



MERCURY SOURCE CATEGORIES



RAW MINERALS AND FUELS

Emissions from Raw Minerals and Fuels

1

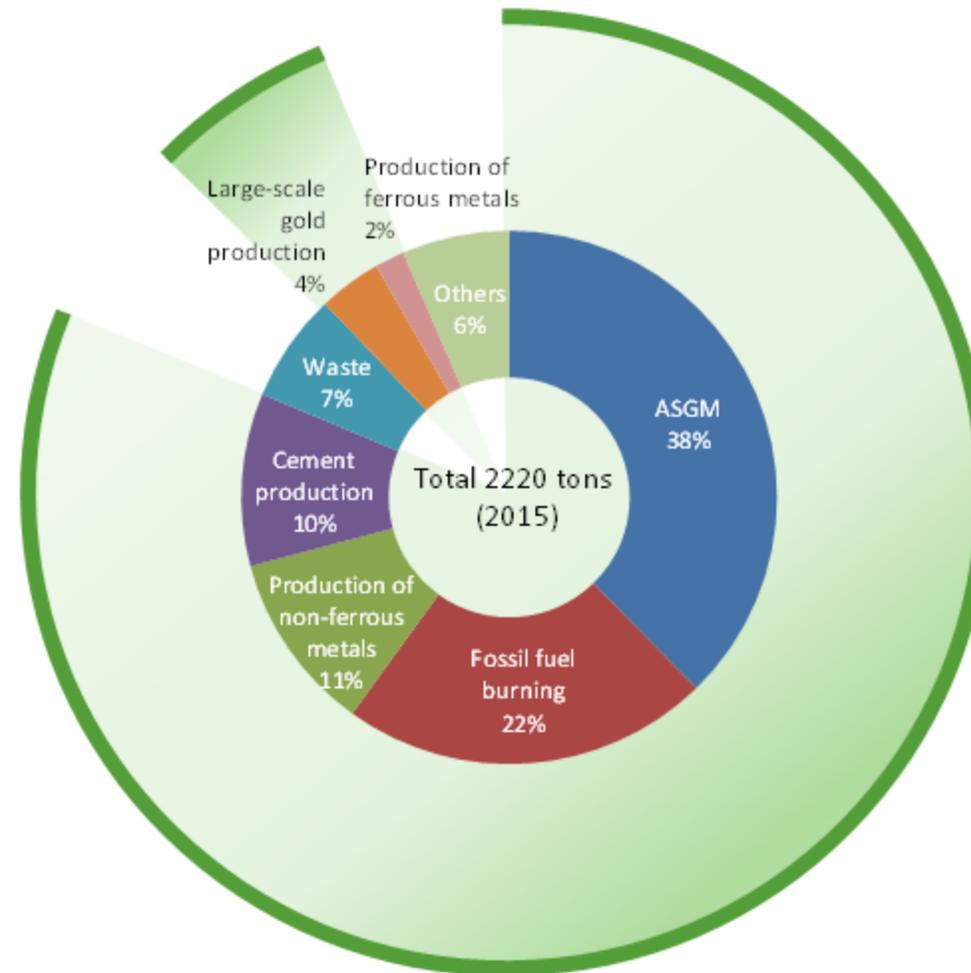
Raw minerals and fuels accounts for most mercury emissions

2

Mercury exists as an impurity that is emitted unintentionally

3

ASGM accounts for the largest mercury emission (intentionally added)

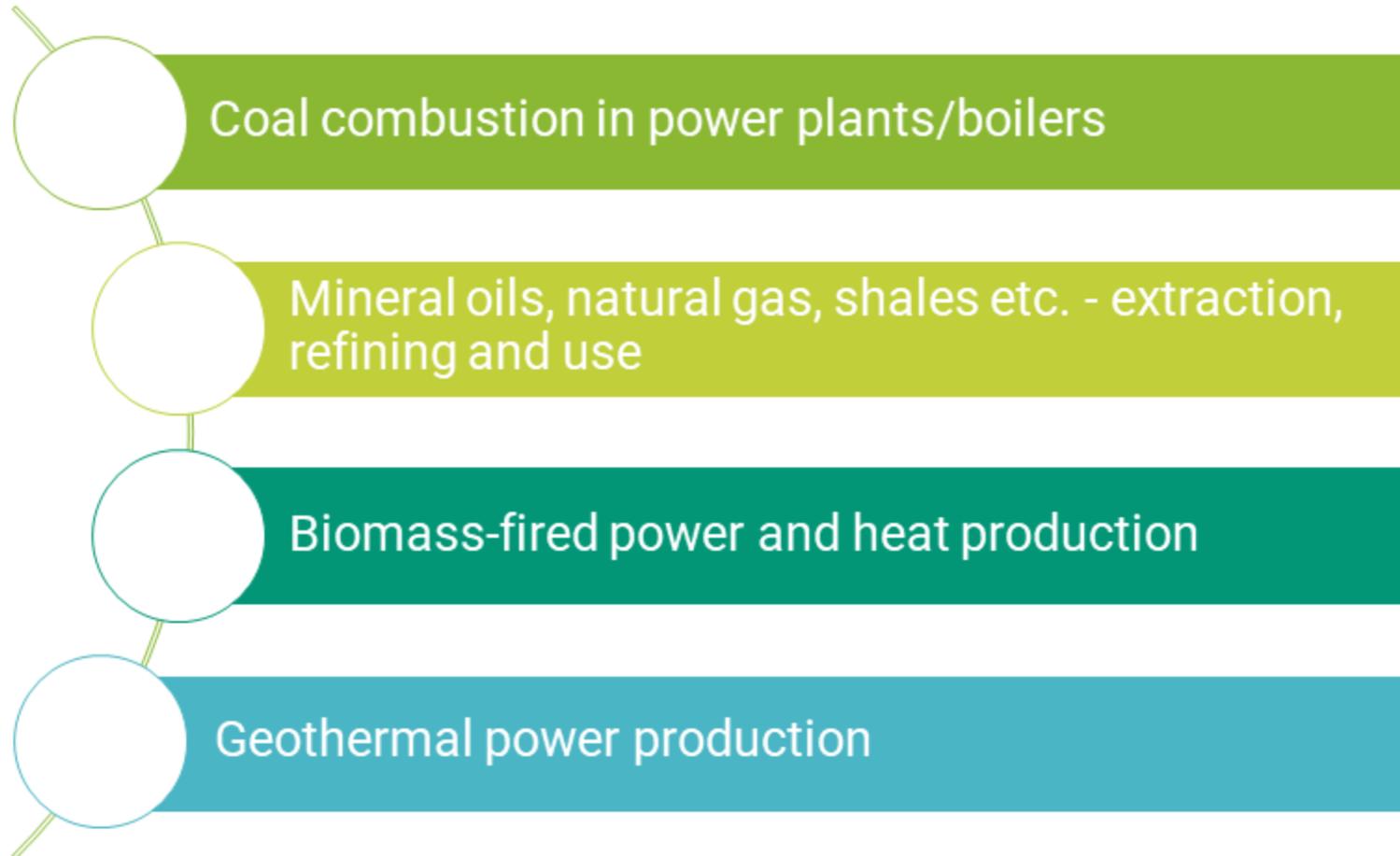


Source: UNEP (2019). Global Mercury Assessment 2018.

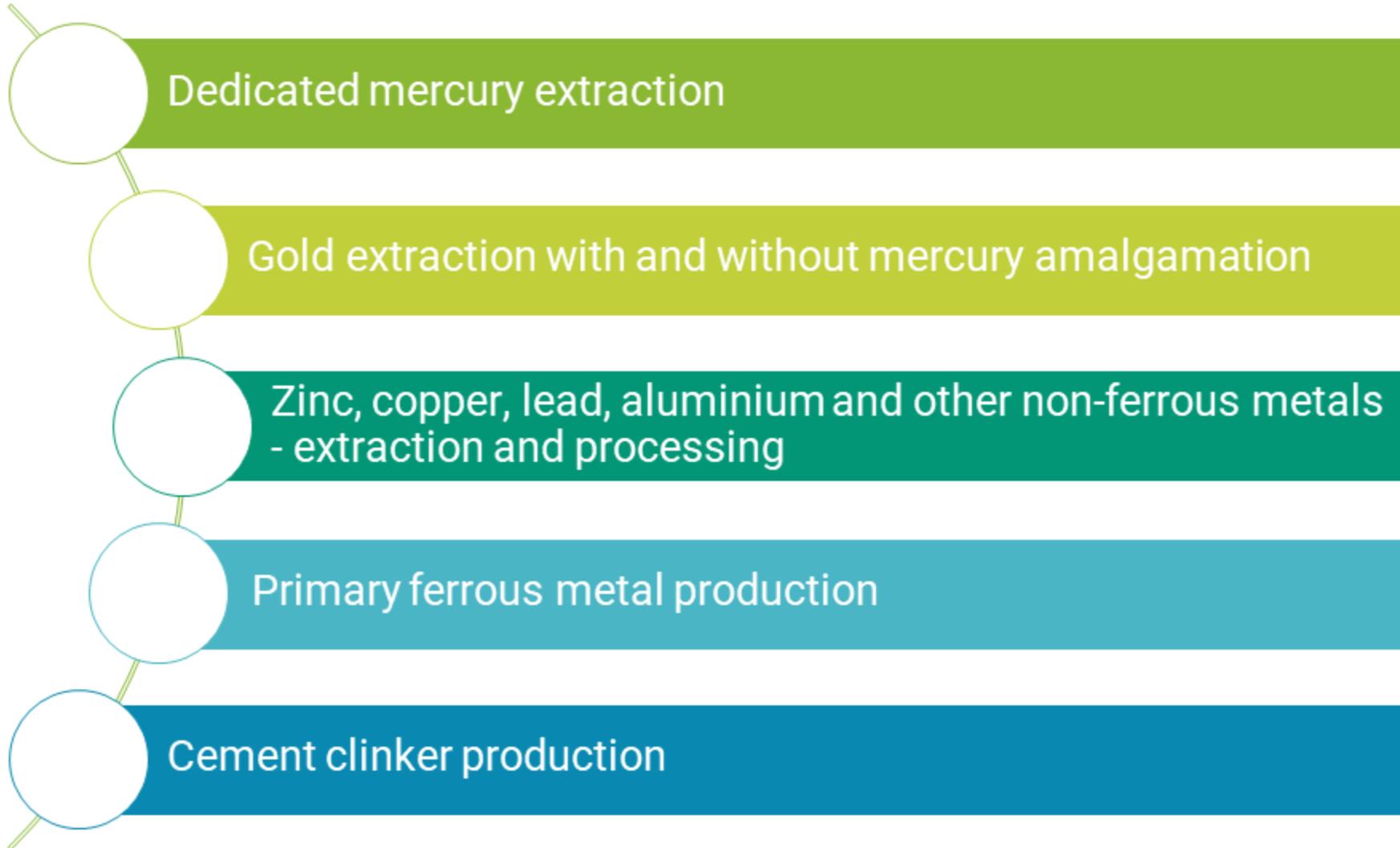
Mercury Source
Categories

Mercury Source
Categories

Energy Consumption and Fuel Production



Primary Metals and Material Production



Mercury Source
Categories

Mercury Source
Categories

INDUSTRIAL PROCESSES USING MERCURY

Mercury Use for Industrial Processes

1

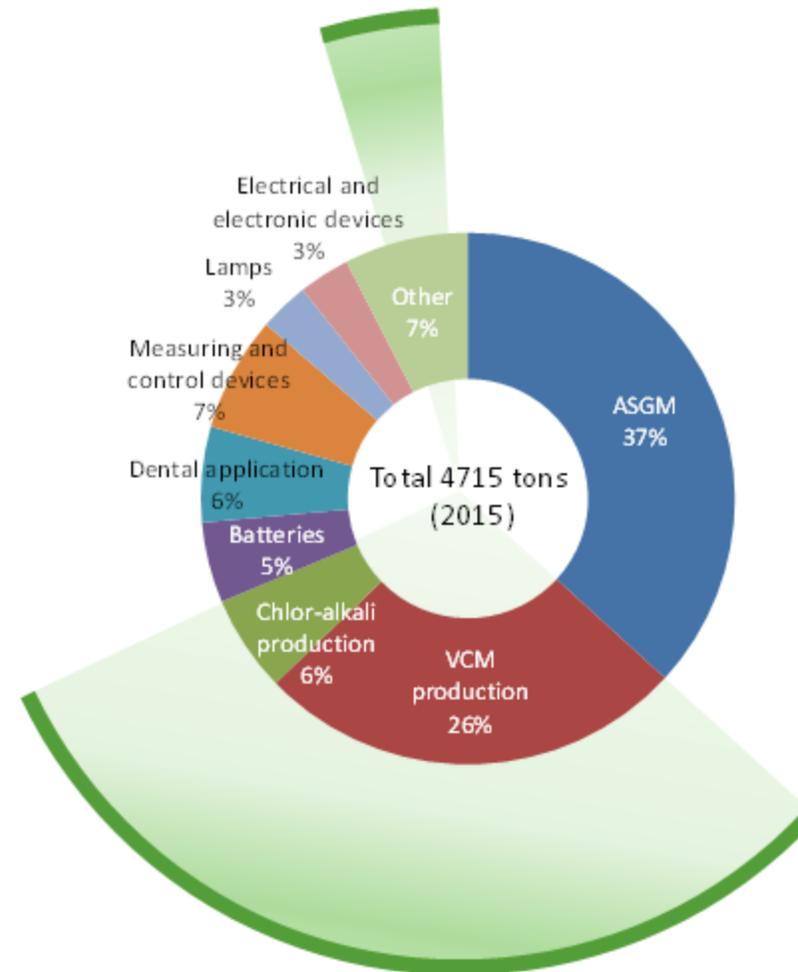
VCM is the largest mercury-using process

2

Acetaldehyde production has moved to the mercury-free process

3

Most of them are controlled under the Minamata Convention



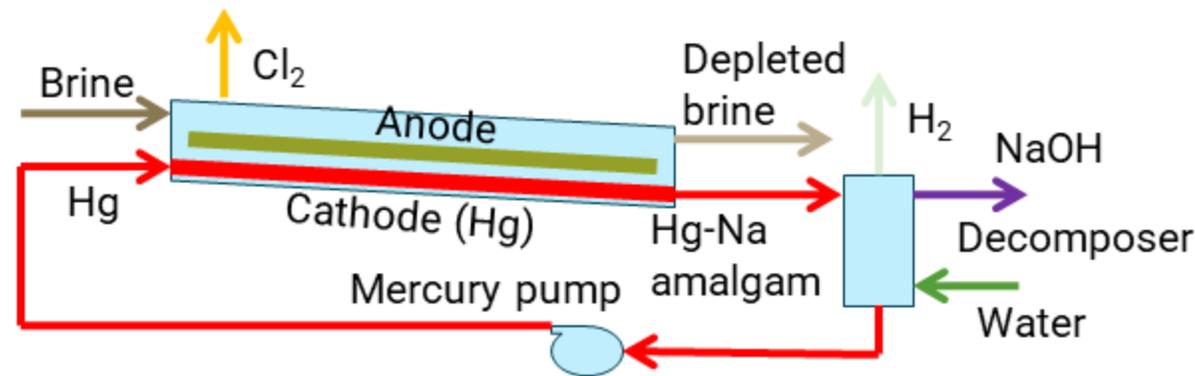
Source: UNEP (2017). Global Mercury supply, trade and demand.

Mercury Source
Categories
Industrial
Processes using
Mercury

Mercury Properties Used for Manufacturing



Manufacturing process	Products	Mercury compound
Mercury compounds work as a catalyst for <u>addition reaction from acetylene</u> ($\text{CH}\equiv\text{CH}$)	<input type="checkbox"/> VCM <input type="checkbox"/> Acetaldehyde, etc.	<input type="checkbox"/> Mercury (II) Chloride <input type="checkbox"/> Mercury (II) Sulphate
Mercury compounds work as latent catalyst to initiate <u>polymerization</u>	<input type="checkbox"/> Polyurethane elastomer	<input type="checkbox"/> Phenylmercury
Metallic mercury works as electrode (cathode) for <u>electrolysis</u> of salts	<input type="checkbox"/> Sodium hydroxide, Sodium methylate, etc.	<input type="checkbox"/> Metallic mercury
Mercury amalgamates gold and <u>gilds</u> surface of metallic object	<input type="checkbox"/> Gold plating, etc.	<input type="checkbox"/> Gold amalgam



MERCURY-ADDED PRODUCTS

Mercury Intentionally Added to Products

1

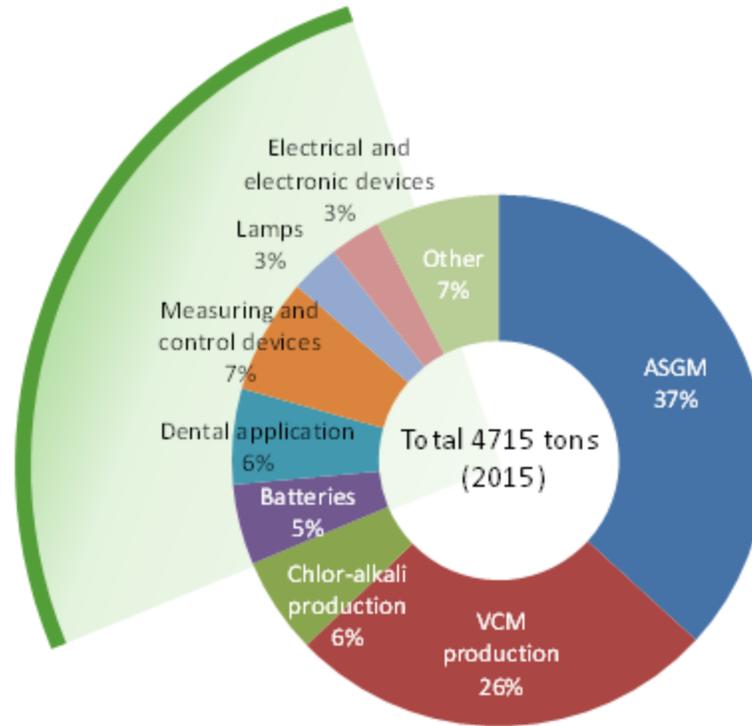
Mercury-added products account for approx. 1/4 of mercury use

2

Major products are controlled under the Minamata Convention

3

Some essential uses are excluded from phase out



Use of Elemental Mercury (1/2)



Type	Theory / principle	Application
Measuring devices	<input type="checkbox"/> High density liquid	<input type="checkbox"/> Manometers, Barometers <input type="checkbox"/> Sphygmomanometers
	<input type="checkbox"/> Liquid in high temperature range <input type="checkbox"/> High thermal conductivity	<input type="checkbox"/> Thermometers, Hygrometers
Discharge tubes	<input type="checkbox"/> Electric valve effect	<input type="checkbox"/> Mercury arc rectifiers
	<input type="checkbox"/> Emitting UV-C (254nm) <input type="checkbox"/> Damaging DNA	<input type="checkbox"/> Neon lamps, Fluorescent lamps <input type="checkbox"/> High pressure discharge lamps <input type="checkbox"/> Low pressure disinfection lamps
Batteries	<input type="checkbox"/> Hydrogen overpotential (prevent H ₂ generation)	<input type="checkbox"/> Button cells
		<input type="checkbox"/> Lithium coin cells (<u>no mercury used</u>)
		<input type="checkbox"/> Dry cells (<u>mercury free alternative</u> widely available)

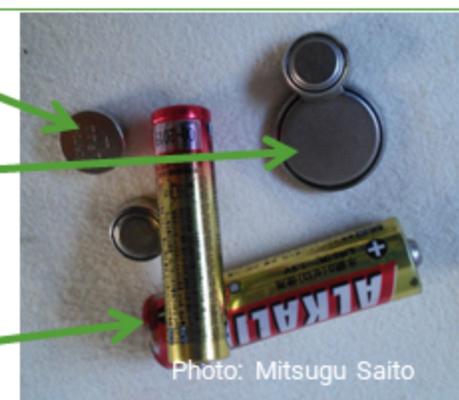


Photo: Mitsugu Saito

Use of Elemental Mercury (2/2)

Type	Theory / principle	Application
Switches and relays	<ul style="list-style-type: none"><input type="checkbox"/> Electrically conductive liquid<input type="checkbox"/> Wetting effect on contact surfaces	<ul style="list-style-type: none"><input type="checkbox"/> Tilt switches/alarms<input type="checkbox"/> Acceleration sensors<input type="checkbox"/> Mercury-wetted relays
Vacuum pumps	<ul style="list-style-type: none"><input type="checkbox"/> High density liquid<input type="checkbox"/> Air induction	<ul style="list-style-type: none"><input type="checkbox"/> Mercury column pumps<input type="checkbox"/> Mercury rotary pumps<input type="checkbox"/> Mercury diffusion pumps
Balancers	<ul style="list-style-type: none"><input type="checkbox"/> High density liquid	<ul style="list-style-type: none"><input type="checkbox"/> Wheel balancers<input type="checkbox"/> Trim and heel controllers (submarine)
Laboratory instruments	<ul style="list-style-type: none"><input type="checkbox"/> High surface tension	<ul style="list-style-type: none"><input type="checkbox"/> Porosimeters



Photo: Carsten Lassen

Use of Amalgam



Type	Theory / principle	Application
Dental fillings	<input type="checkbox"/> Gradually hardening after mixture	<input type="checkbox"/> Dental cavity restoration (silver tin amalgam)  <small>Photo: iStock.com/icefront</small>
Mirror surfaces	<input type="checkbox"/> Gradually hardening after mixture	<input type="checkbox"/> Mirrors (tin amalgam)
Measuring devices	<input type="checkbox"/> Low temperature alloy	<input type="checkbox"/> Thermometers (thallium amalgam, -60 °C)

Use of Mercury Compounds (1/2)



Type	Theory / principle	Application
Mercury sulphide/ cinnabar	<ul style="list-style-type: none"> <input type="checkbox"/> Low solubility and stable chemical form <input type="checkbox"/> Reddish colour 	<ul style="list-style-type: none"> <input type="checkbox"/> Red pigments <input type="checkbox"/> Bodypainting
Mercury (I) chloride / calomel	<ul style="list-style-type: none"> <input type="checkbox"/> Bactericidal & fungicidal actions <input type="checkbox"/> White colour <input type="checkbox"/> Stable electrode potential 	<ul style="list-style-type: none"> <input type="checkbox"/> Pharmaceuticals (syphilis) <input type="checkbox"/> Fungicides (wood preservation) <input type="checkbox"/> White facial powder <input type="checkbox"/> Saturated calomel electrodes
Mercury (II) oxide	<ul style="list-style-type: none"> <input type="checkbox"/> Forming liquid mercury once reduced <input type="checkbox"/> Biocidal action 	<ul style="list-style-type: none"> <input type="checkbox"/> Batteries (cathode for mercury cell) <input type="checkbox"/> Antifouling paint for ship's bottom
Mercury (II) sulphate	<ul style="list-style-type: none"> <input type="checkbox"/> Forming liquid mercury once reduced 	<ul style="list-style-type: none"> <input type="checkbox"/> Weston standard cells (producing highly stable voltage for calibration)



Photo: Mitsugu Saito

Use of Mercury Compounds (2/2)



Mercury Source
Categories

Mercury-added
Products

Type	Theory / principle	Application
Mercury (II) chloride	<ul style="list-style-type: none"> <input type="checkbox"/> Bactericidal & fungicidal actions <input type="checkbox"/> Water solubility 	<ul style="list-style-type: none"> <input type="checkbox"/> Fungicides (wood preservation, seed dressing) <input type="checkbox"/> Preservatives (pulp & paper) <input type="checkbox"/> Standard solution (mercury analysis)
Ammoniated (II) mercury	<ul style="list-style-type: none"> <input type="checkbox"/> Bleaching effects <input type="checkbox"/> Inhibition of bacterial growth 	<ul style="list-style-type: none"> <input type="checkbox"/> Skin whitening cream (bleaching melamine) <input type="checkbox"/> Antiseptic ointment
Phenylmercury	<ul style="list-style-type: none"> <input type="checkbox"/> Bactericidal & fungicidal actions 	<ul style="list-style-type: none"> <input type="checkbox"/> Fungicide (seed dressing against rice blight) <input type="checkbox"/> Preservative (for latex paint, pulp & paper)
Thiomersal	<ul style="list-style-type: none"> <input type="checkbox"/> Bactericidal action 	<ul style="list-style-type: none"> <input type="checkbox"/> Preservative (vaccine and eye area cosmetics)
Merbromin	<ul style="list-style-type: none"> <input type="checkbox"/> Inhibition of bacterial growth <input type="checkbox"/> Water solubility 	<ul style="list-style-type: none"> <input type="checkbox"/> Mercurochrome (topical antiseptic for minor wound)
Mercury (II) fulminate	<ul style="list-style-type: none"> <input type="checkbox"/> Explosive 	<ul style="list-style-type: none"> <input type="checkbox"/> Detonation caps (blasting dynamite, bullet cartridge)

MERCURY WASTE MANAGEMENT

Fate of Mercury from Waste

1

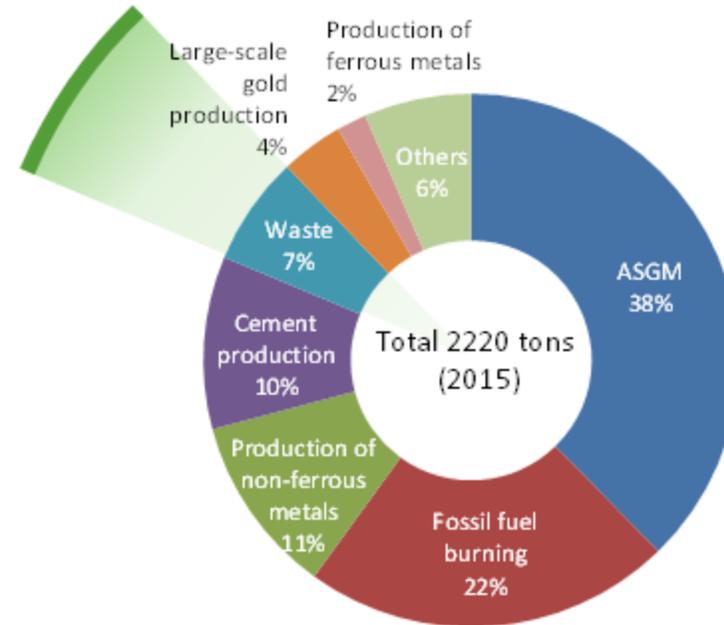
Some mercury is recycled / recovered from waste

2

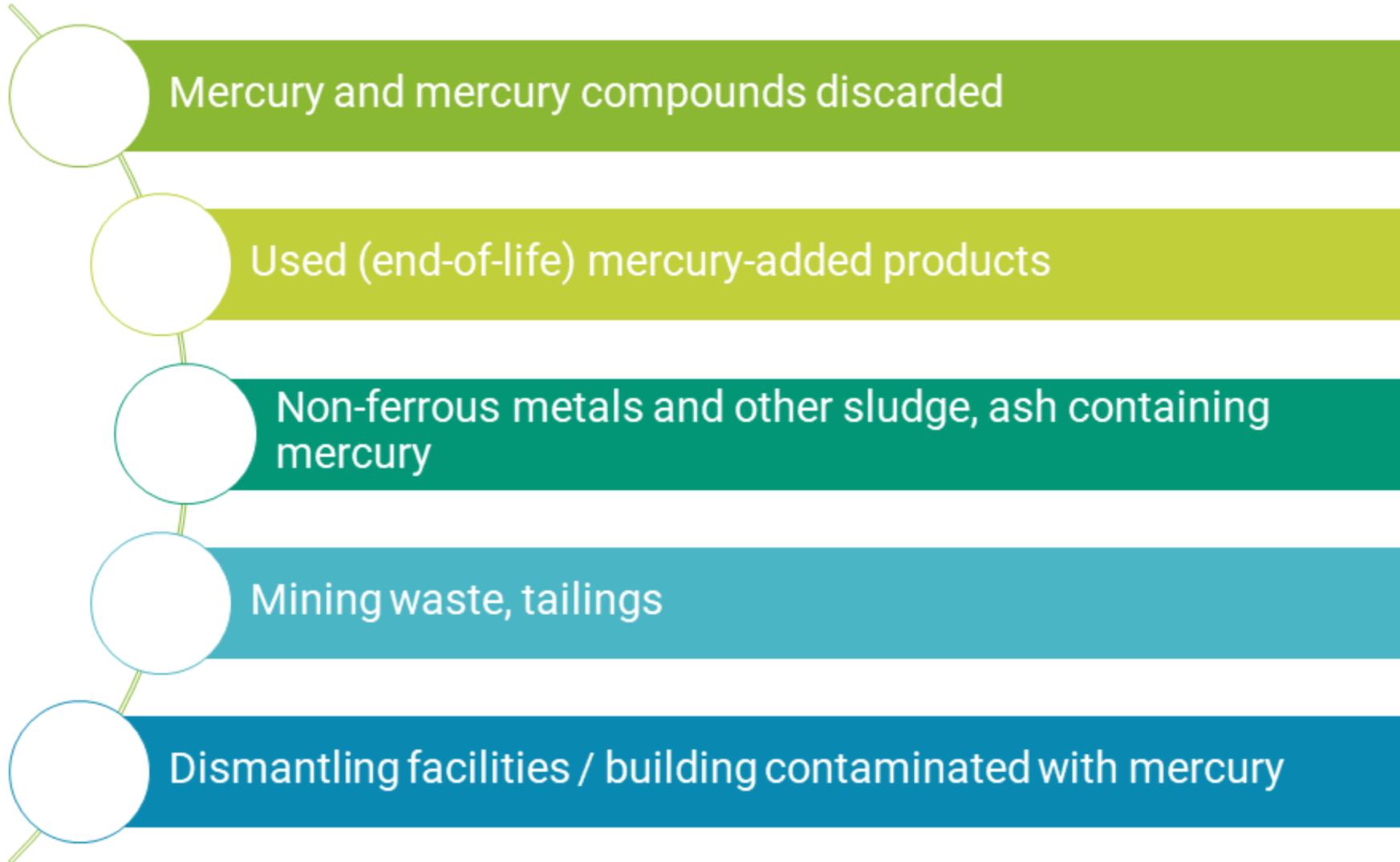
Mercury waste management is significantly different between countries

3

Emission to the atmosphere by both incineration and open burning



Types of Mercury Waste



Recycling Mercury and other Material

Household waste
segregate at the
source

Industrial waste
(hazardous)

Second-hand
components
containing
mercury

Scavenged at
waste stations /
landfill sites



Incineration and Burning of Waste

Controlled incineration vs. uncontrolled waste burning

← Incineration with mercury-specific absorbent

← Incineration with acid control devices

← Incineration with simple PM control devices

← Open burning or incineration without emission control devices



Photo: MOEJ

Landfill and Final Disposal

Landfill, open dumping vs. open waste burning

Stabilization (HgS) and specially controlled landfills

Well controlled landfills

Uncontrolled landfills, informal dumping

Open dumping with spontaneous ignition



MISCELLANEOUS CATEGORIES

Miscellaneous Source Categories

1

Crematoria and cemetery

2

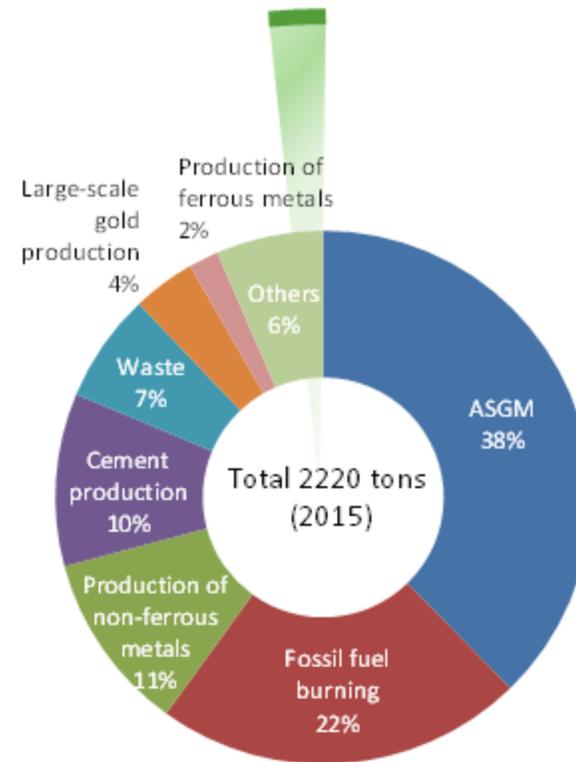
Wastewater treatment

3

Religious and traditional uses

4

Military-related uses that are excluded from international frameworks



Source: UNEP (2019). Global Mercury Assessment 2018.