Workshop to enhance inventories and strategies under Article 8 of the Minamata Convention in South Africa

Eskom Megawatt Park, Sunninghill, Johannesburg

Thursday 31st May 2024

Wojciech Jozewicz, PhD
Background

• iPOG is an interactive application for UNEP’s POG
• Developed for UNEP Coal Partnership by Niksa Associates
• Tool to help determine approaches to Hg emission control and rank them for individual coal-fired units
• Tradeoffs were made to only include basic inputs at the expense of quantitative accuracy
• Allows for addition of flue gas cleaning approaches and systems according to BAT/BEP
  • Improved fuel quality and blending
  • PM, SO₂, and NOₓ control systems for co-benefit
  • Dedicated Hg control technology
• Follows “Decision Tree” logic from the POG
iPOG “Decision Tree” Structure

NO\textsubscript{X} Control

PM Control

SO\textsubscript{2} Control

Hg Control Options
iPOG Calculations Tab - Example

- Final tab to initiate calculations sequence
- In this example: older but well-controlled 500 MW, wall-fired boiler, burning low-S coal, cold-side ESP
- Essentially no Hg removal predicted (<10%)
- Estimated Hg emissions of 24 g/h or up to about 0.2 ton Hg/year
Data Quality Very Important

• Stakeholders should ensure that any missing data are obtained directly from the plant considered for the project rather than by the proxy calculations
• Unit details: generating capacity, commissioning date, planned retirement
• Unit performance: operational load, utilization, gross efficiency, coal consumption, LOI
• Coal quality: calorific value, ash-S-Hg-Cl content
• Emissions controls: PM, FGD, Hg controls
• Quality data in – Quality results out!
Variability Examples

HV

Hg

S

Cl
State-of-the-art Unit

- 800 MW unit with ESP and wet FGD
- Only about 17% Hg removal; emissions 98% of Hg0 and 2% of Hg++
- More mercury removal could be accomplished with more efficient Hg0 oxidation
Strategy for Improvement

- Over 65% removal with addition of 250 ppm of Br to coal
- Some other options
  - Activated carbon injection upstream of the ESP
  - SCR- expensive
Another Strategy

- Addition of 0.02 g/m3 of activated carbon upstream of the baghouse increases Hg removal to 72%
Summary

• Only limited application of FGD throughout the country
• Data quality very important for accurate predictions
• Compliance and improvement strategies for units of varying size and age

• However,
  • Growth projected for power demand
  • Ambitious renewable energy goals
Thank you!
Mercury emission inventory enhancement for the coal sector

PROF LESLEY SLOSS

June 2024
Improving data quality and applicability in the coal sector

- Creating enhanced emission factors
- Improving activity data
- Focussing on the important differences
- Ranking the results
# Emission factors for coal

**EMISSION = EF \times RF \times AV**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Emission Factor, EF</th>
<th>Retention factor, RF</th>
<th>EF x RF</th>
<th>Activity value</th>
<th>Comments</th>
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<tbody>
<tr>
<td>UNEP Toolkit*</td>
<td>Generic – 0.05 g/kg</td>
<td>Generic - minus 10%</td>
<td>0.045 g/kg</td>
<td>Coal burn, t</td>
<td>Assumes all plants and coals are identical. Targets busier units, often unfairly</td>
</tr>
<tr>
<td>2017 UNEP Project</td>
<td>Coal analyses Results averaged across the fleet</td>
<td>iPOGтип model of generic national plant</td>
<td>Convert to g/TJ Applies to all plants and takes average plant efficiency into account</td>
<td>Coal burn, t</td>
<td>EF and RF are now more accurate for the national coal fleet BUT still assumes all plants and coals are identical</td>
</tr>
<tr>
<td>Advanced projects (eg Indonesia)</td>
<td>Coal analysis on a unit-by-unit basis</td>
<td>iPOG analysis on a unit-by-unit basis</td>
<td>Unit-specific emission factor</td>
<td>Unit-specific plant activity</td>
<td>Produces a unit-specific emission estimate</td>
</tr>
</tbody>
</table>

# [https://web.unep.org/globalmercurypartnership/interactive-process-optimization-guidance-ipog%E2%84%A2](https://web.unep.org/globalmercurypartnership/interactive-process-optimization-guidance-ipog%E2%84%A2)
Plant sampling for EF and RF

SAMPLES TAKEN AT PLANTS IN INDONESIA

- Sampling of coal as delivered and as fed into the boiler
- Coal samples from numerous mines were analysed and results collated
- Monitoring and mass balances are challenging but are still more useful than generic emission factors
Emission factor in g/GJ vs g/kg

A SLIGHT MODIFICATION TO THE EF UNITS CAN INCREASE VALUE

<table>
<thead>
<tr>
<th>EF in g/kg</th>
<th>EF in g/GJ</th>
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<tbody>
<tr>
<td>Average mercury contents in coal give an EF of around 0.05 g/kg but mercury contents of coal can vary significantly, even from seam to seam. When we multiply the EF by the amount of coal burned, we get a total emission based on coal consumption. BUT This assumes that all coals have the same mercury content AND that all coal burns the same.</td>
<td>If we know the amount of energy (gigajoules) of energy produced by each tonne of coal, then we can estimate mercury emissions by power output – g/GJ. This allows us to determine when plants are either firing poor-quality coal or running inefficiently. This allows us to see which plants are “cleaner” – that is, which plants produce more power whilst burning less coal. This information is not available with a g/kg emission factor.</td>
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</table>
## Creating the dataset

**REAL DATA FROM PLANTS**
**MISSING DATA ESTIMATED THROUGH PROXY CALCULATIONS**

<table>
<thead>
<tr>
<th>Unit/plant details</th>
<th>Unit performance</th>
<th>Emission controls</th>
<th>Fuel quality</th>
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<tbody>
<tr>
<td>Unit and plant name</td>
<td>Operational load</td>
<td>Flue gas desulphurisation</td>
<td>Calorific value</td>
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<tr>
<td>Location</td>
<td>Utilisation/capacity factor</td>
<td>In boiler additives</td>
<td>Mercury content</td>
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<tr>
<td>Generating capacity</td>
<td>Specific energy consumption</td>
<td>NOx burners or SCR</td>
<td>Sulphur content</td>
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<tr>
<td>Certified operating and commissioning date</td>
<td>Annual coal consumption</td>
<td>PM controls</td>
<td>Chlorine content</td>
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</table>
Using the iPOG

INTERACTIVE PROCESS OPTIMISATION GUIDANCE TOOL

• Input unit-specific data
• RF estimated from plant configuration, coal chemistry and control technologies in place
• Results based on extrapolation and modelling of data from thousands of real data sets
• Used to focus on RELATIVE emission rates, not “actual”
• Image

Demonstration to follow
### Creation of the dataset

**LIVING DOCUMENT TO BE UPDATED REGULARLY**

**PROVENANCE OF DATA TO BE RECORDED**

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**SO2x control (WEPP)**

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**Annual Hg Emission, kg**

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**Annual Hg Emission, g/MWH**

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</table>
Thank you

LESLEY.SLOSS@MQ.EDU.AU

www.mq.edu.au
Using enhanced data to rank sources and create a cost-effective targeting strategy

PROF LESLEY SLOSS

June 2024
Informed ranking of data

Selecting appropriate ranking criteria

Examples of ranking results

Informing a strategic approach to emission reduction
Changing the input

MOVING FROM ASSUMPTIONS TO REAL DATA

All plants are assumed equal

<table>
<thead>
<tr>
<th>Plant</th>
<th>Emissions, g</th>
<th>EF, g/kg</th>
<th>RF, %</th>
<th>AV, t</th>
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Plant B has higher mercury coal

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Plant C has higher ash retention

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<td>90</td>
<td>1</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>180</td>
<td>2</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>1</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

The total coal burned is the same in all assumptions

All plants are NOT the same
## Emission factor in g/GJ vs g/kg

### A slight modification to the EF units can increase value

<table>
<thead>
<tr>
<th>EF in g/kg</th>
<th>EF in g/GJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average mercury contents in coal give an EF of around 0.05 g/kg but mercury contents of coal can vary significantly, even from seam to seam.</td>
<td>If we know the amount of energy (gigajoules) of energy produced by each tonne of coal, then we can estimate mercury emissions by power output – g/GJ</td>
</tr>
<tr>
<td>When we multiply the EF by the amount of coal burned, we get a total emission based on coal consumption.</td>
<td>This allows us to determine when plants are either firing poor-quality coal or running inefficiently.</td>
</tr>
<tr>
<td>BUT This assumes that all coals have the same mercury content AND that all coal burns the same.</td>
<td>This allows us to see which plants are “cleaner” – that is, which plants produce more power whilst burning less coal. This information is not available with a g/kg emission factor.</td>
</tr>
</tbody>
</table>
Fleet emission intensity

Changing the emission factor from g/kg to g/GJ

Amount of Hg (g) emitted per GWh of electricity produced – indication of “cleaner” burning plants.

No indication of size-related intensity of Hg emissions for units >100 MW
SOME UNITS EMIT AN ORDER OF MAGNITUDE MORE MERCURY PER GWh OF POWER PRODUCED THAN OTHERS
Predicted annual emissions from Indonesian coal plants
Bringing in plant lifetime

IMMEDIATELY BRINGS IN COST-EFFECTIVENESS

<table>
<thead>
<tr>
<th>Current method</th>
<th>Add in capacity factor/remaining lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifies plants which emitted the most mercury in the last operating year</td>
<td>Removes older plants which will slow down or close soon.</td>
</tr>
<tr>
<td>BUT assumes all plants are the same age</td>
<td>Allows focus for intervention on plants where control technologies may be effective in the long-term</td>
</tr>
</tbody>
</table>
Units which will emit >1t Hg over their remaining lifetime (Indonesia)

ASSUMING PLANTS RUN UNTIL THEY ARE 40 YEARS OLD
The top 10 units in Indonesia (out of 111 units) emit around 50% of the total emissions from the entire fleet.
Mercury emissions over remaining fleet lifetime

- Over 110 units analysed
- The top 10 units emit around 50% of the total emissions from the entire fleet

This provides valid science for an informed and strategic emission reduction strategy
### Simple method to rank data

#### TOP 10 UNITS >15 years old

<table>
<thead>
<tr>
<th>UNIT NAME</th>
<th>CAPACITY (MW)</th>
<th>Remaining life of 2020 (40yr life)</th>
<th>Operational load</th>
<th>Fuel Consumption (calculated)</th>
<th>Gross unit efficiency</th>
<th>SOx control (WEPP)</th>
<th>Coal Hg content</th>
<th>Coal S content</th>
<th>Coal Cl content</th>
<th>Annual Hg Emission, coal input, kg</th>
<th>Hg Emission Intensity, g/MWh</th>
<th>Annual Hg Emission improvements, kg</th>
<th>Remaining Plant Life Hg Emission</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL SE</td>
<td>4.0</td>
<td>2.0</td>
<td>5.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
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<td>5</td>
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<td>4.0</td>
<td>5</td>
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<td>53.0</td>
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<tr>
<td>PL SE</td>
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<td>5</td>
<td>4.0</td>
<td>5</td>
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<td>53.0</td>
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<tr>
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<td>5</td>
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<tr>
<td>PL TE</td>
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<td>4.0</td>
<td>5.0</td>
<td>1.0</td>
<td>5.0</td>
<td>5.0</td>
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<td>5.0</td>
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<td>46.0</td>
</tr>
<tr>
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<td>5.0</td>
<td>5.0</td>
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<td>3</td>
<td>5.0</td>
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<td>2</td>
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</tr>
<tr>
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<td>4.0</td>
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<td>4</td>
<td>2.0</td>
<td>4</td>
<td>4</td>
<td>45.0</td>
</tr>
</tbody>
</table>
Creating a reduction strategy for coal

BAT/BEP options

Maximising co-benefit
### Two major forms of mercury

THE CHEMISTRY IS AFFECTED BY COAL TYPE, ASH CONTENT, CHLORINE CONTENT ETC – IT IS COMPLEX!

<table>
<thead>
<tr>
<th>Oxidised mercury</th>
<th>Elemental mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Soluble and sticky</td>
<td>• Not soluble and not sticky</td>
</tr>
<tr>
<td>• Easy to capture in solutions, ash or sorbents</td>
<td>• Hard to capture</td>
</tr>
<tr>
<td>( \text{Hg}^2+ )</td>
<td>• Can be oxidised by chemicals such as chlorine and bromine</td>
</tr>
<tr>
<td>( \text{Hg}_0 )</td>
<td></td>
</tr>
</tbody>
</table>
Mercury flow through a coal plant

Hg speciation changes from pure Hg⁰ vapour at the furnace exit to changing mixtures of Hg⁰, Hg²⁺ and Hg-P as the flue gas moves through the APCDs depending on the levels of Cl, Br and unburnt carbon, whether a SCR is present and many other cleaning conditions.

- all coal-Hg leaves as Hg⁰ vapour
- Hg-P begins to form before the flue gas leaves the air preheater
- all coal-Hg leaves as Hg⁰ vapour
- all Hg-P is collected with fly ash
- stack emissions are mostly Hg⁰
- most Hg²⁺ is retained in the scrubber solution/solids
“Co-benefit effects”

MAXIMISING “FREE” MERCURY CONTROL

If you can control mercury, you can also control acid gases and particulates

and

if you control acid gases and particulates, you also control mercury
Flow chart for technology selection

INCLUDED IN THE UNEP BAT/BEP GUIDANCE FOR COAL
Coal cleaning* and blending

*CHEMICAL COAL CLEANING HAS YET TO PROVE COST-EFFECTIVE FOR MERCURY CONTROL

Selecting coal type
- US sub-bituminous coals tend to contain less chlorine and can be high in calcium
- Many US plants firing sub-bituminous coals found mercury reduction a challenge as most mercury is produced in the elemental form
- Oxidation with halogen addition was proven to work, but so was coal-blending

Blending
- Coal plants blend coals to maintain the characteristics required for efficient combustion
  - Low-quality coals can be mixed with higher-quality coals to keep costs down
  - Low sulphur coals can be mixed with high sulphur coals to keep emissions down
  - Coal blending for emission control of anything other than sulphur is not a common strategy but theoretically it is possible

Strategic blending
- Study in a US plant firing sub-bituminous coal – mercury emissions remained high, even though the plant was fitted with a flue gas desulphurisation system
  - Blending with bituminous coal helped to oxidise the mercury
  - By blending in 15% bituminous coal in with the sub-bituminous coal, mercury emissions could be reduced by up to 80%
Co-firing biomass

- Most vegetation for co-firing will be low in mercury content. Reducing the mercury input in the total fuel will reduce the mercury input to the plant and thus reduce overall emissions.
- The chlorine and ash contents of biomass can be higher than coal. This can help mercury oxidation and capture.

Figure 15 Variation of mercury emission during co-firing of subbituminous coal and biomass (Cao and others, 2008)
Particulate controls and mercury

Particulate control systems can reduce PM emissions by >99.99%

Particulate control systems can capture mercury – oxidised mercury will stick to unburnt fly ash (sorbents can be added)

Mercury capture in ESP is generally lower (10-30%) than in fabric filters/baghouses (40-70%)

Emission values must be established for each site, due to potential variations in coal chemistry
NOx controls and mercury

VARIATES WITH COAL AND PLANT TYPE

NOx burners do not have a significant effect on mercury emissions.

Selective catalytic reduction technologies fitted upstream of particulate controls can oxidise mercury and lead to increased mercury capture in the ash.

BUT: Mercury can contaminate and shorten the life of catalysts.

Sulphur controls and mercury

VARIES WITH COAL AND PLANT TYPE

IF mercury is in the oxidised form, it will be trapped in most FGD systems:

• Wet FGD systems will dissolve oxidised mercury

• Dry FGD systems will capture oxidised mercury in the dry sorbent

• Seawater FGD systems will dissolve oxidised mercury but may release it into the local water body

Mercury capture in any FGD system can be enhanced by converting elemental mercury to oxidised mercury by adding an oxidant such as bromine
Many mercury-specific control systems have been developed and some are commercialised.

Most plants see these systems as a “last-resort” to reducing emissions due to the cost.
This is a simple flow diagram which allows the user to work through the BAT/BEP (best available technology/best environmental practice) to choose an option which will work best with different plant configurations.
Using the iPOG as a predictor

THE IPOG CAN HELP DETERMINE THE APPROACHES MOST LIKELY TO SUCCEED
Conclusions

Information and data = power

• The Minamata convention only requires a total sectoral inventory. However, an enhanced inventory could inform a significantly more cost-effective reduction strategy.

• Creating an enhanced inventory takes time but, once established can simply be updated annually to monitor trends in emissions.

• Use a ranking approach, considering plant-specific factors including remaining operating lifetime, to determine where action will achieve the greatest results.

• It is possible and even likely that acting on a few plants could achieve faster and more cost-effective emission reduction than a blanket requirement for action across all plants.
Thank you

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MERCURY FROM THE NON-FERROUS SECTOR

Peter Nelson

School of Natural Sciences
Macquarie University
Sydney, Australia

Co-lead UN Environment Mercury in Coal Combustion Partnership

Image: https://www.mining.com/wp-content/themes/miningdotcom/images/favicon/apple-icon-57x57.png
Non Ferrous Metals in Article 8 Minamata Convention

• Smelting and Roasting only
• Metals:
  – Copper
  – Lead
  – Zinc
  – Industrial Gold
Non Ferrous Metals – Strong Growth
Emission Estimation
Tools for Inventory Development

Inventory Level 2 (IL2)
- a detailed mercury inventory tool
- all factors adjustable to national or local conditions.
- default estimation factors are pre-entered
- requires more reading and experience
- high level of accuracy, provided that the data needed for this are available
Other resources – Study Report on Non Ferrous Metals

Identified uncertainties and knowledge gaps

• Hg content in ores and concentrates, at plant and country level
• Hg air emissions test data
• Hg concentrations in reject material
• Hg distributions between emissions and other releases
• Activity data (amounts of ores and concentrates processed)
• Effects of pollution control technologies, incl. on distribution of Hg between emissions to air, and capture in solid and liquid waste
• Additional quantitative information on how mercury deports to emissions and releases to air, land, water, waste and by-products

DATA REQUIRED FOR BETTER EMISSION ESTIMATES
Mercury variability in ores

Number of mines and the reported Hg concentrations in
a) Cu concentrates
b) Pb concentrates
c) Zn concentrates
Improving emissions estimations

- Improved data (mercury in ore and concentrates, activity data, control technologies and their effectiveness, ...)
- Individual plant data (but a large task; 70 gold mines are in South Africa, according to GlobalData’s mines database)
- Harmony Gold Mining, Anglo Gold Ashanti, and Gold Fields made up about 50% production in 2021
Better understanding of ore characteristics

Gold is typically recovered from ores containing only traces of the metal - main challenge is concentrating

• Techniques:
  – Cyanide leaching; gold must be available for leaching
  – Mercury amalgamation – largely now only used in ASGM
  – Refractory ores – hard to leach ultra-fine mercury; requires pre-treatment (roasting, oxidation, ... )
Reducing mercury emissions
BAT/BEP
Reduction of Hg emissions

- Boliden-Norzink process
  - \( \text{Hg} + \text{HgCl}_2 \rightarrow \text{Hg}_2\text{Cl}_2 \) (calomel)
- Selenium filter
  - \( \text{Se} + \text{Hg} \rightarrow \text{SeHg} \)
- Activated carbon
- Co-benefits of air pollution abatement technologies
  - Particulate matter, \( \text{SO}_2 \), \( \text{NO}_x \)
Case Study: Nevada Gold Plant

- Controls employed:
  - Cyclone separation
  - Gas Quench
  - Venturi gas scrubbing
  - Gas condenser
  - Wet electrostatic precipitator (ESP)
  - Calomel scrubber
<table>
<thead>
<tr>
<th>Mercury Removal Technology</th>
<th>Process Conditions</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Filter beds</td>
<td>Efficiency = 99%</td>
<td>• Effectively removes mercury chloride</td>
<td>• Untreated carbon ineffective in removing elemental mercury</td>
</tr>
<tr>
<td>Fixed activated carbon filter beds</td>
<td>Efficiency = 90%</td>
<td>• Sulfur-impregnated activated carbon is commercially available</td>
<td>• Spent carbon requires disposal in landfill</td>
</tr>
<tr>
<td>Activated carbon injection</td>
<td>Efficiency = 90-95%</td>
<td>• Sulfur-impregnated activated carbon is commercially available</td>
<td>• Spent carbon requires disposal in landfill</td>
</tr>
<tr>
<td>Lime/limestone scrubbing</td>
<td>Efficiency = 10-84%</td>
<td>• Effective for water soluble species</td>
<td>• Ineffective for elemental mercury</td>
</tr>
<tr>
<td>Selenium filters</td>
<td>Efficiency = 99.6%</td>
<td>• Successful installation at metallurgical plants</td>
<td>• Limited inlet mercury concentration</td>
</tr>
<tr>
<td>Boliden-Norzink process</td>
<td>Efficiency = 99% Max Hg$<em>{IN}$ = 5-80 mg/m$^3$ Max Hg$</em>{OUT}$ = 20-50 μg/m$^3$</td>
<td>• Widely demonstrated Mercury removed as marketable product</td>
<td>• Removes only elemental mercury</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Complicated flowsheet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Chlorine gas handling</td>
</tr>
</tbody>
</table>
Introduction: Minamata Convention on Mercury, Article 8, emissions inventories

Workshop to enhance inventories and strategies under Article 8 of the Minamata Convention in South Africa, 31 May 2024

Alexander Romanov, UNEP-GEF Chemicals and Waste (alexander.romanov@un.org) on behalf of the Secretariat of the Minamata Convention on Mercury
Minamata Convention of Mercury

- **Objective:** to **protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.**
- **Adopted in October 2013,** entered into force in August 2017.
- **Mercury** is a chemical of global concern owing to its:
  - Long-range atmospheric transport,
  - Persistence in the environment once anthropogenically introduced,
  - Ability to bioaccumulate in ecosystems, and
  - Significant negative effects and human health and the environment.
- **Recognizes the lessons** of Minamata Disease, in particular the serious health and environmental effects from mercury pollution.

See [Minamata Convention at a Glance](https://www.minamataconvention.org)
GMA 2018 - Update on global Hg pools and cycles
Parties to the Minamata Convention

► 148 parties as of May 2024

For most recent list of parties, see UN Treaties Section website
Control measures and support measures

Control Measures

- Reduce the use and presence of mercury in the economy, industry and society
  - Art. 3.5 (a): Stocks
  - Art. 3.5 (b): Excess mercury from decommissioned chlor-alkali facilities
  - Art. 3.6 – 3.10: Trade of mercury
  - Art. 4: Mercury-added Products
  - Art. 5: Manufacturing Processes
  - Art. 7: ASGM
  - Art. 10: Interim Storage
  - Art. 11: Mercury wastes
  - Art. 12: Contaminated sites

Reduce mercury to the environment

- Art. 7: ASGM
- Art. 8: Emissions
- Art. 9: Releases

Enabling / Supportive Context

- Art. 13: Financial Resources and Mechanism
- Art. 14: Capacity-building, technical assistance and technical transfer
- Art. 15: Implementation and Compliance Committee
- Art. 16: Health aspects
- Art. 17: Information Exchange
- Art. 18: Public information, awareness and education
- Art. 19: Research, development and monitoring
- Art. 20: Implementation plans
- Art. 21: Reporting
- Art. 22: Effectiveness evaluation
- Art. 23: Conference of the Parties
- Art. 24: Secretariat
- Arts. 25-35: Various procedural articles
Major obligations of the parties to the Minamata Convention

- Article 3: Not allow new mercury mines and close old ones in 15 years
- Article 3: Only export mercury with written consent of importing countries
- Article 4: Phase out listed mercury-added products by 2020 (2025 for newly-added product categories).
- Article 4: Take measures to phase down dental amalgam
- Article 5: Phase out listed mercury-using processes by 2018 or 2025, and take measures to restrict other listed processes
- Article 7: Develop and implement national action plans on artisanal and small-scale gold mining in 3 years
- Article 8: Take measures on new emission sources in 5 years and existing sources in 10 years. Establish emission inventory in 5 years
- Article 9: Identify relevant sources and take measures. Establish release inventory in 5 years
- Article 10: Take measures on interim storage
- Article 11: Manage mercury waste in an environmentally sound manner
- Article 12: Endeavour to develop strategies
- Article 21: Report on the implementation of the Convention

See Overview of Key Operational Articles
The predominant source sector is artisanal and small-scale gold mining (about 38%).

It is followed by stationary combustion of coal (about 21%), non-ferrous metal production (about 15%) and cement production (about 11%).
Article 8 of the Minamata Convention

► Controls the emissions of total mercury to air from the following sources listed in Annex D:
  • Coal-fired power plants
  • Coal-fired industrial boilers
  • Smelting and roasting processes used in the production of non-ferrous metals (lead, zinc, copper and industrial gold)
  • Waste incineration facilities
  • Cement clinker production facilities.

► Parties with relevant sources shall take measures to control emissions and may prepare a national plan, which is to be submitted within 4 years after the entry into force if prepared.

► For new sources, each Party shall require the use of BAT/BEP to control and reduce emissions, as soon as practicable but no later than 5 years after the date of entry into force.

► For existing sources, each Party shall include in any national plan, and shall implement, one or more of the following measures, as soon as practicable but no more than 10 years after the date of entry into force:
  • A quantified goal
  • Emission limit values
  • The use of BAT/BEP
  • A multi-pollutant control strategy that would deliver co-benefits
  • Alternative measures to reduce emissions from relevant sources

► Each Party shall establish, as soon as practicable and no later than 5 years after the date of entry into force of the Convention for it, and maintain thereafter, an inventory of emissions from relevant sources.
Guidance under Article 8 of the Minamata Convention

► Decision MC-1/4
  • Adopted the guidance on BAT/BEP and on support for parties in implementing the measures
  • Recognized that some of the measures described in the guidance may not be available to all parties for technical or economic reasons,
  • Requested parties with experience in using such guidance to provide the secretariat with information on that experience, and the secretariat to compile such information and to update the guidance as necessary.

► Decision MC-1/16
  • Adopted the guidance on criteria that parties may develop to identify emission sources, and on the methodology for emission inventories.
UNEP’s Toolkit for identification and quantification of mercury releases

► UNEP’s *Toolkit for identification and quantification of mercury releases* – aka UNEP Mercury Toolkit – is intended to assist countries to identify and quantify the sources of mercury emissions and releases, set priorities and reduction targets, enhance international co-operation, knowledge sharing, and enable targeted technical assistance.

► Inventories from countries contribute to the Global Mercury Assessment, the hub of the scientific knowledge of worldwide mercury emissions and releases.

► The Toolkit provides clear guidance on different stages of inventory development: identifying mercury sources, quantifying the consumption and calculating the final emissions and releases.

► The Toolkit includes detailed manual, calculation spreadsheet and a standard template for reporting.

► The Toolkit is one of the methods recommended in guidance from the Minamata Convention on preparing inventories of emissions pursuant to Article 8.
UNEP’s Toolkit for identification and quantification of mercury releases

Inventory Level 1 (IL1) – simplified model based on default factors, requires national sectoral activity rate data; useful for first-time inventories, yet less accuracy of emission/release estimates should be expected

Inventory Level 2 (IL2) – detailed mercury inventory tool, all emission/release factors can be adjusted to national/local conditions (default factors are included), requires detailed national sectoral data to fully reflect mercury cycles

Inventory Level 3 (IL3) - integrates all mercury sources into their entire mass flow through and out of society to the environment linking different mercury sources and provides increased accuracy in estimations; most data- and expertise-intensive

+ Excel calculations sheets for Level 1, Level 2, and Level 3 inventories

Source: https://www.unep.org/topics/chemicals-and-pollution-action/pollution-and-health/heavy-metals/mercury/mercury-inventory
UNEP's Toolkit for identification and quantification of mercury releases

Minamata Initial Assessment Report for Zambia (2017)

Minamata Initial Assessment Report for South Africa (2021)


https://minamataconvention.org/sites/default/files/documents/minamata_initial_assessment/South_Africa-MIA-2021-EN.pdf
UNEP’s Toolkit for identification and quantification of mercury releases

MercuryLearn Training

- In response to the increasing interest of countries to develop mercury emissions inventories and the subsequent high demand of guidance and training on this topic, UNEP and UNITAR decided to collaborate on developing an online training platform: MercuryLearn. The main component is the UNEP Toolkit for Identification and Quantification of Mercury Releases.
- This initiative has been funded by the European Commission and the government of Switzerland.

► https://mercurylearn.unitar.org/

► Online training modules on the UNEP’s Toolkit for identification and quantification of mercury releases
  Inventory Level 1 and 2

► Self-paced, available in English and Spanish
Minamata Convention Initial Assessments

- GEF enabling activities include the development of Minamata Convention Initial Assessments (MIA), which support countries to prepare to implement the obligations of the Minamata Convention as soon as possible.
- MIA may include:
  - National Mercury Profile, including identification of significant sources of emissions and releases
  - Overview of structures, institutions, and legislation already available to implement the Convention;
  - Challenges to implementation, including identification of legal and/or regulatory gaps to be addressed prior to ratification
  - Capacity building, technical assistance as well as other needs required for the implementation of the Convention.
- MIA reports are available on website.
Minamata (training) Tools

Developed with the generous support of the European Union as part of project "Support to the capacity-building and technical assistance programme of the Secretariat of the Minamata Convention on Mercury"
Register today!

SCAN ME

Minamata Convention on Mercury
Learning Path for National Focal Points
Self-paced

https://www.unssc.org/courses/minamata-tools-0
Minamata Online series of virtual webinars on various topics related to the Minamata Convention on mercury since 2020

https://minamataconvention.org/en/meetings/upcoming-list-view?field_event_type_target_id=287
Thank you for your attention

Secretariat of the Minamata Convention on Mercury
United Nations Environment Programme
11-13, Chemin des Anémones - 1219 Châtelaine, Switzerland

WEB: https://minamataconvention.org/
MAIL: MEA-MinamataSecretariat@un.org
TWITTER: @minamataMEA
#MakeMercuryHistory
Using Inventory Data and Planned Policies to Inform Future Emission Scenarios in South Africa

EDWARD ARCHER

One-day working event on inventory production and compliance strategies for the South African Coal fleet under the Minamata Convention
30 May 2024
OUTCOME 1: Comprehensive coal sectoral analysis

Activities

• Review scientific data on mercury emissions from CFPPs

• Evaluate the impact of commitments and targets by UN Conventions on Hg/GHG/POP emissions from the coal sector

• Potential mercury reduction figures & scenarios from CFPPs produced
  ➢ Expand to Coal-Fired Industrial Boilers (CFIB)
Global Mercury Assessment 2018

SOUTH AFRICA IN THE GLOBAL CONTEXT

Stationary Combustion of Coal at Power Plants
292 tons/year

GMA 2018_SC-PP-COAL (TONS/YEAR)

- China, 81
- India, 61
- South Africa, 28
- Germany, 11
- Indonesia, 8
- Poland, 7
- Turkey, 7
- Russia, 6
- Kazakhstan, 5
- Other, 59

China, India & South Africa = 47% - 59% global coverage

Stationary Combustion of Coal at Industrial Boilers
126 tons/year

GMA 2018_SC-IND-COAL (TONS/YEAR)

- China, 63
- India, 39
- South Africa, 3
- Vietnam, 2
- United States, 2
- Indonesia, 2
- Thailand, 1
- Pakistan, 1
- Kazakhstan, 1
- Turkey, 1
- Other, 9

China & India = 73% - 83% global coverage
**CFPPs:**

**Coal consumption:**
- 77 million tonnes (washed/unwashed)

**Input factor:**
- 0.13-0.24 mg/kg (bituminous)
- 0.15 mg/kg (washed anthracite)
- 0.105 mg/kg (washed coal)

**Emission to air:**
- 18.096 tonnes / year

Important consideration - The mass balance of mercury in CFPPs (input-retention-emission-release)
Methodology – CFPP emissions

BASELINE DATA FROM THE GLOBAL ENERGY MONITOR


Country- & Unit-level information
• Capacity (MW)
• Start/Planned retirement year
• Combustion technology
• Coal type
• Heat rate (Btu/kWh) - https://www.gem.wiki
• Capacity factor - Global average from International Energy Agency's World Energy Outlook
• Remaining plant lifetime

E.g., Heat Rate (Btu per kWh) – South Africa units

Low – 8,409
High – 12,618
Methodology – CFPP emissions

BASELINE DATA FROM THE GLOBAL ENERGY MONITOR

Assumptions/uncertainties

- Default 40-year plant life expectancy (SA plants operating for >40yrs)
- New project start year (where not indicated) – operational by 2030
- Mercury emissions
  - Defined APCD configurations (Garnham & Langerman, 2016, Clean Coal Journal, Vol 26, No 2)
  - Unit-level capacity factors
  - Unit-level GCV (kJ/kg coal) – average levels per coal type based on Annex 28 of the Stockholm Convention Toolkit

<table>
<thead>
<tr>
<th>GCV (kJ/kg coal)</th>
<th>Av</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bituminous</td>
<td>29300</td>
</tr>
<tr>
<td>Subbituminous</td>
<td>14500</td>
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<tr>
<td>Anthracite</td>
<td>30667</td>
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<tr>
<td>Lignite</td>
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<td>Unknown</td>
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<tr>
<td>Waste coal</td>
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</table>

Stockholm Convention
Annex 28 averages

- Limitations: Additions of mercury-specific controls, Br additions, coal washing, Hg speciation, Cl content, coal blending/co-firing
CFPP capacity outlook
Methodology – Mercury Emissions Estimate
(UNEP toolkit)

\[
\text{Mercury emission (kg/year)} = \text{Coal consumption} \times \text{IF} \times \left(\frac{100 - \text{RF}}{100}\right)
\]

HRV / GCV * CAP * CF * 9.24E03

South African CFPPs = 76,740,000 tonnes / year

<table>
<thead>
<tr>
<th>Country</th>
<th>Mercury input factor by country (mg/kg) - USGS default</th>
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<tbody>
<tr>
<td>China</td>
<td>0.17 Liu et al., 2019</td>
</tr>
<tr>
<td>India</td>
<td>0.22 India country profile</td>
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<td>Indonesia</td>
<td>0.06 BCRC-SEA, 2017</td>
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<tr>
<td>Vietnam</td>
<td>0.28 UNEP, 2017</td>
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<tr>
<td>Philippines</td>
<td>0.08 USGS</td>
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<tr>
<td>Thailand</td>
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<tr>
<td>South Africa</td>
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<td>REMAINING WORLD</td>
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<td>Australia</td>
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<td>United States</td>
<td>0.13 <a href="https://pubs.usgs.gov">https://pubs.usgs.gov</a></td>
</tr>
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Energy Action Plan (2022)

Facilitated by the National Energy Crisis Committee (NECOM)

Actions:

1. **Improve availability of existing supply**
   - Reduce unplanned outages & increased generation from renewables
   - Debt relief package from the National Treasury - investment in necessary maintenance, diesel supplies, OCGT load factor increase & expand transmission networks
   - Eskom Generation Recovery Plan – independent technical review
   - Return Kusile & Medupi units to service
   - Distribution Demand Management Programme – energy savings incentives

2. **Accelerate private investment in generation capacity**
   - E.g., Resource Mobilisation Fund (RMF) – technical support
   - E.g., Energy Council of South Africa – engineering support
   - Electricity Regulation Act, Schedule 2, amendments – remove licensing thresholds for generation facilities
   - Reduced time frame for regulatory approvals by energy projects
   - Invest SA – applications for renewable energy projects for authorizations
   - Eskom-leased land for developers of private energy projects – Phase 1 where transmission infrastructure is already available
   - Power purchasing mechanism from private sector - Standard Offer Programme & Emergency Generation Programme
Facilitated by the National Energy Crisis Committee (NECOM)

Actions:

3. **Fast-tract procurement of new generation capacity from non-fossil fuels**
   - 14 GW of new wind/solar/battery storage procurement
   - Three projects from the Risk Mitigation Programme in construction
   - Power Purchase Agreements for 19 projects & additional new capacity construction – 2,300 MW
   - Import power from neighboring countries, subject to transmission networks

4. **Accelerate investment in rooftop solar (businesses & households)**
   - Special tax incentives for businesses & households installing solar
   - Bounce-back loan scheme for small businesses going solar
   - Progress in rooftop solar installments across the country

5. **Fundamental transformation of electricity sector for long-term energy security**
   - National Transmission Company of South Africa as independent entity for managing the national electricity grid (improved private sector participation)
   - New legislation for a competitive electricity market (i.e., Electricity Regulation Amendment Bill)
CFPP Mercury Emissions

BAU – Business as Usual

AERS – Early Retirement
- Subcritical CFPPs
- 5-yr/10-yr early retirement

CFS (Capacity factor scenario)
- 2024 – 0.53
- 2030 – 0.3
- 2050 – 0.2

RETROFIT scenario

<table>
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<th>RETROFIT scenario criteria</th>
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<td>Remaining lifetime</td>
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<td>Original APCD configuration</td>
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<tr>
<td>New APCD configuration</td>
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Reduction in CFPP emissions reliant on alternative energy developments

Energy Institute – Statistical Review of World Energy

Share of electricity generation from fossil fuels, renewables and nuclear, South Africa

Data source: Ember (2024); Energy Institute - Statistical Review of World Energy (2020)
“The key challenge during the implementation periods of this first NDC (2021 to 2025, and 2026 to 2030) will be the transition in the electricity sector, seeking early investment in and preparing for mitigation in harder-to-mitigate sectors, and addressing the economic and social consequences resulting from this transition in coal-producing areas.”

“... developing labour and social plans as and when ageing coal-fired power plants and associated coal production infrastructure are decommissioned.”

“Over the next decade, the NDC will require a much greater investment programme, as specified in IPR 2019, of between R860 billion and R920 billion (in 2019 Rands; USD60-64 billion). The shift away from coal that IRP 2019 requires, will require support in the form of transition finance, and associated technology and capacity-building.”
# Draft IRP2023

## Horizon 1 (2023 – 2030)

### Table 2: Emerging Plan from Horizon One Analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>Coal</th>
<th>Coal IPP Programme</th>
<th>Gas - Eikon</th>
<th>Dispatchable Capacity</th>
<th>Nuclear</th>
<th>Hydro</th>
<th>Pumped Storage</th>
<th>CSP</th>
<th>Solar PV</th>
<th>Wind</th>
<th>Hotel IPP Programme</th>
<th>Distressed Generation</th>
<th>BESS – IPP Programme</th>
<th>BESS – Eikon</th>
<th>Unserved Energy (TWh)</th>
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- **Installed Capacity**
- **Capacity under construction**
- **Capacity procured**
- **New Capacity**
- **Distributed Generation Capacity for own use**
- **Unserved Energy, preferred as low as possible**
5.2.1. Proposed Interventions

Intervention 1: As already identified and in progress as part of the Energy Action Plan interventions, the improvement of Eskom fleet EAF as per the Generation Recovery Plan is crucial and will make a significant contribution in restoring security of supply.

Intervention 2: In addition to non-dispatchable supply initiatives (business plus the State), the deployment of dispatchable generation options such as gas to power in line with Section 34 Ministerial Determinations must be accelerated as they will address the unserved energy risk and can be adapted to the power system requirements in a relatively short time.

Intervention 3: Where technically and commercially feasible, delay shutting down coal fired power plants to retain dispatchable capacity.

Intervention 4: Support and enable the development of the transmission grid as per the TDP 2023-2032 to enable connection of additional generation capacity initiatives by the public and private sector.

Intervention 5: Manage the following emerging risks:

- Completion of Extension of the design life of Koeberg Power Station
  Completion of the planned life extension of the Koeberg nuclear power station should proceed with the necessary speed to mitigate against the loss of dispatchable 1 800 MW.

- Compliance with Minimum Emissions Standards
  Resolving the challenges around compliance with the implementation of the Minimum Emissions Standards (MES) on coal fired power stations in terms of the National Environmental Management: Air Quality Act 39 (2004) is critical as it will drastically ensure capacity totalling 16 000 MW immediately and up to 30 000 MW in April 2025 is retained.

Horizon 2 (2031 – 2050)

- **Renewable & clean energy beneficial for decarbonising the energy system, not for security & supply**
  - Implement dispatchable technologies with high utilization factors.

- **Large need for new capacity build programmes, including improved transmission networks**
  - Need for technical analysis of power systems & regular adjustments of policies to ensure security of supply.
Project Outcomes

Activities

• Synthesis of results from completed & ongoing CFPP projects

• Selection criteria: Future projects based on highest impact potential
  o Guidance on where to support large scale projects – Training/Capacity-Building

• Assist public and private sectors in their decision-making processes

OUTCOME 2:
STRATEGY FOR THE COAL SECTOR’S EMISSIONS REDUCTION CONTRIBUTION TO STOCKHOLM AND MINAMATA CONVENTIONS
Thank you

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