



Minamata Convention Initial Assessment in Vietnam (Vietnam MIA Project)

FINAL REPORT

Hanoi, June 2017

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I. Introduction

The Socialist Republic of Vietnam became a signatory to the Minamata Convention on Mercury on October 11, 2013 in Japan.

According to Decision No. 1811 / QD-TTg on October 4, 2013 by Prime Minister, Vietnam Chemicals Agency, in collaboration with the United Nations Industrial Development Organization (UNIDO) has developed the Project named "Minamata Convention Initial Assessment in Vietnam" sponsored by the Global Environment Facility (GEF). The outputs of project will support Vietnam to ratify the Minamata Convention on Mercury.

The total time frame of the project is 24 months starting from January 2015 and is expected to finalize by end of December 2016.

In order to support to the process of Convention ratification, under the agreement between the UNIDO and Vinachemia representative in the meeting in Vietnam in September 2016, the MIA Project is extended more 6 months (until July 2017).

II. Project Outcome and Output

1. Background

Mercury is a heavy metal in liquid form, silver colored, volatile at room temperature. This is an extremely toxic chemical, environmental persistent and is considered as a global pollutant.

Mercury exists and circulates in air, water, sediment and soil under different forms. Mercury and its compounds can travel a long distance in air, water and be absorbed by micro-organism and gradually accumulate up in the food chain and thereby affect human health. The three most common forms of mercury which are element mercury, organic mercury compounds and methyl mercury are particularly harmful to human health, especially dangerous to unborn baby and children due to its toxicity to the nervous system (brain and spinal cord).

Despite being an extremely toxic element, mercury and mercury compounds are widely used in life and in production. Due to its superiority, mercury is an essential component of a number of products such as fluorescent light bulbs, batteries, electronics, toys, cosmetics, pesticides, medical equipment...; is used as catalysts in some production process (chlor-alkali, acetaldehyde, vinyl chloride monomer ...), is used in artisanal and small-scale gold mining; in dentistry as an amalgam for dental fillings

The use of mercury and mercury containing materials in production process and in life has led to significant emissions of mercury into soil, water, air, and has caused many adverse impacts to human health and the environment globally. A representative impact of mercury is known worldwide as Minamata disease, arising from mercury contamination in Japan caused by Chisso Fertilizer

Corporation which later on is Japan Petrochemicals company dumping chemical compounds containing mercury into Minamata Bay. An estimation of more than 3,000 Japanese were deformed, poisoned or died from this disaster. Another representative case of mercury impact is the use of mercury-containing compounds to process grains (rice, potato, wheat, cotton, peanuts ...) in Iraq in 1972¹ resulting in 6,530 people were hospitalized in which 459 died. In Vietnam, although harmful effects of mercury are not yet recognized but the presence of sources and emissions of mercury, sources of disposal of mercury-containing products that are now under no management measures/ appropriate treatments; the use of mercury in artisanal and small-scale gold mining activities without strict control... or the presence of mercury in the air monitoring result collected in Hanoi recently (April/2016)² show a great potential risk of mercury

Due to the toxicity of mercury and the chemical hazards it cause to human and the environment, on October 10th, 2013 Minamata Convention on mercury - a globally legally binding tool on mercury - has been approved in Minamata (Japan). The objective of the Convention is to call on countries in protecting human health, the environment and ecosystems from the impacts of mercury and mercury compounds. The Convention was named Minamata – after the city where the eventful mercury disaster has occurred in Japan in 1950s. So far, out of 128 countries signed the convention, there were 25 countries have ratified and became an official member of the Convention.

On 14/11/2013 Vietnam Government had signed Minamata Convention and assigned Ministry of Industry and Trade in collaboration with relevant agencies to undertake research and then submit to the Government to consider ratification of the Convention³.

Vietnam Chemical Agency (Vinachemia) on behalf of Ministry of Industry and Trade in collaboration with related parties conducts project GEF / UNIDO "Initial assessment of Minamata Convention on mercury in Vietnam" sponsored by Global Environment Facility (GEF). The project focuses on inventory of mercury sources; review and analyzing of gaps in policy documents and legislation in order to propose amendments to match the requirements of the management of mercury; evaluating the benefit of joining the Convention ... and finally developing an National Profile on mercury, including an action plan to manage and control mercury aiming to reduce and phase out the use of mercury and mercury compounds as required by the Minamata Convention.

2. National survey on mercury

The purpose of the survey/national inventory on mercury is to know of mercury sources and mercury emissions, from which the government can have a

¹ *Environmental Toxicology and human Health: Takizawa Y. Vol.1: Mercury- contaminated Grain in Iraq*

² Detect mercury in air mass in Hanoi. http://vnreview.vn/tin-tuc-khoa-hoc-cong-nghe/-/view_content/content/1815948/phat-hien-thuy-ngan-trong-khong-khi-ha-noi

³ Decision no.1811/QĐ-TTg dated 4 / 10/2013

background to ratify Minamata Convention on mercury and orient mercury management in the future, in accordance with the requirements of the Convention.

The survey/ inventory of mercury emissions into the environment shall be conducted for the following main groups

- (i) Unintentional mercury emissions from combustion of fossil fuels (especially coal, lesser are from gas and oil) and the mining, processing, recycling of ore, because raw material usually have mercury as impurities;
- (ii) Mercury emissions from production process that uses mercury and mercury compounds; and
- (iii) Mercury emissions from products containing mercury circulates on the market, during their use and disposal; and
- (iv) Mercury emissions from the processing of disposed products containing mercury, waste containing mercury.

Basic method used to carry out the inventory is "recognize and classify mercury emissions - level 1" Toolkit issued by the United Nations Environment Programme (UNEP) in 2015⁴. Since this is the first survey the data collected may not be completely accurate and additional investigation might be needed in the future.

Investigation has identified the following sources of mercury (Table 1) in Vietnam

Table 1: Source of mercury emission in Vietnam

No	Source of mercury emission
1	Energy consumption
1.1	Coal combustion in large power plants
1.2	Use of coal for other purposes
1.4	Use of diesel, gas, oil, gasoline, kerosene
1.5	Use of natural gas or cleaned gas
1.7	Production of electrical energy and heat from biomass
1.8	Charcoal
2	Fuel production
2.1	Oil extraction
2.2	Oil refinery
2.3	Exploitation and processing of natural gas

⁴ This toolkit can be downloaded from the following web page of UNEP:

<http://www.unep.org/publications/G.../tabid/4566/language/en-US/Default.aspx>

No	Source of mercury emission
3	Crude metal production
3.2	Metallurgy of tin and zinc from ore
3.3	Metallurgy of copper from ore
3.4	Metallurgy of lead from ore
3.5	Gold production by the method of not using mercury
3.6	Production of aluminum from bauxite
3.7	Production of crude iron
3.8	Gold extraction using mercury amalgam no distillation method.
3.9	Gold extraction using mercury amalgam with distillation method.
4	Other material productions
2.1	Cement production
2.2	Paper and pulp production
6	Production of containing mercury products
6.1	Mercury thermometers (used in medical, water, laboratory, industries ...)
6.2	Mercury-containing circuit breakers/ switches and relays
6.3	Mercury-containing lamps (fluorescent, compact, and others)
6.7	Mercury-containing paints
7	Use and disposal of products containing mercury
7.1	Mercury dental amalgams (silver fillings)
7.2	Thermometer
7.3	Circuit breakers/ switches and relays containing mercury
7.4	Mercury-containing lamps
8	Production of metal from recycling material
8.2	Production of steel from recycling material
9	Waste incineration
9.1	Urban waste incineration
9.2	Harzardous waste incineration
9.3	Medical waste incineration
9.4	Sewage waste incineration
9.5	Waste incineration in open air
10	Waste burving and wastewater treatment
10.1	Burving waste in a controlled landfill
10.2	Waste burying without permission
10.3	Wastewater treatment
11	Cremation and burial
11.1	Cremation
11.2	Burial

Based on the UNEP Toolkit, the amount of mercury (mercury inputs) in various sectors is estimated and presented in Table 2 below.

Table 2: Amount of mercury inputs

No.	Mercury source (sector/field)	Estimated amount/Mercury input	
		(kg Hg/n)	%
1	Energy consumption	6541	13.3
2	Fuel production	1011	2.1
3	Crude metal production	4259	8.7

No.	Mercury source (sector/field)	Estimated amount/Mercury input	
		(kg Hg/n)	%
4	Other fuel productions	7783	16.0
5	Producing of containing-mercury products	2239	1.0
6	Use and disposal of products containing mercury	9749	19.6
7	Waste incineraion	12383	25.2
8	Waste burying and wastewater treatment	58808	11.1
9	Cremation and burial	1565	3.0
Total mercury inputs		110.556	100.0

The amount of mercury outputs (mercury output) in different sectors/fields are shown in Table 3.

Table 3: Summary of mercury outputs by sectors/fields ⁵

No.	Mercury sources (sectors/fields)	Total emissions kg Hg/year	Proportion (%)
1	Energy consumption	6,541	13.3
2	Fuel production	1,041	2.1
3	Crude metal production	4,259	8.7
4	Production of other crude materials	7,783	16
5	Producing of containing-mercury products	504	1
6	Use and disposal of products containing mercury	9,606	19.6
7	Waste incineration	12,383	25.2
8	Waste burying and wastewater treatment	5,440	11.1
9	Cremation and burial	1,565	3
	Total	49,131	100

Table 3 shows:

- **"Waste Incineration" is the field with the largest emission (25.2%).** Of which incineration from landfill with permission takes approximately 9.5%; the rest (15.5%) is emission from burning outdoor. ⁶

⁵ Mercury output

⁶ Errors in estimates of mercury emissions in two sectors of "incineration" and "burial of waste and wastewater treatment" is the highest, due to large scale of survey (nationwide) without statistical data.

- "Use and disposal of mercury-containing products" sector is ranked next in mercury emissions, accounted for 19.6% of the total mercury emission;
- Ranked third in mercury emission is "cement production", accounted for 15.9% of the total mercury emissions;
- Ranked fourth in mercury emission is "energy consumption" (13.3%), of which coal combustion in large power plants accounted for 11%.
- Ranked fifth in mercury emission is "waste collection and wastewater treatment" sector. Mercury emission of this sector accounts for 11.1% of the total mercury emissions throughout the country.
- Ranked sixth in mercury emission is "crude metal production". Mercury emission of this sector accounts for 8.7% of total emissions throughout the country.
- "Fuel production", "producing of mercury-containing products", "cremation and burial" are sectors with mercury emission relatively low (less than 5%).

Proportion of mercury emission into different environments can be summarized in Table 4 below

Table 4. Distribution of mercury emission into the environment

Category	Kg Hg/year	%
Air	29,238	59.5
Water	2,954	6.0
Soil	5,029	10.2
Byproducts/ intermediate products	3,384	6.9
Waste	5,748	11.7
Wastewater	2,778	5.7
Total	49,131	100

The above figures show that mercury released into the atmosphere accounts for the largest proportion (59%), while emission of mercury into soil and water environment are relatively modest: 10,2% into soil and 6% into water. The rest of mercury and mercury compounds exist in solid waste, wastewater and by-products /intermediate products. As mentioned these figures are initial data, the accuracy is not high, so they should be further investigated to have a data system more reliable.

A group of experts had analyzed and assessed the classification of industries/priority sectors. Analysis results shows that 07 sub-sectors are evaluated as high priority, 04 sub-sectors are evaluated as medium priority, and 06 sub-sectors are evaluated as low priority (Table 5)

Table 5: Evaluate and prioritize mercury sources

No.	Mercury sources	Order by priority
1.1	Coal combustion in large power plants	High
2.1	Oil refinery /extraction and processing of natural gas	Medium
3.1	Metallurgy (tin, zinc, copper) from refined ore	Medium
3.2	Gold production by method using mercury amalgams	High
4.1	Cement production	High
5.1	Production of lamps containing mercury (fluorescent lamps, compacts and others)	High
6.1	Use and disposal of dental amalgam containing mercury	Medium
6.2	Thermometer	High
6.3	Circuit breakers/switches and relays containing mercury	High
6.4	Use and disposal of mercury containing lamps	Medium
7.1	Incineration of waste in incineration plants	High
7.2	Outdoor waste incineration	Low
8.1	Waste burial	Low
8.2	Outdoor waste burial with no permission	Low
8.3	Wastewater treatment	Low
9.1	Cremation	Low
9.2	Burial	Low

3. Reviewing the state management of mercury

Currently in Vietnam, chemicals are managed after industry sectors and their use. Participating in the state management of chemicals (including mercury) are seven (07) of the main departments:

- Ministry of Industry and Trade;
- Ministry of Natural Resources and Environment,
- Ministry of Health,
- Ministry of Agriculture and Rural Development,
- Ministry of Science and Technology,
- Ministry of Transport, and
- Ministry of Labour and Social Affairs.

It can be seen amongst those departments above, Ministry of Industry and Trade is the state department that is responsible for overall management of chemicals, Ministry of Natural Resources and Environment is responsible for overall management of environmental protection and chemicals pollution control. The rest as MARD is responsible for chemicals used in agriculture, forestry and fisheries, Ministry of Health manages chemicals used in the health sector, health and safety, Ministry of Labour is responsible for labor safety in work environment with chemicals, Ministry of Transport is responsible for safety in transport of chemicals, and Ministry of Science and Technology is responsible for issuing standards and labeling/packaging of chemicals...

During the review process gaps and institutional barriers are identified as follows:

- There is *no tight coordination* between departments in state management on chemicals/mercury: Since chemicals are managed by industry sectors/fields the ministries generally issue legal documents for group of chemicals under their management. The content of these legal documents therefore is still inadequate and do not cover full management needs, or the entire lifecycle of chemicals. Sometimes the legal documents issued are also overlapping and inconsistent with each other.
- *Database* on chemicals and hazardous waste is generally poor, the data that is not updated regularly by the departments is another barrier making the review and planning for management of chemicals/waste more difficult. Lack of coordination and cooperation between these departments in chemical management also leads to limited access to information, data input causing development of management plans and legal documents less effective.
- *Limited institutional capacity to manage chemicals mercury* is a barrier to effectively manage mercury by its lifecycle.
- *Mercury management legislation system* is incompleting creating a gap for business to evade their responsibility in environmental protection, to not comply with chemicals/mercury safety management principles according to their lifecycle, leading to escalation in environmental pollution, causing adverse impact on human health and natural ecosystems.
- *Environmental monitoring*: Network of national environmental monitoring managed by Vietnam Environment Administration has so far expanded to 26 fixed/automatically air monitoring stations operated by central government and some local government. However, these monitoring networks are usually focused on monitoring basic environmental parameters. Mercury is not regularly monitored and thus ability to control environmental pollution is still limited.

Considering the current state of chemicals management in Vietnam and the unsynchronized coordination between ministries, a development of inter-ministerial mechanism for chemical safety management, including the management of mercury is necessary to improve the efficiency of the integrated management of chemicals according to their life cycle. This has also been highlighted in the National Report on chemical safety management. The formation of inter-ministerial cooperation mechanisms will facilitate and promote the management of chemicals comprehensively.

Besides inter-ministerial cooperation mechanisms in chemicals management, it is also needed to set up a steering committee to implement the Convention directed by Vietnam Chemical Agency (MOIT).

4. Policy framework review

The review of legal documents on mercury management is performed based on the requirements of the Convention Minamata under chemical lifecycle, starting from import stage, production process, circulation on market, product usage, storage, disposal and treatment.

Results of reviewing the policy framework showed that in each stage of lifecycle of chemicals there were several specific regulations issued. These regulations are generally applicable to all chemicals or for specific group of chemicals, but they are not linked together into a comprehensive management system.

Mercury and mercury compounds are in heavy metals group, they are managed by general regulations regulated for this group of chemicals. Regulations regulated specifically for mercury and mercury compounds, mentioned in QVCN or TCVN are maximum values of mercury and mercury compounds allowed in some products referred to in Annex A, section I of Minamata Convention or allowed to emit into the atmosphere, soil and water. All these regulations are not yet mentioned the gradual removal and eventually prohibition of the production/circulation/import/export of these products on the market after 2020 as required by Minamata Convention.

Although mercury and mercury compounds are very dangerous pollutants and are a threat to the environment and global health, provisions relating to the management of mercury have not mentioned much about preventing mercury exposure, or refer specifically to the need to implement measures to protect human health in general and to protect worker's health in particular from the impact of mercury and chemicals. Awareness of the impact of chemicals/mercury and state management capacity on chemicals and particularly mercury and mercury compounds are limited. So far there is almost no data on chemical/mercury exposure as well as incidents related to chemicals/mercury.

Proposal of improvement to the system of mercury management policy include:

- To promulgate a mechanism that develops joint-circulars to manage chemicals/mercury in industrial sector that under the management of two or more ministries;
- Currently the state management agencies could barely manage chemicals after they are imported into Vietnam or after they are produced in Vietnam. Authorities almost could not control the chemical market: where they end up and how they are used (whether for the right purpose or not). Therefore, the development of circulars, regulations to manage chemicals/mercury by their lifecycle or chain is essential to be able to control the flow of chemicals when they are on the market as well as after they are disposed. The issue of declaration of hazardous chemicals when they circulate in the market should be paying extra attention to minimize

the adverse impact of chemicals on consumers and the environment

- To improve legal documents with the guidance on compliance with these documents.
- To promulgate regulations to periodically carry out inventory on usage and emissions of mercury in some key sectors and to build national data systems to manage mercury. This data system should be part of a chemical management data system of each ministry/state management agencies.
- To update/develop joint-circulars on the prevention and response to chemical incidents that can be applied to all industrial sectors, including a chapter or an annex on prevention and response to mercury incidents.

5. National Implementation Plan

National survey results showed an estimated total mercury emissions of 49,131 kg/year (2014) in which amount of mercury emitted into the air was 59%, into soil was 10%, in water was 6% and the rest of 25% existed in waste, wastewater, intermediate products

With the overall goal is to promote the management of mercury and mercury compounds according to their life cycle, reduce risks from mercury to human health and the environment via the establishment and implementation the requirements of Minamata Convention on mercury management, the national action plan for mercury management has set the following specific objectives:

- Strengthen institutional capacity in building tools and regulations of mercury and mercury compounds management, including waste containing mercury, contaminated sites, and mercury storage;
- Develop and implement plans to reduce and to terminate the import, production and use of mercury-containing products described in Part I, Annex A of the Convention in 2020;
- Reduce the use of dental amalgams containing mercury;
- Reduce environmental pollution and affect on people's health through improving the management of artisanal and small-scale gold mining;
- Develop and implement measures to reduce emissions and control the mercury emissions into the atmosphere from sources mentioned in Annex D of the Convention; measures to reduce emissions and control of mercury emissions into soil and water from related sources;
- Media communicate to raise awareness about the impact and risks of mercury to the environment and human health.

Based on the requirements of the Minamata Convention, evaluations of priority fields in mercury management, review of the institutional and review of the existing regulations, policies for mercury management in Vietnam are

presented in the upper part, the action plan has summarized a series of content, activities that Vietnam should focus on implementation after the ratification of the Convention. Besides the action plan also proposes a number of priority projects in order to meet the urgent requirements of the Convention (table 6).

Table 6: Prioritized programs, projects

No	Programmer/Project	Agency responsible		Expected time
		Agency in charge	In coordination	
1	Programme of Removal of mercury-containing products	MOIT MOH MARD MONRE	MOLISA MOT, People Committee and government departments at all levels	2025 (No later than 2020)
2	National Action Plan to reduce the use of mercury in small-scale and artisanal gold mining	MOIT	MONRE, MOLISA MOH, People Committee and government departments at all levels	2023
3	National action plans to control and reduce mercury emissions into the soil and water environment	MOIT MONRE	MOH MARD	2025
4	National action plans to control and reduce mercury emissions into the soil and water environment ⁷	MOIT MONRE	MOH MARD MOLISA ...	2025
5	Programme that controls and reduces mercury emissions from power production process using coal in large thermal power plants	MOIT	MONRE MOLISA	2025
7	Programme that reduces mercury emissions from cement production process	MOIT	MONRE MOLISA	2025
8	Programme that reduces bulbs contain mercury and wastes containing mercury	MOIT	MONRE MOLISA	2025
9	Programme that controls mercury emissions at waste incineration facilities	MONRE	People Committee, Department of Natural Resources and Environment	2015
10	Reduce and replace amalgams containing mercury used in dentistry.	MOH	MONRE	

⁷ Minamata Convention Article 9

VIETNAM CHEMICAL AGENCY
MIA Project Management Unit

Project "Initial Assessment of Minamata Convention in Vietnam"

REPORTS

Roles, functions and responsibilities of each agencies / units involved in mercury management in Vietnam

Hanoi, October 2015

Catergory

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I. General information

Mercury (Hg) is an element that is environmental sustainable and potentially bioaccumulative causing significant adverse impacts to human health and the environment. A basic mercury's life cycle is illustrated below:

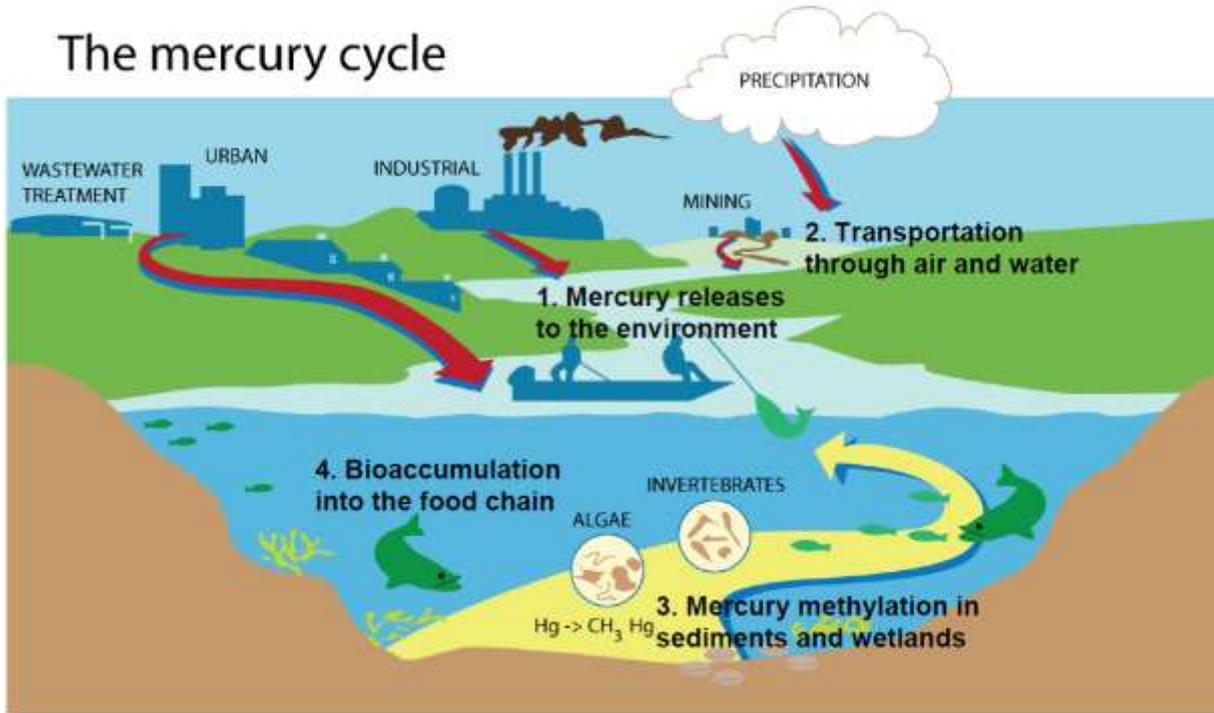


Figure 1: Basic illustration of mercury's life cycle in the environment¹

In Vietnam nowadays, mercury is present in many industrial processes and products such as artisanal gold mining, lighting equipment, coal combustion in cement plant, power plant, fertilizer plant..., in medical (dental amalgam, thermometers...).

In the field of lighting equipments: Dien Quang Light Bulb Company and Rang Dong Light Bulb Vacuum Flask Company (in 2011) shows that Vietnam currently produces about 36 millions fluorescent lamps, 33 millions compact fluorescent lamps and 56 millions incandescent bulbs (using about 3,000 kg of liquid mercury and 64 millions mercury particles). Annually, an estimated breakage of light bulbs is 40 thousands, releasing 350,000 mg of mercury.

Coal combustion causes mercury emission in fertilizer manufacture: the demand of coal in fertilizer plants in Vietnam is estimated around 22,000 tons/year, of which there are about 140,000 tons of coal lumps and 80,000 tons of coal powder.

¹ Martha L. Erwin and Mark D. Munn, USGS Fact Sheet FS-102-97 <http://wa.water.usgs.gov/pubs/fs/fs.102-97>

In the medical field, via a quick survey of UNDP in 2007 from 18 health facilities, the average rate of breaking thermometers is 18.8% and the average amount of mercury release from these broken thermometers is 1.7g/bed/year and that from sphygmomanometer is 1.1g/bed/year. With 196,311 patient beds in the country (in 2007), the total estimated of broken thermometers and sphygmomanometers is 447,558 and the total amount of mercury release is 550kg/year. Under Medical Environment Agency's investigation in 2011, the amount of mercury used in amalgam dental fillings is in a range of 151g-5000g/hospital/year.

Aware of this concern, Prime Minister Nguyen Tan Dung approved Vietnam to sign the Minamata Convention on Mercury in Decision No.1811/QD-TT dated 04/10/2013. Deputy Minister of Ministry of Industry and Trade, on behalf of the Socialist Republic of Vietnam signed the Convention on 11/10/2013 at the Conference of National Representatives took place in Minamata, Japan. Participation in Minamata Convention is not only to improve Vietnam position in the international field but also to bring a lot of benefits such as promoting the improvement of national legislation system on mercury management for the purpose of protecting human health and environment against harmful effects of mercury and mercury compounds.

With the responsibility of an authority management on chemical activities (according to Chemical Law 2007) and being a national focal agency implementing Strategic Approach to International Chemicals Management – SAICM, Chemical Agency- Ministry of Industry and Trade is a lead agency to coordinate relevant ministries to strengthen and improve the mercury management.

Ministry of Industry and Trade is a government agency performing the function of authority management on industry and trade, including sectors and fields of mechanical engineering, metallurgy, electricity, new energy, renewable energy, petroleum, chemicals, industrial explosives, industrial mining and mineral processing, consuming industry, food industry and other processing industries, trade and cosmetic market; import, export and border trade, foreign market development, market management, trade promotion, e-commerce, trading service, international economic integration, competition management, safeguard measures, anti-dumping, anti-subsidy, protection of human rights; authority management of public services, sectors under authority management.

Chemicals Agency is an organization under Ministry of Industry and Trade, performing the function of consulting the Minister of MOIT to manage and implement management tasks on chemicals activities in accordance with law.

International transaction name: Vietnam Chemicals Agency.

Abbreviation : VINACHEMIA.

Address : 21 Ngo Quyen, Hoan Kiem, Ha Noi

Phone : 0422205057-0462874499

Fax : 0422205038

Website : www.cuchoachat.gov.vn

Organizational structure of |Chemicals Agency:



II. Describe the authority and responsibility on mercury management

In authority management, life cycle of mercury and mercury containing products are divided into phrases: production/import – transportation – use – storage – disposal.

This section describes the overview of the responsibilities and activities of ministries, state agencies relevant to mercury management at each stage of the life cycle:

Agencies	Production /Import	Transportation	Use	Storage	Diposal
MOIT	x		x		
MONRE				x	x
MOARD			x		

MOH	x				
MOLISW	x				
MOST		x			
MOT		x			

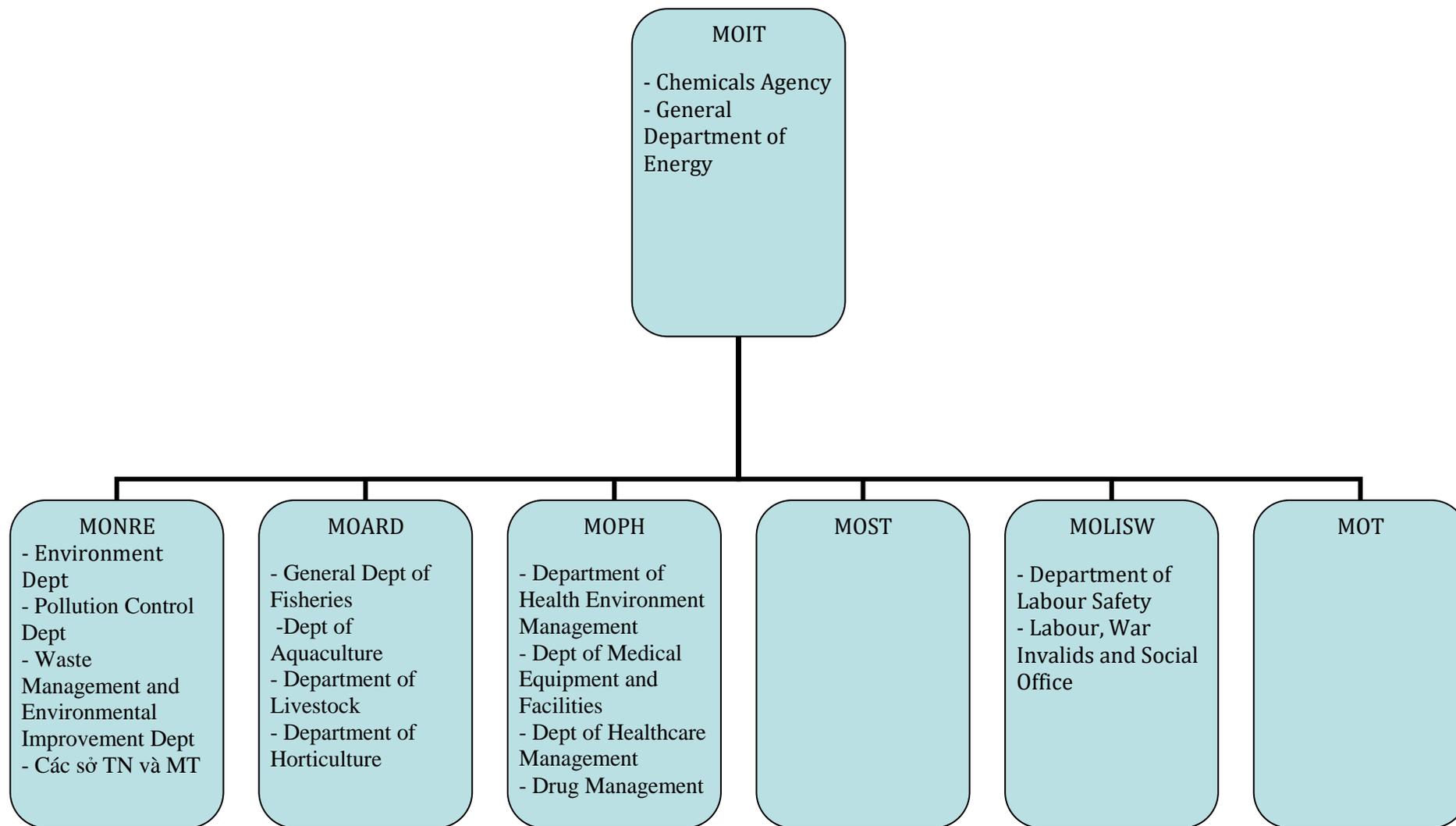


Figure 2: Chart of ministries participating in management of mercury

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
1.	CHEMICALS AGENCY				
		<p>1. For the Minister of MOIT to submit to competent authority to decide/issue, develop:</p> <p>a) Bills and ordinances, Draft Resolution of the National Assembly, the Standing Committee of the National Assembly, Draft Decrees of the Government, Decision of the Prime Minister on chemical activities;</p> <p>b) Strategy, plan and long-term development plan of the national chemical industry; projects, programs, mechanisms and</p>	<p>Chemical Law 2007</p> <p>Decree 108 /2008/ND-CP, 2008 Detailed regulations and guideline of implementation of several Articles in Law on Chemicals</p> <p>Decree 90/2009/NĐ-CP dated 20/10/2009</p>	40 officials	<p>According to Chemicals Law 2007, the Ministry of Industry and Trade is responsible for authority management on general chemical activities. One of the management tasks specified in Chemical Law 2007 is “implementation of international cooperation in chemical activities and chemical safety”, including all</p>

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>policies in chemical and industrial explosives field, as assigned by Prime Minister; negotiation programs, joining international treaties on chemicals</p> <p>c) National list of chemical; national chemicals database; list of precesors used in the industrial sector; list of chemicals subject to conditional production or trading; list of chemicals restricted from production, trading; list of banned chemicals; list of chemicals subject to compulsory declaration; list of chemicals which require elaboration of chemical prevention and response plans; list of chemicals which require elaboration of chemical</p>	<p>Providing for sanctions against administrative violations in chemical operation.</p> <p>Circular 43/2010/TT-BCT dated 29/12/2010</p> <p>Regulation on safety management in industry and trade</p> <p>Circular 12/2006/TT-BCN dated</p>		<p>international treaties on chemicals management such as Mercury Minamata Convention.</p> <p>- Chemical Agency – Ministry of Industry and Trade has an overall responsibility for the implementation of the Convention's provisions and national obligations to the Convention;</p> <p>- Propose the Prime Minister to authorize the sectoral Chief Executive to implement the Convention, negotiate</p>

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No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>prevention and response plans accordant to Chemical Law.</p> <p>d) Documents that allows <u>production, import, export and use of banned chemicals</u> for special purposes as regulated by law.</p> <p>2. Submit to the Minister for approval and promulgation:</p> <p>a) Annual development and 5 years plans for the chemical industry; on production, trade, export and import of chemicals and industrial explosives in accordance with law;</p> <p>b) Regulations, technical standards and process chemicals; provisions on infrastructure</p>	<p>22/12/ 2006 guidelines on activities of chemical safety management: dangerous chemicals declaration ; new chemical assessment; chemical safety sheet; classification and labeling of chemicals, chemical prevention and response plans.</p> <p>Circular</p>		<p>and vote at the conference of States Members;</p> <ul style="list-style-type: none"> - Being a multisectoral focal point to cooperate and implement the Convention; - Being a leader in research, proposing the Prime Minister to promulgate legal documents to implement the Convention; - Gathering information from other related

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>conditions - technical and professional expertise, the safe distance for base chemicals activities in accordance with law; specified conditions and specified organizations assess new chemicals; management regulations precursors used in the industrial sector;</p> <p>c) Toxic chemicals list and <i>selling and purchasing toxic chemicals controlling</i> form;</p> <p>d) Evaluating basic designs of chemical specialized construction works under project group A, B irrespective of the capital and evaluating basic designs of producing ammonium nitrate projects stipulated by law;</p>	<p>04/2012/TT-BCT dated 13/02/2012 Regulations on classification and chemicals labelling.</p> <p>Circular 28/TT-BCT dated 28/06/2010 specifying a number of articles of the Chemicals Law and the Decree 108/2008/NĐ-CP dated 07/10/2008 Detailing and</p>		<p>ministries/agencies and summarize in an annual report of Vietnam on the implementation of the Convention to submit to the Prime Minister before submit to the Secretariat in accordance with Article 21 of the Convention .</p> <p>- Being a focal point for developing Convention implementation plans of Vietnam under Article 20 of the Convention.</p> <p>-Being a focal point to implement the</p>

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>đ) Regulation and management of classification, labelling operations according to Global Harmonized System of Classification and Labeling of Chemicals; chemicals registration, declaration; chemical safety information.</p> <p>3. Coordinating with related agencies, units to organize the appraisal, submit preventing and responding to chemicals incidents plan to the head of ministry to approve. Monitoring, directing and guiding the implementation of regulations on measures to prevent and respond to chemical incidents; chemicals restricted from production, trading; chemicals allowed to production,</p>	guiding a number of articles of the Chemicals Law.		<p>provisions of the Convention on industrial and commercial activities (Article 3. Supplying and trading mercury source; Article 4. Products containing mercury. Article 5. Production process using mercury and mercury compounds. Article 7. Small-scale artisan gold mining).</p> <p>To implement the tasks assigned above, the coordination between different ministries such as the Ministry of Natural Resources and</p>

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>trading with conditions, hazardous, industrial used chemicals by organizations and individuals.</p> <p>4. Lead and coordinate and participate in guiding and monitoring the implementation of legal documents, policies, plans, proposals, projects, programs and regulations on chemical activities after being approved; propagate, disseminate and educate laws on chemical activities.</p> <p>5. Lead and coordinate and guide the classification and labeling of hazardous chemicals; registration, chemicals declaration stipulated by law; chemical safety information.</p>			<p>Environment, Ministry of Public Health, Ministry of Agriculture and Rural Development is very important. Meanwhile, the legislation system for mercury is not yet developed. The inter-agency coordinating mechanism on chemicals management in general and on mercury in particular is still in researching process. Besides, the data on mercury emissions of Vietnam has not yet been studied, systemarized and</p>

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>6. Issue professional chemicals guidelines under the authority; the specified documents; internal documents under the jurisdiction of the Agency in accordance with law.</p> <p>7. Grant, withdraw of licenses, certificates, registrations of chemical activities in accordance with law (export licenses, import precursors used in manufacturing sector; production, trading license for chemicals and restricted chemicals in production and trade; decision on production of explosive precursors, trading license of explosive precursors; export and import permission of explosive precursors and</p>			<p>published officially but only available sectoral. This is the main obstacle in being the focal role of the Ministry of Industry and Trade.</p>

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>explosive industrial materials).</p> <p>8. Check and handle acts of law violation in chemical operations, export and import of industrial explosives, explosive precursors; settle complaints and denunciations related to chemical activities, export and import of industrial explosives, explosive precursors.</p> <p>9. Build laboratory system to evaluate new chemical in Vietnam.</p> <p>10. Lead and coordinate with competent authorities to organize chemical safety training for organizations, individuals engaged in chemicals activities; foster and train staff of expertise</p>			

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>and professional management of chemical activities; build a network to control chemicals activities locally.</p> <p>11. Organize, coordinate with the competent state management bodies in <u>producing, trading inorganic fertilizers.</u></p> <p>12. Steering Committee on prevention of HIV/AIDS, drugs, prostitution of the Ministry; Standing intersectoral working group on implementation of prohibition of chemical weapons Convention and being a leader of the Ministry on international chemical conventions that Vietnam participated in.</p> <p>13. International cooperation in</p>			

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>the field of chemical activities as assigned by the Ministry.</p> <p>14. Organize, coordinate to develop schemes, projects, programs that serve the management and development of the sector, research, apply scientific and technological progress in chemical field as assigned by the ministry.</p> <p>15. Regulate contents, report forms and request organizations and individuals related to chemicals activities to provide information and documents to carry out the tasks assigned; develop synthesis, inventory, reports on chemical activities in the country; develop a database</p>			

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>of national chemicals.</p> <p>16. Advise the Minister in the field of management assigned to exercise the rights, responsibilities and obligations of owner of state for economic groups, corporations and companies with 100% state capital, joint stock companies that the Ministry is assigned as the owner of the state capital.</p> <p>17. Use granted state budget and revenues as stipulated by law.</p> <p>18. Implementation of administrative reform in the field of chemicals according to administrative reforming plan of the Ministry.</p> <p>19. Manage the resources system,</p>			

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		<p>officials, civil servants and employees, finance, assets assigned under the provisions of law and delegation of the Ministry.</p> <p>20. Implementation of specialized inspection on chemical activities under its state management in accordance with law.</p> <p>21. Perform other duties assigned by the minister.</p>			
2.	GENERAL DEPARTMENT OF ENERGY				
		<p>Develop a master plan for the development of the coal industry.</p> <p>b) Submit to the Minister of Ministry and Industry and Trade:</p> <ul style="list-style-type: none"> - Detailed planning of coal region, exploitation and use of peat 			

II.1.Ministry of Industry and Trade					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		planning in the whole country; - The norms and unit prices of coal industry; - Database, conditions and standards of export, import coal; - Planning on production, export and import of coal annually.			

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT					
No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
1.	GENERAL DEPARTMENT OF ENVIRONMENT				
1.1.	Department of Pollution Control	To assist the General Director in performing the national focal agency to implement international treaties in the field of management of hazardous chemicals and environmental health, which Vietnam has acceded to, signed or negotiated: Stockholm Convention (POPs), Rotterdam Convention (PIC), Minamata Convention (Hg); activities of the Strategic Approach to international chemicals management (SAICM) and other international agreements.	Decision No. 1515 / QD-TCMT November 25th, 2014 of the General Director of General Department of Environment.	40 officials and civil servants	Currently there are no written regulations of the National Focal Ministry of Minamata Convention.

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
1.2.	Department of Waste Management and Environmental Improvement	<ul style="list-style-type: none"> - Making survey, statistic report, prediction and planning of hazardous waste on a national scale, development and operation of information systems and national databases of hazardous waste; - Prepare and submit to the competent authorities on issuing the List of hazardous waste; mercury-containing waste considered as hazardous waste, hazardous waste code 02 04 02. - Organize to implement the license grant, renew, adjustment and revocation for hazardous waste management in accordance with law; 	<p>Circular 36/2015 / TT-BTNMT June 30th, 2015 on the management of hazardous waste.</p> <p>Circular 38/2015 / TT-BTNMT of renovation and restoration of the environment in mining operations June 30th, 2015.</p> <p>4. Decision No. 16/2015 / QD-</p>	46 officials and civil servants	Although there is a regulation of list of containing mercury waste products need to be retrieved and handled in Decision 16/2015 / QD-TTg, including: batteries, fluorescent lamps and compacts but environmental restoration activities has no specific regulations for mercury.

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
		<p>d) Direct and supervise the implementation of hazardous waste management, conditions for practicing, hazardous waste management licence;</p> <p>đ) Being a national focal in implementation of BASEL Convention on the control of transboundary transport and disposal of hazardous waste.</p>	<p>TTg of May 22nd, 2015 on withdrawal and handling of disposal wastes.</p> <p>5. Decision No. 1511 / QD-TCMT Hanoi, November 25th, 2014</p> <p>6. Circular 40/2015 / TT-BTNMT August 17th, 2015 on the process of monitoring emissions.</p>		

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
1.3.	Environmental monitoring center	<p>1. Central network of environmental monitoring networks in national environmental monitoring system; the focal agency to conduct the overall planning of national environmental monitoring system.</p> <p>2.. Join the monitoring network, global environmental monitoring network and global environment responding network.</p> <p>3. Mercury (evaporation) is monitored by the methods</p> <ul style="list-style-type: none"> - US EPA method 29 - US EPA method 30B - US EPA method 101A 	<p>5. Decision No. 1511 / QD-TCMT Hanoi, November 25th, 2014</p> <p>6. Circular 40/2015 / TT-BTNMT August 17th, 2015 on the process of monitoring emissions.</p>	<p>Currently there are 20 monitoring networks of air quality nationwide.</p> <p>However, there is only one station that monitors mercury in the air with optical technology in Ho Chi Minh Mausoleum in Hanoi.</p>	<p>Currently, Vietnam is facing with the problem of mercury's present in the air, not only from domestic pollution sources but also from transboundary pollution sources. This fact makes it difficult, challenging in monitoring and controlling mercury pollution due to the limitation of the methods, ways and mercury monitoring techniques and coordination of pollution control among countries.</p>

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
					<p>National environmental monitoring program also do not have many activities to assess the quality of the environment and the impact of emissions of hazardous chemicals. Due to limited funding and program design, monitoring indicators generally focus on the large amount of chemical emissions and can use a convenient measurement method. The indicators of highly toxic chemicals are often only implemented by</p>

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
					<p>research facilities with limited statistical accuracy.</p> <p>Thus it can be seen that the general state of environmental monitoring for emissions of harmful chemicals including mercury in facilities or national programs both contain substantial restrictions, although legally production facilities, trading facilities and service facilities have to meet all the environmental criteria in</p>

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
					environmental technical regulations related to their facilities. The reason is that existing legal provisions are not yet specific and feasible and also due to facilities 's low awareness and ability to comply with the provisions.
2.	Natural resources and environment office	Assess current situation in the local environment; identify environmental pollution areas; inspect the implementation of remedial measures of environmental pollution; Response plan, environmental pollution remedying plan due to	The decision of the provincial People's Committee.		

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
		<p>environmental incidents.</p> <p>Issuance, extension and withdrawal of permits for waste generators, collectors, transporters and handling of hazardous waste;</p> <p>Appraising strategic environmental assessment reports and environmental impact assessment report, environmental protection schemes under its competence.</p> <p>Organize and coordinate to implement environmental landscape protection, remediation, renovation scheme;</p>			

II.2. MINISTRY OF RESOURCES AND ENVIRONMENT

No	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation on the barrier when performing authority management of mercury
		Management of environmental monitoring systems in the local; Communication activities for environmental protection;			

II.3. MINISTRY OF PUBLIC HEALTH

No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of the barrier when performing authority management of mercury
1	DEPARTMENT OF MEDICAL ENVIRONMENTAL MANAGEMENT	Registration for circulation, export, import and use of chemical insecticides, chemicals used in household and medical disinfectants.	Circular No. 29/2011 / TT-BYT on management of insecticidal or germicidal chemicals and preparations for household and medical use. Circular No. 25/2011 / TT-BYT promulgation of insecticidal,	09 officers: 01 Doctor 04 Masters 04 Bachelors Have not been in an intensive training on mercury management	Mercury management measures in composition of insecticidal, germicidal chemicals are not mentioned.

II.3. MINISTRY OF PUBLIC HEALTH					
No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			germicidal chemicals list, which are permitted to register to use, permitted to register but restricted to use and prohibited to register to use.		
		Emissions, storage or disposal	- Decision No 43/2007 / QD-BYT dated 30/11/2007 promulgating the regulation on	-Safety instructions to use medical equipment containing mercury include:	- Lack of equipment and facilities. - The users have not been training.

II.3. MINISTRY OF PUBLIC HEALTH

No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			<p>management of medical wastes (waste containing mercury are classified as waste containing heavy metals).</p> <p>- Decision No 3733/2002 / QD-BYT dated 10/10/2002 of the Ministry of Public Health (regulations on allowable limits of mercury in</p>	<p>+ Use safety</p> <p>+ Collect, transport and safe storage of medical wastes containing mercury.</p>	

II.3. MINISTRY OF PUBLIC HEALTH

No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			working atmosphere) - Circular No. 19/2011 / TT-BYT guiding on labour hygiene management, occupational health and occupational diseases management. - Circular No. 08/1976 / TT-LB regulating some		

II.3. MINISTRY OF PUBLIC HEALTH					
No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			occupational diseases and benefits for civil servants that suffer from occupational diseases.		
2	DEPARTMENT OF MEDICAL EQUIPMENT AND CONSTRUCTION	Registration of circulation, export, import, manufacture, trading.	- Circular No. 24/2011 / TT-BYT Section 47 Appendix 1 Types of long-term implanting equipment, materials (over	Import of dental amalgam materials	- Thermometers and mercury sphygmomanometer are not in the list of equipment that must have import permission. - Import procedures of amalgam are the same as that of other

II.3. MINISTRY OF PUBLIC HEALTH					
No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			30 days) in human body - Circular No. 07/2002 / TT-BYT registration instructions for circulation of medical equipment.		dental filling materials.
3	DEPARTMENT OF MEDICAL SERVICE MANAGEMENT	Use of antiseptics in health facilities	Decision No. 458 / QD-BYT dated 08/2/2014 of the Minister of Public Health regulating the functions, tasks, powers and	No specialized staff	There is no written guidance document on the use of mercury-containing antiseptic.

II.3. MINISTRY OF PUBLIC HEALTH					
No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity⁽³⁾	Evaluation of the barrier when performing authority management of mercury
			organizational structure of the Medical Service Management Department of the Ministry of Public Health		
4	DEPARTMENT OF DRUG MANAGEMENT	Registration of circulation, export and import of cosmetics, antiseptics	Circular No. 06/2011 / TT-BYT regulations on management of cosmetics	There is no specialized staff because cosmetics, and antiseptics are not separated into a specific group but are managed with other cosmetic	There is no specific regulations on mercury levels in antiseptics, cosmetics

II.4. Ministry of Agriculture & Rural Development

II.3. MINISTRY OF PUBLIC HEALTH					
No	Agency's name	Authority responsibility in mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity⁽³⁾	Evaluation of the barrier when performing authority management of mercury
				products, other antiseptics.	

No.	Organization	Authority responsibility in mercury management by its life cycle ¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
1	Directorate of Fisheries - Aquaculture Department	<p>Usage (Application?)</p> <p>Regulate the maximum permissible concentrations for heavy metals in Animal feeds</p> <p>Announce the list of compulsory minimum technical requirements must be disclosed when develop the Animal Feeds Standard</p>	<p>Decision 57/2014/QD-TTg, dated 22/10/2014</p> <p>Circular 81/2009/TT-BNNPTNT dated 25/12/2009 and Circular 23/2012/TT-BNNPTNT Promulgating the National Technical Regulation on Animal Feed</p> <p>Circular 66/2011/TT-BNNPTNT Circular 50/2014/TT-BNNPTNT Detailing the Government's decree on the Management of</p>	05 staffs, with Phd, MSc of Biochemistry, Aquaculture	The Ministry of Agriculture & Rural Development already has (the) regulation (s) of the maximum permissible concentrations for heavy metals Animal Feeds, which clearly states the concentration of mercury. However, on the Circular guiding the Management of Animal Feeds, Mercury is not on the list of compulsory minimum technical requirements must be disclosed

			Animal Feeds		
2	Department of Livestock Production – Division of Animal Feeds	H.5. MINISTRY OF LABOUR – WAR INVALIDS AND SOCIAL AFFAIRS	665/QD-BNN-TCCB dated 4/4/2014	05 staffs, with Phd, MSc of Biochemistry, Animal Husbandry	
3	Department of Farming – Division of Fertilizer		663/QD-BNN-TCCB date 4/4/2014	04 members, with Phd Msc of Pedology, Agrochemistry	

No.	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
1	DEPARTMENT OF LABOUR SAFETY	<p>1. Study, develop and submit the Ministry:</p> <p>a) Strategy, program, long-term and annual plans, projects, proposals for work & labour safety</p> <p>b) Legal Projects, ordinances, legal normative documents for work & labour safety</p> <p>c) Labour safety regulations</p> <p>d) Work Safety and Technical Regulation of Safety:</p> <ul style="list-style-type: none"> - National Technical Regulation on work safety - List of Machines, Equipments 	<p>Government's Decree no. 29/2003/NĐ-CP date 31/3/2003.</p> <p>Decision no. 1123/2003/QĐ-BLĐTBXH date 10/9/2003 and Decision no. 147/QĐ-LĐTBXH date 22/01/2008 of Minister of Labour – Invalids and Social Affairs.</p> <p>Circular no. 23/2003/TT-</p>	40 officials, undergraduates/post-graduates	<p>Circular no. 23/2003/TT-BLĐTBXH date 03/11/2003, Ministry of Labour – Invalids and Social Affairs, on <i>regulating and guiding registration & verification procedure for Machines, Equipments and Supplies having strict requirement on Labour Safety</i>, the list of</p>

		<p>and Supplies having strict requirement on Labour Safety</p> <ul style="list-style-type: none"> - Regulation and guidance of registration& testing procedure of Machines, Equipments and Supplies having strict requirement on Labour Safety - The Ministry’ appraisal of issueance of: +Verifying procedure of Machines, Equipments and Supplies having strict requirement on Labour Safety + Criteria, operating conditions of all Centers of Industrial Safety Registration. -Regulation & guidance of the quality inspection of particularproducts, goods on Labour Safety as regulated - List of jobs, heavy duty tasks, dangerous & hazardous jobs and extremely heavy, dangerous and hazardous jobs. - National Program on Labour Protection, Safety and Sanitaion; 	<p>BLĐTBXH date 03/11/2003 of Ministry of Labour – Invalids and Social Affairs regulating and guidingregistration &verificationprocedure all Machines, Equipments and Supplies having strict requirement on Labour Safety</p> <p>Circular no. 32/2011/TT-BLĐTBXH of Ministry of Labour – Invalids and Social Affairs: Guiding implemetaion of technical verification on work safety on Machines, Equipments and Supplies having strict requirement on</p>		<p>chemicals required strictly compliance with Work Safety regulation includes <i>Mercury and its compounds</i> (number 50, appendix 4).</p> <p>However, circular 04/2008/TT-BLĐTBXH, now is substituted by Circular 32/2011/TT-BLĐTBXH, Ministry of Labour – Invalids and Social Affairs, the mentioned list was dismissed. Thus, Mercury has not yet identified as a chemical having strict requirement on Ministry of Labour - Invalids and Social Affairs’s Labour Safety management duty,</p>
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		<p>National Week on Labour Protection, Safety and Sanitation, national week of Labour Safety and sanitation, fire and explosion prevention;</p> <ul style="list-style-type: none"> - Decision to join with Ministry of Health to promulgate the list of occupational disease; 2. Direct, guide and inspect the implementation of Government and Ministry regulations on work safety, labour safety according to Ministry assignment. 3. Activities of enhancing propaganda, improving awareness and education of Work & Labour Safety regulation as assigned by the Ministry; statistically update and report on accident at work. 4. Management of Work Safety training (training conditions, capability of teachers, trainers participating content training) 5. Cooperation in developing standards and technical 	<p>Labour Safety (Subtitue Circular04/2008/TT- BLĐTBXH date 27/02/2008)</p>		
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		<p>regulations, profession for specialized officers, compensation and benefits regulation for specialized officers and personnel;</p> <p>6. Guide and evaluation the inspection of machines, equipment or supplies having strict requirements on labour safety by organizations operating in technical test of about safety.</p> <p>7. Support the Ministry implements government management toward NGO groups and organizations currently active on the field of Work & Labour Safety</p> <p>8. Implementaion of International Coorperation as assigned by the Ministry.</p> <p>9. Activities of science research; training officers, personnel on Work & Labour Safety regulations as assigned by the ministry.</p> <p>10. Drafting, summarizing,</p>			
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		<p>annual and unanticipated report on Work & Labour Safety.</p> <p>11. Management of officers, personnel, facilities, finance as regulated by laws and the Ministry</p> <p>12. Execution of other assignments from the Ministry</p>			
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II.6.MINISTRY OF SCIENCE AND TECHNOLOGY					
No.	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
1	Departments of Science and Technology	<p>1. Evaluate and issue license for transportation of hazardous goods for companies.</p> <p>2. Coordinate with functional departments (transportation inspector, industry and trade inspector, police) inspects, examine the transportation of dangerous goods activities of companies own the licenses for transportation of hazardous goods.</p> <p>3. Report semi-annually the current situation issuance of license for transportation of hazardous goods to the Ministry of Science and Technology,</p>	<p>Decree no. 104/2009/NĐ-CP, Government, providing the list of dangerous goods and the transportation of dangerous goods by road motor vehicles.</p> <p>Circular no. 25/2010/TT-BKHCN Guiding the procedure</p>		

II.6.MINISTRY OF SCIENCE AND TECHNOLOGY

No.	Agency's name	Authority responsibility on mercury management by its life cycle ⁽¹⁾	Legal grounds ⁽²⁾	Implementation capacity ⁽³⁾	Evaluation of barriers when performing authority management of mercury
		People's Committee of	for licensing the road transport of hazardous goods being oxidants, organic oxides, and corrosive substances		

III. Description of other mechanisms involve with management of mercury

Other mechanisms to manage mercury and its compounds are still under development

IV. Summary

The negative impacts of uncontrolled **mercury emission** to environment and health is significant. In Vietnam, mercury has its appearance in many industrial process and products (manual gold mining, litghing equipments, coal burning at cement factory, thermoelectric, fertilizer), health service (thermometer, dental...), but has not yet regulated and controlled sufficiently and rigorously.

Though there is availability of legal normative documents on interdisciplinary management of mercury (Chemical Law, Environmental Protection Law, Circular no. 30/2011/TT-BCT date 10/8/2011, Ministry of Industry and Trade temporarily regulate the permissible concentrations of hazardous chemicals in electric, electrical device...), the management of mercury still has many limitations. The most significant issue is that that there is no legal normative documents specifically for the management of mercury.

Acknowledgement of mentioned limitations, Vietnam Government has signed the Minamata Convention on Mercury, Decision no 1811/QĐ-TTg date 04/10/2013 in order to control and reduce usage and emission of mercury from products, productions, manufacturing and industries, limit the negative impact toward environment and people. Vietnam participation in the convention not only empowers Vietnam position but also results in a number of benefits, included:

- Impulse the perfection of national legislation system on the management of mercury to protect human health and environment from negative impacts of mercury and its compounds. This will establish the management of mercury systematically, avoid illegal trading, smuggling and usage in Vietnam;
- International support on technology, finance, technology transfer, building capacity of mercury management;
- Exchange information on science, technology, economy, legislation involve related to mercury management with the Convention member countries
- Participate in Cooperation program in study, develop and supervise the economic and technical capability of non-mercury products, optimal

technology process and optimal environmental solutions to reduce and control mercury and its compound emission.

- This is also an opportunity for Vietnam to learn from member countries' experience of mercury management and cooperate with countries that have developed non-mercury products, optimal technology solution to reduce mercury emission

V. Annex

Mentioned legal documents:

1. Chemical Law 06/2007/QH12 year 2007;
2. Decree 108 /2008/ND-CP, year 2008 Stipulate detail and guidance of the implementation of some articles of chemical law;
3. Decree 90/2009/NĐ-CP, dated 20/10/2009 Sanction against administrative violations in chemical operation;
4. Decree 43/2010/TT-BCT dated 29/12/2010 Regulations on Safety Management in Industry and Trade;
5. Decree 12/2006/TT-BCN dated 22/12/2006 Guidance of activities on chemical safety management, included: declaration of hazardous chemicals; assessment of new chemicals; chemical safety note; classification and labeling of chemicals; corrective and preventive plan;
6. Circular 04/2012/TT-BCT dated 13/02/2012 Regulations on the classification and labeling of chemicals;
7. Circular 28/TT-BCT dated 28/06/2010 Detailing a number of articles of the Chemical Law and và Decree 108/2008/NĐ-CP dated 07/10/2008 Detailing and guiding a number of articles of the chemical law;
8. Decision no. 1515/QĐ-TCMT dated 25/11/2014 of Director General of Directorate of Environment;
9. Circular 36/2015/TT-BTNMT dated 30/06/2015 Management of hazardous waste;
10. Circular 38 /2015/TT-BTNMT on Environmental remediation and restoration of mineral mining activities dated 30/06/2015;
11. Decision no. 16/2015/QĐ-TTg dated 22/05/2015 Providing regulations on recall and treatment of discarded products;
12. Decision no. 1511/QĐ-TCMT dated 25/11/2014 of Directorate of Environment
13. Circular 40/2015/TT-BTNMT dated 17/08/2015 of Emission Monitoring process

14. Circular no. 29/2011/TT-BYT On management of insecticidal or germicidal chemicals and preparations for household and medical use
15. Circular no. 25/2011/TT-BYT Promulgating list of insecticidal, germicidal chemicals that is allowed to use, allowed to use but limit, and forbidden in Vietnam;
16. Decisionno. 43/2007/QĐ-BYT dated 30/11/2007 promulgating the regulation on management of medical wastes (wastes contain mercury is classified as waste contains heavy metals);
17. Decisionno. 3733/2002/QĐ-BYT dated 10/10/2002 of Ministry of Health (Regulation permissible content limitation of mercury in the air of the working sphere);
18. Circular no. 19/2011/TT-BYT Guiding the management of labour hygiene, workers' health and occupational diseases;
19. Circular no. 08/1976/TT-LB On occupational diseases, benefits for civil servants that suffer from occupational diseases;
20. Circular no. 24/2011/TT-BYT guiding the import of medical device
21. Circular no. 07/2002/TT-BYT guiding the registration for circulation of medical equipment and facilities
22. QĐ no. 458/QĐ-BYT dated 08/2/2014 Minister of Ministry of Health regulates function, mission, authority and structure of Vienam Medical Service Administration
23. Circular no. 06/2011/TT-BYT providing cosmetic management.
24. Circular 81/2009/TT-BNNPTNT dated 25 tháng 12 năm 2009 và Circular 23/2012/TT-BNNPTNT the promulgation of national technical regulations on animal feeds.
25. Circular 66/2011/TT-BNNPTNT Circular 50/2014/TT-BNNPTNT Detailing Government decree on Animal Feed management.
26. Decree no. 29/2003/NĐ-CP dated 31/3/2003 of Government. Decisionno. 1123/2003/QĐ-BLĐTBXH dated 10/9/2003 và Decision no. 147/QĐ-LĐTBXH dated 22/01/2008 of Minister of Ministry of labour- invalids and Social Affairs.
27. Circular no. 23/2003/TT-BLĐTBXH dated 03/11/2003 of Ministry of Labour – Invalids andSocial Affairs onregulating and providing guidance on application and appraisal procedures of machinery, equipment, materials, and substances with strict occupational safety, hygiene and health requirements.
28. Circular no. 32/2011/TT-BLĐTBXH of Ministry of Labour – War Invalids and Social Affairs: Guiding the technical expertise of occupational safety

of machinery, equipment, materials with strict requirements on occupational safety.

29. Decree no. 104/2009/NĐ-CP providing for the list of dangerous goods and the transport of dangerous goods by road motor vehicles.
30. Circular no.: 25/2010/TT-BKHCN guiding the procedures for licensing the road transport of hazardous goods being oxidants, organic oxides, and corrosive substances.

Annex 2 National mercury inventory report

Vietnam Chemicals Agency - The Ministry of Industry and Trade

NATIONAL INVENTORY OF MERCURY RELEASES IN VIETNAM

Year 2016

INVENTORY OF MERCURY RELEASES IN VIETNAM

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This inventory was performed in accordance with UNEP's "Toolkit for identification and quantification of mercury releases", Inventory Level 1 (version 1.02, April 2013, or newer).

1. Executive summary

1.1. Introduction

Socialist Republic of Viet Nam became the country signing the Minamata Convention in November 2013 in Japan. The Minamata Convention is used to minimize and if possible, limit the use of mercury in key industries. The provisions of the Convention require last time for commercial supplies, mercury-containing products, technological processes using mercury and mercury compounds. Based on these objectives, the Convention demands to systematically reduce mercury releases to soil, water, air and stop using mercury if having other alternatives. According to Decision No. 1811 / QĐ-TT in 4th October 2013, the Office of the Government announced the requirement of Prime Minister: "In appropriate time, the Ministry of Industry and Trade cooperating with other relevant departments to study and approve the Minamata Convention and then submit to the Government". In order to implement the guidance above, with the permission of the Ministry of Industry and Trade's leaders, the Chemical Department (Vinachemia), in collaboration with United Nations Industrial Development Organization (UNIDO), has implemented the project "Initial Assessment of the Minamata Convention in Vietnam, under the funding from the Global Environment Fund (GEF) in the form of technical assistance projects using ODA capital". The results of this project, then, will support the Ministry of Industry and Trade in setting up the Mercury Minamata Convention project. As a result, this database is introduced to assist the implement of the project.

1.2. Method of establishing database

The basic method used for establishing database of mercury releases is the Toolkit named "The identification and classification of mercury releases". This Toolkit has the latest version of published in 2015 by United Nations Environment Programme UNEP

The toolkit can be found on the website:

http://www.unep.org/hazardoussubstances/Lượng_thủy_ngân/Lượng_thủy_ngânPublications/GuidanceTrainingMaterialToolkits/Lượng_thủy_ngânToolkit/tabid/4566/language/en-US/Default.aspx

The database was built in 2015. In this database, the data years depend on the year having existing data, instead of a fixed year; and the statistics and data years are always noted in this report.

This method mainly employs these following approaches:

1. The review of given information in the Toolkit for each resource is based on information searches from reliable sources published on the Internet about related source / sub- sources.
2. In order to update the information about the latest activities happening, the method firstly requires to contact the State management agencies, importers, producers, centres and local industry associations and so on, then assesses or estimate in the most relative way.
3. Using the Toolkit to calculate inputs / outputs, following already installed excel spreadsheets, thus drafting the report for relevant sections of analysis and initial assessments.

Under the overall assessment for all types of mercury emission sources, this database is made based on the first Toolkit. At first level, we will employ the inputs in a

preliminary way in order to calculate the Toolkit formula, thus producing the amount of mercury releasing and then how it releases into the environment. We, therefore, temporally term them as default inputs and default outputs. These factors in the report have been divided into groups depending on input format and mercury releases from relevant sources.

1.3. Results and Discussions

Firstly, the results from main sources of mercury releases are presented in the following Table 1-1

Table 1-1 Summary of mercury inventory results

Source category	Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y							Percent of total releases *3*4
		Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal	Total releases *3*4*5	
Coal combustion and other coal use	5,373.3	4,898.1	0.0	0.0	0.0	0.0	475.2	5,373	11%
Other fossil fuel and biomass combustion	1,168.1	1,168.1	0.0	0.0	0.0	0.0	0.0	1,168	2%
Oil and gas production	1,101.3	158.5	216.1	0.0	306.0	0.0	360.3	1,041	2%
Primary metal production (excl. gold production by amalgamation)	4,017.6	561.3	154.9	250.4	1,111.3	630.3	1,309.4	4,018	8%
Gold extraction with mercury amalgamation	240.8	96.6	76.7	67.5	0.0	0.0	0.0	241	0%
Other materials production	7,783.1	5,839.6	0.0	0.0	1,943.5	0.0	0.0	7,783	16%
Chlor-alkali production with mercury-cells	-	-	-	-	-	-	-	0	0%
Other production of chemicals and polymers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Production of products with mercury content*1	2,239.0	22.4	11.2	223.9	0.0	223.9	22.4	504	1%
Application, use and disposal of dental amalgam fillings	620.6	12.4	206.1	29.8	22.3	104.3	104.3	479	1%
Use and disposal of other products	9,127.0	1,236.0	2,007.0	1,236.0	0.0	3,157.2	1,490.8	9,127.0	19%

Production of recycled metals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Waste incineration and open waste burning*2	12,382.8	11,881.3	0.0	0.0	0.0	0.0	501.5	12,383	25%
Waste deposition*2	24,015.5	240.2	2.4	0.0	-	-	-	243	0%
Informal dumping of general waste *2*3	17,181.2	1,718.1	1,718.1	13,744.9	-	-	-	3,436	7%
Waste water system/treatment *4	17,612.0	0.0	15,850.8	0.0	0.0	1,761.2	0.0	1,761	4%
Crematoria and cemeteries	1,565.1	91.6	0.0	1,473.5	0.0	0.0	0.0	1,565	3%
TOTALS (rounded) *1*2*3*4*5	36,803	29,238	2,954	5,029	3,384	5,748	2,778	49,131	100%

Notes to table above:

*1 To avoid double counting of mercury in products produced domestically and sold on the domestic market (including oil and gas), only the part of mercury inputs released from production are included in the input TOTAL.

*2: To avoid double counting of mercury inputs from waste and products in the input TOTAL, only 10% of the mercury input to waste incineration, waste deposition and informal dumping is included in the total for mercury inputs. These 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of the Toolkit.

*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, input to, and release to water from, waste water system/treatment have been subtracted automatically in the TOTALS.

*5: Total inputs do not necessarily equal total outputs due to corrections for double counting (see notes*1-*3) and because some mercury follows products/metal mercury which is not sold in the same country or in the same year.

As shown in Table 1.1, the following source groups and major mercury inputs were:

1 / "Coal incineration and other coal purposes"accounts for 27% (11% + 16%) of the total amount of final mercury releases

2/ "The waste incineration and open waste burning"accounts for 25% of the total amount of final mercury releases

3/ "Use and disposal of other products"accounts for 19% of the total amount of final mercury releases

4/ Metal production (excl. gold production by amalgamation) accounts for 8% of the total amount of final mercury releases

1.4. Data gaps

Major data gaps were the following:

1/These statistics can not be collected at a point of time. This year's data and other years' data can change daily and hourly.

2/For most of the areas under the controls of government agencies, the access to information sources is possible. However, there are some impracticable issues belonged to the unmanaged areas that cannot be investigated. It, therefore, is impossible to analyse data in either direct or indirect ways.

3/Even in managing areas, it is difficult in gaining accurate statistics in some items and it is required to use some estimation methods, calculations or logical explanation to get approximate numbers => there are data gaps. In addition, many statistics are accumulated from other sources instead being collected and that numbers cannot be used to be the representative data

4/ As for mercury-containing products imported, it is unable to separate out whether which ones are mercury, thus, the determination of mercury releases from used products, disposal of used parts can not be assessed and estimated accurately.

5/ The uncontrollable manufacturing activities, sales and import & export activities also lead to data gaps for all calculations.

Specifically, with reference to each sub-source, we can list the data errors that may occur in the following table:

Table 1-2 The data errors in the mercury database

Sub-source	Data Errors
Manufacture and imports	There are no figures of mercury-containing products in manufacturing, while the import figures might be available but having only statistics by groups with same product codes instead separating particular products. It, therefore, cannot be calculated domestic mercury consumption for specific manufacturing operations.
The burning of Coal combustion and other used coal	There are data errors for the use of coal for other purposes owing to the amount of coal manufacturing, coal import & export and coal smuggling into Vietnam.
Energy and thermal energy production by using biomass	The data of biomass utility to produce heat for cooking purposes in rural areas can not be collected to add to statistics. Therefore, there are certainly data errors.
Metal production (excl. gold production by amalgamation)	

Gold production by amalgamation	The issues related to the manual gold production in small-scale ASMG in "bandits" gold mines can generate difficulties in approaching and gaining accurate data.
Recycled metals production	There are no statistics. These activities are normally conducted in craft villages. It then cannot be able to collect data on these activities
Waste incineration and open waste burning	There are many uncontrollable incineration activities; therefore, the ratios are only indicative estimates instead entirely accurately.
Waste collection	A common problem with waste
Informal dumping of general waste	The data can not be controlled or statistic
Use and disposal of other products	Even the imported mercury-containing products cannot be categorised into mercury-containing ones or not
Crematoria and cemeteries	If do not base on mortality ratio and population rate from national statistics, it will be unable to determine exact quantity. Based on data from some major cities, the cremation rate can only be estimated to interpolate.

1. Mercury releases sources

Table 2-1 shows which mercury releases sources were identified as present or absent in Vietnam. Only source types positively identified as present are included in the quantitative assessment.

It should be noted, however, that the presumably minor mercury release source types shown in Table 2-2 were not included in the detailed source identification and quantification work. These may, however, be present in some countries.

Table 1-1 Identification of mercury release sources in the country; sources present (Y), absent (N), and possible but not positively identified (?). [Overleaf]

Source category	Source present?
	Y/N/?
Energy consumption	
Coal combustion in large power plants	Y
Other coal uses	Y
Combustion/use of petroleum coke and heavy oil	N
Combustion/use of diesel, gasoil, petroleum, kerosene	Y
Biomass fired power and heat production	Y
Use of gas in pipelines (consumption)	N
Production of electrical and thermal energy from biomass	Y
Charcoal combustion	Y
Fuel production	
Oil extraction	Y
Oil refining	Y
Extraction and processing of natural gas	Y
Primary metal production	
Mercury (primary) extraction and initial processing	N
Production of zinc from concentrates	Y
Production of copper from concentrates	Y
Production of lead from concentrates	Y
Gold extraction by methods other than mercury amalgamation	Y
Alumina production from bauxite (aluminium production)	Y
Primary ferrous metal production (iron, steel production)	Y
Gold extraction with mercury amalgamation - without use of retort	Y
Gold extraction with mercury amalgamation - with use of retorts	Y

Other materials production	
Cement production	Y
Pulp and paper production	Y
Production of chemicals and polymers	
Chlor-alkali production with mercury-cells	N
VCM production with mercury catalyst	N
Acetaldehyde production with mercury catalyst	N
Production of products with mercury content	
Hg thermometers (medical, air, lab, industrial etc.)	Y
Electrical switches and relays with mercury	Y
Light sources with mercury (fluorescent, compact, others: see guideline)	Y
Batteries with mercury	N
Manometers and gauges with mercury	N
Biocides and pesticides with mercury	N
Paints with mercury	Y
Skin lightening creams and soaps with mercury chemicals	N
Use and disposal of products with mercury content	
Dental amalgam fillings ("silver" fillings)	Y
Thermometers	Y
Electrical switches and relays with mercury	Y
Light sources with mercury	Y
Batteries with mercury	N
Polyurethane (PU, PUR) produced with mercury catalyst	N
Paints with mercury preservatives	N
Skin lightening creams and soaps with mercury chemicals	N
Medical blood pressure gauges (mercury sphygmomanometers)	N
Other manometers and gauges with mercury	N

Laboratory chemicals	N
Other laboratory and medical equipment with mercury	N
Production of recycled of metals	
Production of recycled mercury ("secondary production")	N
Production of recycled ferrous metals (iron and steel)	Y
Waste incineration	
Incineration of municipal/general waste	Y
Incineration of hazardous waste	Y
Incineration of medical waste	Y
Sewage sludge incineration	Y
Open fire waste burning (on landfills and informally)	Y
Waste deposition/landfilling and waste water treatment	
Controlled landfills/deposits	Y
Informal dumping of general waste *1	Y
Waste water system/treatment	Y
Crematoria and cemeteries	
Crematoria	Y
Cemeteries	Y

2. Mercury inputs

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

Table 2-1 Summary of mercury inputs to society

Source category	Source present?			Estimated Hg input, Kg Hg/y
	Y/N/?	Activity rate	Unit	Standard estimate
Energy consumption				
Coal combustion in large power plants	Y	26,400,000	Coal combusted, t/y	3,960
Other coal uses	Y	10,600,000	Coal used, t/y	1,413
Combustion/use of petroleum coke and heavy oil	N	0	Oil product combusted, t/y	-
Combustion/use of diesel, gasoil, petroleum, kerosene	Y	13,700,000	Oil product combusted, t/y	75
Biomass fired power and heat production	Y	9,969,000,000	Biomass combusted, t/y	997
Use of gas in pipelines (consumption)	N	0		-
Production of electrical and thermal energy from biomass	Y	3,000,000		90
Charcoal combustion	Y	48,477		6
Fuel production				
Oil extraction	Y	17,400,000	Crude oil produced, t/y	59
Oil refining	Y	6,500,000	Oil refined, t/y	22
Extraction and processing of natural gas	Y	10,200,000,000	Produced gas, Nm3/y	1,020
Primary metal production				
Mercury (primary) extraction and initial processing	N	0	Mercury produced, kg/y	-
Production of zinc from concentrates	Y	17,670	Concentrate used, t/y	1,149
Production of copper from concentrates	Y	48,100	Concentrate used, t/y	1,443
Production of lead from concentrates	Y	930	Concentrate used, t/y	28
Gold extraction by methods other than mercury amalgamation	Y	18,549	Gold ore used, t/y	278

Source category	Source present?			Estimated Hg input, Kg Hg/y
	Y/N/?	Activity rate	Unit	Standard estimate
Alumina production from bauxite (aluminium production)	Y	1,939,275	Bauxite treated, t/y	970
Primary ferrous metal production (iron, steel production)	Y	3,006,000	Pig iron produced, t/y	150
Gold extraction with mercury amalgamation - without use of retort	Y	112	Gold produced, kg/y	241
Gold extraction with mercury amalgamation - with use of retorts	Y	0	Gold produced, kg/y	0
Other materials production				
Cement production	Y	59,800,000	t cement produced, t/y	7,774
Pulp and paper production	Y	302,666	t biomass used in production, t/y	9
Production of chemicals				
Chlor-alkali production with mercury-cells	N	0	Cl ₂ produced, t/y	-
VCM production with mercury catalyst	N	0	VCM produced, t/y	-
Acetaldehyde production with mercury catalyst	N	0	Acetaldehyde produced, t/y	-
Production of products with mercury content				
Hg thermometers (medical, air, lab, industrial etc.)	N	0	Mercury used for production, kg/y	-
Electrical switches and relays with mercury	N	0	Mercury used for production, kg/y	-
Light sources with mercury (fluorescent, compact, others: see guideline)	Y	2,233	Mercury used for production, kg/y	2,233
Batteries with mercury	Y	0	Mercury used for production, kg/y	0
Manometers and gauges with mercury	Y	0	Mercury used for production, kg/y	0
Biocides and pesticides with mercury	N	0	Mercury used for production, kg/y	0
Paints with mercury	Y	6	Mercury used for production, kg/y	6
Skin lightening creams and soaps with mercury chemicals	N	0	Mercury used for production, kg/y	0
Use and disposal of products with mercury content				
Dental amalgam fillings ("silver" fillings) (**)	Y	90,728,900	number of inhabitants	621
Thermometers	Y	1,884,775	items sold/y	1,885

Source category	Source present?			Estimated Hg input, Kg Hg/y
	Y/N/?	Activity rate	Unit	Standard estimate
Electrical switches and relays with mercury	Y	90,728,900	number of inhabitants	4,339
Light sources with mercury	Y	158,860,660	items sold/y	2,904
Batteries with mercury	Y	0	t batteries sold/y	0
Polyurethane (PU, PUR) produced with mercury catalyst	N	90,728,900	number of inhabitants	-
Paints with mercury preservatives	Y	0	Paint sold, t/y	0
Skin lightening creams and soaps with mercury chemicals	Y	0	Cream and soap sold, t/y	0
Medical blood pressure gauges (mercury sphygmomanometers)	Y	0	items sold/y	0
Other manometers and gauges with mercury	N	90,728,900	number of inhabitants	-
Laboratory chemicals	N	90,728,900	number of inhabitants	-
Other laboratory and medical equipment with mercury	N	90,728,900	number of inhabitants	-
Production of recycled of metals				
Production of recycled mercury ("secondary production")	N	0	mercury recycled, kg/y	-
Production of recycled ferrous metals (iron and steel)	Y	0	Number of vehicles recycled/y	0
Waste incineration				
Incineration of municipal/general waste	Y	489,954	Waste incinerated, t/y	2,450
Incineration of hazardous waste	Y	92,300	Waste incinerated, t/y	2,215
Incineration of medical waste	Y	14,582	Waste incinerated, t/y	350
Sewage sludge incineration	Y	0	Waste incinerated, t/y	0
Open fire waste burning (on landfills and informally)	Y	1,473,572	Waste burned, t/y	7,368
Waste deposition/landfilling and waste water treatment				
Controlled landfills/deposits	Y	4,803,093	Waste landfilled, t/y	24,015
Informal dumping of general waste *1	Y	3,436,233	Waste dumped, t/y	17,181
Waste water system/treatment	Y	3,354,663,066	Waste water, m3/y	17,612

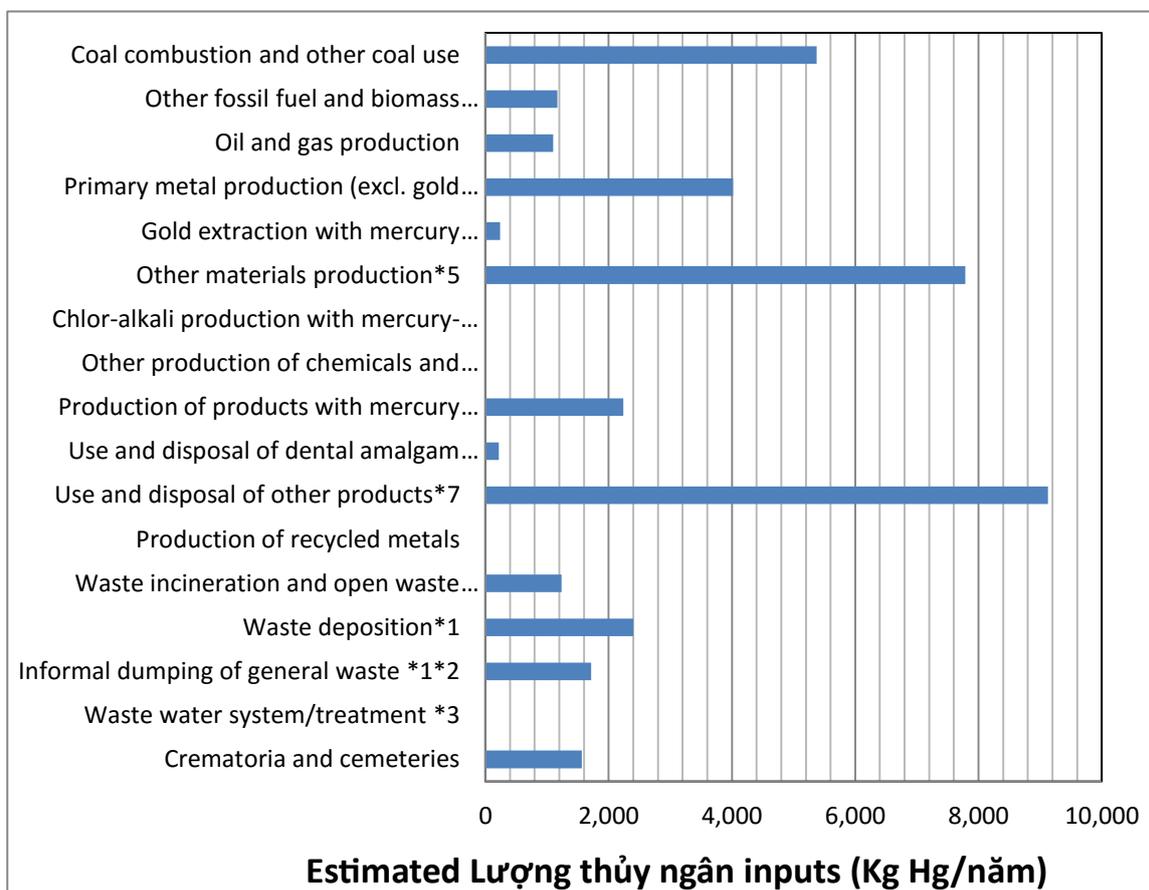
Source category	Source present?			Estimated Hg input, Kg Hg/y
	Y/N/?	Activity rate	Unit	Standard estimate
Crematoria and cemeteries				
Crematoria	Y	36,643	Corpses cremated/y	92
Cemeteries	Y	589,386	Corpses buried/y	1,473
TOTAL of quantified releases				36,803

Note:

(**) This part is calculated by population rate, however if calculated according to the formula of the Toolkit, the mercury inputs will be very high (12.397 kg), and this does not fit with the fact in Vietnam where industrialisation and electrification are poor. The rate of urban population only accounts for 1/3 of the total population (Source 3- Statistical Yearbook 2014). Therefore, the figures here can be acceptable by 35% (ratio 0.35).

According to the above table, the highest value (column 5) is belonged to " Waste collection and waste water treatment " However, according to the note * 2 and * 4 above, this power only accounts for 10% of mercury inputs to avoid being double-counted with other sources. This source, therefore, cannot be considered as the main source.

Figure 1. Estimation of mercury inputs



According to the graph, the major sources providing mercury inputs are listed from high to low as following orders:

- 1 / Use and disposal of mercury-containing products
- 2 / Other types of material productions
- 3 / Burning coal in large factories and other purposes
- 4 / Bare metal productions
- 5 / Manufacture of products containing mercury.

3. Mercury releases

In the Table 4-1 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 waste water systems), to land, to general waste, and to sectors specific waste treatment. An additional output pathway is "by-products and impurities" which designate mercury flows back into the market with by-products and products where mercury does not play an intentional role. See Table 4-2 below for a more detailed description and definition of the output pathways.

Table 3-1 Summary of mercury releases

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Energy consumption						
Coal combustion in large power plants	3,484.8	0.0	0.0	0.0	0.0	475.2
Other coal uses	1,413.3	0.0	0.0	0.0	0.0	0.0
Combustion/use of petroleum coke and heavy oil	-	-	-	-	-	-
Combustion/use of diesel, gasoil, petroleum, kerosene	75.4	0.0	0.0	0.0	0.0	0.0
Biomass fired power and heat production	996.9	0.0	0.0	0.0	0.0	0.0
Use of gas in pipelines (consumption)	-	-	-	-	-	-
Production of electrical and thermal energy from biomass	90.0	0.0	0.0	0.0	0.0	0.0
Charcoal combustion	5.8	0.0	0.0	0.0	0.0	0.0
Fuel production						
Oil extraction	0.0	11.8	0.0	0.0	0.0	0.0
Oil refining	5.5	0.2	0.0	0.0	0.0	3.3
Extraction and processing of natural gas	153.0	204.0	0.0	306.0	0.0	357.0
Primary metal production						

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Mercury (primary) extraction and initial processing	-	-	-	-	-	-
Production of zinc from concentrates	114.9	23.0	0.0	482.4	0.0	528.3
Production of copper from concentrates	144.3	28.9	0.0	606.1	0.0	663.8
Production of lead from concentrates	2.8	0.6	0.0	11.7	0.0	12.8
Methods other than	11.1	5.6	250.4	11.1	0.0	0.0
Alumina production from bauxite (aluminium production)	145.4	97.0	0.0	0.0	630.3	97.0
Primary ferrous metal production (iron, steel production)	142.8	0.0	0.0	0.0	0.0	7.5
Gold extraction with mercury amalgamation - without use of retort	96.6	76.7	67.5	0.0	0.0	0.0
Gold extraction with mercury amalgamation - with use of retorts	0.0	0.0	0.0	0.0	0.0	0.0
Other materials production						
Cement production	5,830.5	0.0	0.0	1,943.5	0.0	0.0
Pulp and paper production	9.1	0.0	0.0	0.0	0.0	0.0
Production of chemicals						
Chlor-alkali production with mercury-cells	-	-	-	-	-	-
VCM production with mercury catalyst	-	-	-	-	-	-
Acetaldehyde production with mercury catalyst	-	-	-	-	-	-

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Production of products with mercury content						
Hg thermometers (medical, air, lab, industrial etc.)	-	-	-	-	-	-
Electrical switches and relays with mercury	-	-	-	-	-	-
Light sources with mercury (fluorescent, compact, others: see guideline)	22.3	11.2	223.3	0.0	223.3	22.3
Batteries with mercury	0.0	0.0	0.0	0.0	0.0	0.0
Manometers and gauges with mercury	0.0	0.0	0.0	0.0	0.0	0.0
Biocides and pesticides with mercury	0.0	0.0	0.0	0.0	0.0	0.0
Paints with mercury	0.1	0.0	0.6	0.0	0.6	0.1
Skin lightening creams and soaps with mercury chemicals	0.0	0.0	0.0	0.0	0.0	0.0
Use and disposal of products with mercury content						
Dental amalgam fillings ("silver" fillings)	12.4	206.1	29.8	22.3	104.3	104.3
Thermometers	377.0	565.4	377.0	0.0	565.4	0.0
Electrical switches and relays with mercury	1,301.7	0.0	1,735.6	0.0	1,301.7	0.0
Light sources with mercury	871.1	0.0	871.1	0.0	1,161.5	0.0
Batteries with mercury	0.0	0.0	0.0	0.0	0.0	0.0
Polyurethane (PU, PUR) produced with mercury catalyst	-	-	-	-	-	-
Paints with mercury preservatives	0.0	0.0	0.0	0.0	0.0	0.0

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Skin lightening creams and soaps with mercury chemicals	0.0	0.0	0.0	0.0	0.0	0.0
Medical blood pressure gauges (mercury sphygmomanometers)	0.0	0.0	0.0	0.0	0.0	0.0
Other manometers and gauges with mercury	-	-	-	-	-	-
Laboratory chemicals	-	-	-	-	-	-
Other laboratory and medical equipment with mercury	-	-	-	-	-	-
Production of recycled of metals						
Production of recycled mercury ("secondary production")	-	-	-	-	-	-
Production of recycled ferrous metals (iron and steel)	0.0	0.0	0.0	0.0	0.0	0.0
Waste incineration						
Incineration of municipal/general waste	2,204.8	0.0	0.0	0.0	0.0	245.0
Incineration of hazardous waste	1,993.7	0.0	0.0	0.0	0.0	221.5
Incineration of medical waste	315.0	0.0	0.0	0.0	0.0	35.0
Sewage sludge incineration	0.0	0.0	0.0	0.0	0.0	0.0
Open fire waste burning (on landfills and informally)	7,367.9	0.0	0.0	0.0	0.0	0.0
Waste deposition/landfilling and waste water treatment						
Controlled landfills/deposits	240.2	2.4	0.0	-	-	-

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
Informal dumping of general waste *1	1,718.1	1,718.1	13,744.9	-	-	-
Waste water system/treatment *2	0.0	15,850.8	0.0	0.0	1,761.2	0.0
Crematoria and cemeteries						
Crematoria	91.6	0.0	0.0	-	0.0	0.0
Cemeteries	0.0	0.0	1,473.5	-	0.0	0.0
TOTAL of quantified releases *1*2	29,238.1	2,954.0	5,029.4	3,384.5	5,747.8	2,777.8

Note:

*1.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.

*2: The estimated release to water includes mercury amounts which have also been accounted for under each source category. To avoid double counting, input to, and release to water from, waste water system/treatment have been subtracted automatically in the TOTALS.

In details, the graphs from Figure 2 and Figure 6 are used to indicate the paths of the mercury from the source / sub-source of inputs until being released into different environments, such as air, soil, water or via products and waste.

Looking at Figure 2, it can be observed that the source having the highest mercury releases into the air is the source of waste incineration, other material productions (cement), coal incineration and the use / disposal of products.

Meanwhile, in Figure 3, the sources having the highest mercury releases into water are water treatment systems and informal municipal waste landfills.

The origin of mercury in the water, waste water from manufacturing is the mercury in products and materials => Waste and waste water, therefore, do not completely represent the mercury inputs (except imported waste). However, waste and waste water can represent a substantial amount of mercury releasing into the environment.

For example, the result of wastewater treatment system having mercury releases into the environment is 15,851 kg.

Next, in Figure 4, an evidence of mercury releases into the soil has been shown. It can be found easily that the highest source of mercury releases into soil is General waste landfills, following by Use / disposal of the product and Crematoria and cemeteries.

Figure 5 shows graphs the highest mercury releases into the environment via products are the source of other materials production (cement), bare metal production, following by oil, gas products.

Figure 6 illustrates mercury releases via general waste, showing that the highest amount of mercury stems from sources of Use / product disposal, Wastewater treatment systems and Bare metal production.

Finally, Figure 7 shows mercury releases via special-waste treatment. It can be observed that the highest amount of mercury releasing is caused by some sources including Bare metal production, Waste incineration, Coal production, Coal incineration and Oil & gas production.

Figure 2. The amount of mercury releasing into the air

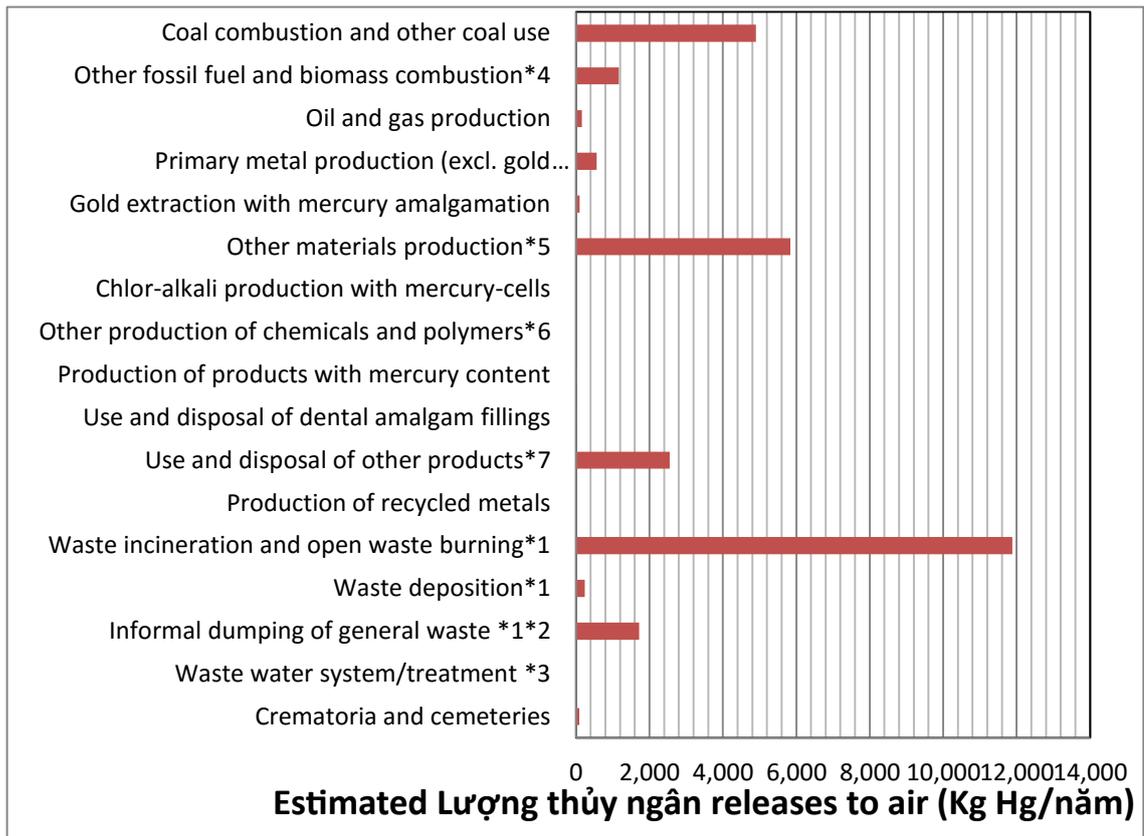


Figure 3. The amount of mercury releases into water

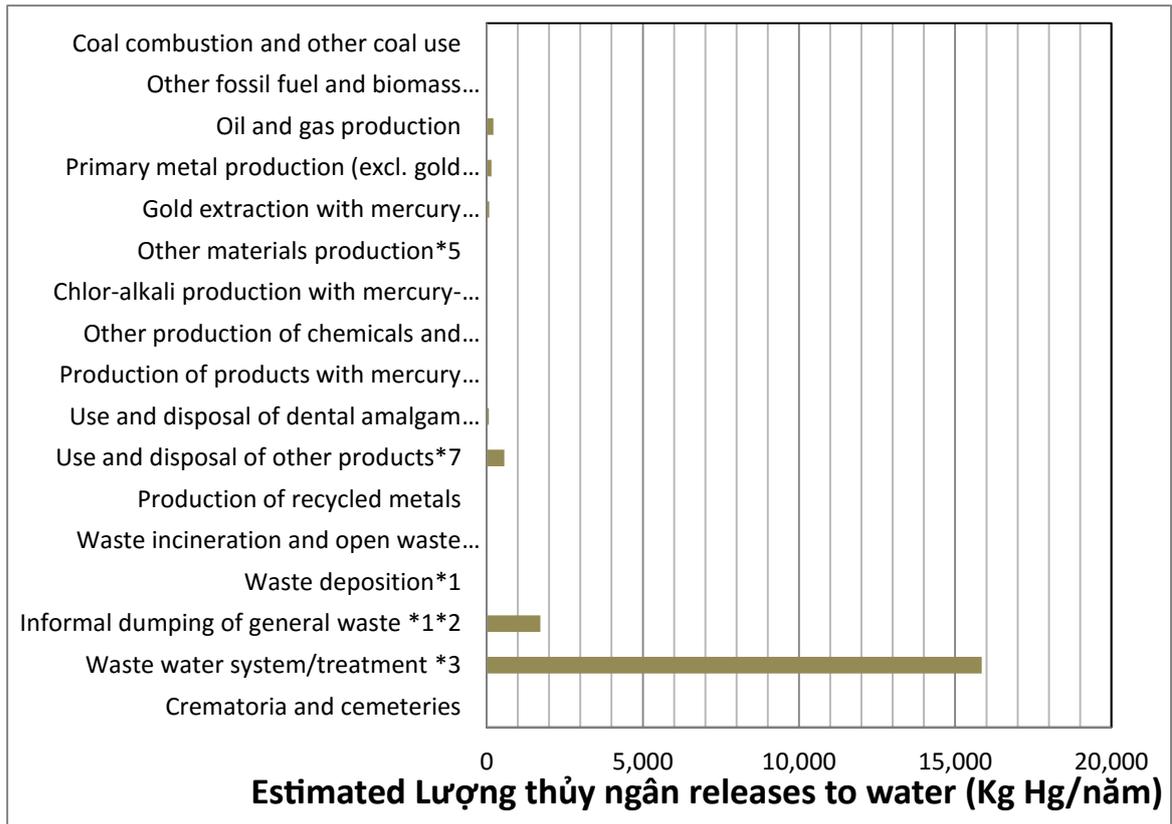


Figure 4. The amount of mercury releases into soil

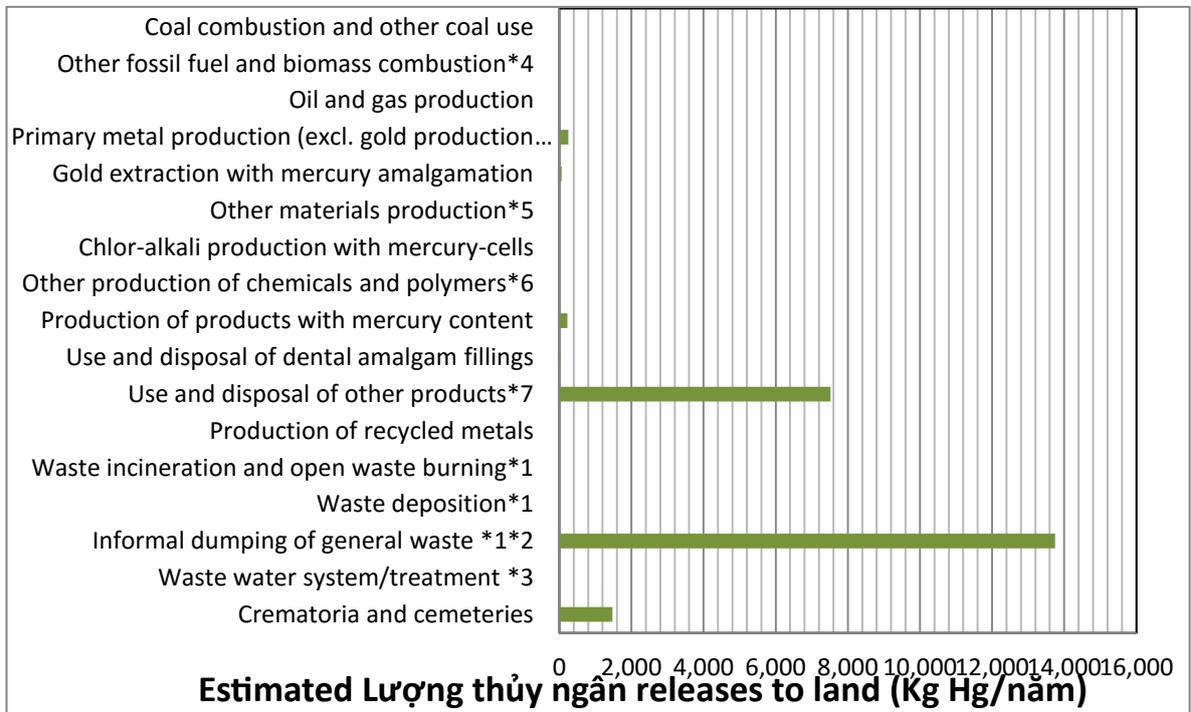


Figure 5. The amount of mercury releases into products

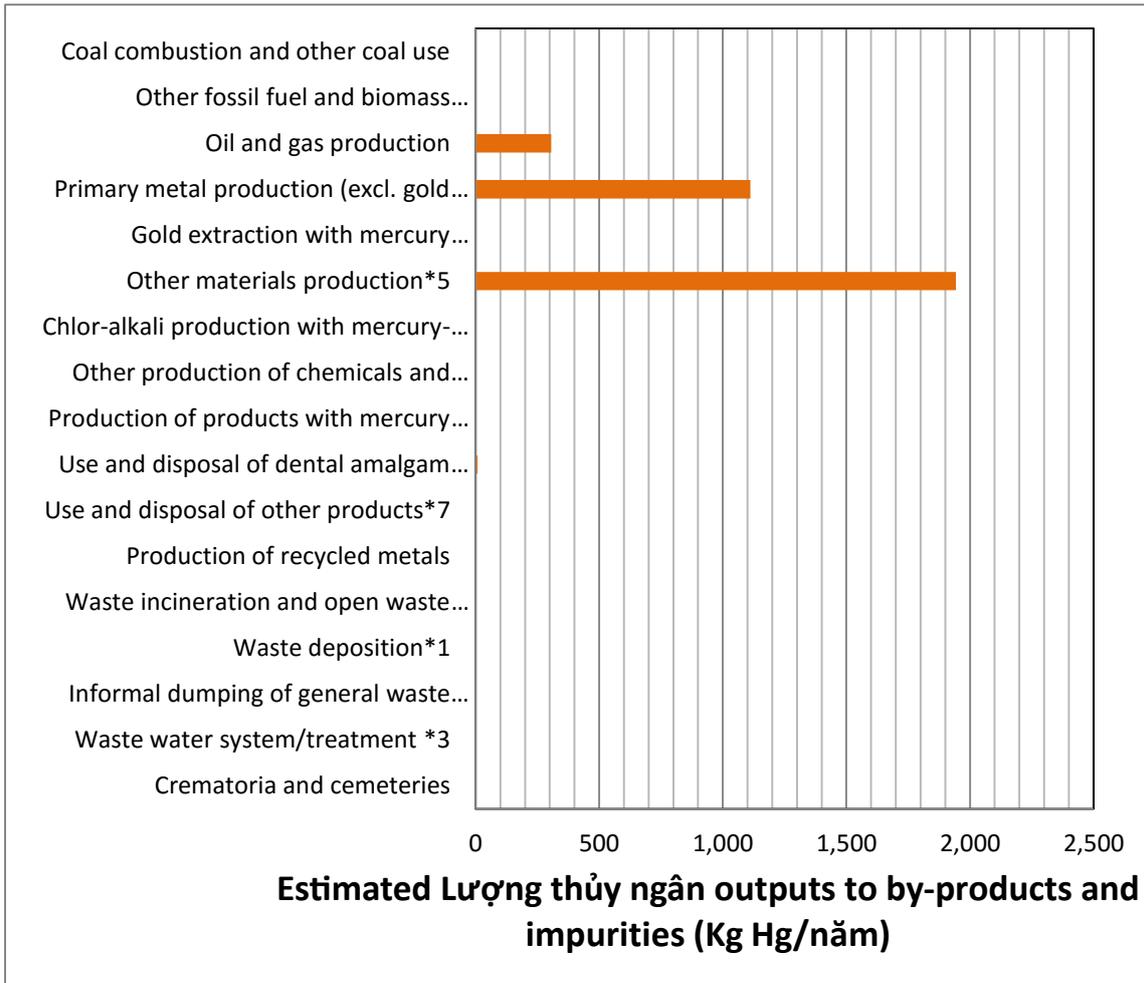


Figure 6. The amount of mercury releases into general waste

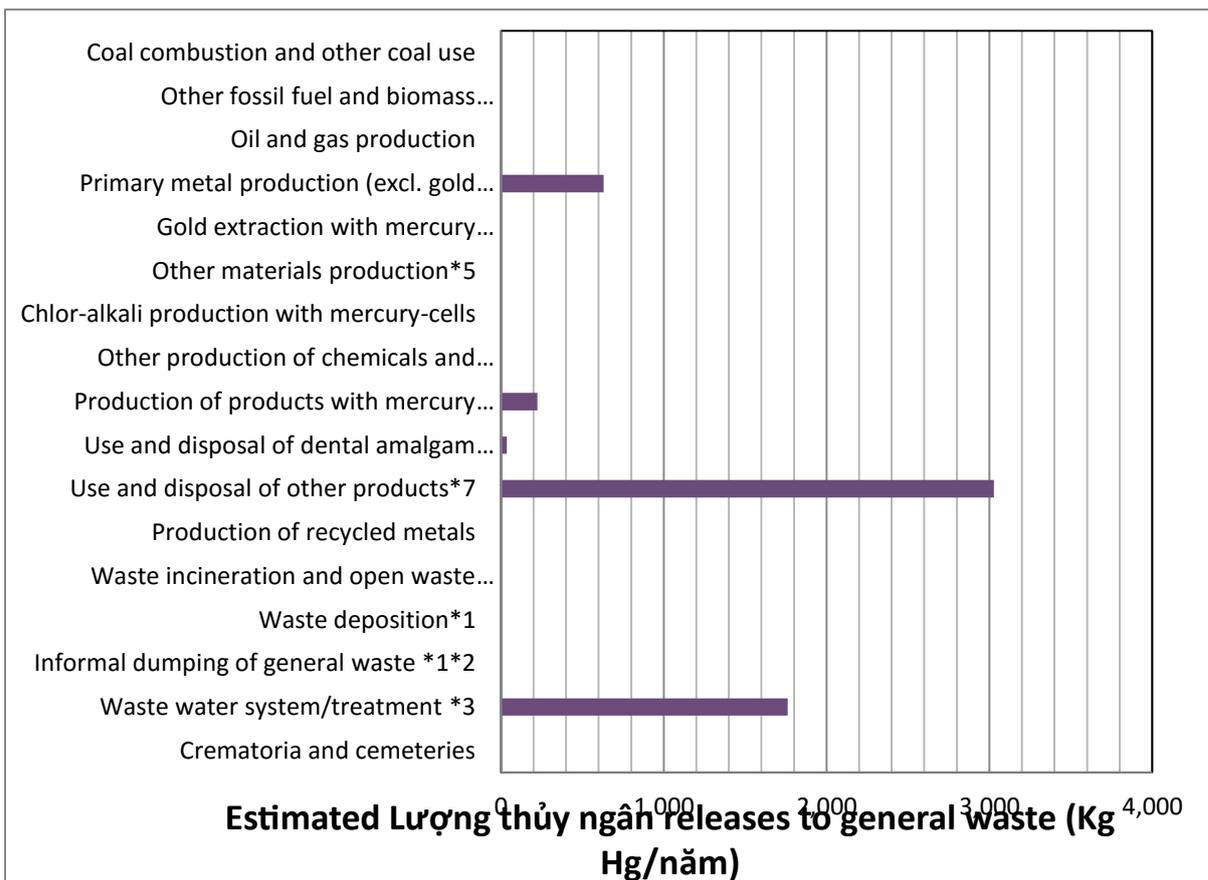
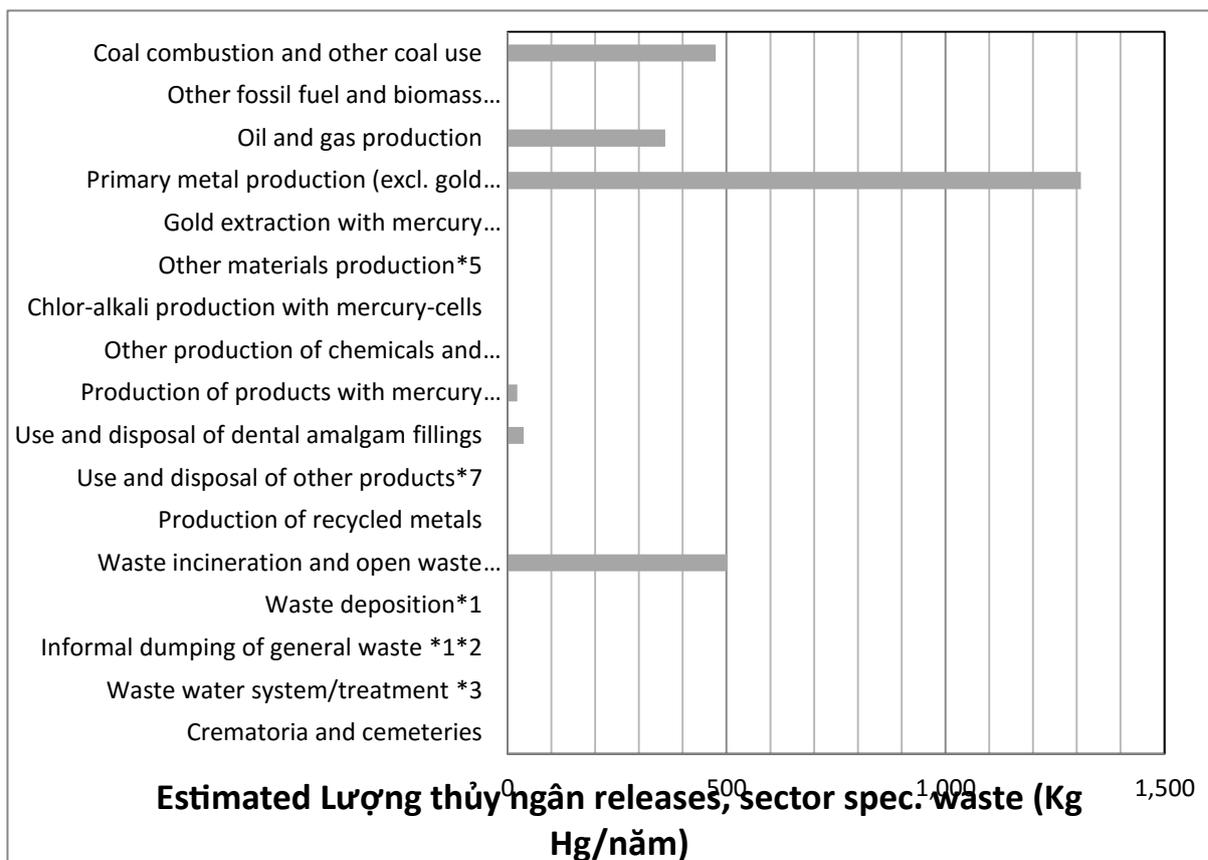


Figure 7. The amount of mercury releases into special-waste treatment



Next, in order to understand the assessment and estimation of how mercury releases into society, Table 4-2 below will describe and particularly defineways of mercury releases into the environment.

Table 3-2 Description of the types of results

Calculation result types	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 amount in 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 with air masses; for example, from: <ul style="list-style-type: none"> • Point sources such as coal-fired power plants, metal smelter, waste incineration; • Diffuse sources such as small-scale gold mining, informal burning of waste with fluorescent lamps, batteries, thermometers.

Calculation result types	Description
Water	<p>Mercury releases to aquatic environments and to waste water systems; point sources and diffuse sources from which mercury will be spread to marine environments (oceans), and freshwaters (rivers, lakes, etc.). for example releases from:</p> <ul style="list-style-type: none"> • Wet flue gas cleaning systems for coal fired power plants; • Industry, households, etc. to aquatic environments; • Surface run-off and leachate from mercury contaminated soil and waste dumps
Land	<p>Mercury releases to the terrestrial environment: General soil and ground water. For example releases from:</p> <ul style="list-style-type: none"> • 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	<p>By-products that contain mercury, which are sent back into the market and cannot be directly allocated to environmental releases, for example:</p> <ul style="list-style-type: none"> • 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	<p>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. 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.</p>
Sector specific waste treatment /disposal	<p>Waste from industry and consumers which is collected and treated in separate systems, and in some cases recycled; for example:</p> <ul style="list-style-type: none"> • 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

4. Data and inventory on energy consumption and fuel production

4.1. Energy consumption

Energy is not only one of the most important sectors of the national economy but also, it contributes to promote economic development.

According to reports of big oil & gas companies worldwide, since now until 2035, the energy demand in the world will continue to increase by approximately 1.5% / year. In which, the fossil fuels will remain the leading role in the overall world energy consumption. In details, the oil, gas and coal will account for merely 27% while other consumptions will employ other types of energy including nuclear energy, hydroelectricity and renewable energy. (33)

4.1.1. Coal incineration in large power plants

In Vietnam, thermal electricity (including Coal, oil or gas incineration) will be the main energy source and will develop dramatically in the future (8). For thermal electricity using coal, in the period 2000 - 2008, this sector accounted for a small proportion (10-15%) of the total of electricity production annually. However, this rate is increasing and accounting for most of the total of national electricity outputs in about 15 years (2010 to 2025) (11). According to the baseline scenario Master Plan VII in the electricity industry, in 2020 and 2030, the total capacity of coal electricity plants will be approximately 36.000MW and 75.000MW respectively (accounting for 47.3% and 56.4% of total electricity outputs in Vietnam respectively).

Table 4-1 The estimated coal consumption for thermal power plants

Categories	Estimation in 2020	Estimation in 2030
Electricity output (109 kWh / year) (Baseline scenario). In which	330	695
Electricity outputs from thermal electricity plants (using coal incineration (109 kWh / year) (1)	156	392
Proportion (%)	47,27	56,40
The quantity of coal demand (106 tons / year):	78	170
	30	35
• Domestic coal (106 tons / year)	48	135
• Imported coal (106 tonnes / year)		

Source: Master Plan VII in National Electricity Industry from 2020 to 2030

The electricity industry's report in December 2013 showed that, in 2013, Vietnam has 18 coal electricity plants with the total capacity of 6766 MW; 52 coal electricity projects have been approved, in which, 17 projects are waiting to be funded by investors (8).

It can be seen that, in Vietnam, the demand for coal electricity production is huge in the near future. According to Vietnam National Coal and Mineral Industries Corporation (TKV), the domestic coal supplies will not be sufficient for Vietnamese thermal electricity plants. Therefore, in order to meet the goal of the National electricity industry planning VII related to the quantity of electricity production, a large amount of coal should be imported in the next few years.

According to reference from the numbers 8-16 and practical surveys obtained from thermal electricity plants by experts (Appendix 1-Source 10), there is a list of 19 small, large power stations in scale with the need to coal consumption of about 34.55 million tons / year. However, under the definition of UNEP, the major power plants are defined as the one having a capacity greater than 300 MW, our report, thus, will only list power houses with the capacity of over 300 MW as large ones. As a result, the total demand of coal consumption for power plants is 26.40 million tons / year (See table 5-2 for details)

Table 4-2 Coal demand for large thermal electricity plants in Vietnam (2014)

No	Name	Capacity (MW)	Coal demand (106 tons / year)		Address	Electricity output (109 kWh / year)
			Domestic coal	Imported coal		
1	Vinh Tan 2 thermal power plant	2 x 622	4.38		Binh Thuan	7.2
2	Vung Ang 1 thermal power plant	2 x 600	2.9	Since 2016	Ha Tinh	7.2
3	Hai Phong 1 thermal power plant	2 x 300	2.19		Hai Phong	6.33
4	Hai Phong 2 thermal power plant	1 x 600	2.19		Hai Phong	
5	Nghi Son thermal power plant	2 x 300	2.92		Thanh Hoa	3.6
6	Cong Thanh thermal power plant	2 x 300	2.92		Thanh Hoa	3.9
7	Pha Lai 2 thermal power plant	2 x 300	1.6		Hai Duong	7.2
8	Uong Bi 1 thermal power plant	153	2.0		Quang	3.0

No	Name	Capacity (MW)	Coal demand (106 tons / year)		Address	Electricity output (109 kWh / year)
			Domestic coal	Imported coal		
					Ninh	
9	Extended Uong Bi 1 thermal power plant	1 x 300			V	
10	Extended Uong Bi 2 thermal power plant	1 x 330			Quang Ninh	
11	Cam Pha 1+2 thermal power plant	670	2.3		Quang Ninh	3.72
12	Quang Ninh 1+2 thermal power plant	4 x 300	3.0		Quang Ninh	6.18
Total		10.032	26.40			48.33

In addition, in order to determine accurately the amount of coal consumption, our expert group also employed the information from other sources and conclude the following results:

-According to the International Energy Agency <http://www.iea.org/stats/>, in 2013, the coal consumption: 16.832 kt = 16.83 million tons with the total electricity output of coal was 24.828 billion kWh.

- According to the Electricity PlanVII, in 2015: it has been estimated that 33 million tons of coal will be used for coal power production.

- According to official data from the General VietNam Electricity CorporationEVN, the total electricity production in 2014 of large thermal power plants nationwide was about 26 to 27.000 billion kWh. In addition, if calculating based on the average calorific value of coal as well as the efficient of coal used, it must consume approximately: 17-18 tons of coal => this number is slightly lower than the estimation in surveys by experts. However, given the fact that not only EVN produces thermal electricity, manyBTO (Build To Order) projects or other companies also involve in thermal power production. The actual data should be greater than that of EVN.

It is inevitable to have data errors. According to power development plans, especially the electricity plan VII, given potential natural resources in Vietnam, a continuous increase in coal thermal electricity production with a vision to 2020 will be observed. We, therefore, selected the largest data of 26.40 million tons / year as the standard to evaluate the current highest of mercury releases.

In the Toolkit, after importing the spreadsheet results, the estimated results of mercury output from this primary source is 3.960 kg / year (see Table 5-4)

Figure 8. Images of energy consumption - Thermal Power Plants



Gas-releasing thermal power plants



Mao Khe 1 thermal power plant's coal warehouse



Cong Thanh thermal power plant



Mao Khe 2 thermal power plant



Vinh Thanh thermal power plant's coal land



O Mon power plant's water filter system

4.1.2. The use of coal fuels for other purposes

Although Vietnam is a country having potential coal resources, the coal mining becomes increasingly difficult due to the exhaustion of open-pit coal mines, poor mining conditions (at depths of 400-500 m) (1), along with the poor quality of coal, the coal excavation and coal production has been reduced in recent years. While in 2012, 42.083 million tons of clean coal was produced then the exported amount was 15.219 million tons, in 2013, these numbers were 41.035 and 12.802 million tonnes respectively. In 2014, the amount of clean coal was 41.200 million tons but the exported figures reduced to only 7.166 million tons. (Source: General Statistics Office GSO)

[Http://www.gso.gov.vn/default.aspx?tabid=718;](http://www.gso.gov.vn/default.aspx?tabid=718)
[http://www.gso.gov.vn/default.aspx?tabid=720\)](http://www.gso.gov.vn/default.aspx?tabid=720)

Thus, in order to ensure domestic demands, especially that of coal incineration power electricity, the development strategy of the coal industry isto set up a target in cutting coal exported.

Besides exports, domestic coal production is used primarily to serve needs of thermal power production. The rest is provided for cement, chemical, iron and steel, building material industries ...

To calculate the remaining amount of coal used for other domestic purposes, the information of coal production, imported and exported coal is required and we have the following formula:

$$\text{Coal consumption} = \text{Coal production} + \text{Imported coal} - \text{Exported coal}$$

There is an advantage that a quite sufficient data can be gained from the Ministry of Industry and Trade in 2014. In details:

- Coal production in 2014: 41,200 million tonnes;
- Import: 2,966 million tons;
- Export: 7,166 million tonnes
- Coal used in large thermal power plants: 26,400 million tonnes

(Source: Summary Report of the Ministry of Industry and Trade in 2014, Appendix 2, 5 and 7)

Coal for other purposes = (41,200 + 2,966) - (26,400 + 7166) = 10,600 million tonnes

According to calculations by the Toolkits, in Vietnam 2014, the estimated volume of mercury inputs from coal incineration of other industries was 1,413 kg / year (See Table 5.3)

4.1.3. Petroleum coke and heavy oil incineration and uses

There is no statistics for these activities in Vietnam. In 2013, even on energy networks (17), in the "coal" items, no data was found => this shows a consistency with the reality.

4.1.4. Diesel, gasoil, gasoline and kerosene incineration and uses

The use of diesel oil, gas, gasoline and kerosene for some purposes such as transportation vehicles, motorcycles or other productive purposes is popular in Vietnam. The data from following sources can be collected:

1 / According to energy websites (17), in the "oil" items in 2013, the results of energy consumption in Vietnam were:

Liquefied Petroleum: 1,330,000t; motor gasoline: 4,813,000t; Jet kerosene 171,000t; other types of kerosene: 71,000t, diesel: 6,948,000t and fuel oil: 372,000t. => In total, 13,705,000 tons of all kinds were consumed.

2 / According to the Ministry of Industry and Trade: The amount of domestic production: 5.7 million tons; petroleum exported and imported volume: 988 thousand tons and 8.429 thousand tons (Source 7, Appendix 2, 5 and 7) => consumption = Production + Imports-Exports = 5.700 + 8.429 to 988 = 13,141 thousand tonnes

We finally decided to use the higher amount of **13, 705** thousand tons for this section

In the spreadsheet of Toolkit, the result for mercury input is 75kg / year (Table 5.3)

4.1.5. Consumption of pre-cleaning natural gas

According to Official Letter 2322 / KVN of the PetroVietnam Gas Corporation PV related to information supplies in 9th November 2015, we have:

- 1 / Gas used for thermal Power: 8.298 million m3
- 2 / Gas used for fertilizer: 1,034 million m3
- 3 / Gas used for other purposes: 637 million m3

Total amount of gas used is 9.969 million m3

This is the exact and unique data as only PetroVietnam manages the entire of gas extraction and supplies in VN.

In the spreadsheet of Toolkit, the result for mercury input is 997kg / year (see Table 5.3)

4.1.6. Gas consumption in pipelines (consumption)

According to Petrovietnam, dry gas is not currently provided for domestic purposes, only Liquefied Petroleum used for this purpose (Source 39)

4.1.7. Electrical and thermal energy production from biomass

In Vietnam, the biomass technology is still not developed and its commercialised process is still very limited. So far, biomass is used mainly in rural areas in small-scale and there is no appropriate technology, however, in fact, the small-scale biomass technology is the most appropriate model and its potential development is quite strong.

The potential sources of biomass energy including:

- Source of wood fuels is from natural and planted forests, scattered trees, annual plants and wood scraps from forestry and logging industry;
- Biomass from straw, husks, grass, leaves, sawdust and other agricultural waste

However, there are no specific studies or surveys, following by no accurate data collected. According to some scientists' analyses (18), the theoretical potential biomass energy is about 3 million tons / year.

According to the other source of (16) "Strategic planning and renewable energy development in Vietnam by 2015 Vision 2025" has put the potential figure of biomass for electricity production in 2005 of approximately 4.4 million tonnes / year (16). This figure is equivalent to 230 to 305 MW of electricity outputs produced from biomass as the following table:

Table 7-3 Types of practical biomass for electricity generation in 2005

Biomass type	Theoretical potential (1,000 tonnes)	Practical potential (1,000 tonnes)	Capacity potential (MW)
Rice husks	7,158	1,615	75-100
Bagasse	4,419	2,784	150-200

Wood scraps	800	80	5
Total			230-305

Source: Development strategy and planning in Vietnam until 2015, Vision to 2025

However, the above figures are just used to evaluate the potentials. According to an international energy website (17), the actual numbers are quite small. In Vietnam 2013, the produced power having total outputs: 127,028GWh made from coal / gas / biomass: 24.828 / 42.655 / 58Gwh. In other words, the proportion of electricity produced from biomass just accounts for 0.23% of coal electricity outputs. In addition, if there is an assumption of the equivalence of heating value between coal and biomass, the coal use is 34.55 million tons / year and the biomass use is $0.0023 * 34.55 = 79.465$ million tonnes, far less than potential numbers. However, in fact, there are a lot of activities using biomass in rural areas such as cooking, thermal production and so on, which can not be statistically calculated. We, thus, selected an average figure of 3 million tons / year since mercury releasing from this source is insignificant compared to that from other sources. Therefore, the respective data errors should not be great.

4.1.8. Charcoal

Charcoal is known as black carbon porous, produced by burning wood or other organic materials in airless conditions. There are many other materials able to produce charcoal. Normally, charcoal production inputs are mainly from trash timber, mangrove timber, perennial fruit trees not able to form fruits or with low yields such as longan, pomelo, plums or from other types of biomass such as coconut shells, bagasse, rice husks, peanut shells, fruit peel, cotton stalks, soybean stalks, corn stalks and corncobs etc. (35)

In Vietnam, besides for use and exports, there is an amount of charcoal imported to supply for coal demands. In 2014, according to Vietnam Customs' statistics with the code HS 44029090 of charcoal (38) we have:

Imported charcoal: 6.417 tons

Exported charcoal: 42.060 tons

Thus, the domestic production of charcoal is used for consumptions and exports. However, only exported quantity is identified. The data using in Vietnam, therefore, is based on imported figures. There is no statistics for cooking or for domestic purposes, thus, the imported value is employed. In this section, we will consider both of domestic charcoal outputs and used charcoal consumption as mercury releasing sources => the charcoal consumption is: $6.417 + 42.060 = 48.477$ tonnes.

Table 5.3 illustrates the data in the energy consumption presented from 5.1.1 to 5.1.8.

Table 8-4 Results of mercury inputs and releases from sources of energy consumption

Source	Value Tons / year	Merc ury input s	Mercury releases via different ways into the environment					
			Air	Wate r	Soil	Produ cts	Gene ral waste	Speci al waste

Energy consumption								
Coal incineration in large power plants	26.400.000	3.960	3.484,8	0.0	0.0	0.0	0.0	475.2
Coal for other purposes	10.600.000	1.413	1.413,3	0.0	0.0	0.0	0.0	0.0
Incineration / use of petroleum coke and heavy oil	0	-	-	-	-	-	-	-
Incineration / use of diesel, Gasoil, gasoline and kerosene	13.700.000	75	75.4	0.0	0.0	0.0	0.0	0.0
Incineration / use of fuel gas or natural gas	9.969.000.000	997	996.9	0.0	0.0	0.0	0.0	0.0
Gas used in pipeline (domestic purposes)	0	-	-	-	-	-	-	-
Electricity and thermal production from biomass	3.000.000	90	90.0	0.0	0.0	0.0	0.0	0.0
Charcoal	48.477	6	5.8	0.0	0.0	0.0	0.0	0.0

Figure 9. Pictures about biomass and charcoal



Source of biomass from wood



Regular (pure) charcoal

Source of biomass from rice husks



Industry use charcoal

4.2. Fuel production

Fuel is the material used to release energy. The main types of fuels are coal, oil, gas and petroleum.

The main fuel source in Vietnam is fuel oil. In Vietnamese energy industry, the Vietnam Oil and Gas Group (Petrovietnam) plays a vital role and have launched infrastructure development strategies for the Oil and Gas industry in order to ensure national energy security and to meet the increasing demand of energy in the economic-social development and.

4.2.1. Oil exploration

Under the management of Petrovietnam PVN, oil & gas exploration and exploitation from both of domestic and abroad sources actively implementing have achieved many positive results. In the period from 2011 to 2014, PVN has completed and far exceeded all targets setting. In 2014, according to the 2014 summary report of the Ministry of Industry and Trade (7, Appendix 2), the volume of oil exploitation has reached 17.3 million tons.

4.2.2. Oil filter

As for the petrochemical industry, under Petrovietnam's development strategy until 2025, Dung Quat oil refinery with the processing capacity of 6.5 million tons/ year of Bach Ho crude oil is one of three plants. In May 6/2010, Dung Quat oil refinery was officially entering commercial operation. Over three years, the factory has so far produced more than 21 million tonnes of crude oil, over 20 million tonnes all types of oil refinery and petrochemistry products with stable quality. In the end of 2012, Dung Quat oil refinery has become profitable, or in other words, the total revenue was greater than the initial costs when establishing the plant. Petrovietnam PVN is researching the possibility of upgrading and expanding the Dung Quat oil refinery to the capacity of 10 million tonnes crude oil / year, with various types of crude oil, in order to meet the domestic demands for gasoline and other petrochemical products since 2015. Currently, Dung Quat oil refinery has reached the full capacity of 6.5 million tons / year.

4.2.3. Natural gas exploitation and processing

In the gas industry, the main sources of gas are from the Cuu Long and Nam Con Son, Malay-Tho Chu field, in details:

Cuu Long field: the production output has reached about 1.4 billion m³ / year from the Bach Ho, Rang Dong, Phuong Dong, Ca Ngu Vang, Su Tu Den / Su tu Vang/ Su Tu

Trang, Rong/ Doi Moi, Te Giac Trang, Hai Su Den/ Hai Su Trang field. Nam Con Son field: the production output has reached about 7 billion m³ / year from the Lan Tay / Lan Do, Rong Doi / Rong Doi Tay, Hai Thach / Moc Tinh, Chim Sao field. In the near future, the Thien Ung and Dai Hung field will start operating.

Malay-Tho Chu field: the production output reached about 2 billion m³ / year from PM3-CAA plot.

Currently, Petrovietnam’s gas pipeline system operated safely and efficiently are : the Rang Dong – Bach Ho- Dinh Co gas pipeline system operated since 1995 with the gas capacity of 1.5 billion m³ / year, the length of 117 kilometers, 16 inch pipe diameter; the Nam Con Son gas pipeline system operated since 2003 with the gas capacity of 7 billion m³ / year, the length of 400 kilometers, 26 inch pipe diameter; PM3-Ca Mau gas pipeline system operated since 2007 with the gas capacity of 2 billion m³ / year, the length of 297 kilometers, 18 inch pipe diameter; the Phu My-Ho Chi Minh City gas pipeline system operated since 2008 with the capacity of 3 billion m³ of gas / year, the length of 70 kilometers, 22 inch pipe diameter; the Phu My - My Xuan - Go Dau low- pressured gas pipeline system operated since 2003 with the capacity of 1 billion m³ / year, the length of 20 kilometers, 8-12 inch pipe diameter.

According to Petrovietnam (Source 39 - Official Dispatch 2322 / KVN- NCPT), the total gas production output has reached 10.2 billion m³ in 2014.

We have the following results after importing data into the Toolkit’s spreadsheet:

Table 9.5 Results of mercury inputs and releases from sources of energy production

Source	Value Tons / year	Mercury inputs	Mercury releases via different ways into the environment					
			Air	Water	Soil	Products	General waste	Special waste
Oil exploration	17.400.000	59	0.0	11.8	0.0	0.0	0.0	0.0
Oil filter	6.500.000	22	5.5	0.2	0.0	0.0	0.0	3.3
Natural gas exploitation and processing	10.200.000. 000	1,020	153.0	204.0	0.0	306.0	0.0	357.0

Figure 10. Images of oil and gas activities in Vietnam



5. Data and inventory on domestic production of metals and raw materials

According to the mining industry’s report (52), Vietnam was considered as one of the countries having potentials and diversity of natural resources, in particular, the mineral resources with more than 5,000 mines and over 60 types of minerals. Specially, there are some types with high quantity such as Bauxite, Titanium, rare earth, coal and other types with high economic value such as oil, Uranium and so on. In details:

Bauxite ore: Vietnam has great potential for bauxite ore with the reserves of approximately 5.5 billion tons of crude ores, located mainly in Tay Nguyen. Particularly in Lam Dong, Tay Tan Rai mine, supplying ore to Alumni factory, reserves more than 67 million tonnes of concentrate.

Currently, the Vietnamese coal and mineral mining industrial conglomerate (Vinacomin) is launching a pilot project of establishing Nhan Co alumina plant, if successful, the plant will support in increasing outputs and value the bauxite industry in Vietnam.

Tin, Tungsten, Antimony ore: In Vietnam, Tin and Tungsten mineralization has been distributed in four areas consisting of Piaoac and Tam Dao in the North, Quy Hop and Da Chay in Midland, Dalat in the South. The total estimated reserves are 13.582 tonnes of SnO₂ with the content of 273g / m³. There are so far 3 workshops exporting First Class Electrolytic Tin with the total capacity of 1.500 to 1.800 tons / year.

Copper ore: mostly located in the NorthWest (Son La) and the most reserved mine so far is the Sing Quyen mine which is a polymetallic mine having both of copper and gold with 60 thousand tons copper, following by the Niken copper mine (Ban Phuc).

Lead-zinc ore: Zinc - lead reserves in Cho Dien- Cho Don (Bac Kan) account for 80% of the national reserves. There are also at Lang Hit (Thai Nguyen), Son Duong (Tuyen Quang) and some small-scaled mines in North Midland. Particularly in Bac Kan, there are 70 mines and zinc ore with reserves of about 4 million tons.

Vinacomin employs Da Tien Nong, Upper India, Cuc Duong, Ba Bo mine and so on with the capacity from 40.000 to 60.000 tons raw ore / year. From raw material including refined ore and zinc powder of 50.000 to 100.000 tons of raw ore / year and establishes two electrolytic zinc plants in Tuyen Quang and Bac Kan with the capacity of approximate 20.000 tons of zinc / year, building a lead-refinement and silver-separation plant with the capacity of 10,000 tons of lead and 15,000 kg of silver / year.

Iron ore: In Vietnam, there are 300 mines and iron ore, are usually located in the Northern provinces such as Thai Nguyen, Cao Bang, Ha Tinh, and so on. In which, the Vietnamese largest iron ore mines are Thach Khe and Quy Xa. (34)

In order to collect data, we use the resources from the General Statistics Office, Vinacomin, the Ministry of Industry and Trade. The results were presented below:

5.1. Exploitation and mercury production

In Vietnam, there is no mercury exploitation and production since currently only a few countries worldwide having mines and mercury mines.

5.2. Refined zinc production from ore concentrate

There are two data sources:

* Source 1: According to the report of the Ministry of Industry and Trade in August 2013 => Therefore, the approximate number for the whole 2013 can be evaluated.

Calculation : in August 2013, the production of 778 tonnes of zinc (24) => in 2013, the estimated average production is about $778 * 12 = 9,336$ tonnes => under Toolkit, this respective figure is about 17,670 tonnes of ore concentrate.

* Source 2 : According to Official Letter No. 4692 / TKV-KH in 30th September 2015 of Vinacomin for the supply of information concerning mercury (Source 37), because of the availability of the metal ores data, in details, we have the total of zinc sulfide ore and lead-zinc oxide ore is 106.373 tons / year.

However, given the fact that Vinacomin just has only raw ores' data, the data from the Ministry of Industry and Trade about ore concentrate has been chosen.

5.3. Refined copper production from ore concentrate

Similarly, we also have two data sources:

* Source 1 : According to the 2014 Statistical Yearbook of GSO, the volume of copper concentrate is 48.100 tonnes.

* Source 2 : According to the data provided by Vinacomin, the volume of copper exploited is 1.355.258 tons.

However, we selected data from source 1 from Vinacomin in 2014 because it provides raw ore data instead ore concentrate one.

5.4. Lead (Tin) production from ore concentrate

Similarly, we also have two data sources:

* Source 1 : According to the 2014 Statistical Yearbook of GSO, the volume of lead concentrate in August 2013 is 48.100 tonnes => Therefore, the approximate number for the whole 2013 is 372 tonnes, equivalent to 930 tonnes of ore concentrate.

* Source 2 : According to Vinacomin data, the volume of lead exploited is 1.163 tonnes.

However, we selected data from source 1 from Vinacomin in 2014 because it provides raw ore data instead ore concentrate data.

5.5. Gold production by methods (not using mercury amalgamation)

In the gold production industry, the companies having gold mining license only use cyanide technology instead mercury one. All of these companies are licensed and subjects to the management of relevant authorities such as the Ministry of Industry and Trade and local authorities.

According to expert surveys, in Quang Nam, there are two large gold mining companies named Bong Mieu and Phuoc Son. However, the operations have been delayed for two years due to the problems in the business. The gold industry's revenue decrease by 60-70%. According to Quang Ninh summary data, it has been showed that the rest amount of gold ore exploited in Quang Ninh is about 486 kg => this figure cannot be used to represent national data, we, therefore, selected the data from Vinacomin and the amount of gold ore exploited in 2014 is 18,549 tonnes (37)

5.6. Aluminum production from bauxite ore

The data about this sub-source is also provided from two sources:

* Source 1 : According to the Ministry of Industry and Trade (Source 7, Appendix 2), the amount of aluminum production is 456.300 tonnes, equivalent to 1.939.275 tonnes of ore concentrate (under the Toolkit).

* Source 2 : According to the data provided by Vinacomin, the amount of aluminum exploited is 2,9741,163 tonnes. (37)

=> We selected data from the Ministry of Industry and Trade in 2014 instead Vinacomin for the need of ore concentrate data.

5.7. Crude steel production

According to statistics from the Ministry Industry and Trade in 2014, the volume of crude steel produced was 3.006.000 (7)

5.8. Gold mining with mercury amalgam chemistry without distillation

Gold mining with mercury amalgams is conducted only in a small scale AGSM or in the illegal gold mining fields known as bandits gold fields.

Vietnam has two biggest gold mines named Bong Mieu in Quang Nam and Pac Lang in Bac Kan. In both of these locations, there is illegal gold mining that the local authorities have no control over. Therefore, the availability of official statistical information for this form of gold mining is completely unavailable. We, therefore, investigate and survey in the scene, particular in Bong Mieu gold mine (Quang Nam), to obtain initial information about special activities (Source 42 , 43).

In the meeting with the local authorities, Nguyen Ba Huyen, Manager of environmental safety techniques of the Department of Industry and Trade, Quang Nam, said that currently the majority of gold mines are using chemical banditry mercury and cyanide to refine gold, we thus cannot know how much chemicals used.

According to Tam Lanh Town’s authorities, the gold refinement is quite simple and mostly handicraft. Illegal gold producers are mainly used mercury and cyanide to refine gold. " They grind directly mercury with rocks and ores then run through the waste spout to refine gold directly".

As calculated by the Bong Mieu gold company (Besra corporation) about gold reserves obtained from Bong Mieu gold mine, the average content of gold in Bong Mieu varies depending on location ranges from 2 -3 gram to 5-6 gr / ton of ore. From 2006 to the end of 2013, the Bong Mieu company has exploited and treated more than 1,793 tonnes of gold and 671kg of silver. The entire amount of gold and silver were being exported abroad. As for the handicraft gold mining or illegal gold production, nobody can fully understand. However, according to estimation, these activities can refine up to 10 “chi”, equivalent to 375gr of gold. (42)

Even from the actual surveys’ data, we are not able to gain close estimation about the gold production in this area. In details:

The gold production with chemical mercury amalgams without distillation: 112kg / year.

Estimation: 375gr / day * 300 days = 112.500 gr = 112 kg (Results can be seen in Table 6.1).

5.9. The gold production with chemical mercury amalgams without distillation

No data and having same results with illegal gold production in the section above

Table 10-1 Mercury input results and releases of metal sources

Source	Value Tons / year	Mercury input s	Mercury releases via different ways into the environment						
			Air	Water	Soil	Products	General waste	Special waste	
<i>Bare metal production</i>									
Mercury exploitation and processing	0	-	-	-	-	-	-	-	-
Refining pure tin and zinc from ore	17.670	1.149	114.9	23.0	0.0	482.4	0.0	528.3	

concentrates								
Refining copper from ore concentrates	48.100	1,443	144.3	28.9	0.0	606.1	0.0	663.8
Refining lead from ore concentrates	930	28	2.8	0.6	0.0	11.7	0.0	12.8
Gold production (do not using mercury)	18.549	278	11.1	5.6	250.4	11.1	0.0	0.0
Producing aluminum from bauxite ore	1.939.275	970	145.4	97.0	0.0	0.0	630.3	97.0
Production of raw iron	3.006.000	150	142.8	0.0	0.0	0.0	0.0	7.5
Gold extraction with mercury amalgam (do not use “ Curvy Neck” method)	112	241	96.6	76.7	67.5	0.0	0.0	0.0
Gold extraction with mercury amalgam using “ Curvy Neck” method)	0	0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 11. Pictures of illegal gold mining



Police arrested illegal gold producers



Gold mining field



Spout using mercury to refind gold



Illegal gold ore exploited



Gold container



Gold mining tools



Use cyanide to manually refind gold



Tunnel in Bong Mieu gold mine

5.10. Cement production

In Vietnam, the cement industry was firstly developed in Vietnam (to serve the French colonisation), since 1899 in Hai Phong. Until now, Haiphong is still the most developing area in this industry. (23)

Currently, the capacity of domestic cement production in Vietnam is about 60 million tons. Some large plants are below:

- The Vissai cement plant : 10 million tons / year

- The Ha Tien cement plant : 8 million tons / year
- The Nghi Son cement plant : 4.3 million tons / year (Tinh Gia, Thanh Hoa)
- The Bim Son cement plant: 3.8 million tons / year (Thanh Hoa)
- The Vinaconex Yen Binh cement plant: 3.5 million tons / year (Yen Binh, Yen Bai)
- The Cam Pha cement plant: 2.3 million tons / year
- The Tam Diep cement plant: 1.4 million tonnes

According to the Statistic Report in 2014 of the Ministry of Industry and Trade, the total value was 59.8 million tonnes, completely appropriate for the cement production situation in Vietnam. The mercury releases from this activity can be said is very significant. According to the calculation of the Toolkit, there are 7.774 tons of mercury inputs releasing into the environment (See Table 6-2)

5.11. Pulp and paper production: 302.666 tons

The paper production industry is under controlled by the Ministry of Industry and Trade. We, therefore, can gain data for this sector and also use calculation results from some documents to estimate statistics under the requirements of the Toolkit.

Calculation: In average, we have have from 1-> 2000pb of paper = 1500pb *453g = 750 kg = 0.75tan

Calculation: In general, 2 tonnes of wood (biomass) will produce 1 to 2000pb paper in average (20) =>We take an average figure of 1500pb, equivalent to 750 kg or 0.75 tonnes of paper (1pb = 453gr).

We also have a total output of all types of paper produced in 2014 is 113.500 tonnes (Source 7, Appendix 2) =>the approximate amount of biomass needed is $x=1135000*2/0.75= 302,666$ tonnes.

Therefore, the mercury inputs are 9 kg / year (see Table 6-2)

Table 11-2 Result of mercury inputs and releases of other materials' production

Source	Value Tons / year	Merc ury input s	Mercury releases via different ways into the environment					
			Air	Water	Soil	Produ cts	Gener al waste	Special waste
Cement production	59.800.00 0	7.774	5.830, 5	0.0	0.0	1.943, 5	0.0	0.0
Pulp and paper production	302,666	9	9.1	0.0	0.0	0.0	0.0	0.0

Figure 12. Cement production



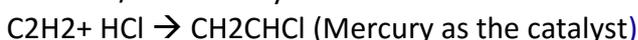
6. Data and inventory on domestic production and processing with intentional mercury use

6.1. Chemicals and polymer products

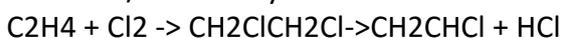
6.1.1. Vinyl Chlorua Monomer (VCM) production

VCM has become an important chemical used in the polymerization to produce PVC, an indispensable plastic in modern life. VCM can be produced by 3 methods:

1/ From acetylene



2 / From ethylene:



3 / By combined methods

Thus, only the technology of producing VCM from the reaction of acetylene with hydrogen chloride with the catalyst of mercury chloride relates to mercury. However, currently, the new technology has been replaced to protect the environment from the toxic effects of mercury due to the use of mercury catalysts as in the above technology (34). With the development of petrochemical technology, all most of the countries start using ethylene method.

In Vietnam, according to the consulting groups' surveys from PVC manufacturers such as the TPC Vina Company, all raw materials to produce PVC is VCM must be imported instead using domestic ones.

6.1.2. Chlorine production

In Vietnam, chlorine is produced by the method of NaCl-electrolysis to obtain caustic soda and chlorine by 1 / 1.1 in proportion



There are 3 methods for the chlorine production

1 / Mercury electrolysis cells: Mercury plays a role as a cathode and caustic soda will be formed outside the sodium mercury amalgam.

2 / Diaphragm electrolysis cells: This method separates anode and cathode, however, the purity of caustic soda obtained is mostly poor

3 / Plasma membrane: Use a film polymeric to separate the compartments, the purity of caustic soda obtained is high.

Because of its advantages, the method using the plasma membrane is favoured by chemical companies such as the companies producing caustic soda from South Basic Chemicals Corporation, Viet Tri Chemical company, Bai Bang Company or the 100% foreign capital Vedan => the chlorine production, therefore, does not use the technology releasing mercury.

6.1.3. Acetaldehyde production with mercury catalysts

Acetaldehyde or ethanol has the molecular formula of CH_3CHO .

Acetaldehyde can be produced using a variety of methods as follows:

1 / Produced from the process of hydrocarbons partial oxidation

2 / Produced from the process of acetylene hydration (plus water) and must use sulfur-mercury compound as catalysts

3 / Produced from the process of direct oxidation of ethylene.

Among three above technology, there is only the 2nd method related to mercury. However, according to experts in this field, in Vietnam, there is no company producing acetaldehyde from this technology.

6.2. Manufacturing of products containing mercury

According to UNEP Toolkit, the mercury-containing products including medical thermometers; battery; paint; cream and whitening soap; mercury manometers and kinds of other devices containing mercury. Vietnam is the country having no mercury exploitation activities, so producers have to import mercury if they wish to produce any type of mercury-containing products.

According to the information from the Chemicals Department as the authority managing chemicals imports, the most obvious purpose of importing mercury into Vietnam is to produce light bulbs (Appendix 6 – List of mercury and mercury compounds imported companies in the South in 2014 – Representative office of the Chemicals Department at TP. HCM). These companies include only 2 bulb companies, 1 battery company, 1 marine paint company, 1 pharmaceutical company and other domestic commercial import companies. Combined with investigations and direct surveys from chemical companies, the items such as paint, batteries, cream, soap and so on are declared that their productions do not use mercury or if have, only use limited volume in an unpublished way. The total amount of mercury imported into Vietnam in 2014 was approximately 14,000 kg, but mercury used for fluorescent lamps and paint companies was only 2.233 kg and 6 kg respectively. However, there is no investigation which can clarify ways and purposes of trading mercury and mercury compounds in the domestic market. Therefore, the data assessment is still mainly based on feedbacks of operating enterprises and the majority of domestic manufacturers is not using mercury. We then have the data results for this data source as below:

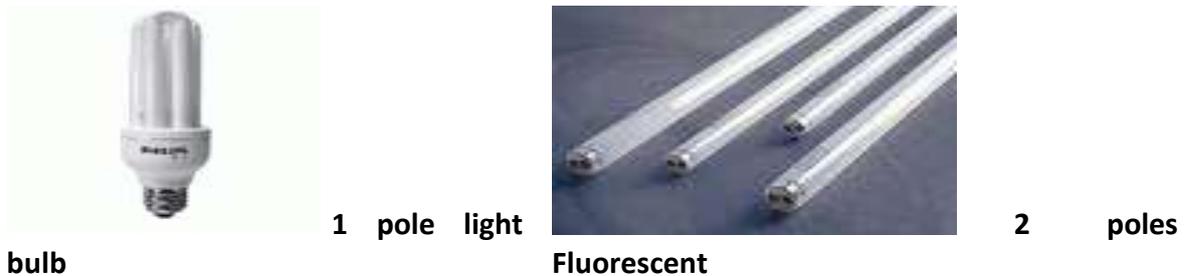
6.2.1. Mercury thermometers: No domestic production

6.2.2. Switches and relays: No domestic production

6.2.3. Lights

The lights containing mercury include fluorescent lamps and compact 1 pole fluorescent light. Two major typical companies producing light bulbs in the Southern are Dien Quang and Phillip who always obey the permitted limit of mercury used in their lighting products. The total amount of mercury used for these two companies in producing bulbs in 2014 was 2.233 kg (According to the information sheet, Appendix 6)

Figure 13. Mercury-containing lights



6.2.4. Mercury-containing batteries

In 2014, there is no battery & accumulators company importing mercury or mercury compounds (26). In addition, according to information gained directly and information provided in information sheets from enterprises, battery and accumulators do not use mercury.

6.2.5. Biocides and pesticides

Domestic pesticides are produced mainly in the form of reprocessing and re-packaging import drugs. Therefore, it has been concluded that this activity does not use mercury.

6.2.6. Mercury-containing paint

According to statistics from the representative office of the Chemical Department, there is only 1 marine paint company importing mercury in 2014. This is in line with information paint companies in the South and the Paint-Ink Association, the mercury-containing paint cannot be consumed (although there is no prohibition or managing controls), except for a few types of paint for marine ships, sailing to anti-fouling, but in unpublished way => there is mercury used illegally with insignificant amount and if have, it can be considered as data errors.

6.2.7. Mercury-containing skin lightening creams and soaps

In fact, there is no cosmetic company importing mercury. This is in line with survey information from enterprises. All of the cosmetic companies claim not to use mercury in manufacturing (Appendix 2 Enterprise feedbacks), especially in 100% foreign capital companies FDI => There is no mercury releasing here.

Mercury inputs' results in this source can be clearly seen in Table 7 and there is nearly no mercury releasing here.

Table 12-1 Result of mercury inputs and releases of sources of mercury-containing products

Source	Value Tons / year	Mercur y inputs	Mercury releases via different ways into the environment					
			Air	Wate r	Soil	Produ cts	Gener al waste	Special waste
<i>Chemical Production</i>								
Caustic-chlorine production using mercury	0	-	-	-	-	-	-	-
PVC production using mercury as catalysts	0	-	-	-	-	-	-	-
Acetaldehyde production using mercury catalysts	0	-	-	-	-	-	-	-
<i>Manufacturing of products containing mercury</i>								
Mercury thermometers (used in medical, water, laboratory, industries ...)	0	-	-	-	-	-	-	-
Switches and Relays	0	-	-	-	-	-	-	-
Mercury- containing lamps (fluorescent, compact, and others)	2,233	2,233	22.3	11.2	22 3.3	0.0	223.3	22.3
Battery containing mercury	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Other devices containing mercury	0	0	0.0	0.0	0.0	0.0	0.0	0.0

Biocides and pesticides with mercury	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Paints containing mercury	6	6	0.1	0.0	0.6	0.0	0.6	0.1
Cream and whitening soap	0	0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 14. Images of chemical companies



Working with chemical companies



Hazardous waste storage areas



General waste containers in factory



Fluorescent production at the Philip company



Image of Dien Quang light company





Battery products

Dong Nai Battery-Accumulator factory

7. Data and inventory on waste handling and recycling

Currently, the data of ordinary waste and hazardous waste is not completely collected and updated in the State management agencies in the environment. The data used in this report is mainly from information of mass media sources such as the Department of Environment's website, the Ministry of Construction, the provincial Department of Natural Resources and Environment, the Management Board of industrial zones, newspapers (newspapers from the Government, the Natural Resources and Environment newspaper, the Industry and Trade newspaper, the Saigon Giai Phong newspaper ...). There is only a small portion of data collected from the General Department of Environment and the Environment Management – Health Department. The data collected was checked against data from other sources at the same time and from the previous time (if any) and / or relatively compared with related data (if available) to exclude irrational numbers.

Due to no updated statistics, some calculations in the report had to use the estimated figures (experts) including the percentage of illegal garbage burning and the total amount of uncollected waste is estimated at 5%; the percentage of rural domestic sewage seeped into soil or water is estimated at 20%; the proportion of animal water waste seeping into the ground, discharging into enclosed ponds and biogas waste into fields is 10%; the rate of medical waste connected to drains (95%).

In this report, the uncertain part is data related to wastewater treatment. In the future, at the level 2 of this project, the data of wastewater, agricultural waste, craft villages and industrial waste is believed more sufficient and reliable.

The results of this section as below:

7.1. Mercury recycling and production

Currently, there is no mercury recycling activity in Vietnam. The technology processing fluorescent lamps have been licensed only in pretreatment levels instead thoroughly splitting into separated waste to facilitate subsequent treatment steps. (Data in 2014, source 47)

7.2. Recycling of scrap metal

Currently, there is no data collected for this section. The data shows that, in 2014, Vietnam had used about 5.4 million tons of steel annealed by scrap steel. In which, about 2 million tons has domestic origins, 3.4 million tons is imported scrap (Source 51). There is no information about steel derived from vehicle demolition or the proportion of demolished vehicles and domestic and imported scrap steel.

These following results relate to scrap steel are represented below:

(1) Domestic scrap steel for refining steel

(1.1) The Quan Do Village (Van Mon Town, Yen Phong District, Bac Ninh): Demolition of aircraft, tanks chain, military vehicles, motorcycles, telephones, computer monitors, electronic circuit boards ... are classified separately into iron, copper and aluminum ... to sell to metal recycling villages or centres=> There is no specific data. (Data in 2015, Source 2 -3 website)

(1.2) Dong Van and Te Lo Town (Yen Lac District, Vinh Phuc): Currently, there is up to 50% of households doing steel recycling by purchasing cars, machine tools, intro scrap, demolishing equipment and baking them out to become steel billets, then sell to steel mills. => There is no specific data. (Data in 2013, Source 48)

(1.3) Te Lo Town (Yen Lac district, Vinh Phuc): Car demolition in order to get spare parts for sale or refurbishing. According to a typical centre, there are 10- 15 vehicles (cars, motorbikes, excavators, bulldozers, ...) dismantled per month and the whole village has about 300-400 centres (Data in 2015, source 49).

Assuming that 20% of vehicles sold for steel mills. The number of recycling vehicles = 10 vehicle / centre / month * 350 centres * 12 months * 20 % = 8,400 vehicles. This data will be imported into Toolkit and the estimated Hg input number = 9 kg Hg / year

(1.4) Thuyen Village (Dinh Tri Town, Lang Giang District, Bac Giang): demolition of automobiles, ships, bulldozers, cranes, excavators ... to get spare parts, accessories for sale, the rest is used to sell as scraps for recycled products. There is no specific data. (Data in 2014, source 50)

(2) Steel scraps imported for steel refining

The amount of imported steel scrap to steel Vietnam: 3.4 million (tons / year). (2014 data, source 51)

The average weight of 1 car: 1 ton with 65% of steel. The average steel, therefore, is 0.65 ton/ car

Assuming that 10% of steel scraps imported into VN stemming from car/ motorbike demolition. The number of cars demolished for steel refining = 3.400.000 * 10% / 0.65 = 523.077 vehicles. This data will be imported into Toolkit and the estimated Hg input number = 575 kg Hg/ year

7.3. Urban/ regular waste normally treated by incineration

The amount of urban waste treated by incineration can be calculated from the amount of burning waste for fertilizer and incineration subtract that for fertilizer, then continue to subtract a small fraction of hazardous waste available in urban waste.

There are 489.954 tonnes of regular waste via incineration in 2014. In details:

We have data of urban waste = 32.000 (tonnes / day) = 11.680.000 (tonnes / year) (Data in 2014, Source 36); the waste collection rate in urban areas = 84 - 84.5%, average 84.25% (Data in 2014, Source 53).

The amount of urban waste collected:
 $11.680.000 * 84.25\% = 9.840.400$ (tons / year)

The rate of urban waste treated by incineration and making fertilizer : 20% (Data in 2014, Source 54); the rate of urban waste is recycled: 15% (Data in 2015, Source 55)
=> The rate of urban waste treated by incineration is: 20% - 15% = 5%

The estimated amount of urban waste treated by incineration (including hazardous waste) = $9.840.400 * 5\% = 492.020$ (tons / year)

We also have the proportion of hazardous waste and total urban waste is = 0:02 - 0.82%, averaging 0.42% to (Data in 2011, Source 56, Section 2.2, Page 37)

=> Hazardous waste burned is = $492.020 * 0.42\%$ to = 2.066 (tons / year)

The amount of regular urban waste treated by incineration = $492.020 - 2.066 = 489.954$ (tons / year)

7.4. Hazardous waste treated by incineration: 92.300 (tons / year)

In this section, only the data of hazardous industrial waste treated in two major companies named the MTV Environment Limited Company belong to Vinacomin and Vietnam Holcim, without refer to the amount of hazardous industrial waste treated in many hazardous waste treatment companies across the country.

The calculated figure is equal to 92.300 tons / year with the calculation as below:

(1) The amount of hazardous waste in household waste treated by incineration: 2.066 (tonnes / year) (as calculated in Section 3 above)

(2) The amount of rural hazardous waste treated by incineration: biocide packages are burned in cement stations or burned with industrial waste

(3) The amount of hazardous waste in craft villages burned: no exact figures, it is estimated by 0 or insignificant

(4) The amount of hazardous waste in industrial waste treated by incineration: 234 tonnes / year

Calculation:

In Quang Ninh, the amount of hazardous waste treated by the MTV Environment Limited Company belongs to Vinacomin in 16 months since January 2014: 304.4 tonnes (Source 57); the amount of hazardous waste treated by Vinacomin in the first 8 months in 2014: 163.1 tonnes (Source 58)

=> the amount of hazardous waste treated by Vinacomin in 2014 = $163.1 + (304.4 - 163.1) / 8 * 4 = 234$ (tonnes / year)

(5) The amount of hazardous waste in industrial waste is co-processed in cement kilns of Holcim: 90,000 (tons / year) (2014 data, source 59)

=> The total amount of hazardous waste handled via incineration:

(1) + (2) + (3) + (4) + (5) = $2.066 + 0 + 0 + 234 + 90.000 = 92.300$ (tonnes / year)

7.5. Medical waste handled via indoor and outdoor incineration: 14.582 (tons / year)

There is no data of outside burning. This section below just estimates that medical waste treated by incineration is 14.582 tonnes / year. The calculation is presented as below:

The total amount of hazardous medical waste in Vietnam = 47 (t / d) = 17.155 (tonnes / year) (Source 60)

The rate of solid medical waste treated formally is temporarily equal to = 1-15% (source 52: "However, at present in Vietnam, on the national scale about solid medical waste: about 15% hospitals do not handle medical waste in accordance with regulations")

=> The amount of medical waste handled via incineration: $17.155 * (1-15\%) = 14.582$ (tonnes / year)

7.6. Sludge waste water treated by incineration: No

"In Vietnam, the first step has been applied when employing some sludge treatment technologies at low cost." (Data in 2015, Source 61)

"Currently, sludge treatment methods are primarily applicable at Vietnamese urban waste water stations is water dehydration and transportation to landfills. There is a small number of treatment plants with fertilizer production from sludge after a process of stabilizing sludge and drying them in drying yards (Dalat), fertilizer production after a process of mechanically drying sludge (TP. HCM). In Hanoi, Yen So waste water station, with the designed capacity of 200,000 m³ / day, with the application of anaerobic digestion technology to stabilise sludge, biogas then is recovered and burned" (Data in 2015, Source 62)

7.6. Outdoor burning waste (at formal and informal landfills): 1,473,572 (tonnes / year)

There is no data of outdoor burning waste in unhygienic landfills in 2014, thus, this below part uses only figures in 2011. There is no data of urban uncollected waste and burned informally, the numbers in these calculations below are estimated as experiences is 1.473.572 tonnes / year, including:

(1) Outdoor burning waste at landfills: 1,239,890 (tons / year)

We have the amount of urban waste collected = 9.840.400 (tonnes / year) (calculated in Section 3 above); the burying ratio over the total amount collected = 80% (Data in 2014, Source 54) => The amount of waste collected at sanitary landfills and landfills: $9.840.400 * 80\% = 7.872.320$ (tonnes / year) (Data in 2014).

The ratio of household waste handled at unhygienic landfills over the entire amount of waste treated by incineration: 1- 61% = 39% (61% can be taken from section 8 below); the estimated rate of open burning waste at unhygienic landfills: 45% (Data in 2011, Source 56, Section 2.5) => The amount of Outdoor burning waste at unhygienic landfills is $7,872,320 * 39\% * 45\% = 1,381,592$ (tons / year)

(2) Other informal outdoor burning waste: 91.980 (tons / year)

We have the amount of urban waste collected (dumping illegally into the environment / spontaneous incineration / unallowed incineration): 1 - 84.25% = 15.75%

The amount of urban waste = 11.680.000 (tonnes / year) (Data in 2014, Source 52) => the amount of waste informally treated: $11.680.000 * 15.75\% = 1.839.600$ (tonnes / year)

It has been estimated that the rate of informal incineration of waste over the total amount of discollected waste = 5% (Source from experts) => the amount of waste discollected and treated informally by incineration): $1,839,600 * 5\% = 91.980$ (tonnes / year)

Total (1) + (2) = $1.381.592 + 91.980 = 1.473.572$ (tonnes / year)

7.7. Waste treated at sanitary landfills

After producing compost fertilizer from urban waste, medical waste/ hazardous waste is treated landfill, waste is treated by incineration. Then, the amount of ash and sludge from waste treatment centres in local can be included or not in the below data.

According to sanitary landfills and urban areas having sanitary landfills, we have the following data: "There are 98 waste landfills operating nationwide, but in which, only 16 is considered as sanitary landfills" (Data in 2014, Source 65). "There are up to 85% of urban and older towns used unhygienic landfills" (Data in 2015, Source 66). Up until August 2015, Vietnam had 124 urban areas (from town above) (Source 67). We then can calculate the number of urban areas having sanitary landfills: $15\% * 124 = 18.6$

Figures of urban household waste treated in sanitary landfills is summarized below:

- (1) Hanoi: Nam Son and Xuan Son Landfill: 3.700 (t / d) = $1.350.500$ (tons / year) (Data in 2014, Source 68)
- (2) Ho Chi Minh: Phuoc Hiep and Da Phuoc Landfill: 7.100 (t / d) * $90\% = 2.332.350$ (tons / year) (Data in 2014, Source 69)
- (3) Hai Phong: Trang Cat Waste Treatment Plant: 900 (t / d) - 200 (td) = 700 (t / d) = 255.500 (tons / year) (Data in 2015, Source 70)
- (4) Danang: 300.000 (tons / year) (Data in 2014, Source 71)
- (5) Thai Nguyen City: Da Mai Landfill: 150 (t / d) = 54.750 (tons / year) (Data in 2014, Source 72)
- (6) Vung Tau: Landfill of Kbec Vina Limited Company in Toc Tien Centralised Waste Treatment Centre, Toc Tien Town: 328 (t / d) = 119.720 (tons / year) (Data in 2014, Source 73)
- (7) Ba Ria City: Landfill of Kbec Vina Limited Company in Toc Tien Centralised Waste Treatment Centre, Toc Tien Town: $65\% * 761-328 = 167$ (t / d) = 60.827 (tons / year) (Data in 2014, Source 74)
- (8) Bac Ninh City: Phu Lang Landfill: 230 (t / d) = 83.950 (tons / year) (Data in 2014, Source 74)
- (9) Thu Dau Mot City: 480 (t / d) = 175.200 (tons / year) (Data in 2014, Source 76)
- (10) Tuy Hoa City: Tho Vuc Landfill: 110 (t / d) = 40.150 (tons / year) (Data in 2014, Source 77,78)
- (11) Tay Ninh City: Tan Hung CRT Treatment Zone : $326/5 * 0.96 = 63$ (t / d) = 22.846 (tons / year) (Data in 2015, Source 79,80)
- (12) Hue: Loc Thuy Landfill: 20 (t / d) = 7.300 (tons / year) (Data in 2014, Source 81)
- (13) Nam Dinh City : Hoa Xa Waste Treatment Zone: There is no data of waste treated, but it is believed less than 175 tons / day (2014)
- (14) Vinh Long City: sanitary landfills: no accurate figures, but it is believed less than 120 tons / day (2015)

- (15) Tam Diep Town (Category 3 Urban Area, Ninh Binh): Tam Diep CTR Waste Treatment Plant: no accurate figures, but it is believed less than 7,000 t / 10 months (6 last months' data in 2014 and 3 first months in 2015)
- (16) Hung Yen City: sanitary landfills have no waste data
- (17) Tuy Phong Sanitary Landfill (Binh Thuan): treats municipal rural waste in Tuy Phong District.

The total amount of urban waste buried in 12 cities (13 sanitary landfills) is 4,803,093 (tons / year) (2014), equal to 61% of total urban waste at landfills.

7.8. Illegally dumping of regular waste into the environment

- (1) Urban household waste is collected and disposed at unhygienic landfills:

The proportion of household rubbish collected at unhygienic landfills and the total amount of waste collected in landfills is estimated by 1-61%. While the proportion of household rubbish disposed (no burning) at unhygienic landfill = 1-45%

In subsection (1) Section 8.7 above, the amount of waste in landfills is 7,872,320 (tons / year) => The amount of municipal disposed waste (no burning) at unhygienic landfills:

$$7.872.320 * (1-61%) * (1-45%) = 1.688.613 \text{ (tons / year)}$$

- (2) Urban waste disposed illegally into the environment (dispersion)

The amount of waste disposed illegally (discarding to the environment / open incineration) is 1.839.600 (tonnes / year) (calculated as in Section 7 above).

The estimated proportion of waste disposing illegally into the environment = 1-5%
=> The amount of illegally dumped waste into the environment is: $1.839.600 * (1-5%) = 1,747,620$ (tonnes / year) (Data in 2014)

$$\text{Total (1) + (2) = } 1.688.613 + 1.747.620 = 3.436.233 \text{ (tonnes / year)}$$

7.9. The amount of wastewater directed into receiving sources or being treated

This is the part with greatest uncertainty in this report.

Without updated figures, the percentage of urban wastewater in the common drainage system temporarily is taken from data in 2012. There is no figure of rural household wastewater into soil, ponds or pit containers; this amount is temporarily calculated equal to 20% of wastewater. Craft Villages' wastewater data is incomplete and updated. There is no data of aquaculture wastewater animal water waste directed to ponds, canals, rivers or sea.

Industrial wastewater figures of 46/63 provinces (equal to 73% of provinces) in Vietnam are calculated here. The data collected might not fully reflect the amount of industrial wastewater in local. Some provinces just concern about the largest amount of wastewater instead taking into account wastewater in and outside of industrial zones (for example: Quang Ninh). There is no actual data in some, it should have to estimate the amount of waste water via land-used acreage figures. Data does not include industrial wastewater of 17 provinces, including Ha Giang, Son La, Lai Chau, Cao Bang, Lang Son, Tuyen Quang, Yen Bai, Ha Tay, Nghe An, Ha Tinh, Kon Tum, Gia Lai Khanh Hoa, Dong Thap, Vinh Long, Tra Vinh, Bac Lieu. However, these provinces do not have key industrial activities, therefore, they discharged only a small fraction of the total amount of industrial waste water in Vietnam.

Figures calculated here is 3.639363.066 (m³ / year), including 5 components:

- (1). Domestic wastewater connected to sewerage systems: 1.518.400.000 (m³ / year)

(1.1) The amount of urban waste water connected to sewers / being treated:
1.138.800.000 (m³ / year)

The amount of urban waste water: 5.200.000 (m³ / day) = 1.898.000.000 (m³ / year)

(Data in 2015, source 82)

We have the number of households connected to public sewerage systems: 60% (Data in 2012, Source 83, page 2)

=> The amount of urban waste water into the sewer system is temporarily calculated by: 1.898.000.000 * 60% = 1.138.800.000 (m³ / year)

(1.2) Rural wastewater connected to sewers / being treated

The amount of waste water in rural areas = 1.300.000 (m³ / day) = 474.500.000 (m³ / year) (Source 84, Data in 2015)

The rate of rural domestic wastewater seeped into the soil, discharged into ponds / pits is estimated by 20% (expert)

The amount of rural domestic wastewater treated or directed via pipeline to lakes, canals, rivers, the sea:

$$474.500.000 * (1-20\%) = 379.600.000 \text{ (m}^3 \text{ / y)}$$

$$\text{Total (1.1) + (1.2) = } 1.138.800.000 + 379.600.000 = 1.518.400.000 \text{ (m}^3 \text{ / y)}$$

(2) Animal and aquacultural wastewater production: 27.000.000 (m³ / y)

The amount of liquid waste (urine, water from washing cages, water from playgrounds, stadiums, stockyards) across the country in 2014: 30.000.000 (m³ / y) (Source 85)

The estimated proportion of animal waste water seeped into the ground, discharged into enclosed ponds or biogas processed then discharged into fields...: 10% (expert)

The amount of animal waste water treated or directed via lakes, canals, rivers, the sea:

$$30.000.000 * (1-10\%) = 27.000.000 \text{ (m}^3 \text{ / y)}$$

(3) The wastewater from craft villages are connected to sewers / being processed: 31,181,169 (m³ / y)

Bac Ninh: Phong Khe paper recycling village: 4.500 - 5.000 (m³ / d), averging 4.750 (m³ / d) = 1.733.750 (m³ / y) (Data in 2011, Source 86); Khac Niem Noodle village: 5.000 (m³ / d) = 1.825.000 (m³ / y) (Data in 2014, Source 87); Chau Khe iron and steel production village: 15.000 (m³ / d) = 5.475.000 (m³ / y) (Data in 2012, Source 88); Dai Bai bronze casting village: 40 (m³ / d) = 14.600 (m³ / y) (Data in 2011, Source 89).

Bac Giang: Phuc Lam cattle slaughter village: 50-80 (m³ / d), averging 65 (m³ / d) = 23.725 (m³ / y) (Data in 2012, Source 90); Van Ha winemaking village: 500 - 1.000 (m³ / d), an average of 750 (m³ / d) = 273.750 (m³ / y) (Data in 2012, Source 90).

Wastewater of 100 villages along Nhue River: 45.000 - 60.000 (m³ / d), averging 52.500 (m³ / d) = 19.162.500 (m³ / y) (Data in 2009, Source 91)

Wastewater from craft villages belongs to Day River basin: food processing of agricultural products villages; rattan handicraft villages, conical hats villages, weaving and dyeing villages: 1.219 + 91.1 + 111.76 (m³ / d) = 1.422 (m³ / d) = 518.979 (m³ / y) (Data in 2011, Source 92)

Thai Binh: Phuong La textile and dyeing village (Thai Phuong Town): 1.000 -1.500 (m³ / d), averging 1.250 (m³ / d) = 1.368.750 (m³ / y) (Data in 2011, Source 92, Chapter 3, page 17)

Da Nang: Non Nuoc stone carving village: 1.500 (m³ / d) = 547.500 (m³ / y) (Data in 2015, Source 94)

Ben Tre: Wastewater of Ben Tre villages into Ba Lai River: 651 (m³ / d) = 237.615 (m³ / y) (Data in 2013, Source 95)

The total volume of waste water of above villages = 31.181.169 (m³ / y)

(4) Industrial waste water connected to sewers / being processed: 2.019.438.147 (m³ / y)

(4.1) Industrial waste water in the basin of Dong Nai River (7 provinces in the Southern key economic area including HCM City, Dong Nai, Binh Duong, Binh Phuoc, Ba Ria - Vung Tau, Tay Ninh and Long An): 1.800.000 (m³ / d) = 657 million (m³ / y) (Source 96)

(4.2) Industrial wastewater in river basins of Cau River (Bac Kan, Thai Nguyen, Bac Ninh, Bac Giang, Vinh Phuc, Hai Duong and a part of Hanoi): 2.000.000 (m³ / d) = 730 million (m³ / y) (Data in 2012, Souce 97)

(4.3) Industrial wastewater of provinces belongs to Nhue – Day River (Hanoi, Hoa Binh, Ha Tay, Ha Nam, Ninh Binh, Nam Dinh): 89.836.172 (m³ / y)

Hanoi wastewater from industrial zones, craft villages and villages having work in 2014: 230.000 (m³ / d) = 83.950.000 (m³ / y) (Data in 2014, Source 98)

Hoa Binh: the total renting area: 83.53 ha, the coefficient of wastewater generated per industrial area is 30 m³ / ha / day. Thus, the amount of waste water from industrial zones = 83.53 * 30 = 2.506 (m³ / d) = 914.654 (m³ / y) (Data in 2014, Source 99, annex III)

Ha Nam: Wastewater from 4 industrial zones of Dong Van Industrial Zone I, II, Chau Son and Hoa Mac: 69.064 (m³ / m) = 828.768 (m³ / y) (Data in 2014, Source 100)

Ninh Binh: Wastewater from industrial zones: 10.150 (m³ / d) = 3.704.750 (m³ / y) (Data in 2014, Source 101)

Nam Dinh: Wastewater from industrial zones: 1.200 (m³ / d) = 438.000 (m³ / y) (Data in 2014, Source 102)

A total of five provinces (excl Ha Tay): 89.836.172 (m³ / y)

(4.4) Industrial wastewater at some (8) Northern provinces: 95.544.821 (m³ / y)

Lao Cai: Industrial zones wastewater: 5.210 (m³/d) = 1.901.650 (m³/y) (data 2015, source 103)

Phu Tho: Wastewater at Bai Bang Paper Factory: 23.000 (m³/d) = 8.395.000 (m³/y) (data 2014, source 104)

Hung Yen: the total square of leased industrial land: 408.62 ha. Estimated of generated wastewater: 408.62 * 30 = 12.259 (m³ / d) = 4.474.389 (m³ / y) (date 2014, source 99, Annex III)

Hai Phong: Trang Due Industrial zone: 187ha, filling 97% (data 2015, source 105) The Son, Nomura, Nam Cau Kien, Ouyang industrial zones have a total land area of 762 hectares (figure 2014, source 99, annex III), temporary filling rate equal to 67% (the average filling rate of industrial zones in the country - the source 106). The total active industrial land area is = 692 ha. Estimated industrial wastewater = 20.758 (m³ / d) = 7.576.634 (m³/y)

Quang Ninh: Wastewater of mining industry: 55.000.000 (m³ / y) (data 2014, source 107)

Thai Binh: total industrial land used until 2015 is 1.029,4 hectares (data 2015, source 108).
With 67% of filling rate and coefficient of generated wastewater is 30 m³ / ha / day, the amount of estimated industrial wastewater of the province = 7.552.193 (m³/y)

Thanh Hoa: 10.000.000 (m³/y) (date 2015, source 109)

Nghe An: Vinh City: 1.767 (m³/d) = 644.955 (m³/y) (figures in 2015, the source 110)

The total sum of 8 northern provinces above = 95,544,821 (m³/y)

(4.5) Area industrial wastewater at (12 provinces) Central and Highlands: 391.577.017 (m³/y)

Ha Tinh: Leased industrial land area: 13,7 (ha) (data 2014, source 99, annex III). Estimated industrial wastewater: 150.015 (m³/y)

Quang Tri: Industrial Wastewater: 1.900.000 (m³/y) (data 2014, source 111)

Thua Thien – Hue: Phu Bai Industrial Zone wastewater = 0.5 * 6.500 (m³/d) = 3.250 (m³/d) = 1.186.250 (m³/y) (data 2015, source 112)

Quang Nam: Dien Ban district: Industrial zones and others manufacturing organizations wastewater: 85.000 (m³/m) = 1.020.000 (m³/y) (data 2014, source 113)

Da Nang: Treated industrial wastewater: 6.820 (m³/d) = 2.489.300 (m³/y) (figures in 2015, the source 114)

Quang Ngai Province wastewater from industrial zones and vocational villages = 1.000.000 (m³/d) = 365.000.000 (m³/y) (figures in 2015, the source 115)

Binh Dinh: Total area of 4 Industrial zones Phu Tai, Long My, Nhon Hoa, Cat Trinh = 1.138 hectares (figures 2014, source 99). Estimated Industrial Wastewater = 8.348.937 (m³/y)

Phu Yen: The agricultural product processing factories: Wine Van Phat, Dong Xuan Starch, Starch production factory of Fococev, Son Hoa Sugar Factory have a total volume of wastewater: 7.337 (m³/d) = 2.678.005 (m³/y) (data 2014, source 116)

Ninh Thuan: Leased industrial land area: 62.075 ha (data 2014, source 99 Appendix III). Estimated Industrial Wastewater = 679.721 (m³/y)

Binh Thuan: Leased industrial land area: 169,55 hectares (data 2014, source 99, annex III). Estimated Industrial Wastewater = 1,856,573 (m³/y)

Dak Lak: Hoa Phu Industrial zone covers an area of 182 hectares (figure 2014, source 99), Tan An Industrial Complex 1 and 2 have to an area of 65,1ha and filled 91.5% (data 2014, source 107). Estimation of industrial wastewater = 1.987.496 (m³/y)

Dak Nong: wastewater from factories, industrial zones: 11.728 (m³ / d) = 4.280.720 (m³/y) (figures in 2010, the source 118)

Total industrial wastewater volume of 12 central provinces and the Highlands above is 391.577.017 (m³/y)

(4.6) Industrial wastewater of some (8) Southern provinces: 55.480.138 (m³ / y)

Wastewater from industrial zones of Mekong River Delta key economic zone (Can Tho, An Giang, Kien Giang, Ca Mau): 120.500 (m³ / d) = 43.982.500 (m³ / y) (Data in 2015, Source 63)

Tien Giang: The area of renting land in 4 operating industrial zones (My Tho Industrial Zone, Tan Huong, Long Giang, Soai Rap Petroleum Industrial zone) is: 79.14 * 100% + 98.38% + 197.33 * 540 * 39.79 % + 22.9 = 511.04 ha; operating land area of 4 operating

industry locations (Trung An, An Thanh, Song Thuan, Tan My Chanh): 108.9 hectares (Data in 2015, Source 64). Estimated amount of wastewater: 6.788.335 (m³ / y)

Hau Giang: industrial wastewater in Tan Phu Thanh and Hau River industrial zone: 3.500 (m³ / d) = 1.277.500 (m³ / y) (Data in 2015, Source 63)

Ben Tre: Land area in Giao Long, An Hiep Industrial zone: 239 (ha) (Data in 2014, Source 99, annex III). The occupancy rate is 67%. The estimated amount of land area is 160.13 ha. 3 industrial zones of 90.88 hectares, filled 38.45% (Data in 2015, Source 120). The estimated amount of wastewater: 2.136.053 (m³ / y)

Soc Trang: An Nghiep Industrial Zone: 3.300 -3.800 (m³ / d), averaging 3.550 (m³ / d) = 1,295,750 (m³ / y) (Data in 2014, Source 121)

The total amount of wastewater od above 8 southern provinces is 55.480.138 (m³ / y)

The preliminary estimate amount of wastewater CN in 46 provinces belong to Dong Nai River Basin, Nhue - Day and Cau and 8 Northern provinces, 12 provinces in Midland and Central Highlands and Southern provinces = 2.019.438.147 (m³ / y)

(5) Medical waste water connected to sewers / being processed: 43.343.750 (m³ / y)

The amount of medical waste generated from all health facilities in 2014: 45.625.000 (m³ / y) (source 114). The estimated amount of wasterwater connected to the sewer is 95% (expert)

The estimated amount of waste water connected into sewers / being processed:

$$95\% * 45.625.000 = 43.343.750(m^3 / y)$$

The estimated amount then is equal to:

$$(1) + (2) + (3) + (4) + (5) = 1,518,400,000 + 27,000,000 + 31,181,169 + 2,019,438,147 + 43,343,750 = 3,639,363,066 (m^3 / y)$$

Cell B4

Cell C13: Urban/ Regular waster treated via incineration = 489.954 (tonnes / year)

Cell C17: Outdoor burning waste (landfills and unauthorized ones) = 1.473.572 (tonnes / year)

Cell C20: Waste handled at landfills / sanitary landfills = 4.803.093 (tonnes / year)

Cell C21: Regular waster dumping illegally into the environment = 3.436.233 (tonnes / year) => C13 + C20 = 5.293.047 (tonnes / year) <(C13 + C17 + C20 + C21) * 0.67 = 6.835.911 (tons / year)

So why the value of Cell B4 is "N" in the question "Is More Than 2/3 (67%) of the general waste landfills lined thập and deposited on or incinerated with pollution abatement?"

After importing data into Toolkit spreadsheet, the amount of mercury releasing into the environment from this source is illustrated in Table 8

Table 13.1 Results of mercury inputs and releases of sources processing waste

Source	Value Tons / year	Mercury inputs	Mercury releases via different ways into the environment					
			Air	Water	Soil	Products	General waste	Special waste
<i>Metal Recycling</i>								
Recycled mercury production	0	-	-	-	-	-	-	-
Recycled steel production	0	0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Waste incineration</i>								
Urban waste incineration	489,954	2,450	2,204. 8	0.0	0.0	0.0	0.0	245. 0
Hazardous waste incineration	92,300	2,215	1,993. 7	0.0	0.0	0.0	0.0	221. 5
Medical waste incineration	14,582	350	315.0	0.0	0.0	0.0	0.0	35.0
Sludge waste incineration	0	0	0.0	0.0	0.0	0.0	0.0	0.0
Illegal open waste incineration	1,473,572	7,368	7,367. 9	0.0	0.0	0.0	0.0	0.0
<i>Waste collection and waste water treatment</i>								
Waste collected into controlled landfills	4,803,093	24,015	240.2	2.4	0.0	-	-	-

Illegal waste burial	3,436,233	17,181	1,718.1	1,718.1	13,744.9	-	-	-
Waste water treatment	3,354,663,066	17,612	0.0	15,850.8	0.0	0.0	1,761.2	0.0

Figure 15. Images related to waste disposal



Thai Nguyen Waste Landfills



Hau Giang Waste Landfill



Quy Thanh Landfill, Can Tho



Hau Giang Landfill



Electronic-waste recycling zone in

Paper recycling in Ho Chi Minh City



Ba Ria Vung Tau



Aluminum recycling in Binh Dinh

Steel recycling in Ba Ria Vung Tau



Medical waste incinerator in Nghe An hospital



**Hazardous waste treatment
by curing**

Burning household waste in Hue

8. Consumption of mercury and mercury compounds in products

If no or few local products are manufactured, the source on the market is mostly imported. Based on the HS code of the product, most of these items and materials imported into Vietnam can be found on Comtrade.com. However, only data up to 2013 can be found and mostly in USDE. Next, the consultants have more information from the General Department of Customs on quantity in 2014 (Official Letter No. 912 / 01.10.2015 IT-TK days of the Department of Information Technology and Customs Statistics IT & TKHQ) however, the data provided under HS code covers many categories, prices so accurate determination of the number of kg or certain products based on the relative value only or approximation.

Here are the results obtained and the analysis to estimate mercury release according to the Toolkit:

8.1. Dental amalgams

According to the Toolkit, sub-sources of data are estimated according to population and with population over 90 million, the figure is estimated at 620 kg / year (Table 9.2)

8.2. Types of thermometer

8.2.1. Thermometers used in medicine

In this sub source, estimated figures will be based on the thermometers imported for use as domestic annual production. This type of product has HS code of 902511. Based on this code, the information collected from the customs statistics and on the website of Comtrade.com on annual import and export product data in Vietnam

According to ComTrade.com, the import data is 20.765 kg (2013), 5,191,250 units; exported is 33 kg= 8,250 units (converted according to toolkit)

On the other hand, according to the General Department of Customs 1,885,676 units (\$ 6.505 worth of imports) were import and export data: 901 (2014) => Select the Customs 2014 data for consistency and also the newer data. (See Table 9.1)

8.2.2. Other types of thermometers for air, laboratory or household: No data

8.2.3. Other types of thermometers specialised for technology: No data

8.3. Switches and circuit breaker

According to Toolkit, sub-sources of data are estimated according to the population. However, as explained above, the population of more than 90 million people will produce a huge amount of mercury and seems inconsistent with the reality of industrialized and electrification of Vietnam. The use of these types of equipment is mainly in the city only. So the sub source for this is a factor of 0.35 was applied to the population, equivalent to the proportion of the urban population to estimated mercury release. (See Table 9-2)

8.3. Lamps containing mercury

8.3.1. 2 poles Fluorescent

2 poles Fluorescent also known as tube lights, has HS code 853 931, is the kind of products that contain mercury mainly produced in Vietnam, exported and imported to serve the domestic demand. Information and data on this sub source are provided from two statistical sources: Customs and ComTrade.com. Then on the basis of the Toolkit calculation with the formula: Use / disposal = Production+ Imports-Exports to calculate release of mercury to the environment. As follows:

According to ComTrade.com we have import value of 5,900,940 units (10,318,712 USD) (2013)

On the other hand, we have the statistics of the General Department of Customs (2014) for this HS code are:

(1) Import: 20,496,710 units (8,540,400 USD)

(2) Exports: 12,432,249 + 8,876,000 = 21,308,249 (units)

(3) In terms of domestic production, the amount of mercury used is 2,223kg (according to section 7 above) for different lamps, combined with the calculations from the Tool to calculate the amount of mercury on average contained in each bulb, thereby deduct the production of bulbs is about 88,187,194.

Thus, results from two sources in value quite coincide, only data on the number of the units on Comtrade.com are incomplete while statistics of the General Department of Customs can be more accurate and newer => use of Customs 2014 data. That data will be calculated as follow: Production + Imports-Exports = (1) + (3) - (2) = 20,479,710 + 88,187,194-21,308,249 = 87,375,655. (See Table 9.1)

8.3.2. CFL compact fluorescent lamps non- rechargeable (1 pole)

This type has HS code of 853 939

Similar to how to data collection and calculation of fluorescent lights above, we have:

According to ComTrade.com, 2013 figures only have import value of 236,886,131 USD, the amount can not be determined; Export value is 1,762,169. => Estimated amount accounted for 0.7% of exports to imports.

On the other hand, we have the source from the General Department of Customs to provide export and import data in 2014 to 853 939 HS code are 71.933.330 units (149.243.500 USD) but no export data. However, acceptable rate from Comtrade.com between exports and imports (0.7%) to adjust the equation=> export quantity = 71,933,330 * 0.7 = 503.533. (See Table 9.1)

8.3.3. Other lamps (without regarding of some ultraviolet lamps, sodium vapor ...)

We based on the identification of zip codes for these lamps as HS 853 932 to gain more information. However, according to General Department of Customs, there is no statistics for this HS code. There is only data in accordance from Comtrade.com 2013 with the import result of 355.404 unit and the export result of 196 units => the rest: 355.208 unit (See Table 9.1)

Table 14.1 Synthesis sub source of data for thermometers and lights

Section	Products	Production	Import	Export	Calculation results (Production+import- Export)	HS Code

8.2	Thermometers	0	1,885,676	901	<u>1,884,775</u>	HS 952011
			5,191,250	8250	5,183,000	
8.4.1	2 polesFluorescent	88,187,194	20,496,710	21,308,249	<u>87,375,655</u>	HS853931
8.4.2	1 polesFluorescent	0	71,933,330	503,533	<u>71,429,797</u>	HS853939
8.4.3	Other light bulbs	0	355,404	196	<u>355,208</u>	HS853932

Data from Table 9-1, after entering spreadsheet results we have results in mercury emissions into the environment as shown in Table 9-2.

Table 15-2 Result of input mercury release and for resource use / disposal of some mercury-containing products

Source	Value (units or population)	Amount of input mercury	Mercury releases in different environmental aspects					
			Air	Water	Soil	Product	General waste	Special Waste
<i>Use and reject products containing mercury</i>								
Dental amalgam fillings	90.728.900 (total population)	621	12.4	206.1	29.8	22.3	104.3	104.3
Medical thermometer	1.884.775	1.885	377.0	565.4	377.0	0.0	565.4	0.0
Switches contacting mercury	31.755.115 (35% population)	4.339	1,301.7	0.0	1,735.6	0.0	1,301.7	0.0
Light bulbs containing	158.860.6	2.904	871.1	0.0	871.1	0.0	1,161.5	0.0

mercury	60							
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8.4. Batteries containing mercury

Various types of battery manufactured in Vietnam fully include zinc, alkaline, silver oxide, including cylindrical batteries with different sizes but manufacturers and providers declare no mercury existed. Thus, this sub source accepts a value of 0, although there are export and import data provided by Customs Comtrade page.

8.4.1. Mercury oxide battery (button battery with other sizes)

8.4.2. Other types of batteries (zinc, alkaline, silver oxide)

8.4.3. Other types of batteries: 0

These batteries do not contain mercury.

8.5. Paints containing mercury

Worldwide, the mercury was banned for paints. According to Ms. Huyen Lac, Paints Association, paint contains lead and mercury can not be publicly circulated because it is difficult to sell, so Vietnamese companies do not produce nor import this type of paint. However, the use of this paint illegally, not published it still possible for some kind of special paint coating Anti-fouling hull has 3 separate HS code numbers as follows: 32,091,050; 32082040 and 32100091. With these three types of eight-number HS code, no data were found both on Comtrade.com and the Customs statistics. But in general, larger groups of HS code 320 910 and 320 820, we have the results according to the Customs as follow:

HS code 320910: 18.513.116 USD/ 5.829.297 kg

HS code 320820: 24.665.446 USD/ 3.978.734 kg

Total of 9.808.031 kg

If accept errors, if this whole imported paint is the types containing mercury spreadsheet then red alert is too high. So accept the value 0 for this sub source. Errors are inevitable, but because it can not distinguish different types of paint containing mercury or not and so these inaccuracies should be smaller than the error being warned.

8.6. Skin whitening cream and whitening soap

Same problem with paint, we have two kinds of data with the HS 3304 and HS 3401 for a total of 12,300,735 kg collectively. If we put in spreadsheets there will be red alert. Thus the actual amount of this cream is the amount of all the creams not only whitening cream, sunscreen and therefore, none of them contains mercury types. The fact that no statistics or tests for this information to be able to distinguish the exact number of creams that use mercury. Even if found separate HS code (8 digits) of skin lightening creams is 33,049,930 but statistics on both Comtrade or Customs should temporarily be ignored => accept errors with a value of 0.

8.7. Medical blood pressure measurement device

Currently, type mercury sphygmomanometer is no longer widely used as there are a lot of alternative modern sphygmomanometer. Although we have found specific HS codes of this type is 90189090 (Class 8 digits), the number entered is not correlated significantly overall, while no statistics from Customs should also accept the value 0.

8.8. Other types of device containing mercury

According to Toolkit, this figure depends on the population. However, with the actual consumption in Vietnam, it will be more reasonable not to choose this existing source.

8.9. Chemical Laboratory

Similar to the above section, we do not pick this existing source.

8.10. Laboratory Equipment

Similar to the above section, we do not pick this existing source.

8.11. Manufacture of Polyurethane

Similar to the above section, we do not pick this existing source.

9. Data and inventory on crematoria and cemeteries

This issue is related to various social factors across Vietnam. The **crematoria** trend is gradually increasing due to its outstanding advantages and simplicity.

To determine an appropriate information approach, we collected cremation data, then determined the number of deaths given the mortality rate before estimating **cemeteries** figures as the remaining. This is an approximation but feasible method since it is very difficult to determine **cemeteries** data in the countryside. The results are presented below:

Total deaths / year: 626.029 people / year

We have: death rate: 6.9 ‰ (General Statistics Office); Total population: 90.728.900 => Number of deaths: $90.728.900 * 0.0069 =$ approximately 626.029 people / year (A)

People cremated: 36.643 / year

In the South: According to statistics, HCM City has annually about 35.000 deaths (over the total of 60.000 people dead in TPHCM- Dong Nai-Binh Duong). In 2020, it is estimated up to 40,000 deaths. Therefore, HCM City is encouraging of replacing old cemetery fields to cremation centers and new constructions of new cremation centers to meet the needs of society.

According to crematoria and **cemetery** data in HCM City-Binh Duong-Dong Nai-Vung Tau (28), cremation services' data can be approached and we then can investigate crematoria numbers. This is also important to estimate and evaluate by regions.

Currently, in HCM City, the City Urban Environment Company has managed below cremation centres:

- (1) Binh Hung Hoa Cremation Centre - Tan Binh, HCM City
- (2) Da Phuoc Cremation Centre – Da Phuoc Cemetery - Binh Chanh
- (3) Phuoc An Vien Cremation Centre– Da Nang
- (4) Hoa An Cremation Centre (An Hoa, Hoa An Town, Bien Hoa City - Dong Nai)

According to the City Urban Environment Company, in 2014, there are 18.600 deaths cremated. Besides, there are below cremation centres outside HCM City

- (5) Premium Phu An Vien Cremation Centre (Long Thanh My Ward, District 9), in 2014, there are 2517 deaths cremated.

(6) Long Huong Cremation Centre (Ba Ria-Vung Tau) belonging to the Long Huong cemetery, in 2014, there are 2066 deaths cremated

=> the estimated number of cremations in HCMCity, Binh Duong, Dong Nai and Vung Tau is: $18.600 + 2517 + 2066 = 23.183$ (B)

We have the total population of these four provinces (according to Statistic Yearbook 2014) is:

(1 *) HCM City: 7.981.000 people

(2 *) Dong Nai: 2.838.600 people

(3 *) Binh Duong: 1.887.000 people

(4 *) Vung Tau: 1.059.500 people

Total: $1 * + 2 * + 3 * + 4 * = 13.767.000$ people (C)

For these cities, the average death rate is $6.9 \text{ }^{\circ}/\text{oo}$

=> Number of annual deaths: $(C) * 0.0069 = 13.767.000 * 0.0069 = 94.992$ persons / year
(D) => the crematorium rate in these four provinces is: $(B) / (D) = 23.183 / 94.992 = 0,244 = 24\%$

However, this rate might not be applied in rural areas where nearly 100% of deaths are cemetered as traditions or because of more spare landscape compared to urban areas or because there is no crematorium station in local.

In the North, especially in Hanoi, this ratio is high in urban towns (around 30-35%) but low in suburban towns (only 3-8%):

"Bui Anh Tuan - Deputy chairman of Hanoi National Battle Field Committee – said more families in the capital used crematoria for relatives compared to last years. In 2011, only 25% deaths cremated, in 2012 this rate increased to 32%, and only past 6 months was 35%. The locations having a low rate of crematoria are suburban districts such as Soc Son 8%, Ba Vi 3%, Quoc Oai 7%, Phuc Tho 6.1% ... " (source 41). Thus, the average crematorium rate in Hanoi is estimated at 22-25% similar to that in HCM City.

The rate of crematoria in HCM City and Hanoi, two largest cities in Vietnam, is about 24-45%, while as for other provinces, this ratio is approximately about only 10-15% => Given the increasing trend of crematoria, the general crematorium rate of urban areas is 18-20%.

We also have: the annual crude rate of deaths in urban areas is about 6.1 per thousand and the urban population is 30.035.400 => The total number of annual deaths in urban areas (according to Statistics Yearbook 2014): $30.035.400 * 0.0061 = 183.216$

=> Estimated crematorium numbers: $183.216 * 0.2 = 36.643$ persons / year (E)

=> Estimated cemetery numbers: $(A) - (E) = 626.029 - 36.643 = 589.386$ people / year

Table 16-1 Result of mercury inputs and releases of crematorium and cemetery sources

Source	Value Tons / year	Mercury inputs	Mercury releases via different ways into the environment					
			Air	Water	Soil	Products	General waste	Special waste
Crematoria								

and cemeteries								
Crematoria	36,643	92	91.6	0.0	0.0	-	0.0	0.0
Cemeteries	589,386	1,473	0.0	0.0	1,473.5	-	0.0	0.0

10. Conclusion

The cooperation of initial database on National surveys of mercury at level 1 and the UNEP Toolkit, despite certain errors, was able to make the initial assessment of levels of mercury penetration and releases into the environment. These initial assessments can assist us in viewing inputs, different ways of final mercury releases into different types of environments. From there, the State can impose effective controls, approaches minimizing and, if possible, limiting the use of mercury in key industries.

Given initial calculations' results, the total of estimated initial amount of mercury releasing into the environment is about 36.803 kg / year and the amount of mercury finally releasing into the environment is 49.131kg / year.

Mercury inputs are mainly located in following sources:

1 / Use and disposal of mercury-containing products

2 / Other material productions

3 / Coal **incineration** in large factories and other coal purposes

4 / Bare metal productions

5 / Mercury-containing products productions.

(See Graph 1 above)

Mercury releasing in many ways which are (major ones):

1 / Coal incineration and other material productions – accounts for 27% (11% + 16%) of final mercury releases.

2 / Waste incineration and open waste incineration - accounts for 25% of final mercury releases.

3 / Use and disposal of other products - accounts for 19% of final mercury releases.

4 / Metal production (excluding gold production by the amalgam method) - accounts for 8% of final mercury releases.

Furthermore, in Vietnam, the initial assessments show results that mercury mostly releasing into the air with 29.238 kg over 49.131 kg of other environments, accounting for 59.5%, following by mercury releasing into general waste (16%) and into the soil (10%). The remaining mercury releasing into water and products.

In addition, given the database of surveys and national initial assessment mercury, the Ministry of Industry and Trade is able to submit the Minamata Convention to the Government for considering and then approving at the appropriate time. This, therefore, is the main purpose of these project results.

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