	3.44	0.99
25.	F	37	Sungai Manau	37	Farmer		2	3.9	0.56
26.	F	29	Tabir Barat	29	Housewife		2	1.27	<LOD
27.	F	49	Tabir Barat	49	Wiraswasta		5	12.71	<LOD
28.	F	42	Tabir Barat	42	Housewife		5	1.51	0.3
29.	F	40	Tabir Barat	40	Farmer		2	1.33	0.67
30.	F	33	Tabir Barat	33	Farmer	Perangkat Desa	Na	1.72	2.57
31.	F	43	Tabir Barat	43	IRT		2	6.25	0.66
32.	F	41	Tabir Barat	41	Petani		0.5	5.49	0.2
33.	F	36	Tabir Barat	36	IRT		3	6.36	2.22
34.	M	37	Tabir Barat	10	Berkebun Karet		2	4.16	4.13
35.	M	58	Tabir Barat	28	Berkebun Karet		0.08333	2.25	0.53
36.	M	49	Tabir Barat	49	Pengantar Solar		2	3.96	<LOD
37.	M	49	Tabir Barat	49	Kuli Bangunan		3	1.34	0.36
38.	M	50	Tabir Barat	20	Berkebun Karet		1.5	7.51	1.84
39.	F	32	Tabir Barat	26	Guru		Na	2.84	23.01
40.	F	33	Tabir Barat	33	Guru		Na	1.21	1.6
41.	F	34	Batang Masumai	34	Merangin		Na	0.5	0.44
42.	F	32	Batang Masumai	32	Petani		Na	0.23	<LOD
43.	F	26	Batang Masumai	7	IRT		Na	0.61	0.35
44.	F	35	Batang Masumai	14	Wiraswasta	Housewife	Na	5.45	<LOD
45.	F	33	Batang Masumai	33	IRT		Na	3.49	2.45
46.	F	49	Batang Masumai	49	Petani		Na	0.3	<LOD
47.	F	32	Batang Masumai	32	Petani	Housewife	Na	0.12	0.29
							Avg	**4.29**	**2.00**

Table 4.4. **Results of Mercury Concentration Measurement in Urine and Blood of Children Respondents in Study Location of Merangin Regency**

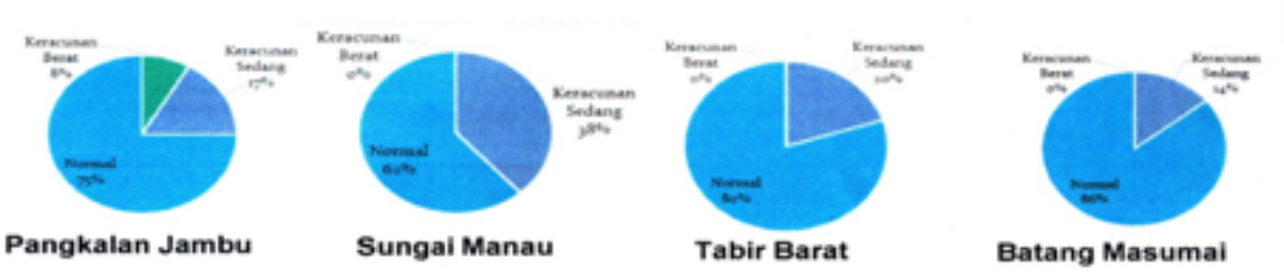
No.	Gender	Age (Year)	Weight (kg)	Height (cm)	Address (Village)	Address (Regency)	Creatinine Concentration in Urine (mg/dl)	Hg Concentration in Urine (µg/g creatinine)	Hg Concentration in Blood (µg/M)
01.	F	7	22	NA	Bungo Tanjung	Pangkalan Jambu	71.15	14.05	25
02.	F	12	35	NA	Bungo Tanjung	Pangkalan Jambu	63.56	15.73	50
03.	M	9	25	NA	Bungo Tanjung	Pangkalan Jambu	126.68	17.76	25
04.	F	10		NA	Bungo Tanjung	Pangkalan Jambu	22.08	226.45	10
05.	F	8	14	NA	Bukit Perentak	Pangkalan Jambu	124.16	20.14	35
06.	F	12	21	NA	Bukit Perentak	Pangkalan Jambu	187.68	7.99	35
07.	M	11	22	NA	Bukit Perentak	Pangkalan Jambu	163.14	3.06	25
08.	F	6	12	NA	Bukit Perentak	Pangkalan Jambu	134.66	7.43	20
09.	M	8	20	NA	Bukit Perentak	Pangkalan Jambu	77.14	22.69	40
10.	F	8	22	NA	Baru	Pangkalan Jambu	36.72	54.47	35
11.	F	8	26	NA	Baru	Pangkalan Jambu	84.03	20.83	50
12.	F	6	21	NA	Bungo Tanjung	Pangkalan Jambu	26.24	47.64	35
13.	M	8	18	NA	Sungai Pinang	Sungai Manau	111.1	20.25	5
14.	M	10	24	NA	Sungai Pinang	Sungai Manau	133.55	37.44	15
15.	M	8	14	NA	Sungai Pinang	Sungai Manau	34.2	146.2	33.333
16.	M	11	21	NA	Sungai Pinang	Sungai Manau	27.22	91.84	50
17.	F	8	17	NA	Sungai Pinang	Sungai Manau	37.84	52.85	25
18.	F	9	19	NA	Sungai Pinang	Sungai Manau	175.37	0	45
19.	F	8	23	NA	Sungai Pinang	Sungai Manau	69.56	71.88	333.333
20.	F	9	16	NA	Sungai Pinang	Sungai Manau	40.8	122.55	5
21.	F	8	24	NA	Sungai Pinang	Sungai Manau	58.86	0	50
22.	M	8	18	NA	Sungai Pinang	Sungai Manau	111.1	20.25	5
23.	F	8	19	NA	Sungai Pinang	Sungai Manau	30.06	0	50
24.	F	12	28	NA	Sungai Pinang	Sungai Manau	187.07	6.65	200

No.	Gender	Age (Year)	Weight (kg)	Height (cm)	Address (Village)	Address (Regency)	Creatinine Concentration in Urine (mg/dl)	Hg Concentration in Urine (µg/g creatinine)	Hg Concentration in Blood (µg/M)
25.	M	12	23	NA	Sungai Pinang	Sungai Manau	143.66	15.66	10
26.	M	10	24	NA	Sungai Pinang	Sungai Manau	237.34	9.48	30
27.	M	10	19	NA	Muara Kibul	Tabir Barat	12.82	78	40
28.	F	11	25	NA	Muara Kibul	Tabir Barat	62.1	8.05	20
29.	M	11	23	NA	Muara Kibul	Tabir Barat	27.18	73.58	3
30.	M	10	28	NA	Muara Kibul	Tabir Barat	126.09	39.65	25
31.	M	10	27	NA	Muara Kibul	Tabir Barat	121.49	12.35	20
32.	M	10	27	NA	Muara Kibul	Tabir Barat	40.63	30.77	30
33.	F	11	42	NA	Muara Kibul	Tabir Barat	92.75	8.09	4.5
34.	M	10	22	NA	Muara Kibul	Tabir Barat	64.62	30.95	35
35.	F	10	20	NA	Muara Kibul	Tabir Barat	182.07	5.49	30
36.	M	10	22	NA	Muara Kibul	Tabir Barat	178.85	11.18	25
37.	F	12	22	NA	Muara Kibul	Tabir Barat	107.02	7.01	10
38.	M	11	42	NA	Muara Kibul	Tabir Barat	89.73	22.29	35
39.	F	11	30	NA	Muara Kibul	Tabir Barat	101.62	4.92	35
40.	F	11	28	NA	Muara Kibul	Tabir Barat	52.75	9.48	5
41.	F	10	25	NA	Muara Kibul	Tabir Barat	106.03	7.07	30
42.	M	9	18	107	Titian Teras	Batang Masumai	151.09	6.62	10
43.	M	7	20	116	Titian Teras	Batang Masumai	141.63	7.06	10
44.	F	9	19	122	Titian Teras	Batang Masumai	133.37	5.62	25
45.	M	9	20	123	Titian Teras	Batang Masumai	192.07	5.21	15
46.	M	9	19	102	Titian Teras	Batang Masumai	159.17	31.47	10
47.	M	11	24	126	Titian Teras	Batang Masumai	199.86	3.75	20
	M	11	31	134	Titian Teras	Batang Masumai	22.35	55.93	50
	M	12	25	NA	Muara Kibul	Tabir Barat	189.59	26.37	200
						AVG	**103.47**	**31.51**	**39.37**

The following tests were performed during the collection and examination of the HBM health sample in Merangin Regency: (1) anamnesis test; (2) ataxia test; (3) tremor test; (4) dysdiadochokinesia test; (5) neuropsychological tests; (6) physical examination, with a total of 25 miners and 22 non-miners

The results of the collecting and examination of health-HBM samples in the four districts are shown in the figure below.

Figure 4.2. **Results of Health Sampling and Examination – HBM in Four Districts**



Number of samples :
Miner : 42
Non Miner : 7

Source: Bandung Institute of Technology presentation with the title "Dissemination of study results: Mapping of Mercury's Impact on the Environment, Health and Socio-Economic Community Around Small-Scale Gold Mining Sites", p. 171, presented on November 29, 2018 at Hotel Dafam Teraskita.

According to the results of the general health assessment, the respondents' general health concerns are as follows:

- 6 out of 42 respondents had hypertension grade I;
- 5 out of 42 respondents had eye disorder in the form of pterygium grade III;
- 2 out of 42 respondents had spinal line disorders (susp. Scoliosis);
- 2 out of 42 respondents had wrist complaints (susp. Carpal tunnel syndrome);
- 1 out of 42 respondents had a bending deformity of the leg bones due to a history of fractures.

Almost all respondents still have adequate sensory and motor skills, as well as reflexes in their four locomotor organs. Medical history can be confounding of sensory/motor/nerve disorders that may be found.

Tracing analysis of special case was conducted in form of profiling one respondent in Merangin Regency whose analysis result showed high mercury concentration in his body. In this study, one respondent was selected for tracing as shown in the table below.

Table 4.5. ***Average Mercury Concentration in Respondent's Body***

	Results Measurement	Quality standards	Information
Mercury concentration in urine	32.05 µg/g creatinine	5 µg/g creatinine	Mercury concentration in urine indicates acute exposure
Mercury concentration in nails	11.363 µg/g	1.6 µg/g	Marker that chronic exposure have occurred in respondents
Mercury concentration in hair	9.677 µg/g	2 µg/g	Marker that chronic exposure have occurred in respondents

Source: Bandung Institute of Technology (ITB) presentation with the title "Dissemination of study results: Mapping of the Impact of Mercury on the Environment, Health and Socio-Economic Society Around Small-Scale Gold Mining Sites", page 177, presented on 29 November 2018 at Hotel Dafam Teraskita

The measurement results of mercury intake from consumption materials compared with quality standards are shown in the table below.

Table 4.6. **Mercury Intake from Consumable Ingredients**

	Measurement results	Quality standards	Information
Mercury concentration in water	0.0008 mg/L	0.001 mg/L	Mercury concentration in water is still safe
Mercury concentration in rice	0.2 mg/kg	0.03 mg/kg	Mercury concentration in rice is almost 10 times above the quality standard
Mercury concentration in fish	0.052 mg/kg	0.5 mg/kg	Mercury concentration in fish is still safe*
PTWI	6.88 µg/kg	1.6 µg/kg	This high intake value is caused by the high concentration of mercury

** Quality standard for Hg concentration in fish is 0.5 mg/kg based on Indonesian National Standard:7387 2009 concerning Quality Standard of Metal Contamination in Food for Fish and Fishery Product*

Source: Bandung Institute of Technology presentation with the title "Dissemination of study results: Mapping of the Impact of Mercury on the Environment, Health and Socio-Economic Community Around Small-Scale Gold Mining Sites", page 178, presented on 29 November 2018 at Hotel Dafam Teraskita

The results of measuring mercury intake from mining compared to the quality standards can be seen in the following table.

Table 4.7. **Mercury Intake From Mining**

	Measurement results	Quality standards	Informasi
Mercury concentration in residential air	0.0915 µg/m^3	10 µg/m^3	The concentration of mercury in the air is safe because it is far below the quality standard
Mercury concentration in inhaled air	-	0.3 µg/m^3	
Working duration as a miner	8 years		With 8 years of work, it is possible that this respondent is chronically exposed to mercury

Source: Bandung Institute of Technology (ITB) presentation with the title "Dissemination of study results: Mapping of Mercury's Impact on the Environment, Health and Socio-Economic Community Around Small-Scale Gold Mining Sites", page 179, presented on 29 November 2018 at Hotel Dafam Teraskita.

The results of measuring the health condition of adults and children are as in **Table 4.8** and **Table 4.9**.

Table 4.8. **Health Conditions of Adult Respondents**

	Measurement results	Quality standards	Information
HBM Score	5	0 – 2	With an HBM value of 5 which is categorized as moderate mercury poisoning, all the previous explanations are related. This is since chronic mercury exposure can be measured from this HBM test, in addition to looking at the mercury concentration in nails and hair
Lung function test	Heavy Restrictive	-	-
Other health disorders	-	-	Not suffering from any other disease. Decreased ability to coordinate finger movements (finger tap test)

Source: Bandung Institute of Technology presentation with the title "Dissemination of study results: Mapping the Impact of Mercury on the Environment, Health and Socio-Economic Society Around Small-Scale Gold Mining Sites", page 180, presented on November 29, 2018 at Hotel Dafam Teraskita

Table 4.9. **Child Health Condition**

	Measurement results	Quality standards	Information
Mercury concentration in the child's blood	45 µg/L	2 µg/L	The concentration of mercury in children's blood is far above the quality standard. This could be due to mercury exposure outside the house which is still in the respondent's residence area
Mercury concentration in child's urine	LOD	5 µg/g Creatinine	The mercury concentration in the child's urine is below the detection limit, which is < 0.000004

Source: Bandung Institute of Technology presentation with the title "Dissemination of study results: Mapping the Impact of Mercury on the Environment, Health and Socio-Economic Society Around Small-Scale Gold Mining Sites", page 181, presented on November 29, 2018 at Hotel Dafam Teraskita

The conclusion of the study in Dharmasraya Regency for the calculation of PTWI and the measurement of mercury concentration in the respondents' body samples in the two districts can be seen in the table below.

Table 4.10. **Conclusion of PTWI Calculation Results and Concentration of Respondents' Body Samples in Two Districts**

PTWI/mercury concentration	Conclusion of calculation and measurement results
PTWI District IX Koto (previously did not exist)	No respondent exceeded the quality standard (5 µg/Kg BW for total mercury*)
PTWI Sitiung District	No respondent exceeded the quality standard (5 µg/Kg BW for total mercury)
Mercury concentration in miners' urine (District IX Koto)	No respondent exceeded the quality standard (quality standard (WHO, 2008): 5 µg/g Creatinine)
Mercury concentration in miners' urine (Sitiung District)	Some respondents exceeded the quality standard (quality standard (WHO, 2008): 5 µg/g Creatinine)
Mercury concentration in adult respondents' nails (District IX Koto)	Some respondents exceeded the quality standard (quality standard (WHO, 2008): 1.6 µg/g)
Mercury concentration in adult respondents' nails (Sitiung District)	2 respondents exceeded the quality standard (quality standard (WHO, 2008): 1.6 µg/g)
Mercury concentration in the adult respondents' hair (District IX Koto)	Most did not exceed the quality standard (quality standard (WHO, 2008): 2 µg/g)
Mercury concentration in the adult respondents' hair (Sitiung District)	Some respondents exceeded the quality standard (quality standard (WHO, 2008): 2 µg/g)
Mercury concentration in children's blood (District IX Koto)	All respondents exceeded the quality standard (quality standard (WHO, 2008): 2 µg/L)
Mercury concentration in children's blood (Sitiung District)	Almost all respondents exceeded the quality standard (quality standard (WHO, 2008): 2 µg/L)
Mercury concentration in children's urine (District IX Koto)	More than half respondents exceeded the quality standard (quality standard (WHO, 2008): 5 µg/L)
Mercury concentration in children's urine (Sitiung District)	Most of respondents exceeded the quality standard (quality standard (WHO, 2008): 5µg/L)

*Based on SNI: 7387 2009

Source: Bandung Institute of Technology presentation "Dissemination of study results: Mapping of the Impact of Mercury on the Environment, Health and Socio-Economic Community around Small-Scale Gold Mining Sites", pp. 220-238, presented on 29 November 2018 at Hotel Dafam Teraskita.

Due to the fact that mercury is utilized in medical devices, personnel in the health industry may be exposed to mercury if the medical devices break or if medical waste is not managed according to applicable laws and regulations. Furthermore, because mercury is used as amalgam for filling teeth, workers at the dentist may be exposed to mercury while preparing amalgam, and/or used residues disposed of in the trash or directly through the sink water may contaminate the waste and/or wastewater treatment site, resulting in worker contamination.

Another concern is for people who use mercury-containing cosmetics. BPOM has conducted several inspections, and according to the findings of research conducted by university staff in Makassar, several brands of whitening cream were studied, and several samples contained mercury at levels of CII = 0.0296 mg/kg; CIII= 0.0518 mg/kg; DI=0.0738 mg/kg; DII=0.0724 mg/kg; DIII=0.0590 mg/kg; and EIII=0.0222 mg/kg (Anggraeni, 2014). In accordance with BPOM Regulation Number 23 of 2019 concerning Technical Requirements for Cosmetic Ingredients, mercury and its compounds are included in Annex V as a List of Prohibited Substances in Cosmetics.

The illegal recycling of electronic waste poses a danger of mercury contamination in industrial activities since mercury is used to separate gold (Au) metal. In Indonesia, pollution control technology is employed in coal-fired power plant operations, and personnel wear work garments that meet relatively high safety standards. Workers in the handling of fly ash and bottom ash disposal, as well as those involved in air pollution control, are particularly vulnerable.

4.2. Implications of the Study's Findings for Indonesia as a Minamata Convention Party

According to Article 4 of the Minamata Convention on Mercury-Added Products, campaign regarding mercury-free products and their use and/or mercury contamination is the best way to eliminate mercury from the market. Currently, Indonesia has banned the use of mercury-containing insecticides, as well as the use of mercury in the "mercury cell" process in the manufacture of NaOH and the processing and refining of gold in gold mining and ASGM.

According to Presidential Regulation No. 21 of 2019 concerning RAN-PPM in 4 (four) priority sectors, the following are the targets for mercury reduction and elimination:

a) Manufacturing sector 50% in 2030;
b) The energy sector 33.2% in 2030;
c) The ASGM sector 100% in 2025;
d) The health sector 100% in 2020.

Meanwhile, equipment such as barometers, hygrometers, and manometers have not been prioritized unless they are part of the above-mentioned category.

According to Article 7 of RAN-PPM, mercury will no longer be used for ASGM operations by 2025. According to the artisanal miners' group and the MoEMR's action plan, mercury will no longer be utilized for gold processing by 2018. However, according to the facts shown in point 4.1, mercury is still used in ASGM, and its effects on miners, women, and children living around ASGM sites have been detected. Various actions will be carried out as part of the RAN-PPM; however, implementation will be challenging due to the fact that ASGM is generally an illegal activity.

It is critical to grant ASGM permits that are environmentally beneficial and do not utilize mercury so that local governments, governments, and non-governmental organizations (NGOs) may formally guide them. As a result, it is suggested that MoEF Regulation Number 23 of 2008 concerning the Technical Guidelines for the Prevention of Pollution and/or Environmental Damage Due to People's Gold Mining, be revised. These guidelines are currently being amended.

To comply with Article 8 pertaining to emissions, there is now a mercury pollution regulation for emissions from hazardous waste treatment incinerators, the cement industry, and coal-fired power plants (CFPP). Therefore, mercury emission standards for additional industries included in Annex D of the Convention, such as coal-fired boilers and smelting and roasting processes used in the manufacture of non-ferrous metals, must be established. MoEF Regulation Number 15 of 2019 concerning The Emission Quality Standard for Thermal Power Plants has been issued with a maximum mercury level of 0.03 mg/Nm^3. Industries that emit mercury must install an air monitoring device that is connected from CEMS to MoEF in order to simplify monitoring.

To prevent water pollution from contaminating the community, it is crucial to establish standards and monitor industries that generate mercury-containing wastewater.

Considering Article 10 of the Minamata Convention, In Indonesia, mercury storage criteria must be established in light of the fact that some activities can still use mercury, whereas the achievement target of mercury use reduction is 50% for the majority by the year 2030.

In terms of the implementation of Articles 11 and 12 concerning mercury waste and contaminated site management, the regulation is included in MoEF Regulation Number 101 of 2018 concerning Guidelines for the Remediation of Land Contaminated by Hazardous Waste, and this has been managed by sending it abroad in accordance with the Basel Convention's provisions. Waste with a mercury content that meets the standard is disposed of in a licensed hazardous waste landfill or utilized in a licensed facility. Only in some activities, such as in ASGM and other activities, hazardous wastes are dumped into the environment, and remediation is required, as described in Chapter II regarding Lhokseumawe.

In the implementation of Article 16. on Health Aspects, the health aspect is given serious attention both in MoH Regulation Number 57 of 2016 concerning the National Action Plan for Controlling Health Impacts Due to Mercury Exposure in 2016-2020 and the RAN-PPM, wherein the agency in charge must make efforts to protect populations at risk, especially for children and women, as well as control health impacts due to mercury exposure through the development of guidelines for controlling risk factors, health impacts due to mercury exposure to the environment and guidelines for procedures of handling mercury poisoning.

In addition, in the RAN-PPM, MoH is also tasked with developing standard methods for measuring mercury exposure including nodes 1-3 (source, media and receptor) consisting of sampling and analysis methods. Several activities have been carried out; however, they are limited and therefore cannot cover the entire country of Indonesia. As a result, it is necessary to add an additional budget to the budget for which regulations are available.

Chapter V.
Awareness/Understanding of Workers and the Public and Existing Training and Education Opportunities of Target Groups and Professionals

5.1. Increasing Awareness/Understanding of Labour and the Public

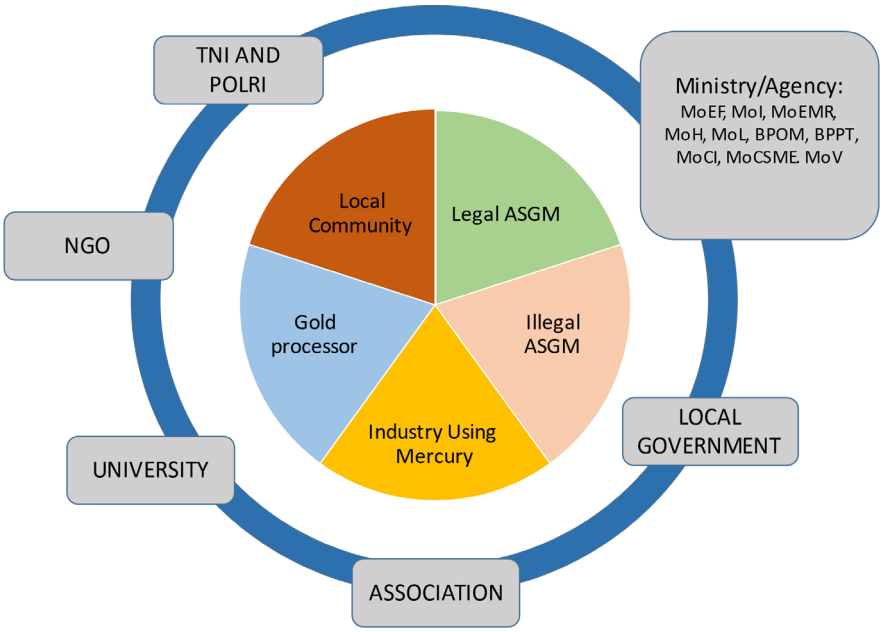
According to information from Chapter II and the study of the National Overview of Indonesian ASGM undertaken by MoEF and BSCRC-SEA (2020), the sector that currently contributes to the largest mercury release is ASGM. Data from the national overview of ASGM study estimated that there are 179,200 gold miners in Indonesia that are actively working in ASGM. Apart from the miners, the families of the miners in the ASGM area are also affected by the health hazards of mercury.

Exposure to a variety of substances that are toxic to mothers can have major consequences for their children. Chemicals transmitted during development, for example, can result in lifelong risks such as birth abnormalities and disorders in infants and adults. Multigenerational and transgenerational impacts have been discovered in a growing number of substances (Medicuss, 2018).

In a study conducted by the PSLH-LPPM ITB and MoEF in 2018, 41 children (case group) exceeded the quality standard with one extreme data outcome, namely MRA 23 respondents at 333.3 µg/g and only 3 persons below the quality standard of 5 µg/g (WHO, 2008 in MoEF & ITB, 2018). Meanwhile, all of the mercury levels in the urine of the children (control group) surpassed the quality standard (7 respondents).

Given the vast number of people at risk, the large negative impact on health, and the lack of information about mercury's hazards, the existing awareness raising needs to be enhanced and integrated amongst many institutions and the community. The participation of various institutions in initiatives to raise worker and community awareness can be seen in **Figure 5.1**.

Figure 5.1. **Involvement of Various Institutions in Efforts to Increase Public Awareness**



Awareness raising activities have been carried out by various institutions, namely the government, NGOs, associations and universities. A summary of information regarding the awareness raising activities that has been carried out from 2015 to 2019 can be seen in Table 5.1. Detailed information regarding this awareness raising can be seen in **Annex III**.

Table 5.1. **Awareness Raising Activities to the Community about Mercury by Various Institutions**

No.	Institutions and Activities Related to Awareness Raising to the Community About Mercury
A.	**Ministries and Institutions**
1.	MoEF has carried out awareness raising to miners, community members and students in Maros (South Sulawesi), Gelora Bung Karno (Jakarta), North Sulawesi, Kulon Progo, Palu (Central Sulawesi), Karangjaya, Lebak (Banten), North Arut, Sukabumi, Bolaang Mongondow East and North Kalimantan. Awareness raising was also carried out to students of vocational high schools about the dangers of mercury in Serpong. Awareness raising about the dangers of mercury through the media has also been carried out in Bogor. Awareness raising on the Mercury Research and Monitoring Committee and the establishment of institutions related to mercury research and monitoring in the regions have been carried out in Manado, Gorontalo, Pekanbaru, Yogyakarta, Mataram and Ternate. Awareness raising about plans to remediate land contaminated with hazardous waste (mercury) has also been carried out in 2 districts in Lebak Regency, Banten.
2.	The Directorate General of Electricity, MoEMR in collaboration with JCOAL conducted a field visit to the Lontar CFPP, and there were a series of "Workshop on Effective Mercury Management in Relation to Coal" activities in Jakarta in 2020.
3.	The Ministry of Health (MOH) carried out awareness raising with the community, women for Family Welfare Empowerment (*Pemberdayaan Kesejahteraan Keluarga*, PKK), miners and gold processors through the Germas (Healthy Living Community Movement) Program in Lebak Regency, Konawe, (Southeast Sulawesi), Sampit (East Kotawaringin Regency), Pesawaran Regency. The West Lombok District Health Office in collaboration with the West Lombok Regency Government and the BaliFokus Foundation has raised public awareness of the dangers of mercury to health at the gold mining location and from other sources such as amalgam fillings teeth, face whitening, mercury-based medical devices, and others. In addition, awareness raising activities have also been carried out related to the elimination of mercury medical devices in healthcare facilities (hospitals and public health centers) and coordination with healthcare facilities (hospitals and public health centers) as well as cross-cutting programs and sectors in order to commit to the elimination of mercury medical devices in year 2020.
4.	MoI has carried out a Green Industry program.
5.	MoCI has already established a communication forum, where ministries/agencies take turns being invited on to the Radio of the Republic of Indonesia (RRI).
6.	Regarding RAN-PPM and in accordance with Presidential Regulation Number 21 of 2019, since 2019, BPOM has carried out several activities as follows: ▸ Declaration of the National Action for Mercury-Free Cosmetics (2019), ▸ Dissemination of Mercury Cosmetics Elimination Strategy and Program (2020), ▸ WEBINAR SERIES: STOP MERCURY COSMETICS held both at central and at Balai Besar/Balai and Loka POM throughout Indonesia in 2020 with the title: a. Webinar Series 1, STOP Mercury Cosmetics: The catastrophe behind "White in an Instant" b. Webinar Series 2, End White Obsession in an Instant, Be Proud of Your Skin Color!
7.	BPPT has carried out awareness raising of Mercury-Free Gold Processing in Kulon Progo Regency.
8.	Polri and the Indonesian National Armed Forces (T*entara Nasional Indonesia*, TNI) have raised awareness on the dangers of mercury to health to miners, traditional leaders, religious leaders, gold craftsmen, industry, local government and communities in Hulung Hamlet (Lha Village), Palu (Central Sulawesi), Tapin Regency, Wonogiri Regency, Manokwari Regency, Parakansalak District, Piru District, Waelata District, North Kalimantan Province, South Barito Regency, Kapuas Regency and Buru Island.

B.	**Local Government**
1.	The Central Sulawesi local government has conducted awareness raising in Poboya, Palu, central Sulawesi.
2.	The Gresik district government, East Java, has raised awareness on the Presidential Regulation on RAN-PPM in gold processing and the dangers of mercury to gold craftsmen, industry and local governments.
3.	The Aceh Provincial Government has conducted awareness raising in Aceh Jaya District.
4.	The Secretary of Central Kalimantan Province has carried out awareness raising in the Regencies of Gunung Mas, Katingan, East Kotawaringin to West Kotawaringin.
5.	The West Sumbawa Regency Government has carried out awareness raising for controlling illegal ASGM to illegal miners in West Sumbawa Regency.
6.	The West Seram Regency Government has conducted awareness raising in Lha and Luhu Villages, Piru District.
7.	The Cikondang Village Government, Cineam Subdistrict, Tasikmalaya Regency, has carried out awareness raising of guidance and control of mercury use to ASGM.
8.	The Public Housing Service, Environmental Settlement Area of Landak Regency, has conducted awareness raising in Kuala Behe District to the local government, traditional councils, youth leaders, community leaders and business actors.
9.	The Maluku Provincial Government has carried out awareness raising to illegal miners and the surrounding community for the implementation of the Presidential Instruction for the closure of illegal ASGM.
10.	The West Lombok Regency Government in collaboration with the West Lombok Regency Health Agency and the BaliFokus Foundation has carried out awareness raising and efforts to increase public awareness of the dangers of mercury to health, not only at gold mining activities, but also from other sources such as amalgam fillings, teeth, face whitening, mercury-based medical devices, and others.
11.	The Energy and Mineral Resources Agency of Aceh and the Energy and Mineral Resources Agency of North Kalimantan together with the Environmental Agency (*Dinas Lingkungan Hidup*, DLH) of North Kalimantan and Polri have carried out awareness raising to the community in Aceh and North Kalimantan.
12.	The DLH of East Bolaang Mongondow Regency (Boltim) together with the Artisanal Gold Council (AGC) conducted an awareness raising of "Prosperous People's Gold Mining" in Boltim Regency, January 2019.
13.	The DLH Sukabumi Regency Disseminates Mercury's Impact on the Environment in Parakansalak and Waluran Districts, November 2017. Participants: 40 participants from local government, police, and military personnel, religious leaders, community leaders and youth.
C.	**Non-Governmental Organizations (NGOs)**
1.	The Blacksmith Institute/Pure Earth has been educating miners about the health hazards of mercury and acting as a 'resource person' in various workshops on mercury.
2.	BaliFokus has made a press statement with the EcoWaste Coalition from the Philippines, warning online shoppers not to buy skin whitening cream products containing mercury from the Philippines and in collaboration with the Health Service and the West Lombok Regency Government to raise public awareness of the dangers of mercury to health, not only at mining sites gold, but also from other sources.
3.	AGC has carried out awareness raising of "Prosperous People's Gold Mining (*Program Emas Rakyat Sejahtera*, PERS)" in North Sulawesi. In collaboration with the DLH of East Bolaang Mongondow Regency (Boltim) carried out PERS awareness raising in Boltim Regency. In collaboration with ASPERA in PERS implementation, awareness raising of mercury-free alternatives in separating and refining gold from ASGM mining in Central Kalimantan and preventing the use of mercury, AGC Indonesia and the NGO Lentera Kartini conducted training at community mining sites in East Kotawaringin.
4.	The Medicuss Foundation became a resource person in the awareness raising in Lha and Luhu Villages, Piru District.
5.	The NGO Kalesang Environment Maluku has conducted awareness raising on Romang Island, which was attended by hundreds of local people.

D.	Association
1.	APRI held an international community mining conference in 2016 which was attended by more than 1,000 miners and representatives from 10 countries, initiating (the negotiation process) cooperation with several parties, including universities, the TEKMIRA Research and Development Center, business associations, banks, and a number of other private parties.
2.	ASPERA of Central Kalimantan in collaboration with AGC in the implementation of PERS, disseminated mercury-free alternatives in separating and refining gold from artisanal mining in Central Kalimantan.
E.	**Universities and Colleges**
1.	The Islamic University of Bandung (*Universitas Islam Bandung*, Unisba) has conducted awareness raising on the Risks of Mercury Exposure to Women's Health in the Unisba Campus.
2.	ITB, Unisba, Halmahera Peace Polytechnic, North Maluku Muhammadiyah University, Khairun State University, the DLH of North Halmahera Regency, has conducted a mercury and cyanide hazard awareness program in the area around the mine with case studies in the Kao Bay area, Malifut and Kao, North Halmahera.
3.	Surabaya State University and PT Gizi Indonesia Company has launched nanogold cosmetics.
4.	Mutiara Indonesia University, Medan, has held a seminar on the dangers of mercury to health.

The UNDP project will conduct an inventory of IPR in 1 (one) WPR with 6 focus locations. The objective is the formalization or enforcement of the law.

5.2. Training and Educational Opportunities Available to Target Groups and Professionals

In addition to awareness raising to increase awareness and understanding of the workforce and the community, various workshops and trainings for target groups and professionals have been conducted by various institutions. Summary of information related to workshops and training is shown in **Table 5.2.** Detailed information on workshops and training can be seen in **Annex III**.

Table 5.2. Activities related to Mercury Workshops and Training by Various Institutions

No.	Institutions and Activities Related to Workshops and Training for Target Groups and Professionals
A.	**Ministries and Institutions**
1.	MoEF has conducted PROPER, held various workshops, among others, in Jakarta and Pacitan, and technical guidance related to the awareness raising of increasing public awareness of the dangers of mercury in the South Sulawesi region. The formation of the Mercury Research and Monitoring Committee (*Komite Penelitian dan Pemantauan Merkuri*, KPPM). The launch of a laboratory car has been carried out in order to support the Early Warning System for Environmental Disasters for the areas of Banten, South Sumatra, Riau, East Java, Kutai Kartanegara-East Kalimantan. When conducting coaching, companies are always educated to use environmentally friendly goods. One of them is to endorse companies to use non-mercury lamps. In 2020, MoEF with funding from UNDP GOLD-ISMIA increased institutional capacity in Manado, Gorontalo, Pekanbaru, Yogyakarta, Mataram and Ternate.

2.	MoEMR has held workshops in Jakarta and Pacitan. The Directorate General of Electricity, MoEMR, in collaboration with UNEP held a Workshop on Hg emissions from Coal Fired Power Plants in Indonesia and a coordination meeting with electricity business actors as a follow-up to the workshop in 2017. In addition, it also held a Workshop on Capacity Building in Indonesia to Reduce Mercury Emissions from the Coal the Combustion Sector in collaboration with the US Department of State in 2020.
3.	MoH has developed guidelines on how to conduct community participatory approach specifically in ASGM locations so that they can change their behavior, developing kits for public health centers cadres in the field, the Pamekasan Health Agency provided guidance on the healthy use of cosmetics for consumers, West Lombok Health Agency in collaboration with the West Lombok Regency Government and the BaliFokus Foundation, conducted training for health workers from ASGM hotspots in the Sekotong and Pelalang areas. In addition, pilot activities for mercury-free hospitals were also carried out by providing stimulant assistance in the form of non-mercury medical devices (thermometers, sphygmomanometers) at 7 hospitals in 7 provinces in 2014-2015.
4.	MoI develops Green Industry.
5.	BPPT held workshops and initiated the establishment of INCAM as a research and technology center as well as a training center.
B.	**Local Government**
1.	The West Lombok Regency Government in collaboration with the West Lombok Health Agency and the BaliFokus Foundation conducted training for health workers from ASGM hotspots in the Sekotong and Pelangan areas.
2.	The Energy and Mineral Resources Agency of North Sulawesi Province has held a training entitled "North Sulawesi Training on Minamata Convention: NAP Baseline Data Collection."
3.	The Banten Provincial Government has conducted training on mercury testing for environmental laboratories.
C.	**Non-Governmental Organizations (NGOs)**
1.	The Blacksmith Institute/Pure Earth in collaboration with the Tambuhak Sinta Foundation (YTS) developed a health education kit and trainings for mercury-free alternative techniques and made videos on how to introduce and use retorts.
2.	BaliFokus organized workshops, and conducted training for community health center doctors, West Lombok District Health Agency staff and health workers from ASGM hotspots in the Sekotong and Pelangan areas.
3.	AGC conducted the "Sustainable Development of Artisanal and Small-Scale Gold Mining in Indonesia" project, trained national participants in the Asian Region in developing baseline estimates of mercury use and investigated socio-economic and health aspects in the ASGM sector and also conducted training in data collection at the mining site in Tobongon. In collaboration with the Energy and Mineral Resources Agency of the Province of North Sulawesi, held a "North Sulawesi Training on Minamata Convention: NAP Baseline Data Collection" training, built a laboratory-like facility that was also used for the training center in Tatelu and conducted a training on Baseline of Mercury Use Estimation in ASGM in Kotamobagu, North Sulawesi.
4.	YTS collaborated with AGC in the "Sustainable Development of Artisanal and Small-Scale Gold Mining in Indonesia" project, conducted training for miners on processing gold without mercury at the trial center and in collaboration with MoEF applied the method of mining gold without mercury (the Manado method) in Pototano.
D.	**Universities and Colleges**
1.	Airlangga University, Surabaya, produced a set of mercury test kits.
2.	Dian Nuswantoro University, Semarang, conducted a study on the awareness raising of the harmful effects of mercury on cosmetics in Semarang through the design of public service advertisements.
3.	ITB, Unisba Polytechnic of Perdamaian Halmahera, North Maluku Muhammadiyah University, Khairun State University, the DLH of the North Halmahera Regency, conducted a mercury and cyanide hazard awareness program in the area around the mine: a case study of the Kao Bay area, Malifut Dan Kao, North Halmahera.
4.	State University of Surabaya and PT Gizi Indonesia launched nanogold cosmetics.
5.	Dian Nuswantoro University, Semarang, made an animated educational video about the dangers of mercury.

5.3. Recommendations for Awareness Raising and Capacity Building on Mercury

1. Currently, solutions seem to lie in transforming ASGM into licensed and responsible small-scale mining. Granting permits therefore provides one option for a solution. For example, in Banyumas, an illegal activity nevertheless carried out CSR activities such as providing road repairs and help for the poor community. If such ASGM groups are licensed, they can be utilized for a broader range of purposes, and coaching will be provided, as it is difficult to provide coaching for illegal activities. Hence, currently, one possible option is to cooperate with miners and NGOs, such as AGC, the Tambuhak Sinta Foundation, Pure Earth/Blacksmith Institute, and others. A licensed ASGM group can be in the form of a cooperative and/or an MSME, which is better from an economic, social, and environmental standpoint. In addition, capacity building can be further enhanced, and for ASGM areas which are almost exhausted in gold, trainings for changing professions can be provided. Funding for these trainings can be obtained from the government, including Bappenas, through relevant government agencies and with clear programs and terms of reference.

2. According to Presidential Instruction No. 9 of 2015 on Public Communication Management, MoCI can serve as a coordinator for national public communications management. MoCI in collaboration with the public relations in other ministries/agencies can use all available resources in each ministry/agency to promote a particular issue. MoCI is required by this Presidential Instruction to coordinate ministries/agencies and review data and information from ministries/agencies on the mercury issue to be informed to the public (related to Article 18 of the Minamata Convention).

3. At the moment, Airlangga University has developed a set of mercury testers that will allow individuals to test mercury in water and cosmetics without having to visit a laboratory. KUMAK is the brand name for this series of mercury test kits (Mercury Test Kit in Water and Cosmetics). It is intended that BPPT would undertake a KUMAK feasibility test so that the community can use it and investors can create it. It is hoped that BPPT or P3KLL will continue to create community-friendly testing equipment.

4. In terms of monitoring, not only MoEF but also the community is expected to carry out voluntary mercury testing to determine the environmental condition of their area.

5. In relation to Articles 3, 4, 5, 8, 9, 10, 11 and 12, it is necessary to raise awareness and capacity for mercury traders, gold processors, including gold craftsmen and shops, Annex B manufacturing industry, CFPPs, boilers, smelters, incinerators, industries generating and managing mercury waste, temporary mercury storage, and handling of mercury-contaminated land.

6. The UNEP guidelines and other mercury-related guidelines need to be translated into Indonesian.

7. Use of commercials, cartoons, social media, comics, stories, and other forms of awareness raising to educate people about the hazards of mercury.

8. Educating pupils through the school curriculum.

9. A curriculum to raise awareness of mercury, particularly ASGM and industry, must be developed based on the target audience, which includes children, miners, workers, and others.

10. Separate the curriculum for awareness raising, such as animation and others, including information on what mercury is, its impact, where it is, prevention efforts, etc. with professional training, such as oil and gas training on how to treat it, its transportation and requirements, labels, protection, etc.

CHAPTER VI.
IMPLEMENTATION PLAN AND PRIORITIES FOR ACTION

Indonesia has ratified the Minamata Convention with Law no. 11 of 2017 concerning Ratification of the Minamata Convention on Mercury (State Gazette of the Republic of Indonesia Year 2017; Number 209, Supplement to the State Sheet of the Republic of Indonesia Number 6125). The ratification of the Minamata Convention is very important as the basis for the government to implement the Law which is also to implement the entire contents of the Minamata Convention.

On April 22, 2019, Presidential Regulation No. 21 of 2019 concerning RAN-PPM was issued in a concerted effort to reduce the impact of mercury on public health and the environment due to the release of mercury into the environment. Furthermore, MoEF Regulation Number P.81/ Menlhk/Setjen/Kum.1/10/2019 is stipulated for the implementation of the Presidential Regulation concerning RAN-PPM.

6.1. Manufacturing as a Priority Sector

Taking into account the national target and RAN-PPM as attached (**Annex IV** and **Annex V**), the mercury reduction targets for manufacturing priority areas and their relation to the Convention targets are as follows.

The target for mercury reduction for batteries in 2020 has yet to be determined, whereas the Convention states that these must be phased out by 2020. Meanwhile, the reduction objective for mercury in 2030 is only 50%. The 2020 phase-out target for lamps at the Convention is also targeted; in the 2020 NAP, the aim for achieving a decrease from 2018 is just 9%, and by 2030, it will be 50%.

The achievement target for mercury reduction for batteries in 2020 has not been set, while under the Convention they must be phased-out by 2020. Meanwhile, the achievement target for mercury reduction in 2030 is only 50%. For lamps, under the Convention, the phase-out target is also by 2020, in the 2020 NAP, the achievement target of reduction from the 2018 baseline is only 9% and in 2030 it will be 50%.

The Minamata Convention, in 2020, does not eliminate 100% of the use of mercury in batteries and lamps. There is a limit to the mercury content, namely button zinc silver oxide batteries with a mercury content < 2% and button zinc air batteries with a mercury content < 2% and an amount of 5 mg in lamps in the Convention which are still allowed to be used.

Furthermore, the Convention only requires mercury reduction in compact fluorescent lamps (CFL), linear fluorescent lamps (LFL), high-pressure mercury vapor lamps (HPMV), cold cathode fluorescent lamps, and external electrode fluorescent lamps (CCFL and EEFL), whereas the RAN-PPM requires mercury reduction in all types of lamps, not just those listed in the Convention.

Hence, it is recommended that the government conduct an inventory of mercury sources from manufacturing activities and their reduction alternatives and the availability of substitutes so that they can be harmonized with the Minamata Convention. The use of other manufactured products such as cosmetics that are controlled under the Convention is already prohibited under BPOM Regulation Number 23 of 2019 concerning Technical Requirements for Cosmetic Ingredients. Topical biocides and antiseptics have also been banned in Indonesia, while mercury thermometers, sphygmomanometers and dental amalgams have been regulated in RAN-PPM for the health sector as a priority.

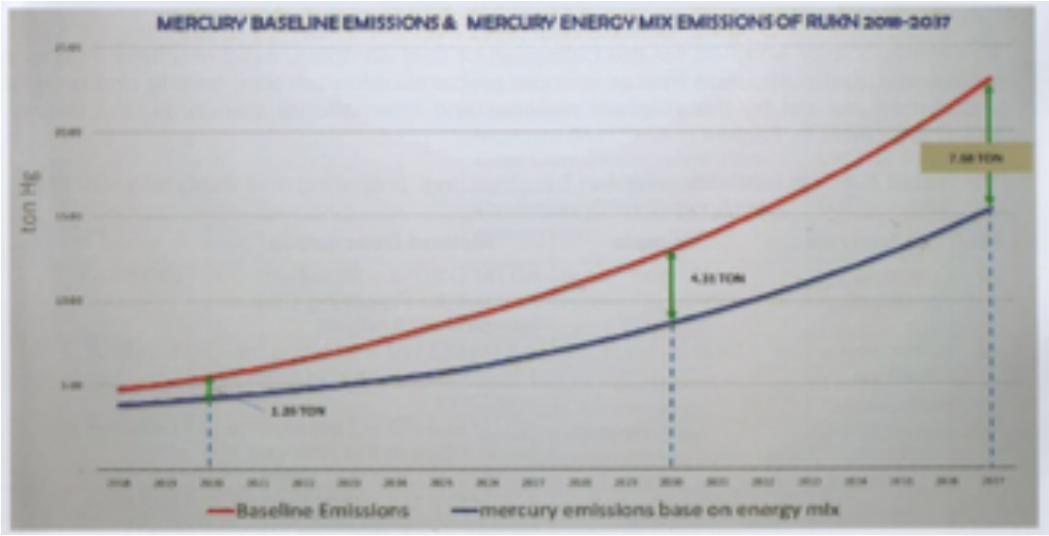
6.2. Energy as a Priority Sector

The objective for mercury emission reduction in the energy sector in 2030 is 4.31 tonne Hg, down from a baseline of 12.95 tonnes Hg, representing a 33.2 percent reduction from Business as Usual (BaU). According to the Final Report on Mercury Emissions From Coal-Fired Power Plants in Indonesia, mercury emissions from coal-fired power plants in 2026 will be 7.7 tonnes based on the UNEP Toolkit or 5.8 tonnes based on the results of Interactive Process Optimization Guidance (IPOG) modeling. In order to reduce mercury emissions in the energy industry, efforts are being made to develop new renewable energy facilities that use more efficient technologies in coal-fired power plants. This is specified in GR Number 79 of 2014 concerning National Energy Policy, which stipulates that New Energy and Renewable Energy will play at least a 23 percent part in 2025, and at least a 31 percent role in 2050, as long as the economy is fulfilled. The policy is also mentioned in PLN Company (Persero2019-2028)'s Electricity Supply Business Plan, which covers the years 2019-2038.

The reduction target for mercury emissions in the energy sector in 2030 is 4.31 tonne Hg from the baseline emission of 12.95 tonnes Hg or a 33.2% decrease from Business as Usual (BaU). Based on the Final Report on Mercury Emissions from Coal-Fired Power Plants (CFPPs) in Indonesia, it is estimated that mercury emissions from CFPPs in 2026 will be 7.7 tonnes with reference to the UNEP Toolkit or 5.8 tonnes based on the results of Interactive Process Optimization Guidance (IPOG) modeling. In order to reduce mercury emissions in the energy sector, efforts are being made to use more efficient technology in CFPPs by developing new renewable energy plants. This has been stated in GR Number 79 of 2014 concerning National Energy Policy which has stipulated that the role of New Energy and Renewable Energy will play at least 23% in 2025 and at least 31% in 2050, as long as the economy is fulfilled. The policy is also mentioned in the 2019-2038 National Electricity Master Plan and 2019-2028 Electricity Supply Business Plan of PT PLN.

According to the study of the Final Report on Mercury Emissions from Coal-Fired Power Plants in Indonesia (2017), if the power plant planning is in accordance with the 2018-2037 draft National Electricity Master Plan, mercury emissions will be reduced when compared to BaU conditions, as shown in the following figure.

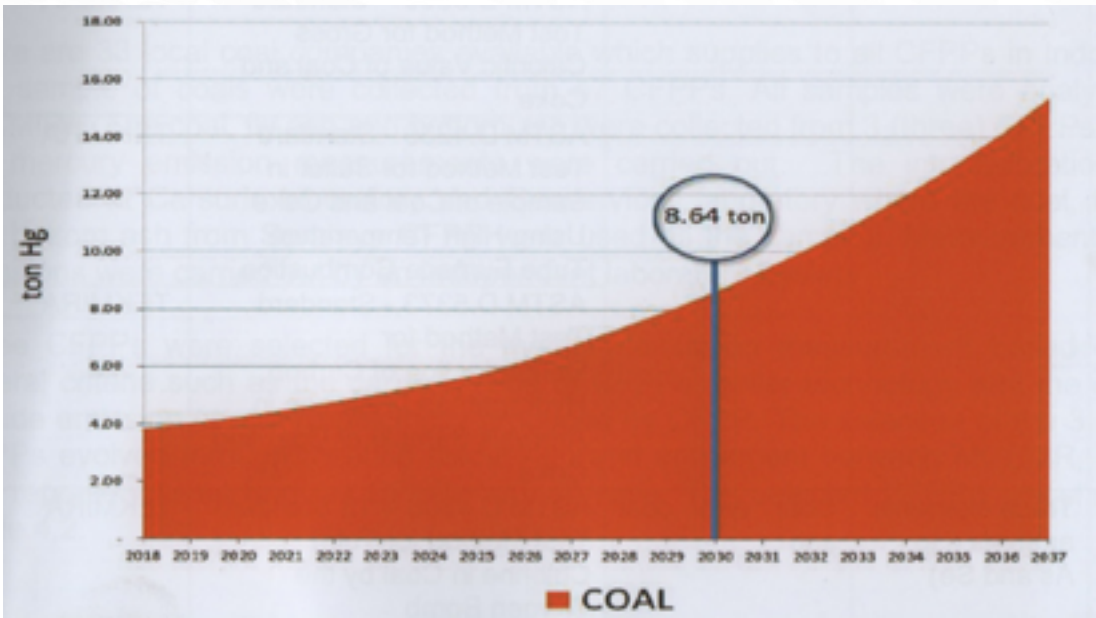
Figure 6.1. **Baseline Mercury Emissions and Energy Mix Mercury Emissions of the 2018-2037 Draft National Electricity Master Plan**



Source: Final Report Mercury Emissions From Coal-Fired Power Plants in Indonesia, 2017

The use of renewable energy must be consistent with GR Number 79 of 2014 in order to avoid an increase in mercury emissions and meet the target and RAN-PPM, as depicted in the figure below.

Figure 6.2. **Projected Mercury Emissions in the 2018-2037 Draft National Electricity Master Plan Using the BAU (Business as Usual) Scheme**



Source: Final Report Mercury Emissions From Coal-Fired Power Plants in Indonesia, 2017.

6.3. ASGM as a Priority Sector (Elimination of Mercury Use and Illegal Mining)

For the ASGM sector, and based on the RAN-PPM, in 2018 there were 180-220 locations and the target percentage reduction was set at 100% by 2025. ASGM is generally an illegal activity so that its handling requires strong efforts, one of which is by granting a permit if the mining complies with the provisions and no longer uses mercury in its mining. This is intended to facilitate guidance so that mercury is no longer used in the ASGM sector, as has been mentioned in the activity description c.2.1.1 of the RAN-PPM. In the description of the priority sector of ASGM activities, in RAN-PPM, various activities have been developed, ranging from awareness raising on the impact of mercury on the community and miners, efforts for licensing, mercury storage, remediation guidelines, research and technology development, monitoring emission status and reports, capacity building, database and information development, awareness campaigns to stop using mercury, application of alternative mercury-free gold processing technology, diversion of livelihoods of local communities and strengthening law enforcement.

According to the preceding description, sufficient efforts have been made to eliminate mercury from ASGM activities. Simplification of the process for issuing small-scale mining permits (IPR) and having the availability of clear data that does not overlap with licensed gold mining data are two things that the government should accomplish. Furthermore, it is required to offer incentives by providing an "eco-label" for gold products and the government to identify a market that accepts the eco-labelled gold product at a reasonable price in order to enhance new ecologically-friendly mining systems (in ASGM). As a result, ASGM can put the proceeds from gold sales towards environmental control.

6.4. Health as a Priority Sector

The achievement target for mercury elimination in the health sector is 100 percent by 2020, according to the RAN-PPM, with a baseline unit of 21,663 units in 2018. In 2019, the goal is to eliminate 50 percent of mercury from the environment (10,832 units). The following are several efforts to eliminate mercury in the health priority sector:

1. Increasing the existing level of commitment, coordination, and collaboration among related ministries and non-ministerial government agencies;
2. Improving coordination and collaboration between the central and locald governments;
3. Establishment of an information system;
4. Increasing community participation through communication, knowledge, and education;
5. The use of mercury-free alternative technology;
6. Improving law enforcement.

Based on the RAN-PPM, Indonesia has identified 4 (four) priority sectors in line with Annex A-D of the Minamata Convention. Priority setting to reduce and eliminate mercury is based on the inventory of mercury-producing sources that have been carried out by relevant agencies and the BaliFokus 2012 study. Considering RAN-PPM Article 7 letter b, namely monitoring and evaluation of the implementation of RAN-PPM, the results of the monitoring and inventory of mercury-producing sources in accordance with the provisions of the Convention need to be carried out to improve the RAN-PPM so that it is in line with the Convention and existing conditions in Indonesia. The implementation of the RAN-PPM is currently being monitored and evaluated.

The achievement targets for mercury reduction are provided in Annex I of the RAN-PPM, while the action plan activities are listed in Annex II. Some of the products regulated in Article 4 paragraph 1 of the Minamata Convention, have not yet been detailed or specified in the RAN-PPM, such as barometers, hygrometers and manometers. For the manufacturing sector, the description on the success indicators have been stated in more detail as in the description of activities a.3.1.1, which mentions that the identification of products and processes in the manufacturing industry that still uses mercury refers to the Minamata Convention. In the success indicators, the description of activities a.3.1.2 covers the activities of the manufacturing industry using mercury. In the description of activities a.3.1.3, the success indicator is the availability of data and information regarding the use and content of mercury in cosmetic products. Data collection on the use of mercury in manufacturing activities will also be carried out. In the description of activities a.3.1.4. the emission and release of mercury will be identified in the non-ferrous metal industry, cement industry and coal-fired industrial boilers (included in Annex D of the Minamata Convention).

Coal-fired power plant activities are included in the description of activities b.1.1.1, b.3.1.1, b.4.1.1, b.5.1.1, b.5.1.2.

Although waste incineration facilities are not listed in the RAN-PPM, government and ministerial regulations have been issued to address emissions from hazardous waste and solid waste incineration.

Presidential Regulation No. 21 of 2019 concerning RAN-PPM contains prioritized national actions based on an inventory of mercury-producing sources. However, the priority of the national action plan will not be effective if there is no funding. Based on information from Bappenas, there are no funds available on top of the funds available in each ministry and agency for implementing the 2019 RAN-PPM. At an inter-ministerial/institutional meeting for mercury reduction and elimination activities, the need for on top funds from available K/L funds was discussed. For this reason, it is recommended that MoEF propose that the RAN-PPM can be implemented with on-top funds from the usual activities of ministries/agencies and Bappenas can accept the activities of the presidential regulation mentioned above.

Given that many multinational and bilateral funds are currently available for the implementation of the Minamata Convention, it is proposed that MoEF in collaboration with relevant ministries/agencies develop a proposal for the RAN-PPM implementation.

The priority activity currently being carried out is to develop a ministerial regulation on "Environmentally Sound Intermediate Storage of Mercury." In GR Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, the storage and/or warehousing of hazardous waste is limited to maximum 365 days. Meanwhile, storage for mercury hazardous waste can be used indefinitely until treatment technology is developed. In addition, mercury storage needs to be regulated to prevent mercury exposure to the environment.

The RAN-PPM has tasked the manufacturing sector to provide 1 (one) regulation of the Minister of Industry by 2020 for the reduction and elimination of mercury in the industrial sector and this is currently being drafted. However, to strengthen the commitment to coordination and cooperation among relevant ministries/agencies, a proposal from MoEF is required as a focal point. For the implementation of Article 8 of the RAN-PPM, the development of a presidential regulation regulates the reduction and prohibition of mercury which includes activities from mining and trading, utilization, waste, recovery and transportation, availability of technology, availability of funding and stakeholder participation.

In terms of capacity building, awareness raising, training and other matters including human resources, laboratories and institutions, the RAN-PPM covers these aspects but the emphasis is on strengthening community involvement through awareness raising. This is addressed in strategies a.4, b.4, c.3, c.7 and d.4 which focuses on strengthening community involvement through communication, information and education.

In terms of laboratories, in strategy c.3 of RAN-PPM, the development of a national mercury research and monitoring laboratory will be carried out, as indicated in the activity description 3.1.1, for which the MoEF is responsible.

Currently P3KLL have been designated as mercury research centers and laboratories. However, it is also necessary to establish a mercury laboratory and research center in each province within the next five years. As a result, it is critical to improve laboratory facilities and infrastructure and their human resources, including training related to research and development of environmental laboratories in the region.

In terms of technology, BAT/BEP is specified in the description of activities a.5.1.2 letter c and strategy a.6, namely the application of environmentally friendly alternative technologies and is detailed in the description of its activities. The success indicator is the availability of reports on BAT/BEP recommendations for regulating mercury emissions and releases that can be applied in national industries. It is also mentioned in strategy b.5, the application of alternative technology without mercury.

In ASGM activities, c.2.2 activities are planned, namely the development of research and technology, but the indicator of success is the implementation of integrated cooperation. This is due to the fact that many research results on mercury from each agency have not been well coordinated. This cooperation is intended to ensure that all stakeholders are aware of each agency's research and does not run alone.

The strategy in c.6 is the application of alternative mercury-free gold processing technology, with research and technology development as the activities. In strategy d.5 the application of alternative technology without mercury, the activity is the substitution of mercury-containing medical devices.

For quality standards of air, water and soil emissions, in strategy a.2, description of activities a.2.1.1, environmental quality monitoring (multimedia) will be carried out periodically. It is also stated in the description of a.3.1.4, identification of mercury emission and release content in non-ferrous metal

industry, cement industry and coal-fired industrial boilers. In the description of activities a.5.1.2, the success indicator is the availability of mercury emission reports in the cement industry, lighting industry, non-ferrous metal industry and industries that use coal-fired boilers. In b.3.1.1, the description of the activities is the identification of mercury emission and release content in CFPPs. In activity c.2.3, monitoring of emission and release status will be carried out. In d.3.1.2, the activity description is identification of the content of mercury emissions and releases in incinerator facilities in hospitals.

In the RAN-PPM, there is no mention of advances in setting specific emission, effluent, soil contamination standards as well as more specific standards per type of activity/industry. Therefore, it is recommended that in revising RAN-PPM, it is necessary to develop more specific mercury standards for each type of activity. In relation to this, it is only mentioned in the description of activity b.5.1.1, which is to revise and strengthen regulations on environmental quality standards for mercury emissions.

In terms of supervision and law enforcement, it is mentioned in a.5.1. that the type of activity is strengthening and implementing regulations and policies with a description of activities of carrying out monitoring and evaluation and the result is a report on mercury use. However, there is no follow-up of law enforcement for violating the laws and regulations. Follow-up actions for violations of the law are regulated in the regulations on sanctions. For this reason, enforcement on these regulations is necessary.

For the energy sector, activities b.2.1 and b.2.2 are monitoring and supervising the status of emissions and releases.

For the ASGM priority sector, the activity description points, c.8.2 mentions the supervision and prosecution of mercury in the country. The description of activity c.1.1.6 is to develop a standard method for measuring mercury exposure covering nodes 1-3 (source, media and receptor) consisting of sampling and analysis methods. The activity description c.4.1.3, is the identification and improvement of national standards for the threshold value of mercury exposure to human health.

According to Presidential Regulation Number 21 of 2019 on RAN-PPM, and taking into account Attachments A, B, C, and D of the Minamata Convention, as well as the report on the inventory of mercury sources and releases in Indonesia (Chapter II), there are mercury sources in:

a. Energy priority sector, but this does not yet include activities of natural gas and crude oil extraction and processing. This is not included since it is not regulated under the Convention, despite the fact that based on the results of an inventory, these sectors are among the large mercury producers in Indonesia. Hence, further discussion is required since it is not the authority of the responsible agency in Presidential Regulation Number 21 of 2019.

b. In the manufacturing sector, an emissions inventory for information availability will be conducted only for non-ferrous metals, cement, coal-fired boilers, the cosmetics industry, insecticides, biocides, and topical antiseptics. As for lamps, in general, monitoring and evaluation of technical guidelines is carried out. This is also done for the cement industry and non-ferrous metal industry. Several other sources of mercury waste are activities to produce copper, gold extraction, bauxite processing, pulp and paper, mercury from chlor-alkali and the battery industry are not included in RAN-PPM. The Convention does not cover gold extraction activities, bauxite mining, pulp and paper manufacturing.

   Comparing with Annex A of the Convention, Part I. Products subject to Article 4 paragraph 1, lamps are not specified in RAN-PPM as in the Convention because in the RAN-PPM they apply to all types of lamps. Mercury-containing thermometers, sphygmomanometers and dental amalgams are included in the mercury-containing medical devices regulated in the RAN-PPM.

As for Annex B, Part I. The processes that are subject to Article 5 paragraph 2, they consist of two types of activities that use mercury, namely the production of chlor-alkali and the production of acetaldehyde using mercury or mercury compounds as a catalyst. This type of industry has not been included in RAN-PPM. For the chlor-alkali industry, through Presidential Regulation Number 10 0f 2021 concerning the Investment Business Sector which is the implementation of Law Number 11 of 2020, the chlor-alkali industry has been excluded from the list of closed business fields. Currently in Indonesia there is only one chlor-alkali facility that uses mercury.

Part II of Annex B. The National Action Plan for the Reduction and Elimination of Mercury does not yet include processes that are subject to Article 5 paragraph 3 for processes that use mercury, such as the production of vinyl chloride monomer, sodium or potassium methylate or ethylate, or the production of polyurethanes using a mercury-containing catalyst.

In Annex B Part II. Processes that are subject to Article 5 paragraph 3, processes that use mercury, namely the production of vinyl chloride monomer, sodium or potassium methylate or ethylate and the production of polyurethanes using a mercury-containing catalyst, are also not yet included in the RAN-PPM.

c. ASGM has been included in the RAN-PPM as per Annex C, and the details that must be carried out are close to conformance with the Convention;

d. Regarding Annex D, attention has been paid to this in the RAN-PPM, however, waste incineration facilities have not been included in the description of the RAN-PPM.

The RAN-PPM has only included some parts of Annex A-D, as the inventory data was gathered in 2012.

In order to synchronize and comply with the Minamata Convention, it is proposed to carry out an inventory that is adjusted to the list of mercury sources from the list of Annexes A to Annex D. It is also proposed that the preparation of the RAN-PPM is in accordance with the guidelines provided in the Minamata Convention.

Recommendations for proposed activities for Article 3 of the Minamata Convention can be seen in **Table 6.1**.

Table 6.1. **Proposed Activities for Article 3 of the Minamata Convention**

Article 3: Mercury supply sources and trade
Baseline & findings from the Mercury Inventory Report (Chapter II): 1. There is a large production of mercury from cinnabar mining from illegal mining activities. 2. Indonesia legally imports mercury at an average of 550 kilograms/year during 2011-2014 limited to the industrial use of 2 (two) tubes fluorescent lamps. During 2015-2016, according to the Ministry of Trade, there was no application for mercury imports. *Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:* 1. There is no information on mercury stocks as required in Article 3.5. 2. Since 2015, there has been no importation of mercury, but mercury is still used in various activities. It is estimated that mercury has both entered illegally and has been manufactured domestically from illegal cinnabar mining activities. 3. Various activities that use mercury have been banned, but have not been properly disseminated to various stakeholders including the local government, customs authorities, the Ministry of Trade, the Ministry of Industry and the community. *Recommendations for further action:*

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	3.1	Drafting a government regulation or presidential regulation regarding the ban on cinnabar mining in Indonesia.	MoEF dan MoEMR	2022
1	3.2	Law enforcement against illegal cinnabar mining.	MoEF in coordination with the Police	2022
1	3.3	Law enforcement against Article 31 of GR 74/2001 concerning the obligation to submit reports, especially mercury stocks and individual mercury compounds that exceed 50 metric tonnes, as well as sources of mercury supply that produce stocks exceeding 10 metric tonnes per year, which are located within its territory.	MoEF and MOT	2022
1	3.4	Tightening supervision of the export and import of mercury, especially at customs and must be declared and go through the red line.	Customs	2022
1	3.5	Products that contain mercury and have been banned from use need to be informed to the Ministry of Finance c.q the Directorate General of Customs.	MoEF	2022
1	3.6	It is proposed to set a specific Harmonized System (HS) number for these products, so as to make it easier for customs officials to monitor illegal imports.	Customs, MoEF, MoI, MoT	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 4 of the Minamata Convention can be seen in **Table 6.2**.

Table 6. 2. **Proposed Activities for Article 4 of the Minamata Convention**

Article 4: Mercury-added products

Baseline & findings from the Mercury Inventory Report (Chapter II):

1. Mercury is used in electrical and mechanical equipment
2. According to APERLINDO (2020), the use of LED lamps in Indonesia is increasing, the existence of around 300 million lamps was recorded in 2019. The lowest number of lamps used in 2019 was for the incandescent lamp type (16,101,490 lamps), followed by fluorescent tube lamps (48,304,469 lamps) and compact fluorescent lamps (193,217,874 lamps). The types of lamps that release mercury are the fluorescent tube lamps and the compact fluorescent lamps.
3. Indonesia legally imported 550 kilograms of mercury per year during 2010-2014 for manufacturing fluorescent lamps (tubes).
4. According to data reported from local manufacturers to the Ministry of Industry (2020), the amount of mercury used to produce batteries in 2019 was 326.1 kg. This is the last of the stock of mercury available for battery production, as the trade and use of mercury has already been banned in Indonesia.
5. Cosmetics supervision results:
   - During 2018, the POM Agency found many illegal cosmetics and/or cosmetics containing Prohibited Materials/ Hazardous Materials as much as IDR 128 billion illegal cosmetics;
   - In 2018, the discovery of tons of cosmetic raw materials containing Hg in Jakarta;
   - Data on the findings of cosmetic product supervision operations in 2019 from routine supervision, intensification of supervision and prosecution (including online) amounted to IDR 185.8 billion;
   - Illegal Cosmetics found during the 2020 Covid-19 Pandemic reached IDR 69 billion.
6. Based on questionnaires distributed to health care facilities throughout Indonesia from June 2020 to February 2021, there are 6,033 units mercury thermometer that are still in use, 20,537 units that are no longer used and stored in good condition and 9,020 units damaged. There are 20,008 units of desktop sphygmomanometers that are still in use and 24,481 are damaged. There are 4,254 units floor-standing sphygmomanometer that are still in use, and 176 spill cases in 2019. A total of 35,107 tabletop sphygmomanometers and 11,707 standing sphygmomanometers are no longer used and are stored in good condition. Approximately 26.25 kg of mercury per year is used for amalgam fillings.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Some of the products regulated in Article 4 paragraph 1 of the Minamata Convention are not yet included and have not been detailed in RAN-PPM. Examples that have not been specified as in the Convention are lamps and measuring instruments such as barometers, hygrometers, manometers.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	4.1	It is necessary to set reduction and elimination targets for products that have not been regulated in the RAN-PPM such as switches and relays, etc., for this reason it is necessary to include them during the review and revision of the RAN-PPM.	MoI	2022
1	4.2	For products listed in Annex A part I which have been included in the RAN-PPM but have not been detailed, it is necessary to set targets for their reduction and elimination in detail in accordance with the Convention.	MoI	2022
1	4.3	It is recommended that the government conduct an inventory of mercury sources from manufacturing activities and their reduction alternatives and the availability of their substitutes so that they can be harmonized with the Minamata Convention.	MoI	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 5 of the Minamata Convention can be seen in **Table 6.3**.

Table 6.3. **Proposed Activities for Article 5 of the Minamata Convention**

Article 5: Production Processes Using Mercury or Mercury Compounds

Baseline & findings from Mercury Inventory Report (Chapter II):

Currently, there is one chlor-alkali plant that uses mercury cells for the production of chlorine and NaOH, with a capacity of 3,000 tonnes/year. The industry is now trying to change its technology, otherwise it will be shut down by 2025.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Some of the processes set out in Annex B Part I and Part II of the Minamata Convention have not yet been included in the RAN-PPM.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
2	5.1	In the preparation of the Ministerial Regulation on the reduction and elimination of mercury in the industrial sector in accordance with RAN-PPM, the description of activities a.1.1.1, is proposed to regulate in detail all the industries listed in Annex B.	MoI	2022
2	5.2	Propose that a Presidential Regulation or GR be drawn up which regulates the management of mercury from the source to the disposal of mercury waste and is adjusted to the provisions of the Convention.	MoEF	2022
1	5.3	For products listed in Annex B parts I and II that have not been included in the RAN-PPM, it is necessary to set targets for their reduction and elimination as well as their restrictions in detail in accordance with the Convention.	MoI	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 6 of the Minamata Convention can be seen in **Table 6.4**.

Table 6.4. **Proposed Activities for Article 6 of the Minamata Convention**

Article 6: Exceptions for Parties Upon Request

Baseline & findings from the Mercury Inventory Report (Chapter II):

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Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Some of the products and processes regulated in Annex A and Annex B of the Minamata Convention are not yet in accordance with the reduction and elimination targets under the Convention.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	6.1	Submit exemptions to the Minamata Convention Secretariat for products and processes in Annex A and Annex B that do not meet the reduction and elimination targets set out by the Convention. For Annex A: batteries, switches and relays, lamps, barometers, hygrometers, manometers; for Annex B: production of chlor-alkali, production of vinyl chloride monomer, sodium or potassium methylate or ethylate, production of polyurethane with a mercury-containing catalyst.	MoEF	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 7 of the Minamata Convention can be seen in **Table 6.5**.

Table 6.5. **Proposed Activities for Article 7 of the Minamata Convention**

Article 7: Small-Scale Gold Mining

Baseline & findings from the National Overview of ASGM in Indonesia Report:

1. 29 out of 34 provinces in Indonesia with a total of 132 regencies and cities were identified as having ASGM with primary and secondary gold deposits.
2. The total amount of mercury emission and release to the environment from all ASGM activities in Indonesia is estimated at 345.5 tonnes per year.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Revision of the Minister of Environment Regulation Number 23 of 2008.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	7.1	Revising the Minister of Environment Regulation Number 23 of 2008.	MoEF	2022
1	7.2	Simplification in granting permits for Small-Scale Mining Permits (*Izin Pertambangan Rakyat*, IPR) and People's Mining Areas (*Wilayah Pertambangan Rakyat*, WPR) with the availability of clear data and not overlapping with licensed gold mining data.	MoEMR and Local Government	2022
3	7.3	To strengthen mining systems (in ASGM) that are environmentally friendly, incentives need to be given by creating an "eco-label" for gold products and the government looking for a market that accepts the eco- labelled gold product at a good price. Thus, ASGM can use the gold sales funds for environmental management.	MoEF	2025

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 =high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 8 of the Minamata Convention can be seen in **Table 6.6**.

Table 6.6. **Proposed Activities for Article 8 of the Minamata Convention**

Article 8: Emissions

Baseline & findings from the Mercury Inventory Report (Chapter II):

1. Sampling has been carried out in the air for baseline data at several locations by the MoEF.
2. Currently there are 141 active Coal Power Plants (PLTU) in Indonesia with various types of boilers, capacities, and air pollution control devices. Total coal consumption in 2018 was 91.4 million tonnes, with lignite coal composition of 61.7 million tonnes (67.4%) and the remaining 29.8 million tonnes (32.6%) was sub-bituminous coal. Measurements of Hg emissions have been carried out from 84 PLTU boilers owned by 46 companies. Other available data are emission debits, operating hours during a certain period, and the amount of coal consumed during that period.
3. The individual mercury release sub-categories contributing the highest inputs of mercury were gold (and silver) extraction by mercury amalgamation process (362,343 kg/yr), gold extraction and initial processing by methods other than mercury amalgamation (101,750 kg/yr), electrical switches and relays with mercury (36,953 kg/yr), copper extraction and initial processing (32,079 kg/yr).
4. The individual mercury release sub-categories contributing the highest mercury releases to the atmosphere were gold (and silver) extraction by mercury amalgamation process (102,223 kg/yr), incineration of hazardous waste (15,830 kg/year), electrical switches and relays with mercury (11,086 kg/yr), other non-ferrous metals extraction (9,470 kg/yr) and coal combustion in coal fired power plants (5,370 kg/yr).

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. The mercury emission quality standards have not been specifically determined for all of the sources of mercury emissions as regulated in Annex D of the Convention, namely for coal-fired boilers and the smelting and roasting processes carried out in the production of non-ferrous metals;
2. The absence of BAT/BEP for mercury emission control for all mercury emission sources as set out in Annex D of the Convention.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
3	8.1	Incorporate alternative use of supercritical technology in the preparation and determination of BAT and BEP guidelines for controlling mercury emissions from coal-fired boilers in power plants (National Action Plan for Mercury Reduction and Elimination activities description b.1.1.1)	MoEMR and MoEF	2025
3	8.2	Specify mercury emission quality standards specifically for all sources of mercury emission in Annex D to the Convention which have not yet been regulated, namely coal-fired boilers and smelting and roasting processes used in the production of non-ferrous metals.	MoEF	2025
4	8.3	Incorporate waste incineration facilities into RAN-PPM.	MoEF	2025
3	8.4	To facilitate monitoring of mercury in the air, a toolkit is needed so that it can detect the mercury concentration in the air. For this reason, it is hoped that P3KLL-MoEF will consult with BPPT to develop guidelines for the monitoring procedures.	MoEF and BPPT	2025

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 =medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 9 of the Minamata Convention can be seen in **Table 6.7**.

Table 6.7. **Proposed Activities for Article 9 of the Minamata Convention**

Article 9: Release

Baseline & findings from the Mercury Inventory Report:

1. Sampling has been carried out on river water, soil, rice, hair, plants and biota for baseline data in several locations by MoEF.
2. Waste and wastewater may represent substantial flows of mercury through society. The following were found to be the major flows of mercury with waste and wastewater: informal dumping of waste, incineration of hazardous waste, wastewater system/treatment, incineration of medical waste, and informal waste burning.
3. The biggest source of release comes from gold (and silver) extraction by mercury amalgamation into water (103.553 kg/yr) and soil (131.930 kg/yr).
4. Other sources for releases:
   - Extraction and use of fuel/energy sources;
   - Primary metal production;
   - Production of minerals and other materials with mercury impurities;
   - Intentional use of mercury in industrial processes;
   - Consumer products with intentional use of mercury;
   - Intentional use in other products/processes;
   - Waste incineration and burning;
   - Waste deposition/landfill and wastewater treatment;
   - Crematoriums and funerals.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. The quality standards for mercury release to soil have not been specifically determined for all significant sources of mercury release.
2. The quality standards for mercury release to soil have not been specifically determined for all significant sources of mercury release and quality standard according to land use is not yet available.
3. A practical tool for detecting mercury is not yet available.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	9.1	Establish wastewater quality standards for mercury parameters for all significant sources of mercury release to water.	MoEF	2022
1	9.2	Establish quality standards for mercury release to soil and establish mercury quality standards on land based on location designations, for example for industry, settlements and others.	MoEF	2022
3	9.3	To facilitate the monitoring of mercury in water and soil, a practical toolkit is needed to detect mercury concentration in the environment. For this reason, it is hoped that P3KLL-MoEF will consult with BPPT to develop guidelines for the monitoring procedures.	MoEF and BPPT	2025
2	9.4	It is expected that BPPT or P3KLL-MoEF review and recommend test equipment that has been created by the community (individuals, universities, research centers, etc.).	MoEF and BPPT	2024
4	9.5	Regarding monitoring, not only the Ministry of Environment and Forestry, but the community are also expected to conduct a voluntary mercury test to find out the condition of their area.	MoEF and NGO	2028
2	9.6	Monitoring and inventory of mercury-producing sources in accordance with the provisions of the Convention needs to be carried out to improve the National Action Plan for the Reduction and Elimination of Mercury so that it is in line with the Convention and existing conditions in Indonesia.	MoEF	2023
2	9.7	It is also necessary to develop a mercury laboratory and a research center in each province in the next 5 (five) years. For this reason, it is necessary to improve laboratory facilities and infrastructure and their human resources, including training related to research and development of environmental laboratories in the region.	MoEF and Local Government	2026

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 10 of the Minamata Convention can be seen in **Table 6.8**.

Table 6.8. **Proposed Activities for Article 10 of the Minamata Convention**

Article 10: Environmentally friendly temporary storage for Mercury, other than Mercury waste
Baseline & findings from the Mercury Inventory Report (Chapter II): - *Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:* 1. Technical guidelines for the requirements criteria for hazardous substances storage, the definition of storage for hazardous substances and hazardous waste must be distinguished so that the provisions regarding storage for 365 days at the longest for mercury are no longer in effect. 2. There needs to be an explanation regarding the meaning of mercury waste storage and storage based on the Convention because the Convention is intended as the final treatment of mercury waste so that the time exceeds 365 days according to GR 22 of 2021. *Recommendations for further action:*

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	10.1	Develop technical guidelines for criteria for requirements for hazardous substances storage, including the definition of storage for hazardous substances and hazardous waste must be distinguished. The guidelines should also include the definition of hazardous substances which includes the meaning of the definition of hazardous materials. In this guideline, it is necessary to stipulate "Environmentally Sound Intermediate Storage of Mercury", since in GR Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, the storage and/or warehousing of hazardous waste is only 365 days. Meanwhile, storage for mercury hazardous waste can be used continuously, before the processing technology is obtained. In addition, mercury storage needs to be regulated so that mercury exposure to the environment can be prevented. MSMEs that produce mercury in remote areas need to be considered as well.	MoEF	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 11 of the Minamata Convention can be seen in **Table 6.9**.

Table 6.9. **Proposed Activities for Article 11 of the Minamata Convention**

Article 11: Mercury Waste

Baseline & findings from the Mercury Inventory Report (Chapter II):
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Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. Information on mercury quality standards in Indonesia as hazardous waste.
2. More specific guidelines for the treatment (reuse, recycle, recovery etc.) of hazardous waste in accordance with the Convention or disposed of on condition that it must be environmentally friendly disposal.
3. Mercury concentration requirements in the utilization of mercury waste.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
2	11.1	Indonesia must be more active in setting standards for mercury waste in the Convention in the working group because Indonesia already has its own standards and/or follows the Basel Convention, namely recognizing international standards but also recognizing the standards of each country or following the requirements of the Convention if it is in accordance with social, economic, environmental and cultural conditions Indonesia.	MoEF	2022
2	11.2	Develop more specific guidelines for the treatment (reuse, recycle, recovery etc.) of mercury waste in accordance with the Convention or disposed of on the condition that it must be environmentally friendly.	MoEF	2024
2	11.3	Adding mercury concentration requirements in the utilization of mercury waste	MoEF	2024

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 12 of the Minamata Convention can be seen in **Table 6.10**.

Table 6.10. **Proposed Activities for Article 12 of the Minamata Convention**

Article 12: Contaminated Land

Baseline & findings from the Mercury Inventory Report (Chapter II):

1. MoEF has carried out remediation of mercury-contaminated land by ExxonMobil Oil Indonesia Inc in North Aceh District, Aceh Province in 2012.
2. MoEF has carried out remediation of mercury-contaminated land in Lebak Regency, Banten in 2019 and plans to prepare a Feasibility Study (FS) Document for the Remediation of Mercury-Contaminated Land in the Mount Botak Area, Waelata District, Buru Regency, Maluku Province in the 2021 fiscal year.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. Coverage of all methods and approaches contained in the Convention in the preparation of guidelines for the remediation of contaminated land.
2. Develop a program plan at the Ministry of Environment and Forestry for the remediation of mercury-contaminated land, especially in ASGM locations.
3. Carry out remediation as has been done in Lhokseumawe and Lebak Regency, Banten, as described in Chapter II.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	12.1	Conduct inventory of locations contaminated by mercury for remediation	MoEF	2022
2	12.2	Complementing the methods and approaches of the Convention in the preparation of guidelines for the remediation of mercury-contaminated land (RAN-PPM, activity description c.1.1.5) especially the risk of impacts on human health with a risk assessment methodology.	MoEF	2024
2	12.3	Prepare program plans at the MoEF, MoH and related ministries for the remediation of mercury contaminated land, especially in ASGM locations.	MoEF	2022
2	12.4	Carry out remediation as has been done in Lhokseumawe and Lebak Regency, Banten, for locations contaminated with mercury as described in Chapter II.	MoEF	2023

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 13 of the Minamata Convention can be seen in **Table 6.11**.

Table 6.11. **Proposed Activities for Article 13 of the Minamata Convention**

Article 13: Sources and Mechanisms of Funding

Baseline & findings from the Mercury Inventory Report (Chapter II):
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Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Funding for the implementation of Presidential Regulation No. 21 of 2019 concerning RAN-PPM.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
1	13.1	Propose that the RAN-PPM can be included in the National Medium-Term Development Plan with on-top funds from existing activity plans originating from the APBN and APBD. Ministries/agencies and Ministry of National Development Planning can accept activities from RAN-PPM and include them in the National Medium-Term Development Plan and in the blue book if foreign assistance is required.	MoEF	2022
1	13.2	MoEF and related ministries/agencies develop proposals to multinational and bilateral funds for the implementation of RAN-PPM to be proposed to Ministry of National Development Planning to be included in the blue book.	MoEF	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Article 14 of the Minamata Convention can be seen in **Table 6.12**.

Table 6.12. **Proposed Activities for Article 14 of the Minamata Convention**

Article 14: Capacity Building, Technical Assistance and Technology Transfer

Baseline & findings from the Mercury Inventory Report (Chapter II):

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Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. To improve the performance of the Agency for the Assessment and Application of Technology (BPPT) to create non-mercury technology, it is necessary to conduct studies to find mercury substitutes in various activities that use mercury.
2. Capacity building for stakeholders related to import, export, use, emission, release of mercury to the environment and cinnabar mining.
3. UNEP, WHO and other guidelines related to mercury need to be translated into Indonesian.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
2	14.1	Research needs to be done to suitable substitutes for mercury in various activities that use mercury in order to create non-mercury technology.	BPPT	2022
2	14.2	Increasing the capacity of stakeholders related to import, export, use, emission, release of mercury to the environment and cinnabar mining.	MoT and MoEF	2022
2	14.3	UNEP, WHO and other guidelines related to mercury need to be translated into Indonesian.	MoEF and MoH	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low 5 = very low

Recommendations for proposed activities for Article 16 of the Minamata Convention can be seen in **Table 6.13**.

Table 6.13. **Proposed Activities for Article 16 of the Minamata Convention**

Article 16: Health Aspect

Baseline & findings from the Mercury Inventory Report (Chapter II):

In a study conducted by the Medicuss Foundation (2018) in several ASGM locations in the provinces of East Kalimantan, Maluku, South Sulawesi and West Java, it was found that miners reported suffering from muscle aches, headaches, impaired concentration, sleep disturbances, and some miners reported vibrations (tremors) in their hands.

Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. Development of guidelines for eating fish by looking at their daily intake.
2. Often the symptoms of the health effects of mercury are similar to those of nervous disorders, such as cramps and loss of balance. For this reason, it is necessary to conduct a study on the impact of mercury, especially on children, by conducting toxicological research, which includes testing the placenta of babies born to mothers with mercury levels in their blood, nails and hair exceeding the established standards.
3. Taking into account that mercury is also widely used by micro, small and medium enterprises (MSMEs) with gold craftsmen, thus specific arrangements are needed to protect the health of workers and the environment in this activity.
4. Considering that mercury has such a negative impact on human health, it is critical for health workers, such as doctors and nurses in public health centers, to understand mercury and its health effects, as well as prevention and treatment options. This is especially important in areas where mercury is expected to be released to the environment, such as at ASGM locations. This requires adequate funding (capacity building for all public health centers).
5. Availability of a reporting system from the regions to the center if mercury is detected so that it can be treated early. Reporting from the public health center to the local health agency (*Dinas Kesehatan*, Dinkes)/DLH.
6. Availability of the minimum equipment needed to detect mercury levels in blood, urine, hair, nails and long term for all public health centers in each district.
7. For proving mercury in the human body and the environment, a portable tool is needed to prove mercury contamination in the human body and the environment.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
3	16.1	Develop guidelines for eating fish by looking at their daily intake.	BPOM	2026
2	16.2	Conduct studies on the impact of mercury, especially on children, by conducting toxicological research, which includes testing the placenta of babies born to mothers with mercury levels in their blood, nails and hair exceeding the established standards.	MoH	2024
2	16.3	Specific arrangements for the protection of workers' health and the environment in micro, small and medium enterprises (MSMEs) with gold craftsmen.	Ministry of Manpower (MoM)	2024
2	16.4	Capacity building for all community health centers is prioritized in areas that are estimated to be exposed to mercury to the environment, for example in ASGM locations.	MoH	2023
2	16.5	There is a reporting system from the regions to the center if mercury is detected. Reporting from the public health center to local health agency (Dinkes/DLH).	MoH	2022
2	16.6	Provide a portable device to each sub-district to detect mercury levels in blood, urine, hair, nails and long term for all community health centers.	MoH	2024

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Articles 17-21 of the Minamata Convention can be seen in **Table 6.14**.

Table 6.14. **Proposed Activities for Articles 17-21 of the Minamata Convention**

Article 17-21: Exchange of Information-Awareness Raising

Baseline & findings from the Mercury Inventory Report (Chapter II):
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Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

1. Develop an information system that covers the various activities related to studies and reports on health and safety and the environment.
2. Information system that can be used for emergency response.
3. Under Presidential Instruction Number 9 of 2015 concerning Public Communication Management. MoCI can serve as a coordinator for the national public communication management. It can collaborate with the public relations in other ministries/agencies by utilizing all available resources within each ministry/agency to promote a particular issue. With this Presidential Instruction, MoCI needs to coordinate ministries/agencies and review data and information from ministries/agencies related to mercury issues to be informed to the public.
4. Awareness raising in an interesting and easy to understand form about the dangers of mercury such as commercials, animations, social media, comics, fairy tales, and so on.
5. Awareness and capacity building for mercury traders, gold processors, including gold craftsmen and shops, Annex B manufacturing industries, CFPPs, boilers, smelters, incinerators, industries generating and managing mercury waste, temporary mercury storage, people involved in mercury-contaminated land remediation and surrounding communities.
6. Noting that BPJS has not been able to cover the costs of sufferers of mercury exposure due to difficulties in proving the symptoms of the illness, MoH is to ask the BPJS to include symptoms of mercury-related illness.
7. Miner associations, environmental and health NGOs play a very important role in monitoring, coaching, capacity building and mercury-free technology for local government and regency/city human resources. For this reason, it is necessary to further enhance cooperation with the government, companies and the community.
8. Universities are very important in various efforts to handle mercury as well as carry out the necessary research to minimize the use of mercury and exposure to mercury. It is hoped that the cooperation of all stakeholders can continue to be improved.
9. Noting that mercury is also widely used by MSMEs with gold craftsmen, it is necessary to regulate and raise awareness as well as transfer technology for activities by gold craftsmen who do not use mercury.
10. Some gold craftsmen are known to already use environmentally friendly technology. This needs to be publicized so that it can be an example for other craftsmen.
11. Conduct an inventory and information system for data collection to facilitate reporting obligations to the Minamata Convention Secretariat (so information is not scattered).
12. Carry out surveillance and law enforcement efforts to users, importers, exporters, waste management, implementation of 3R, cinnabar mining, both legal and illegal.

Recommendations for further action:

Priority*		Proposed Action/Activity	Responsible Agency	Timeframe
2	17.21.1	Develop an information system that covers several activities related to studies and reports on health and safety and the environment.	MoEF	2022
2	17.21.2	Information system that can be used for emergency response.	MoEF	2023
2	17.21.3	In cooperation with public relations, ministries/agencies use all available resources in each ministry/agency to promote a particular issue. With Presidential Instruction No. 9 of 2015, MoCI needs to coordinate ministries/agencies and review data and information from ministries/agencies related to mercury issues to be informed to the public.	MoCI	2023
2	17.21.4	Awareness raising in an interesting and easy to understand form about the dangers of mercury such as advertisements, animations, social media, comics, stories and others.	MoH	2022

2	17.21.5	Awareness and capacity building for mercury traders, gold processors, including gold craftsmen and shops, Annex B manufacturing industries, CFPPs, boilers, smelters, incinerators, industries generating and managing mercury waste, temporary mercury storage, people involved in mercury-contaminated land remediation and surrounding communities.	MoEF	2024
2	17.21.6	More widespread awareness raising of the risk of disease caused by mercury.	MoH	2022
2	17.21.7	Increase the cooperation of all stakeholders (central government, local government, associations, environmental and health NGOs, universities).	MoEF	2022
2	17.21.8	Regulation and awareness raising as well as technology transfer of gold craftsman activities to non-mercury processes.	MoEF	2023
2	17.21.9	Awareness raising of environmentally friendly technology by several gold craftsmen to be an example for other craftsmen.	MoEF	2024
1	17.21.10	Conduct an inventory and information system for data collection to facilitate reporting obligations to the Minamata Convention Secretariat (so information is not scattered).	MoEF	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

Recommendations for proposed activities for Articles 25-30 of the Minamata Convention can be seen in **Table 6.15**.

Table 6.15. **Proposed Activities for Articles 25-30 of the Minamata Convention**

Article 25-30: Participation as a Party/Administrative Issue

Baseline & findings from the Mercury Inventory Report (Chapter II):
-
Outstanding Minamata Convention Requirements that the country needs to comply with in order to meet its future commitments:

Stating that any amendment to Annex A, B or C shall enter into force only on the basis of the deposit of its instrument of ratification, acceptance, approval or accession to the amendment (Article 30.5).

Recommendations for further action:

Priority*	Proposed Action/Activity	Responsible Agency	Timeframe
3	Stating that any amendment to Annex A, B, or C shall enter into force only upon the deposit of its instrument of ratification, acceptance, approval or accession to the amendment (Article 30.5)	MoEF	2022

*Indicates the priority level for each proposed action/activity with the following indications: 1= very high; 2 = high; 3 = medium; 4 = low; 5 = very low

CHAPTER VII.
CONCLUSIONS AND RECOMMENDATIONS

The following actions are proposed, taking into account the RAN-PPM, the Minamata Convention framework, and the conditions for mercury reduction and elimination in Indonesia:

1. In preparing the RAN-PPM, it is proposed that the recommended template table be adapted to meet with the Minamata Convention, including financing planning for carrying out its operations. The funding is made in accordance with the schedule. Following up on the implementation of Article 21 of the Convention, adapting the RAN-PPM to its template will make compliance and reporting to the Minamata Convention Secretariat easier.

2. The RAN-PPM is expected to include funding and be included in the National Mid-Term Development Plan, as well as Kementerian PPN/ Bappenas's blue book for programs that require foreign support. As a result, MoEF in partnership with other ministries and institutions, will develop a TOR, which is to then be submitted to Kementerian PPN/Bappenas for inclusion in the blue book. The funding is expected to be on-top of any funds that the ministries/agencies may receive.

3. The following are the planned activities in order of priority:

Table 7.1. **Priority on the Proposed Activities**

Priority	Number of Proposed Activities from Table 6.1 to 6.15
Very High	3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 4.1, 4.2, 4.3, 5.3, 6.1, 7.1, 7.2, 9.1, 9.2, 10.1, 12.1, 13.1, 13.2, 17.21.10
High	5.1, 5.2, 9.4, 9.6, 9.7, 9.8., 11.1, 11.2, 11.3, 12.2, 12.3, 12.4, 14.1, 14.2, 14.3, 16.2, 16.3, 16.4, 16.5, 16.6, 17.21.1, 17.21.2, 17.21.3, 17.21.4, 17.21.5, 17.21.6, 17.21.7, 17.21.8, 17.21.9
Medium	7.3, 8.1, 8.2, 8.4, 9.3, 16.1, 17.21.4, 25.30.1
Low	8.3, 9.5
Very Low	-

4. It is proposed that the priority program of the RAN-PPM be maintained when the Covid-19 epidemic is declared to have ended in 2021, as proposed by MoEF in collaboration with other ministries/agencies.

5. It is expected that the local governments will develop Regional Action Plans as soon as possible, in conformity with the framework outlined in MoEF Regulation Number 81 of 2019.

6. Based on the identification of mercury sources, it is proposed that several other mercury sources that are not controlled under the Minamata Convention are monitored and if they show an increase they need to be included in the RAN-PPM.

7. In the import and export of mercury, it is necessary to consider the provisions stipulated in Article 3 of the Minamata Convention and the

provisions in the Rotterdam Convention and clearer arrangements are needed in the revision of GR Number 74 of 2001 and the development of other implementing regulations.

8. The mining sector delivers the extraction of non-renewable natural resources. Therefore, it is hoped that the mining sector can become a trigger or generator for other sectors so that the economy is no longer dependent on mining.

9. With the amendment of Law No. 32 of 2009 through Law No. 11 of 2020 concerning Job Creation, the Environmental Permit was changed to a provision for environmental approval, it needs to be ensured that mercury and mercury-containing tailings are still managed as hazardous waste in accordance with applicable laws and regulations, with reference to GRs no. 22 of 2010.

10. Considering that some of the data needed for the inventory are not yet available, it is hoped that regular monitoring of mercury emissions and releases, as well as the establishment of mercury emission standards, will be carried out for the types of activities regulated by the Minamata Convention, as follows:

- Extraction and use of fuel/energy sources;
- Primary metal production;
- Production of minerals and other materials with mercury impurities;
- Intentional use of mercury in industrial processes;
- Consumer products with intentional use of mercury;
- Intentional use in other products/processes;
- Waste incineration and burning;
- Waste deposition/landfill and wastewater treatment;
- Crematoriums and funerals.

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ANNEXES

Annex I. Stakeholders Involved in the Development of the MIA

Stakeholder institutions which have been involved in the development of the MIA by providing inputs, among others, through interviews, questionnaires, delivering presentations and participations in meetings, workshops and focus group discussions can be seen in **Table Annex 1**.

Table Annex 1. **Stakeholders Institutions Involved in the Development of MIA**

No	Title/Institution
1.	Assistant of Minister of Environment and Forestry for Supporting Field of Hazardous Solid Waste Management
2.	Directorate General of Solid Waste, Hazardous Wastes and Substances Management, Ministry of Environment and Forestry
3.	Directorate of Hazardous Substances Management, Ministry of Environment and Forestry, Ministry of Environment and Forestry
4.	Directorate of Remediation of Contamination and Emergency Response of Hazardous Wastes, Ministry of Environment and Forestry
5.	Directorate of Assessment of Hazardous Wastes and Non-Hazardous Wastes Management Performance, Ministry of Environment and Forestry
6.	Directorate of Remediation of Open Access Damage, Ministry of Environment and Forestry
7.	Directorate of Water Pollution Control, Ministry of Environment and Forestry
8.	Centre for Research and Development of Environmental Quality and Laboratory, Ministry of Environment and Forestry
9.	Head of Centre for Environmental and Forestry Standardization, Ministry of Environment and Forestry
10.	Directorate of Occupational Health and Sports, Ministry of Health
11.	Directorate of Environmental Health, Ministry of Health
12.	Directorate of Technical and Environmental Mineral and Coal, Ministry of Energy and Mineral Resources
13.	Directorate of Technical and Environmental Electricity, Ministry of Energy and Mineral Resources
14.	Coordinating Ministry for Economic Affairs
15.	Coordinating Ministry for Maritime and Investment Affairs
16.	Coordinating Ministry for Political, Legal, and Security Affairs
17.	Directorate of Import, Ministry of Trade
18.	Directorate of Supervision of Circulating Goods and Service, Ministry of Trade
19.	Directorate of Export of Industry and Mining Products, Ministry of Trade
20.	Directorate of Downstream Chemical Industry, Ministry of Industry
21.	Directorate of Technical Customs, Directorate General of Customs and Excise, Ministry of Finance
22.	Directorate of Economic and Environmental Development, Ministry of Foreign Affairs
23.	Directorate of Public Media Management, Ministry of Communication and Information
24.	Directorate of Guidance for Labor Supervision and Occupational Health and Safety, Ministry of Manpower
25.	Environmental Agency of DKI Jakarta Province
26.	Environmental Agency of Lebak Regency

27.	Research Centre for Chemistry, Indonesian Institute of Sciences
28.	Clean Technology Research Institute, Indonesian Institute of Sciences
29.	Center for Mineral Resources Development Technology, Agency for the Assessment and Application of Technology
30.	Criminal Investigation Agency, National Police of Republic of Indonesia
31.	Artisanal Gold Council
32.	BaliFokus
33.	Indonesian Centre for Environmental Law
34.	Medicuss Foundation
35.	Pure Earth/Blacksmith Institute
36.	Yayasan Tambuhak Sinta
37.	UN Environment
38.	University of Edinburgh
39.	Basel and Stockholm Conventions Regional Centre for Southeast Asia
40.	PT Prasadha Pamunah Limbah Indonesia
41.	School of Environmental Sciences, University of Indonesia

Annex II. List of Legislations Related to Mercury Management in Indonesia

Legislations related to mercury management in Indonesia can be seen in the **Table Annex 2**.

Table Annex 2. **Legislations and Regulations Related to Mercury Management in Indonesia**

Number	Legislations and Regulations
1.	Law Number 11 of 2017 concerning Ratification of the Minamata Convention on Mercury.
2.	Presidential Regulation Number 21 of 2019 concerning National Action Plan for Reduction and Elimination of Mercury
3.	Minister of Environment and Forestry Regulation Number P.81/Menlhk/Setjen/ Kum.1/10/2019 concerning Implementation of Presidential Regulation Number 21 of 2019 concerning National Action Plan for Reduction and Elimination of Mercury
	Mercury Source **Primary Mercury Mining**
1.	Law Number 4 of 2009 concerning Mineral and Coal Mining
2.	Law Number 32 of 2009 concerning Environmental Protection and Management.
3.	Law Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining.
4.	Law Number 11 of 2020 concerning Job Creation.
5.	Government Regulation Number 19 of 1973 concerning the Arrangement and Supervision of Safety in the Mining Sector
6.	Government Regulation Number 22 of 2010 concerning Mining Areas.
7.	Government Regulation Number 23 of 2010 concerning the Implementation of Mineral and Coal Mining Business Activities.
8.	Government Regulation Number 5 of 2021 concerning Implementation of Risk-Based Business Licensing.
9.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
10.	Minister of Environment Regulation Number 23 of 2008 concerning the Technical Guidelines for the Prevention of Pollution and/or Environmental Damage Due to People's Gold Mining.
11.	Minister of Energy and Mineral Resources Regulation Number 26 of 2018 concerning Implementation of the Good Mining Practices and Supervision of the Mineral and Coal Mining
12.	Minister of Energy and Mineral Resources Regulation Number 7 of 2020 concerning Procedures for Giving the Region, Licensing, and Reporting on the Mineral and Coal Mining Business Activities
13.	Minister of Energy and Mineral Resources Decree Number 1796 K/30/MEM/2018 concerning Implementation Guidelines for the Application, Evaluation and Issuance of Licences for Mineral and Coal-Mining Activity.
14.	Minister of Energy and Mineral Resources Decree Number 1827 K/30/MEM/2018 concerning Guidelines for Implementation of Good Mining Engineering Standards
15.	Decree of the Director General of Mineral and Coal of the Ministry of Energy and Mineral Resources Number 185.K/37.04/DJB/2019 concerning Technical Guidelines for the Implementation of Mining Safety and the Implementation, Assessment and Reporting of the Mineral and Coal Mining Safety Management System.

Mercury Trade	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Law Number 10 of 2013 concerning Ratification of the Rotterdam Convention on The Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
3.	Law Number 7 of 2014 concerning Trade.
4.	Government Regulation Number 74 of 2001 concerning Hazardous Substances Management
5.	Minister of Environment Regulation Number 02 of 2010 concerning the Use of the Electronic Registration System for Hazardous Substances
6.	Minister of Trade Regulation Number 75/M-DAG/PER/10/2014 concerning the Second Amendment to the Regulation of the Minister of Trade Number 44/M DAG/PER/9/2009 concerning the Procurement, Distribution and Supervision of Hazardous Substances.
7.	Minister of Trade Regulation Number 47 of 2019 concerning Third Amendment of The Regulation of The Minister of Trade Number 44/M-Dag/Per/9/2009 concerning Procurement, Distribution and Supervision of Hazardous Substances.
8.	Minister of Industry and Trade Decree Number: 254/MPPKep/7/2000 concerning the Trading System for the Import and Circulation of Certain Hazardous Substances.
Mercury Utilization	
1.	Law Number 1 of 1970 concerning Work Safety.
2.	Law Number 4 of 2009 concerning Mineral and Coal Mining
3.	Law Number 18 of 2008 concerning Waste Management.
4.	Law Number 32 of 2009 concerning Environmental Protection and Management.
5.	Law Number 36 of 2009 concerning Health
6.	Law Number 3 of 2014 concerning Industry.
7.	Law Number 22 of 2019 concerning Sustainable Agricultural Cultivation Systems.
8.	Law Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining.
9.	Law Number 11 of 2020 concerning Job Creation.
10.	Government Regulation Number 74 of 2001 concerning Management of Hazardous Substances.
11.	Presidential Regulation Number 10 of 2021 concerning the Investment Business Sector.
12.	Minister of Environment and Forestry Regulation Number 23 of 2008 concerning the Technical Guidelines for the Prevention of Pollution and/or Environmental Damage Due to People's Gold Mining.
13.	Minister of Health Regulation Number 1189/MENKES/PER/VIII/2010 concerning Production of Medical Devices and Household Health Supplies.
14.	Minister of Agriculture Regulation Number 39/Permentan/SR.330/7/2015 concerning Pesticide Registration.
15.	Minister of Health Regulation Number 7 of 2019 concerning Hospital Environmental Health.
16.	Minister of Health Regulation Number 41 of 2019 concerning Elimination and Withdrawal of Mercury-Containing Medical Devices in Healthcare Facilities
17.	Minister of Trade Regulation Number 47 of 2019 concerning Third Amendment of The Regulation of The Minister of Trade Number 44/M-Dag/Per/9/2009 concerning Procurement, Distribution and Control of Hazardous Substances.
18.	Minister of Environment and Forestry Regulation Number P.27/Menlhk/Setjen/Kum.1/12/2020 concerning Management of Medical Device Waste Containing Mercury.
19.	Department of Manpower and Transmigration Decree Number 124/M/SK/4/1985 concerning Handling, Processing, Transport, and Storage of Hazardous Chemicals.

20.	Minister of Industry Decree Number 148 of 1985 concerning Safeguarding of Hazardous Substances in Industrial Companies.
21.	Minister of Manpower Decree Number KEP.187/MEN/1999 concerning Control of Hazardous Chemicals in the Workplace.
22.	Head of the National Police of the Republic of Indonesia Regulation Number 2 of 2008 concerning Supervision, Control and Security of Commercial Explosives.
23.	Food and Drug Supervisory Agency Regulation Number 23 of 2019 concerning Technical Requirements for Cosmetic Ingredients.
24.	Circular Letter of Director General of Pharmacy and Medical Devices, Ministry of Health, Number HK.02.02/V/0720/2018 concerning Determination of Validity Period of Distribution License and Distribution of Mercury-Containing Medical Devices
25.	Circular Letter of the Directorate General of Health Services Number HK.02.02/V/0361/2019 concerning the Obligation to Have a Temporary Hazardous Waste Storage Place (TPS-LB3) in Healthcare Facilities.
26.	Circular Letter of the Directorate General of Health Services Number HK.02.02/I/2899/2019 concerning Elimination and Withdrawal of Mercury-Containing Medical Devices.
Mercury Waste	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Law Number 11 of 2020 concerning Job Creation.
3.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
4.	Presidential Decree Number 61 of 1993 concerning Ratification of the Basel Convention on The Control of Transboundary Movements of Hazardous Wastes and Their Disposal.
5.	Minister of Environment and Forestry Regulation Number P.56/Menlhk-Setjen/2015 concerning Procedure and Technical Requirement for Hazardous Wastes Management from Healthcare Facilities.
6.	Minister of Environment and Forestry Regulation Number 6 of 2021 concerning Procedures and Requirements for Hazardous Wastes Management
7.	Minister of Health Regulation Number 7 of 2019 concerning Environmental Health in Hospitals
Mercury Emission	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
3.	Minister of the Environment Decree Number KEP.13/MENLH/3/1995 concerning Quality Standards for Emissions from Stationary Sources.
4.	Minister of Environment Regulation Number 07 of 2007 concerning Quality Standards for Emissions from Stationary Sources for Steam Boilers.
5.	Minister of Environment Regulation Number 4 of 2014 concerning Quality Standards for Emissions from Stationary Sources for Mining Businesses and/or Activities.
6.	Minister of Environment Regulation Number P.70/Menlhk/Setjen/Kum.1/8/2016 concerning Quality Standards for Business Emissions and/or Thermal Waste Processing Activities.
7.	Minister of Environment and Forestry Regulation Number P.19/Menlhk/Setjen/Kum.1/2/2017 concerning Emission Quality Standards for Cement Industry Business and/or Activities.
8.	Minister of Environment and Forestry Regulation Number P.15/Menlhk/Setjen/Kum.1/4/2019 concerning The Emission Quality Standard for Thermal Power Plants
9.	Minister of Environment and Forestry Regulation Number 6 of 2021 concerning Procedures and Requirements for Hazardous Wastes Management

Mercury Release	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Law Number 11 of 2020 concerning Job Creation.
3.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
4.	Minister of Environment Regulation Number 5 of 2014 concerning Wastewater Quality Standards.
5.	Minister of Environment Decree Number 202 of 2004 concerning Wastewater Quality Standards for Gold and/or Copper Ore Mining Businesses and/or Activities.
6.	Minister of Environment and Forestry Regulation Number 6 of 2021 concerning Procedures and Requirements for Hazardous Wastes Management
Contaminated Land	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Law Number 11 of 2020 concerning Job Creation.
3.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
4.	Minister of Environment and Forestry Regulation Number 101 of 2018 concerning Guidelines for the Remediation of Land Contaminated by Hazardous Waste.
Freight/Transport	
1.	Law Number 32 of 2009 concerning Environmental Protection and Management.
2.	Law Number 22 of 2009 concerning Traffic and Road Transport.
3.	Law Number 11 of 2020 concerning Job Creation.
4.	Government Regulation Number 74 of 2014 concerning Road Transport.
5.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
6.	Government Regulation Number 30 of 2021 concerning Implementation of Traffic and Road Transport Field.
7.	Minister of Transportation Regulation Number KM. 02 of 2010 concerning Amendments to Minister of Transportation Decree Number KM 17 of 2000 concerning Guidelines for Handling Dangerous Material/ Goods in Shipping Activities in Indonesia.
8.	Minister of Transportation Regulation Number PM. 90 of 2013 concerning Safety of Transportation of Dangerous Goods by Airplane.
9.	Minister of Transportation Regulation Number PM. 29 of 2014 concerning Maritime Environment Pollution Prevention
10.	Minister of Transportation Regulation Number 48 of 2014 concerning Procedures for Loading, Arranging, Transporting, and Unloading Goods by Train
11.	Minister of Transportation Regulation Number PM 52 of 2016 concerning Amendments to Minister of Transportation Regulation Number 48 of 2014 concerning Procedures for Loading, Compiling, Transporting and Unloading Goods by Train.
12.	Minister of Transportation Regulation Number PM 58 of 2016 concerning Amendments to Minister of Transportation Regulation Number PM 90 of 2013 concerning the Safety of Transportation of Dangerous Goods by Airplane.
13.	Minister of Transportation Regulation Number PM 60 of 2019 concerning the Implementation of the Transportation of Goods by Motor Vehicles on the Road.
14.	Minister of Environment and Forestry Regulation Number 6 of 2021 concerning Procedures and Requirements for Hazardous Wastes Management.

15.	Minister of Transportation Decree Number KM 17 of 2000 concerning Guidelines for Handling Dangerous Material/Goods in Shipping Activities in Indonesia
16.	Director General of Land Transportation Decision Letter No. SK.725/AJ.302/DRJD/2004 concerning Transportation of Hazardous Substances on The Road.
17.	Circular Letter of Director General of Sea Transportation Number UM. 003/1/2/DK-15 concerning Hazardous Wastes Transportation for Ship Carrying Indonesian Flag.
Financial Resources	
1.	Law Number 9 of 2020 concerning State Revenue and Expenditure Budget for Fiscal Year 2021.
2.	Presidential Regulation Number 113 of 2020 concerning Details of the State Budget for Fiscal Year 2021.
3.	Financial Services Authority Regulation Number 60/POJK.04/2017 concerning Issuance and Requirements for Environmentally Friendly Debt Securities.
4.	Financial Services Authority Regulation Number 51/POJK.03/2017 concerning the Implementation of Sustainable Finance for Financial Service Institutions, Issuers and Public Companies.
Information Exchange and Public Awareness Raising	
1.	Law Number 14 of 2008 concerning Public Information Disclosure
2.	Law Number 32 of 2009 concerning Environmental Protection and Management.
3.	Law Number 36 of 2009 concerning Health.
4.	Law Number 11 of 2020 concerning Job Creation.
5.	Government Regulation Number 61 of 2010 concerning the Implementation of Law Number 14 of 2008 concerning Public Information Disclosure.
6.	Government Regulation Number 46 of 2014 concerning Health Information Systems.
7.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
8.	Presidential Instruction Number 9 of 2015 concerning the Management of Public Communication.
9.	Minister of the Environment Regulation Number 03 of 2014 concerning the Company Performance Rating Program in Environmental Management.
10.	Minister of Health Regulation Number 56 of 2016 concerning the Implementation of Occupational Disease Services.
Monitoring and Law Enforcement	
1.	Law Number 4 of 2009 concerning Mineral and Coal Mining
2.	Law Number 32 of 2009 concerning Environmental Protection and Management.
3.	Law Number 3 of 2020 concerning Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining.
4.	Law Number 11 of 2020 concerning Job Creation.
5.	Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management
6.	Minister of Trade Regulation Number 47 of 2019 concerning Third Amendment of The Regulation of The Minister of Trade Number 44/M-Dag/Per/9/2009 concerning Procurement, Distribution and Control of Hazardous Substances.

Annex III. Awareness Training and Training Activities to Increase Understanding/ Awareness Raising among Workforce, Community, Target Groups and Professionals Concerning the Impact of Mercury on Health and Environment

Awareness raising activities to the community to raise awareness about the impact of mercury on health and the environment that have been carried out by various institutions can be seen in **Table Annex 3.1**.

Table Annex 3.1. **Institutions and Awareness Raising Activities to the Community Concerning Mercury**

No.	Institution	Awareness Raising Activities to the Community Concerning Mercury
A.	**Ministries & Bodies (K/L)**	
1.	MoEF	- Awareness raising in Maros, South Sulawesi, August 2018. Participants: College students, School students, residents - Awareness raising at *Car free day* at Gelora Bung Karno area, Senayan, Jakarta, July 2018. - Awareness raising of "Pertambangan Emas Rakyat Sejahtera" in North Sulawesi, August 2018. - Awareness raising of Mercury-Free Gold Processing, Kulon Progo Regency, July 2018. - Awareness raising in Poboya, Palu, Central Sulawesi since 2016. - Dissemination of guidance and control of mercury use to gold miners in Karangjaya. Participants: about 50 gold miners from Karang Jaya District. - Awareness raising to the residents and gold miners in Lebak Regency, Banten, 2018. - Awareness raising to gold miners in North Arut District, October 2018. - 25th Anniversary P3KLL *"History and Future Environmental Cooperation Between Indonesia and Japan"*, with material on Mercury, in Serpong on August 7th, 2018. - *Tropical Forestry and Environment Research Festival* in Serpong on August 13th, 2019, namely awareness raising to vocational school students comcerning the dangers of mercury. - *International Conference of Indonesia Forestry Researchers*, INAFOR in Bogor on August 29th, 2019, namely awareness raising about the dangers of mercury through the media. - Increasing institutional capacity through awareness raising on KPPM and the establishment of institutions related to mercury research and monitoring in the regions. January to March 2020 in Manado, Gorontalo, Pekanbaru, Yogyakarta, Mataram and Ternate. - Awareness raising of the plan to restore land contaminated with B3 (mercury) waste in Girimukti Village, Cilograng District, Lebak Regency, Banten in 2019; - Awareness raising on the recovery of land contaminated with hazardous waste (mercury) in Ciladaeun Village, Lebakgedong District, Lebak Regency, Banten, 2019.
2.	MoEMR	The Directorate General of Electricity in collaboration with JCOAL conducted a field visit to the Lontar PLTU, which was part of a series of activities of *"Workshop on Effective Mercury Management in Relation to Coal"* in Jakarta, February 13th, 2020. The stakeholder is PT Indonesia Power.

3.	MoH	- Directorate of Environmental Health:
		  - Awareness raising on to the elimination of mercury-containing medical measuring devices in healthcare facilities (hospitals and public health centers)
		  - Coordination with healthcare facilities (hospitals and public health centers) as well as across related programs and sectors concerning commitment to the elimination of mercury-containing medical measuring devices by 2020.
		- Directorate of Occupational Health and Sports:
		  - Awareness raising of the prevention and control of the impact of mercury pollution through the Germas Program, Lebak Regency, May 2017.
		  Participants: around 100 people from the *muspika* elements of Lebak Gedong District, Women member of Family Welfare Programme (*PKK*), miners and gold processors.
		  - Awareness raising of Germas in the context of health impacts due to mercury in Sampit, East Kotawaringin Regency, May 2017.
		  Participants: health office, local government and local police, religious leaders and miners

No.	Institution	Awareness Raising Activities to the Community Concerning Mercury

		- Directorate of Health Promotion and Community Empowerment:
		  - Awareness raising of the dangers of mercury in the context of Germas in Konawe Regency, Southeast Sulawesi Province, May 2017.
		  - Germas awareness raising on the harmful impact of mercury in Teluk Pandan District, Pesawaran Regency, May 2017. Participants: Hundreds of employees of the Teluk Pandan District Health Center attended.
		  - Awareness raising of Germas in the context of controlling health impacts due to mercury exposure (youtube)
		- West Lombok District Health Office: In collaboration with the West Lombok Regency Government and the BaliFocus Foundation: Increase public awareness of the dangers of mercury to health, not only at gold mining activities, but also from other sources such as amalgam, dental fillings, face whiteners, mercury-containing medical measuring devices, and others, 2015.

4.	MoI	Conducting Green Industry Program
5.	MoCI	- Establishment of a communication forum, where ministries/agencies are invited in turn to Radio of the Republic of Indonesia (RRI).

6.	National Agency of Drug and Food Control (BPOM)	Regarding RAN-PPM in accordance with Presidential Regulation Number 21 of 2019, BPOM has conducted several activities as follows:
		- The declaration of the National Action for Mercury-Free Cosmetics (2019) was held at the Resinda Hotel, Karawang, on 27 August 2019. The commitment to raising mercury-free cosmetics was signed, represented by Secretary of the Karawang Regency, Representative from MoH, Representative from MoT, Representatives from MoEF, Representatives of the Polri Criminal Investigation Agency; Representatives of the Association of Cosmetic Business Actors; and Millennial Generation Representatives.
		- The preparatory meeting for the Dissemination of the National Strategy for the Elimination of Mercury in Cosmetics on 17 July 2020 took place at the Aryaduta Hotel, Jakarta.
		- Preparation for the Dissemination of the National Strategy for the Elimination of Mercury in Cosmetics in Jakarta on 28 July 2020.
		- National Strategy Formulation Meeting on the Elimination of Mercury in Cosmetics, in Jakarta on 5 August 2020.
		- Dissemination of the Mercury Cosmetics Elimination Strategy and Program in Jakarta on 19 August 2020. It is a dissemination of implementation results of the National Strategy Formulation for Mercury Elimination in Cosmetic Products sourced from the strategy that was set out in RAN-PPM. The delivery of this dissemination is carried out by the head of the relevant central agency aimed at relevant agencies in the region through the local POM Center/Balai/Loka POM.
		- Webinar Series: Stop Mercury Cosmetics
		  a. Webinar Series 1 STOP Mercury Cosmetics: The disaster behind "White in an Instant" on 16 September 2020 (https://www.youtube.com/watch?v=BBrVgOOd01c&t=1828)
		  b. Webinar Series 2, End White Obsession in an Instant, Be Proud of Your Skin Color! on 23 October 2020 (https://www.youtube.com/watch?v=H70hXZOV6Q4&t=5419s).

		Awareness raising conducted by Balai Besar/Balai and Loka POM on mercury-containing cosmetics: - The Belitung POM workshop intensively invites the public to Stop Mercury Cosmetics, 9 October 2020; - Together with FKH Unsyiah, BBPOM Aceh Invites Millennials to Choose Smart Cosmetics, 15 October 2020; - Mercury Cosmetics on the Radio, 3 November 2020; - Beauty Doesn't Have to be White", BPOM Ambon Again Holds KIE Cosmetics Online, 10 December 2020; - Makassar BBPOM is back with a new innovation, namely MOLKIKA (Safe Cosmetic Mobile Laboratory Car), 6 May 2021
7.	Agency for the Assessment and Application of Technology (BPPT)	Awareness raising of Mercury-Free Gold Processing, Kulon Progo Regency, July 2018

No.	Institution	Awareness Raising Activities to the Community Concerning Mercury
8.	Indonesian National Police (Polri) and Indonesian National Army (TNI)	- Dusun Hilir Police, Barsel Police, Central Kalimantan Police: Awareness raising on the prohibition of illegal mining, use of mercury/cyanide chemicals and illicit trafficking in Mengkatip Village, Buntok, April 2021. - Jenamas Police, Barsel Police, Central Kalimantan Police: Awareness raising on the prohibition of illegal mining, use of mercury/cyanide chemicals and illicit trafficking in Rantau Kujang Village, July 2021. - Kapuas Timur Police, Kapuas Police, Central Kalimantan Police: Awareness raising of the prohibition of illegal mining, the use of mercury/cyanide chemicals and illicit trafficking at the Anjir border, Central Kalimantan-South Kalimantan km.14 East Kapuas District. Kapuas Regency, Central Kalimantan Province. - Maluku Regional Police: - Awareness raising of the closure of the cinnabar mine at Tembaga Mountain, Seram Island, Maluku, 2020. - Awareness raising of the dangers of illegal mining on Mount Botak, Buru Island, Maluku, 2018-2019. - Huamual Police: Awareness raising of the dangers of mercury to public health and illegal ASGM, Hulung Hamlet, Lha Village, April 2017 Participants: about 500 miners and local traditional leaders. - Tapin Police: Awareness raising of the dangers of mercury and the prohibition of mercury use to the people of Tapin Regency, November 2017 - Poboya, Palu, Central Sulawesi since 2016 - Selogiri Police, Wonogiri Police: Awareness raising of the prohibition on the use of mercury in ASGM, 2017 - Gresik Police: Awareness raising of the Presidential Instruction on RAN-PPM in gold processing and the dangers of mercury. Participants: gold craftsmen, industry, local government - Directorate of ComDev Polda West Papua: In Masni District, Manokwari Regency, November 2017. Participants: about 100 local people - Sukabumi Police: Awareness raising of Law Number 11 of 2017 concerning Mercury in Sukakersa Village, Parakansalak District, November 2017 Participants: DPRD members, DLH, *muspika* elements, religious leaders, community representatives from 4 (four) sub-districts - Kodam XVI/Pattimura: In Lha and Luhu Villages, Piru District, May 2017 - Mandailing Natal District Police: Awareness raising of the dangers of mercury to religious leaders and the community - Kodim Namlea: Awareness raising of the dangers of using mercury to the community of Dava Village, Waelata District, Buru Regency, June 2017 - In collaboration with Public Environmental Service Office of North Kalimantan and the Energy and Mineral Resources Office of North Kalimantan to disseminate information on the harmful effects of mercury use in North Kalimantan.
B.	**Local Government**	
1.	Government of Central Sulawesi	Awareness raising in Poboya, Palu, Central Sulawesi since 2017
2.	Government of Gresik Regency, East Java	Awareness raising of the Presidential Instruction on RANPPM in gold processing and the dangers of mercury. Participants: goldsmiths, industry, local government
3.	Government of Aceh	Awareness raising in Aceh Jaya District, April 2018
4.	Provincial Secretary of Central Kalimantan	Awareness raising in Gunungmas, Katingan, East Kotawaringin to West Kotawaringin Regencies
5.	Government of West Sumbawa Regency	Awareness raising for controlling Unlicensed Gold Mining to Unlicensed Gold Miners and rod mills workers in West Sumbawa Regency, 2018
6.	Government of West Seram Regency	Awareness raising in Lha and Luhu Villages, Piru District, May 2017
7.	Office of Cikondang Village, Cineam District, Tasikmalaya Regency	Awareness raising of the guidance and control of mercury use to ASGM, November 2018

No.	Institution	Awareness Raising Activities to the Community Concerning Mercury
8.	Public Housing Service, Environmental Settlers Area of Landak Regency	Awareness raising in Kuala Behe District. Participants: local government, tradition councils, youth leaders, community leaders, business owner
9.	Government of Maluku	Awareness raising to illegal miners and the surrounding community for the implementation of the Presidential Instruction for the closure of illegal ASGM, 2017
10.	Government of West Lombok Regency	In collaboration with the West Lombok Regency Government and the BaliFocus Foundation: Increase public awareness of the dangers of mercury to health, not only at gold mining activities, but also from other sources such as amalgam, dental fillings, face whiteners, mercury-containing medical measuring devices, and others, 2015
11.	Energy and Mineral Resources Office of Aceh	Awareness raising to the community in areas related with gold activity potential to the dangers of using mercury to the surrounding environment, 2016.
12.	Energy and Mineral Resources Office of North Kalimantan and Environmental Services Office of North Kalimantan	Collaborating with the Police to disseminate information on the harmful effects of mercury use in the province of North Kalimantan.
13.	Environmental Services Office of Bolaang Mongondow Timur Regency	Together with the Artisanal Gold Council (AGC) conducted an awareness raising of *"Pertambangan Emas Rakyat Sejahtera"* in Bolaang Mongondow Timur Regency, January 2019.
14.	Environmental Services Office of Sukabumi Regency	Dissemination of Mercury's Impact on the Environment in Parakansalak and Waluran Districts, November 2017. Participants: 40 participants from local government, police, and military personnel, religious leaders, community and youth leaders.
C.	**Non-Governmental Organizations (NGOs)**	
1.	Blacksmith Institute/ Pure Earth	- Educate miners about the health hazards of mercury - Resource persons in various workshops on mercury
2.	BaliFokus	- Joint press statement with the EcoWaste Coalition from the Philippines, warning online shoppers not to buy skin whitening cream products containing mercury from the Philippines, November 2018 - In collaboration with the West Lombok Regency Government and Public Health Office: Increase public awareness of the dangers of mercury to health, not only at gold mining activities, but also from other sources such as amalgam, dental fillings, face whiteners, mercury-containing medical measuring devices, and others, 2015
3.	Artisanal Gold Council (AGC)	- Awareness raising of "Pertambangan Emas Rakyat Sejahtera (PERS)" in North Sulawesi, August 2018. - In collaboration with Public Environmental Services Office of Bolaang Mongondow Timur (Boltim) Regency, conducting PERS awareness raising in Boltim Regency, January 2019. Several PERS activities are: construction of mercury-free gold processing facilities, mineral processing training, gender equality training, cooperative driving training, basic data inventory training mercury use and environmental monitoring training. - Collaborating with AGC in implementing PERS, socializing mercury-free alternatives in separating gold from mining in Central Kalimantan. - Preventing the Use of Mercury, AGC Indonesia and the NGO Lentera Kartini Conduct Guidance at People's Mining Locations in East Kotawaringin.
4.	Medicuss Foundation	Resource persons in awareness raising in Lha and Luhu Villages, Piru District, May 2017.
5.	LSM Kalesang Lingkungan Maluku	The awareness raising on Romang Island, March 2018 was attended by hundreds of local people.
D.	**Association**	

No.	Institution	Awareness Raising Activities to the Community Concerning Mercury
1.	Indonesian People's Miners Association (*Asosiasi Penambang Rakyat Indonesia,* APRI)	Organizing the International People's Mining Conference in 2016 which was attended by more than 1000 miners and representatives from 10 friendly countries, initiation (negotiation process) of cooperation with several parties, including universities, Research and Development Center tekMIRA, associations of entrepreneurs, banks, and several other private parties.
2.	People's Mining Association *(Asosiasi Pertambangan rakyat,* ASPERA)	ASPERA Central Kalimantan collaborates with AGC in implementing PERS, socializing mercury-free alternatives in separating gold from mining in Central Kalimantan.
E.	**Universities and Colleges**	
1.	Bandung Islamic University (Unisba)	Awareness raising of the Risks of Mercury Exposure on Women's Health in the Unisba Campus.
2.	ITB, Unisba, Poltek Perdamaian Halmahera, Univ. Muhammadiyah Maluku Utara, Univ. Negeri Khairun, DLH Kab. Halmahera Utara	Mercury and Cyanide Hazard Awareness Program in Mine Circle Areas: A Case Study of the Kao Bay Area, Malifut and Kao, North Halmahera.
3.	State University of Surabaya, *PT Gizi Indonesia*	Launching Nanogold Cosmetics, Collaboration between Unesa & PT Gizi Indonesia.
4.	Universitas Mutiara Indonesia, Medan	Organizing a Mercury Hazard Seminar for Health.

Workshops and trainings have also been carried out by various institutions to target groups and professionals as shown in **Table Annex 3.2.**

Table Annex 3.2. **Training Activities and Educational Opportunities Available to Target Groups and Professionals**

No.	Institution	Activities Related to Workshops and Training for Target Groups and Professionals
A.	**Ministries & Bodies (K/L)**	
1.	MoEF	- Company Performance Rating Program/*Program Penilaian Peringkat Kinerja Perusahaan* (PROPER) - Workshop on "*Integrasi Pemantauan dan Penelitian Merkuri Sebagai Basis Kebijakan untuk Mewujudkan Indonesia Bebas Merkuri 2030*" in Serpong, 3rd May 2018 through P3KLL and in collaboration with BaliFokus. - Workshop "*Alih Teknologi Pengolahan Emas Bebas Merkuri*" in Pacitan Regency, 21st July 2016 - Workshop on Hg Emissions from Coal-Fired Power Plants in Indonesia in Jakarta, 20th March 2017 - Technical Guidance, Regarding the Awareness raising of Increasing Public Awareness Against Mercury Hazards in the South Sulawesi Region, August 2018. - The establishment of the Mercury Research and Monitoring Committee/*Komite Penelitian dan Pemantauan Merkuri* (KPPM) based on the Decree of the Minister of Environment and Forestry No. 340 of 2018 on August 4th, 2018. - Launch of a laboratory car in order to support the Early Warning System for Environmental Disasters for 5 regions, namely Banten, South Sumatra, Riau, East Java and Kutai Kartanegara-East Kalimantan . - When conducting coaching, the company is always given an understanding to use environmentally friendly goods. One of them is to endorse companies to use non-mercury lamps. - Institutional capacity building by MoEF with funding from UNDP GOLD-ISMIA in Manado, Gorontalo, Pekanbaru, Yogyakarta, Mataram and Ternate in 2020.

No.	Institution	Activities Related to Workshops and Training for Target Groups and Professionals
2.	MoEMR	- The Directorate General of Mineral and Coal in collaboration with the MoEF and BPPT held a Workshop "*Alih Teknologi Pengolahan Emas Bebas Merkuri*" in Pacitan Regency, 21 July 2016. - The Directorate General of Electricity in collaboration with UNEP conducted a Small-Scale Funding Agreement on Hg emissions from Coal-Fired Power Plants in Indonesia, by holding a Workshop on Hg Emissions from Coal-Fired Power Plants in Indonesia in Jakarta, 20 March 2017. - The Directorate General of Electricity in collaboration with UNEP held a coordination meeting with electricity business actors as a follow-up to the Workshop on Hg Emission from Coal-Fired Power Plants in Indonesia, April 2017. The stakeholders are PT PLN (Persero), Independent Power Producers (IPP) and Associations. - The Directorate General of Electricity in collaboration with the US Department of State (US Embassy) held a Workshop on Capacity Building in Indonesia to Reduce Mercury Emissions from the Coal Combustion Sector in Jakarta, January 29, 2020. Stakeholders are ministries/agencies, PT PLN (Persero), Independent Power Producers (IPP) and Associations. - The Energy and Mineral Resources Office of North Sulawesi in collaboration with AGC held a training "North Sulawesi Training on Minamata Convention: NAP Baseline Data Collection", 4 December 2017.
3.	MoH	- Pilot activities for mercury-free hospitals by providing stimulant assistance in the form of non-mercury medical devices (thermometers, sphygmomanometers) at 7 hospitals in 7 provinces in 2014-2015. - Develop guidelines to approach specific community participation in ASGM locations for their behavioral changes. - Develop kits such as equipment that can be used by Public Healthcare Center cadres when they go to the field. - Pamekasan Health Office: Guidance on Healthy Use of Cosmetics for Consumers, April 2016 - West Lombok District Health Office: In collaboration with the West Lombok Regency Government and the BaliFokus Foundation: Conduct training for health workers from ASGM hotspots in the Sekotong and Pelangan areas, West Lombok Regency to understand the dangers of mercury, recognize the symptoms of mercury poisoning, and detect early symptoms of mercury poisoning especially in mothers, infants, and children, 2015.
4.	MoI	- Green Industry
5.	Agency for the Assessment and Application of Technology (BPPT)	- Workshop "*Alih Teknologi Pengolahan Emas Bebas Merkuri*" in Pacitan Regency, 21 July 2016 - Initiated the establishment of the Indonesian Center for Artisanal Mining (INCAM) as a research and technology center as well as a training center.
B.	**Local Government**	
1.	Government of West Lombok Regency	In collaboration with the West Lombok District Health Office and BaliFokus Foundation: Conduct training for health workers from ASGM hotspots in the Sekotong and Pelangan areas, West Lombok Regency to understand the dangers of mercury, recognize the symptoms of mercury poisoning, and detect early symptoms of mercury poisoning especially in mothers, infants, and children, 2015.
C.	**Non-Governmental Organizations (NGOs)**	
1.	Blacksmith Institute/ Pure Earth	- Cooperating with YTS to develop health education and trainings for mercury-free alternative techniques - Create a video to introduce an easy and inexpensive retort that gold miners can use to recapture the mercury burned during the gold mining process.

No.	Institution	Activities Related to Workshops and Training for Target Groups and Professionals
2.	BaliFokus	- Workshop on "*Integrasi Pemantauan dan Penelitian Merkuri Sebagai Basis Kebijakan untuk Mewujudkan Indonesia Bebas Merkuri 2030*" in Serpong, 3rd May 2018 through P3KLL and in collaboration with MoEF. - Training for PHCC doctors and staff of West Lombok District Health Office to recognize the symptoms of mercury poisoning are also in Jakarta, October 20 to 22, 2014. - In collaboration with the Government of the West Lombok Regency and West Lombok District Health Office: Conduct training for health workers from ASGM hotspots in the Sekotong and Pelangan areas, West Lombok Regency to understand the dangers of mercury, recognize the symptoms of mercury poisoning, and detect early symptoms of mercury poisoning especially in mothers, infants, and children, 2015.
3.	Artisanal Gold Council (AGC)	- The "Sustainable Development of Artisanal and Small-Scale Gold Mining in Indonesia" project, in collaboration with Global Affairs Canada and the Tambuhak Sinta Foundation in Central Kalimantan, South Kalimantan, Java and Sulawesi. The project has 3 (three) pillars i.e., training on better practices for male and female miners and training for government and community groups on the regulation and management of ASGM (2016-2021). - UNITAR and AGC trained national participants in the Asian Region in compiling baseline estimates of mercury use and investigating socio-economic and health aspects of the ASGM sector, as well as training in data collection at a mining site in Tobongon, North Sulawesi (27th November – 1st December 2017). - In collaboration with the Energy and Mineral Resources Office of North Sulawesi Province held a training "North Sulawesi Training on Minamata Convention: NAP Baseline Data Collection", 4th December 2017. - In collaboration with the Alliance of Indigenous Peoples of the Archipelago (AMAN) of North Sulawesi, through PERS, to build facilities such as a laboratory which is also used for the training center in Tatelu. Activities i.e., capacity training for women's and children's groups about the dangers of mercury and the roles they can play. - Baseline Training on Estimating the Use of Small-Scale Gold (ASGM) in Kotamobagu, North Sulawesi, 16th-19th October 2018 and in Sampit, Central Kalimantan, 23rd-26th October 2018.
4.	Yayasan Tambuhak Sinta	- Collaborating with AGC in the "Sustainable Development of Artisanal and Small-Scale Gold Mining in Indonesia Project (2016-2021). - Training for miners on processing gold without mercury in the test center. - In collaboration with MoEF, applying the mercury-free gold mining method (the Manado method) in Pototano, West Sumbawa and Kebon Sari Village, Pacitan.
D.	**Universities and Colleges**	
1.	Airlangga University, Surabaya	Preventing Mercury Hazard, UNAIR Students Produce a Test Kit Named "KUMAK".
2.	Dian Nuswantoro University, Semarang	- Research: Socializing the Impact of Mercury Hazards on Cosmetics in Semarang through the Design of Public Service Advertisements. - Two-Dimensional Animated Educational Video Regarding the Danger of Mercury to the Community of Central Lombok Regency as an Impact of Illegal Gold Mining
3.	ITB, Unisba, Poltek Perdamaian Halmahera, University of Muhammadiyah North Maluku, Univ. Negeri Khairun, DLH of North Halmahera Regency	Mercury and Cyanide Hazard Awareness Program in Mine Circle Areas: Case Study of Kao Bay Area, Malifut and Kao, North Halmahera
4.	State University of Surabaya, PT Gizi Indonesia	Launching Nanogold Cosmetics, Collaboration between Unesa & PT Gizi Indonesia

Annex IV. National Target of Mercury Reduction and Elimination

Table Annex 4.1. **Mercury Reduction Target Achievement**

Achievement	Year												
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Priority Areas of Manufacturing													
a.1. Battery													
Baseline (percentage per production):	0.0202												
Achievement Target (percentage per production)		0.0202	0.0202	0.0192	0.0182	0.0172	0.0162	0.0152	0.0141	0.0131	0.0121	0.0111	0.0101
Achievement Target (%)				95	90	85	80	75	70	65	60	55	50
a.2. Lamp													
Baseline (kg/Year):	163												
Achievement Target (kg)		156	149	142	135	129	122	115	108	101	94	87	81.5
Achievement Target from 2018 Condition (%)		96	91	87	83	79	75	71	66	62	58	53	50
Priority Areas of Energy	**AMOUNTS OF REDUCTION OF MERCURY EMMISION FROM BUSINESS AS USUAL IN YEAR 2030**												
Emission Baseline (Ton)	12.95												
Emission Reduction (Ton)													4.31
Reduction Percentage (%)													33.2

Table Annex 4.2. **Mercury Elimination Target Achievement**

Achievement	Year							
	2018	2019	2020	2021	2022	2023	2024	2025
C. Priority Areas of ASGM (Elimination of the Use of Mercury and Illegal Mining)								
Baseline (location)	180 - 220							
Reduction Percentage (%)								100

Achievement	Year		
	2018	2019	2020
D. Priority Areas of Health			
Baseline (unit)	21,663		
Achievement Target (unit)		10,832	0
Reduction Percentage (%)		50	100

Annex V. National Action Plan on Mercury Reduction and Elimination

5.1. Mercury Reduction

Table Annex 5.1. **Priority Area of Manufacturing**

Strategy	Activity	Activity Description	Indicator of Achievement	Responsible Institution
a.1 Strengthening commitment, coordination and cooperation between relevant ministries/ non-ministerial government agencies	a.1.1 Strengthen and Implement regulations and policies	a.1.1.1 Develop a Ministerial Regulation on the reduction and elimination of Mercury in the industrial sector	One Ministerial Regulation is issued	Ministry of Industry
a.2 Strengthening coordination and cooperation between Central and Local Governments	a.2.1 Monitoring the status of emissions and releases in manufacturing	a.2.1.1 Monitoring environmental quality (multimedia) on a regular basis	Implementation of periodic environmental quality monitoring activities	Ministry of Environment and Forestry
a.3 Establishment of an information system	a.3.1 Develop database and information	a.3.1.1 Identify the use of Mercury in products and processes in the manufacturing industry	The identification of products and processes in the manufacturing industry that still uses Mercury in accordance to the Minamata Convention	Ministry of Industry
		a.3.1.2 Inventory of Mercury usage in products and processes in the manufacturing industry	Availability of primary data and secondary data on the use of mercury in products and processes in the manufacturing industry	Ministry of Industry
		a.3.1.3 Inventory of the use and content of mercury in cosmetic products	Availability of data and information regarding the use and content of mercury in cosmetic products	National Agency of Drug and Food Control
		a.3.1.4 Identification of the content of emissions and releases of mercury in the non-ferrous metals industry, cement industry, and coal fired industrial boilers	Availability of data on mercury content in emissions in the non-ferrous metals industry, cement industry, and coal-fired industrial boilers	Ministry of Industry
		a.3.1.5 Inventory of the use of mercury in pesticide products, biocides, and topical antiseptics	Availability of data and information regarding the use of mercury in pesticides, biocides, and topical antiseptic products	Ministry of Agriculture

Supporting Institution	Year											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ministry of Environment and Forestry		1										
Ministry of Industry	1	1	1	1	1	1	1	1	1	1	1	1
Ministry of Environment and Forestry	1	1										
Ministry of Environment and Forestry	1	1										
Ministry of Environment and Forestry		1	1									
Ministry of Environment and Forestry	1	1	1	1	1	1	1	1	1	1	1	1
Ministry of Environment and Forestry			1									

Strategy	Activity	Activity Description	Indicator of Achievement	Responsible Institution
a.4 Strengthening community involvement through communication, information and education	a.4.1 STOP Mercury Movement Campaign	a.4.1.1 Conducting socialization of emission control and release of mercury from the manufacturing industry	Socialization in 20 provinces conducted	Ministry of Environment and Forestry
			Implementation of campaign activities through Car Free Day in 28 cities (metropolitan cities and big cities)	Ministry of Environment and Forestry
a.5 Strengthening the commitment of the business community in reducing mercury	a.5.1 Strengthening and implementing regulations and policies	a.5.1.1 Monitoring and Evaluation of the Implementation of Technical Guidelines for the use of Mercury in lamps (lamp production and assembling)	Availability of reports on the use of mercury in the lighting industry	Ministry of Industry
		a.5.1.2 Monitoring and Evaluation of the Implementation of the Guidelines: a. Guidelines for Controlling Mercury Emissions in the Cement Industry b. Mercury Emission Control Technical Guidelines for Smelting and Roasting Activities in the Non-ferrous Metal Industry c. BAT and BEP Guidelines for Controlling Mercury Emissions from Coal-fired Boilers in the industry	Availability of mercury emission reports in the cement industry, lighting industry, non-ferrous metal industry, industries that use coal-fired boilers	Ministry of Industry
a.6 Application of alternative environmentally friendly technologies	a.6.1 Strengthening regulations and policies	a.6.1.1 Conduct a review of the best available techniques and technology needs assessment for the regulation of mercury emissions and releases in smelting and roasting processes used in the production of non-ferrous metals (lead, zinc, copper, and industrial gold), Cement clinker production facilities, and Coal-fired industrial boilers	Availability of reports on BAT/BEP recommendations for regulation of mercury emissions and releases that can be applied in the national industry	Ministry of Industry

Supporting Institution	Year											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ministry of Industry	1	2	2	2	2	2	2	2	2	2	1	
Ministry of Industry	4	5	4	5	3	3	3					
Ministry of Environment and Forestry		1	1	1								
Ministry of Environment and Forestry	1	1	1	1	1	1	1	1	1	1	1	1
Ministry of Environment and Forestry	1					1					1	

Table Annex 5.2. **Priority Area of Energy**

Strategy	Activity	Activity Description	Indicator of Achievement	Responsible Institution
b.1 Strengthening commitment, coordination and cooperation between relevant ministries/ non-ministerial government agencies	b.1.1 Develop regulations and policies	b.1.1.1 Development and implementation of BAT and BEP Guidelines for Control of Mercury Emissions from Coal-fired Boilers in power plants	Controlled mercury emission in the power generation industry	Ministry of Energy and Mineral Resources
b.2 Strengthening coordination and cooperation between Central and Local Governments	b.2.1 Monitoring of emissions and release status	b.2.1.1 Monitoring environmental quality (multimedia) on a regular basis	Implementation of periodic environmental quality monitoring (multimedia)	Ministry of Environment and Forestry
	b.2.2 Monitor and supervise	b.2.2.1 Coordination with Ministry/ Institutions and Local Government	Coordination meetings with Ministries/ Institutions and Local Government Conducted	Ministry of Energy and Mineral Resources
b.3 Establishment of an information system	b.3.1 Develop database and information	b.3.1.1 Identification of mercury emission and release content in coal-fired power plants	Availability of data on mercury emissions and release of coal power plants (fly ash and bottom ash)	Ministry of Energy and Mineral Resources
b.4 Strengthening community involvement through communication, information and education	b.4.1 STOP Mercury Movement Campaign	b.4.1.1 Conducting socialization on controlling emission and release of mercury from the energy sector	Socialization in 34 provinces conducted	Ministry of Environment and Forestry
b.5 Application of alternative mercury-free technology	b.5.1 Develop regulations and policies	b.5.1.1 Revision and strengthening of regulations concerning environmental quality standards for mercury emissions	One Ministerial Regulation is issued	Ministry of Environment and Forestry
		b.5.1.2 Utilization of High Efficiency and Low Emissions (HELE) technology	Utilization of High Efficiency and Low Emissions (HELE) technology in coal-fired power generation units	Ministry of Energy and Mineral Resources

Supporting Institution	Year											
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ministry of Environment and Forestry							1					
Ministry of Energy and Mineral Resources	1	1	1	1	1	1	1	1	1	1	1	1
Ministry of Environment and Forestry	1	1	1	1	1	1	1	1	1	1	1	1
Ministry of Environment and Forestry					1							
Ministry of Energy and Mineral Resources	3	3	3	3	3	3	3	3	3	3	2	2
Ministry of Energy and Mineral Resources		1										
Ministry of Environment and Forestry	1	1	1	1	1	1	1	1	1	1	1	1

5.2. Mercury Elimination

Table Annex 5.3. **Priority Areas of ASGM**

Strategy	Activity	Activity Description	Indicator of Achievement
c.1 Strengthening commitment, coordination and cooperation between relevant ministries/ non-ministerial government agencies	c.1.1 Develop and strengthen regulations and policies	c.1.1.1 Conducting policy outreach to the provincial government	Policy outreach to local governments in 34 provinces is conducted
		c.1.1.2 Conducting monitoring and evaluation on the implementation of the Ministry of Energy and Mineral Resources Regulation concerning the Prohibition of Gold Processing Using Amalgamation	Monitoring and evaluation to local governments in 34 provinces are conducted
		c.1.1.3 Development and revision of regulations regarding the trade system for imports, exports and domestic distribution of mercury	One Ministerial Regulation is issued
		c.1.1.4 Development of guidelines for storage and handling of mercury and waste containing mercury	One Ministerial Regulation is issued
		c.1.1.5 Development of guidelines for remediation of mercury- contaminated land	Availability of guidance documents for remediation of mercury-contaminated land
		c.1.1.6 Development of a standard method for measuring mercury exposure covering nodes 1 - 3 (source, media and receptors consisting of sampling and analysis methods)	Availability of 1 standard method
		c.1.1.7 Carrying out efforts to protect at-risk populations, especially children and women, and control the health impacts of mercury exposure through the development of guidelines for controlling risk factors, health impacts due to mercury exposure to the environment and guidelines for handling mercury poisoning	Two guidelines are available

Responsible Institution	Supporting Institution	Implementation Output During Implementation Period						
		2019	2020	2021	2022	2023	2024	2025
Ministry of Energy and Mineral Resources	Ministry of Environment and Forestry	5	5	5	5	5	5	4
Ministry of Energy and Mineral Resources	Ministry of Domestic Affairs	5	5	5	5	5	5	4
Ministry of Trade	Ministry of Energy and Mineral Resources, Ministry of Trade, Ministry of Environment and Forestry, Ministry of Finance	1						
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources	1						
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources	1						
Ministry of Health	Ministry of Environment and Forestry		1					
Ministry of Health	Ministry of Environment and Forestry, Ministry of Women Empowerment and Child Protection	1		1				

Strategy	Activity	Activity Description	Indicator of Achievement
c.2 Strengthening coordination and cooperation between Central and Local Governments	c.2.1 Strengthen central and local institutions	c.2.1.1 Increasing the understanding of local government officials related to licensed small-scale mining	Outreach to local government officials in all provinces in Indonesia
	c.2.2 Develop research and technology	c.2.2.1 Development and conduct cooperation to reduce and eliminate the use of mercury and mitigate the impact of mercury with non-governmental organizations, donor agencies, and other countries (bilateral).	Integrated cooperation is implemented
	c.2.3 Monitor emission and release status	c.2.3.1 Conduct regular monitoring on environmental quality (multimedia)	Monitoring on environmental quality (multimedia) on a regular basis is conducted
c.3 Increase the capacity of leadership, institutions and human resources in the elimination of mercury	c.3.1 Increase the capacity of laboratory facilities, infrastructure and Human Resources (HR) to support the implementation of research and monitoring	c.3.1.1 Development of a national mercury research and monitoring laboratory	1) Capacity of 5 laboratory human resources is increased every year. 2) Research and monitoring of mercury are conducted. 3) Availability of appropriate laboratory equipment for mercury analysis from samples of air, water, soil, foodstuffs, biological/ biomarker monitoring samples, and other materials 4) Mercury parameter proficiency test is conducted
		c.3.1.2 Conducting Mercury Research	Mercury Research is conducted

Responsible Institution	Supporting Institution	Implementation Output During Implementation Period						
		2019	2020	2021	2022	2023	2024	2025
Ministry of Domestic Affairs	Ministry of Energy and Mineral Resources	7	7	7	7	7	7	6
Ministry of Environment and Forestry	Ministry of Research, Technology and Higher Education, Ministry of Energy and Mineral Resources	1	1	1	1	1	1	1
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Ministry of Domestic Affairs	1	1	1				
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Ministry of Health	5	5	5	5	5	5	5
Ministry of Environment and Forestry	Ministry of Health, Ministry of Energy and Mineral Resources, Ministry of Trade, Ministry of Research, Technology and Higher Education, Agency for the Assessment and Application of Technology	1	1	1	1	1	1	1

Strategy	Activity	Activity Description	Indicator of Achievement
c.4 Establishment of an information system	c.4.1 Develop database and information	c.4.1.1 Mapping the impact of mercury emissions and releases on the environment around ASGM locations	Availability of impact distribution map
		c.4.1.2 Identification of hotspots, population at risk, and vulnerable populations due to mercury exposure through cross-sectoral cooperation.	Availability of maps of areas and populations of communities vulnerable to mercury exposure
		c.4.1.3 Identification and improvement of national standards for threshold limit values for mercury exposure to human health	Availability of mercury exposure threshold values for human health
		c.4.1.4 Development of a national database system related to the trade, distribution and use of mercury	Availability of a national database system
		c.4.1.5 Development of a map information system for the distribution of cinnabar and mercury rocks in Indonesia	Availability of map information system
		c.4.1.6 Conduct an inventory and mapping of sources, procurement supplies, distribution, and use of mercury	1) Availability of inventory data 2) Availability of maps
c.5 Strengthening community involvement through communication, information and education	c.5.1 Mercury STOP Movement Campaign	c.5.1.1 Including the dangers of using mercury in gold processing in the content of the national formal education curriculum	Mercury dangers course is included into the national formal education curriculum
		c.5.1.2 Conduct a campaign on the risk of the impact of mercury use on vulnerable communities and a campaign for gender mainstreaming.	Information through mass media, social media and other media is disseminated by publishing a minimum of 2 (two) articles per week
		c.5.1.3 Conduct outreach and increase capacity to health workers about health risks due to mercury exposure.	Outreach and trainings in 34 provinces are conducted
		c.5.1.4 Development of a community approach to increase knowledge and awareness about the health hazards of mercury	Approach in the community and the emergence of public awareness are developed along with collective community action not to use mercury and efforts to reduce the impact of mercury on health

Responsible Institution	Supporting Institution	Implementation Output During Implementation Period						
		2019	2020	2021	2022	2023	2024	2025
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources	1						
Ministry of Health	Ministry of Environment and Forestry	3	5	6	5	5	5	5
Ministry of Health	Ministry of Environment and Forestry		1					
Ministry of Environment and Forestry	Ministry of Trade, Ministry of Finance	1	1					
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources	1						
Ministry of Environment and Forestry	Statistics Indonesia, Ministry of Energy and Mineral Resources	1						
Ministry of Education and Culture	Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources, Ministry of Health	1						
Ministry of Environment and Forestry	Ministry of Communication and Information, the Ministry of Women's Empowerment and Child Protection	2	2	2	2	2	2	2
Ministry of Health	Ministry of Domestic Affairs		17	17				
Ministry of Health	Ministry of Domestic Affairs		1	1				

Strategy	Activity	Activity Description	Indicator of Achievement
		c.5.1.5 Development of participatory approaches to communities in ASGM locations that aim to increase knowledge about the health impacts of mercury exposure and sustainable behavior change in the community	Participatory approaches in 34 provinces are developed
		c.5.1.6 Increasing the understanding of good mining practices for business actors in the Small-Scale Mining Permit (IPR)	Guidance and supervision of IPR
		c.5.1.7 Conduct outreach of guidelines for remediation of mercury -contaminated land	Outreach of guidelines for remediation of mercury -contaminated land is conducted
c.6 Application of alternative technology for processing mercury-free gold	c.6.1 Develop research and technology	c.6.1.1 Development of research and studies on alternative technology for mercury-free gold processing	Availability of documents on the results of research and study of alternative technology for mercury-free gold processing
	c.6.2 Remediate mercury contaminated land and land rehabilitation	c.6.2.1 Remediation of land contaminated with mercury and land rehabilitation due to gold mining activities	Mercury contaminated land in 4 locations is remediated
	c.6.3 Physical construction of integrated mercury-free gold processing facilities	c.6.3.1 Development of Feasibility Study (FS) and Detailed Engineering Design (DED) for gold processing without mercury	Availability of 5 FS and DED documents in 5 locations
		c.6.3.2 Construction of gold processing facilities without mercury	Integrated installations in 13 locations are constructed
	c.6.4 Provide mercury storage facilities	c.6.4.1 Development of FS and DED for the provision of mercury storage facilities	Availability of FS and DED documents on the provision of mercury storage facilities
		c.6.4.2 Provision of mercury storage facilities	Construction of mercury storage facilities

Responsible Institution	Supporting Institution	Implementation Output During Implementation Period						
		2019	2020	2021	2022	2023	2024	2025
Ministry of Health	Ministry of Energy and Mineral Resources, Ministry of Environment and Forestry	3	5	6	5	5	5	5
Ministry of Energy and Mineral Resources	Ministry of Domestic Affairs	2	2	2	2	1	1	1
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Agency for the Assessment and Application of Technology		1	1	1	1	1	1
Agency for the Assessment and Application of Technology	Ministry of Energy and Mineral Resources	1						
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Ministry of Research and Technology and Higher Education, Ministry of Domestic Affairs	2			1			1
Agency for the Assessment and Application of Technology	Ministry of Energy and Mineral Resources	2	2	1				
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Agency for the Assessment and Application of Technology	2	2	2	2	2	2	1
Ministry of Environment and Forestry	Ministry of Research, Technology and Higher Education	1						
Ministry of Environment and Forestry	Ministry of Research, Technology and Higher Education	1						

Strategy	Activity	Activity Description	Indicator of Achievement
c.7 Transfer of local community livelihoods	c.7.1 Conduct mapping of the social and economic conditions of the mining community	c.7.1.1 Development of a social study on the impact of mercury use on ASGM activities	Availability of 1 social study result
		c.7.1.2 Development of an economic study of the impact of mercury use	Availability of 1 economic study result
	c.7.2 Economic and social empowerment of communities outside the Small-Scale Mining Area (WPR)	c.7.2.1 Social and economic transformation of illegal miners using mercury	Six productive economic business models are created
		c.7.2.2 Business opportunity coaching	Communities in 5 ASGM locations per year are coached
		c.7.2.3 Facilitating the issuance of permits for cooperatives and SMEs	Cooperative and SMEs permits in 5 ASGM locations per year are issued
c.8 Strengthening law enforcement	c.8.1 Increase supervision	c.8.1.1 Increasing import and export supervision of mercury as commodity	Availability of import and export control reports on mercury as commodity
		c.8.1.2 Supervising and controlling primary mercury mining activities (cinnabar mining) without permit/illegal	There is no cinnabar mining in Indonesia
		c.8.1.3 Supervising domestic mercury circulation	100% action taken
	c.8.2 Enforcement	c.8.2.1 Control of illegal ASGM using mercury	There are no illegal ASGM using mercury
		c.8.2.2 Control of illegal mercury trade system	Amount of illegal mercury controlled 10 tonnes per year

Responsible Institution	Supporting Institution	Implementation Output During Implementation Period						
		2019	2020	2021	2022	2023	2024	2025
Ministry of Environment and Forestry	Ministry of Village, Development of Disadvantaged Areas and Transmigration, Ministry of Cooperatives and Small and Medium Enterprises (SMEs), Ministry of Social Affairs, Ministry of Women's Empowerment and Child Protection	1	1					
Ministry of Environment and Forestry	Ministry of Villages, Development of Disadvantaged Areas and Transmigration, Ministry of Cooperatives and SMEs, Ministry of Social Affairs, Ministry of Women's Empowerment and Child Protection	1	1					
Ministry of Environment and Forestry	Ministry of Energy and Mineral Resources, Ministry of Cooperatives and SMEs, Ministry of Domestic Affairs	1	1	1	1	1	1	
Ministry of Cooperatives and SMEs	Ministry of Domestic Affairs	5	5	5	5	5	5	5
Ministry of Cooperatives and SMEs	Ministry of Domestic Affairs	5	5	5	5	5	5	5
Ministry of Finance	Ministry of Environment and Forestry, Ministry of Energy and Mineral Resources, Ministry of Trade	1	1	1	1	1	1	1
Indonesian National Police	Attorney General	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indonesian National Police	Ministry of Trade, Attorney General, National Agency of Drug and Food Control							100%
Indonesian National Police	Attorney General	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indonesian National Police	Attorney General	10	10	10	10	10	10	10

Table Annex 5.4. **Priority Areas of Health**

Strategy	Activity	Activity Description
d.1 Strengthening commitment, coordination and cooperation between relevant ministries/ non-ministerial government agencies	d.1.1 Strengthening and implementing regulations and policies	d.1.1.1 Develop policies or regulations concerning the substitution of mercury-containing medical devices in health care facilities
	d.1.2 Develop regulations and policies	d.1.2.1 Develop guidelines for the management of mercury-containing medical device waste originated from health care facilities
	d.1.3 Implementation of evaluation	d.1.3.1 Data collection, processing and analysis
d.2 Strengthening coordination and cooperation between Central and Local Governments	d.2.1 Monitor and supervise	d.2.1.1 Coordination with Ministries/Agencies and Local Government
d.3 Establishment of an information system	d.3.1 Develop database and information	d.3.1.1 Inventory of the use of mercury in products and processes in mercury-containing medical devices
		d.3.1.2 Identification of the content of emissions and releases of mercury in incinerator facilities in hospitals
d.4 Strengthening community involvement through communication, information and education	d.4.1 STOP Mercury Movement Campaign	d.4.1.1 Develop socialization and outreach programs to medical personnel concerning the substitution of mercury-containing medical devices and the risk of mercury exposure in health care facilities
		d.4.1.2 conduct socialization and increase capacity to medical personnel concerning the health risks of using and handling mercury
d.5 Application of alternative mercury-free technology	d.5.1 Substitution of mercury-containing medical devices	d.5.1.1 Conduct substitution of mercury-containing medical devices in health care facilities
	d.5.2 Storage of mercury-containing medical device waste	d.5.2.1 Storage of mercury-containing medical device waste in storage depots available in each province
		d.5.2.2 Setting up storage depots in the province to store mercury-containing medical device waste
		d.5.2.3 develop technical instructions for handling mercury medical device waste for health care facilities and for storage depots

Indicator of Achievement	Responsible Institution	Supporting Institution	Implementation Output During Implementation Period	
			2019	2020
One Ministerial Regulation is issued	Ministry of Health	Ministry of Environment and Forestry	1	
One Ministerial Regulation is issued	Ministry of Environment and Forestry	Ministry of Health	1	
Availability of data and information regarding the implementation of policies regarding the elimination of mercury-containing medical devices in the regions	Ministry of Health	Ministry of Environment and Forestry	1	1
The establishment of a partnership network between the Central Government, Local Governments, Non-Governmental Organizations, and Universities	Ministry of Health	Ministry of Environment and Forestry	1	1
Availability of data and information concerning the use of mercury in mercury-containing medical devices	Ministry of Health	Ministry of Domestic Affairs	1	
Identified emission and release of mercury in incinerator facilities in hospitals	Ministry of Environment and Forestry	Ministry of Health	1	
1) Implementation of counseling and socialization in vertical hospitals and provincial hospitals. 2) Implementation of counseling and socialization in hospitals and health service facilities	Ministry of Health	Ministry of Domestic Affairs	1	1
Socialization and training in 34 Provinces conducted	Ministry of Health	Ministry of Domestic Affairs	17	17
Substitution of mercury-containing medical devices to non-Mercury alternatives in hospitals and health care facilities	Ministry of Health	Ministry of Domestic Affairs	1	1
Mercury-containing medical device waste stored in the storage depot	Ministry of Environment and Forestry	Ministry of Health	1	
Availability of storage depots for mercury-containing medical device waste in each province	Ministry of Environment and Forestry	Ministry of Health	1	
Availability of technical guidelines for handling mercury-containing medical device waste for health care facilities and for storage depots	Ministry of Environment and Forestry	Ministry of Health	1	

Strategy	Activity	Activity Description
d.6 Strengthening law enforcement	d.6.1 Increase supervision	d.6.1.1 Supervision of domestic circulation of mercury-containing medical devices
		d.6.1.2 Supervision and enforcement of mercury-containing cosmetic products
	d.6.2 Enforcement	d.6.2.1 Controlling the trading system of illegal mercury-containing medical devices

Indicator of Achievement	Responsible Institution	Supporting Institution	Implementation Output During Implementation Period	
			2019	2020
Supervision of domestic circulation of mercury-containing medical devices activities conducted	Ministry of Health	Indonesian National Police, Ministry of Trade, Attorney General	1	1
Supervision and enforcement of mercury-containing cosmetic products activity conducted	National Agency of Drug and Food Control	Indonesian National Police	1	1
100% Enforcement	Indonesian National Police	Ministry of Health, Attorney General		100%

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