



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

CIRCULAR ECONOMY and the Emerging Compliance Regimes Division

Department of
Environment





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About this publication

The aim of this publication is to introduce the work of UNIDO's Emerging Compliance Regimes Division (ECR) and ways in which it supports the circular economy. The reduction and elimination of mercury from industrial activities is crucial to achieve a circular economy approach. Removing hazardous chemicals from products and processes will facilitate the replacement, reduction, reuse and recycling of both products and materials, promoting circularity and maximizing environmental and social gains.

This publication is part of a series by UNIDO showcasing ways in which to facilitate the uptake of circular economy practices, as well as views on how to simultaneously improve environmental sustainability and advance economic development in developing and middle income countries.

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1 | Retaining Value in Sustainable Industry

UNIDO's mandate is to promote and accelerate Inclusive and Sustainable Industrial Development (ISID) (SDG 9) in developing countries and economies in transition by contributing to poverty reduction, economic growth, and sustainable development.

UNIDO is fully committed to contributing to the achievement of the Sustainable Development Goals (SDGs), including responsible consumption and production (SDG 12) and climate action (SDG 13), while delivering on its mandate to support Member States in achieving ISID.

The building blocks of a circular economy have existed for decades now and already underpin many of our technical assistance projects, policy advice and innovation initiatives. Circular economy practices, therefore, fully complement UNIDO's mandate and we are dedicated to supporting Member States in introducing such practices into their economies and industrial value chains to help improve resource productivity and minimize waste.

Today's manufacturing takes materials from the materials supply chain and turns them into products. Within current consumption patterns, these products usually have only one lifetime, after which they are discarded. This "take-make-use-discard" model – also known as the linear economy – is enormously inefficient. It not only depletes the planet's limited resources and creates a multitude of waste, pollution and health issues, it also makes a substantial contribution to greenhouse gas (GHG) emissions.

An economy achieving full circularity is an ideal. It enables stakeholders to aim high when setting their vision, priorities and strategies for inculcating circular practices within their industries and societies for a better future.

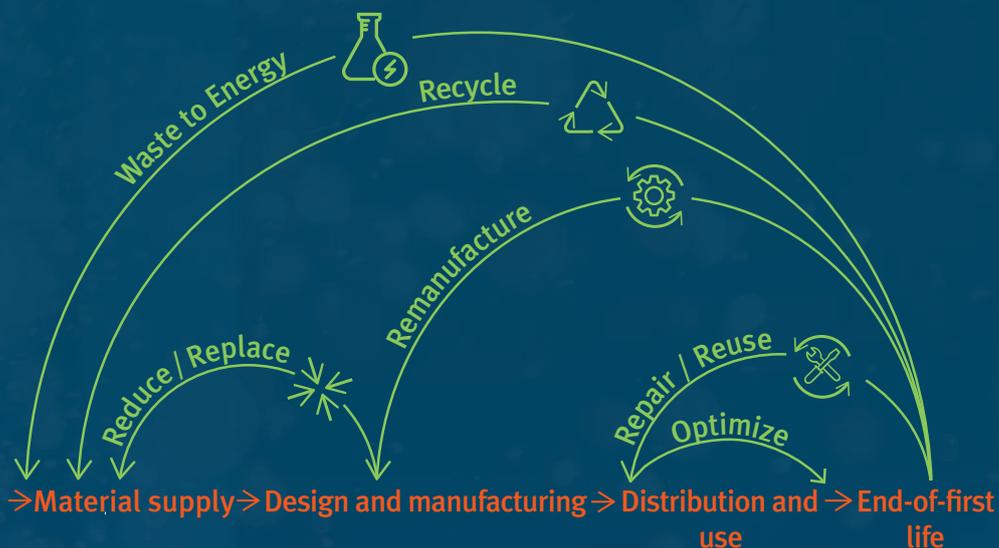
Through circular practices and business models – reduce, replace, regenerate biomass, repair, refurbish, re-manufacture, reuse and recycle, product-as-service, and waste-to-energy – everything gets additional lifetimes, is reused as an input material, part or component, or energy source, or as a last resort, disposed of.

The retained value in products and resources continue to create new business opportunities, income and jobs many times, and not only once as in a linear industrial system, where products usually end up in landfills at the end of their first life with negative impacts on health and the environment.



UNIDO defines circular economy as an industrial economy that routes materials, parts and products back into use several times and creates more value and less waste. It is an alternative in which value is maintained for as long as possible, products are designed to last, and the generation of waste is minimized.

- Linear supply chain
- Circular economy practices



ECONOMIC OUTCOME: increased resource productivity	ENVIRONMENTAL OUTCOME: reduced environmental impact	SOCIAL OUTCOME: improved well-being
Reduced production costs and improved competitiveness	Reduced emissions of greenhouse gases	New jobs and incomes
New business activities and models	Reduced emissions of pollutants and end-of-life waste	Improved health and working conditions
New markets and investment opportunities	Quality of ecosystem services ensured	New partnerships and collaborations
Enhanced consumer loyalty	Natural resources (water, land and materials) preserved	Innovations and technologies that make life easier
Increased long-term availability of supply	Biodiversity safeguarded	

2 | Circular Economy and the Emerging Compliance Regimes Division

Mercury is one of the most toxic substances in the world. The Minamata Convention on Mercury seeks to address the devastating effects of this natural element throughout its life cycle. The UNIDO Emerging Compliance Regimes (ECR) Division supports developing and transition countries to meet their obligations under the Convention by promoting best practices in mercury use and mercury waste management.

Through a combination of capacity building, technology transfer, and waste management efforts, the Division seeks to contribute towards reducing and, where possible, eliminating the release of mercury into the environment in industrial processes – an ongoing challenge for countries across the world. UNIDO stands ready to support countries in their efforts to reach ambitious targets in this area, as in China, where UNIDO is aiming to reduce more than 360 tons of mercury in the Vinyl Chloride Monomer (VCM) sector – one of the biggest global mercury pollutants through the feedstock production for PVC.

In order to achieve mercury use reduction and/or elimination, ECR works with businesses to promote industrial solutions that make sense, in terms of both economic and environmental impact. In parallel, ECR works with governments globally to support them in ensuring that the adequate legal frameworks are in place to protect people and the environment from significant threats, such as mercury.

Marrying positive environmental impact with increasing prosperity, and affecting structural change through policies and legislation that matter, are at the heart of how both the Division, and more broadly, the Organization, makes a difference.

Circular economy underpins ECR's approach in two main ways. Firstly, the Division works to increase the sustainability of the sourcing of materials used to make a wide range of products, from jewelry to PVC. These materials are then the basis for greener products, with a lower environmental footprint.

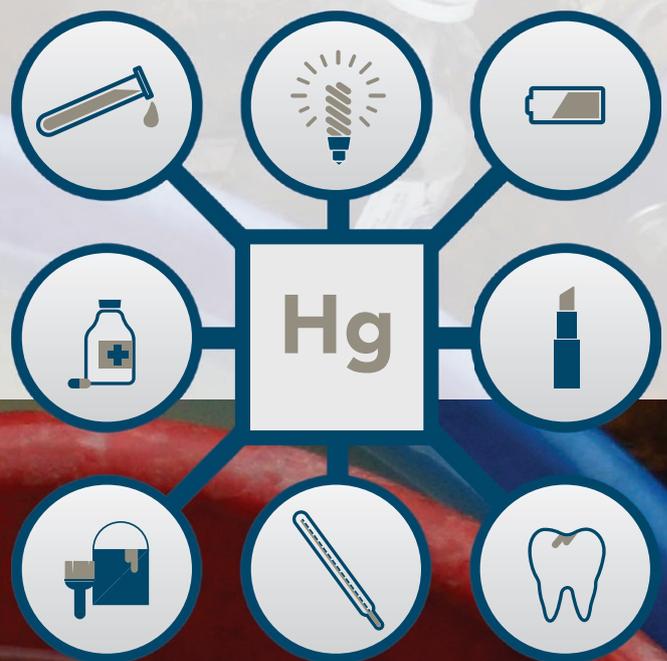
Secondly, where mercury use cannot be avoided completely, as in the case of fluorescent lamps, for example, ECR works with industry to come up with solutions that promote the collection and recycling of mercury.

As governments across the world continue to encourage the adoption of circular economy practices in the name of enhanced resource efficiency and reduced pollution intensity, UNIDO's ECR Division will continue to adopt circular economy approaches in its work globally.

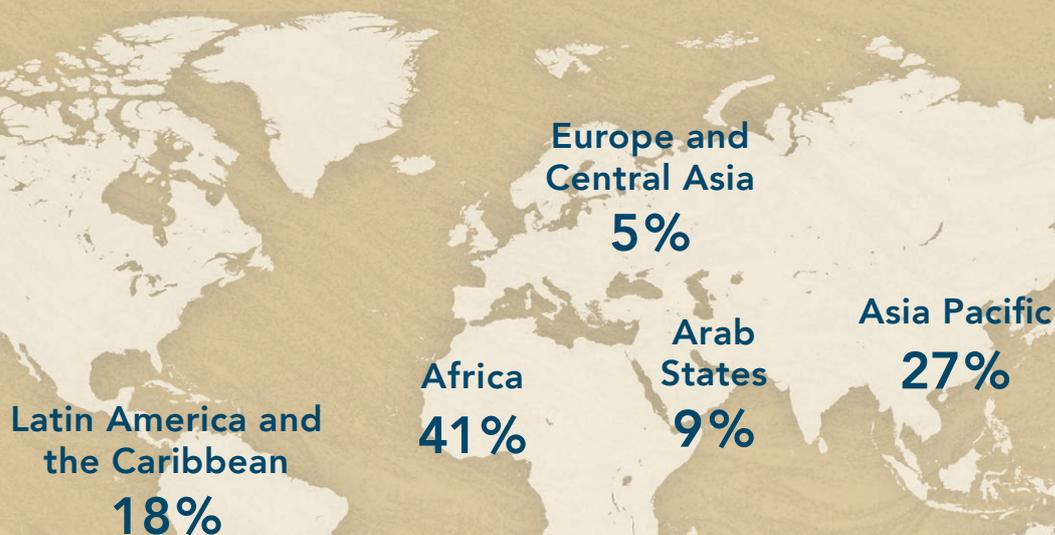
From promoting mercury-free technologies in the artisanal and small-scale gold mining (ASGM) sector, UNIDO will shift its focus to adopt an integrated value chain approach for artisanal gold. Meanwhile, various interventions, including a detailed investigation to define the baseline of mercury emissions in the cement industry in China, will form one starting point for more intensive circular economy work in the construction sector – the fastest-growing sector globally in terms of resource consumption.

Based on the outcome of this study, UNIDO is currently working with international partners to formulate a large-scale programme on mercury emissions reduction in the cement sector, targeting countries among the top 10 global producers of cement. Moreover, UNIDO is planning to extend the investigation on mercury emissions reduction to non-ferrous metals smelters, as well as the iron and steel industry, in selected developing countries.

While there remains some way to go before circular economy practices replace the dominance of unsustainable linear patterns in industry today, UNIDO and its ECR Division remain persistent in facilitating this step change. For us, there is simply very little choice left.



3 | ECR in Action!



45

ECR-projects
in total

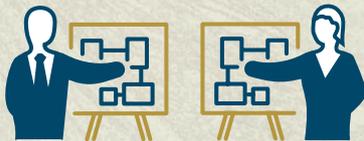
Angola, Argentina, Armenia, Bangladesh,
Benin, Burkina Faso, Cabo Verde, Chad, China,
Colombia, Comoros, Costa Rica, Côte d'Ivoire, Ecuador,
Gabon, Ghana, Guatemala, Guinea, Lebanon, Malawi,
Mali, Mongolia, Mozambique, Nepal, Niger, Nigeria,
Peru, Philippines, Rwanda, Sao Tome and Principe,
Senegal, Sri Lanka, Sudan, Togo, Tunisia, Turkey,
Vietnam, Yemen



AREAS

- Policy and regulatory support
- Artisanal and small-scale gold mining (ASGM)
- Chlor-alkali
- Vinyl chloride monomer (VCM)
- Air emissions from industrial activities
- Mercury waste


22 completed
23 ongoing



100%
 of projects with a
 gender-informed design

4 | From Action to Impact

The services of the UNIDO Emerging Compliance Regimes Division (ECR) work to encourage the adoption of sustainable industrial solutions for pollution reduction and circular economy by designing and implementing a wide range of projects tailored to developing countries and economies in transition. The following case studies provide a snapshot of some of the Division's projects, which form part of a much larger and growing portfolio of circular economy projects, as just one element of UNIDO's broader work on circular economy.

To read more on all our projects in partner countries, PLEASE VISIT:



bit.ly/openUNIDO



Cementing China's mercury reduction

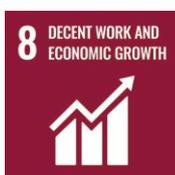
The construction industry continues to drive global materials use as countries across the world develop infrastructure, contributing to rising pollution levels and climate change.

As a key building material, cement production contributes significantly to CO₂ and mercury emissions. Since 2012, China has been responsible for around 60% of the world's annual cement production. UNIDO will adopt a number of circular economy practices to reduce emissions in the country's cement sector through a project running from 2017–2020.

However, reducing mercury emissions per ton of cement produced is just the first step. Focus will also be placed on reducing the amount of cement needed in construction. From the development of new concrete mixtures using less fresh cement and/or recycled material, to the promotion of alternative building materials,

the project will consider a wide range of circular economy practices. Efforts to extend the utility of every ton of cement produced will also be central to ultimately ensuring reduced CO₂ emissions, reduced mining for raw materials, lower transport costs and more.

Furthermore, this project will help to foster a better understanding of the role of mercury and emission levels in cement production, particularly in co-processing cement kiln lines. Enhancing knowledge of how to use waste as alternative fuel and raw materials will also help to promote the circular economy.



FACTS & FIGURES

- 1 international conference on mercury emission reduction technologies
- 5 field visits to investigate emissions from cement kilns
- 2 training courses on management and minimization of mercury
- 1 workshop on the results of the assessments and the risks of mercury
- Mercury inputs monitored in 30 plants in different regions of China
- Mercury mass flow analysed in 5 typical cement kilns
- 1 set of guidelines to enforce the reduction of emissions in the cement sector

UNIDO is applying circular economy practices in the cement industry in China as a starting point for more intensive circular economy work in the construction sector. As the fastest-growing sector globally in terms of resource consumption, this represents a significant opportunity to generate global environmental benefits.

Main Approach

This project investigated major sources of mercury and mercury emission levels in cement plants across China to establish a baseline for the sector. Subsequently, assessments of the feasibility of established best available techniques and best environmental practices (BAT/BEPs) to efficiently and effectively minimize mercury emissions will be conducted. The project will also seek to raise awareness of mercury as a pollutant and methods for

reducing mercury releases in the cement industry. The project is funded by the China IDF and executed by the International Centre for Materials Technology Promotion of China Building Materials Academy (ICM/CBMA).

Results and Impact

This project paves the way for future demonstration and private investment for mercury reduction in the cement industry in China, while strengthening institutional capacities for monitoring mercury releases and contributing to the enforcement of the new emission threshold implemented in China in 2015.



How to mine gold safely – and make a profit

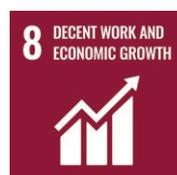
From earrings to electronic devices and reserve currency, gold has been admired for thousands of years, and in an increasingly-connected world its uses continue to evolve.

Against the backdrop of rising demand for communication electronics, the opportunities for circular economy practices that promote the recovery and reuse of gold, wherever possible, are also growing. As more gold is being mined, a consideration of the sources and how to make them sustainable also broadens the scope for producing gold in an environmentally-friendly way. This gold then goes into a vast range of products that are now deemed essential for modern life.

Millions of people across the world rely on artisanal and small-scale gold mining (ASGM) to make a living. In West Africa, growing numbers of families depend on income from this form of mining, which is also responsible

for around a third of the world's total mercury emissions. The emissions from ASGM pose significant health risks, particularly to those working directly in the sector. They also severely contaminate sites and rivers, at times leading to food wastage, in cases where crops irrigated with contaminated downstream water cannot be sold due to their high mercury content.

UNIDO has over 20 years of experience of working in the ASGM sector. Circular economy practices underpinned UNIDO's efforts to reduce the negative health and environmental impacts of ASGM activities in Burkina Faso, Mali and Senegal from 2012 to 2017. Mercury-free technologies, such as those introduced



under the project, recover gold at a higher rate than currently-used mercury amalgamation. Furthermore, the methods introduced promote enhanced resource efficiency, and also allow for a virtuous and toxic-free material flow. Going beyond the phasing out of mercury, the limited water available in the arid and semi-arid region of West Africa can now be recycled in closed loop systems thanks to sedimentation tanks, further supporting the circular economy.

Main Approach

This project introduced mercury-free technologies for gold extraction at sites in Burkina Faso and Senegal and strengthened local and national capacity on environmentally sound mining and better management practices. Awareness-raising activities on the risks of mercury and health-related issues complemented the strategy.

The project was jointly supported by the Global Environment Facility (GEF) and the Fonds Français pour l'Environnement Mondial (FFEM) with the collaboration of the Alliance for Responsible Mining (ARM), the Artisanal Gold Council (AGC) and the governments of the respective countries.

Results and Impact

From training local doctors and nurses, to introducing new gravitation-based technologies, this project brought together capacity building, technology transfer and awareness-raising to reduce mercury use, emissions and exposure, while creating opportunities for sustainable development in the ASGM sector.

Technology that uses gravitation to extract gold without the need for mercury was made available at the project sites. This resulted in a higher gold recovery rate and the improvement of environmental and health conditions. To ensure long-term impact, local miners were trained on the operation and maintenance of the new equipment.

FACTS & FIGURES

- 6 kg of mercury-free gold exported to international markets
- 72 Miners trained on mercury-free technologies
- 50 Miners exposed to the technology (through site visits and technical guide)
- 73 Health professionals/ ASGM leaders trained on health risks related to mercury use
- 5 educational publications
- 4 mines selected to assess potential for Fairmined certification
- 175 miners gained official mining rights
- 35 female miners received technical assistance

Awareness-raising on better practices in mercury handling was targeted at the most vulnerable in the local community – many of whom were previously unaware of the dangers they faced daily when using mercury. Efforts were also successfully made to formalize the mining sites and training on administrative and financial management was provided. Inventories on artisanal gold mining and practical guidelines that will contribute to the development of National Action Plans were another output of the project.

One of the project's key achievements was the development of health curricula for local mining communities. As well as focusing on health specialists nationwide, doctors and nurses were also trained to diagnose and prevent diseases and accidents related to mercury use.



Photos: Robynne Hu/Unsplash

New catalysts to reduce toxic emissions in China

Polyvinyl chloride (PVC), a very resilient plastic, can be found in the floors we walk on, the windows we look through, and the waste water pipes hidden under our feet. PVC production also plays a key role in mercury use.

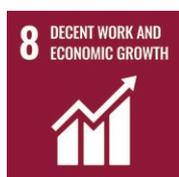
To produce PVC, first Vinyl Chloride Monomers (VCM) are made. In China, VCM are made from the country's vast coal resources, and to do so a mercury-containing catalyst is used. VCM production alone is responsible for 60% of the country's mercury usage, translating to 30 per cent of global mercury use.

UNIDO is adopting circular economy practices to help China meet its goal of reducing mercury use in the VCM sector on an output basis by 50% by 2020. In a GEF-funded project, reduction, recycling, and replacement strategies are all being employed to produce PVC with minimum mercury use and minimum mercury releases. PVC being a key building material, this intervention also represents

another opportunity for UNIDO to engage in more intensive circular economy work in the construction sector.

Main approach

Reducing mercury pollution caused by VCM production is a complex problem. Supporting the Government in strengthening the regulatory framework, facilitating technology transfer and investment, and promoting resource efficiency and cleaner production, are just some of the ways in which this project will help China reach its reduction target. The project is funded by the Global Environment Facility (GEF) and executed by the Ministry of Environmental Protection of China.



FACTS & FIGURES

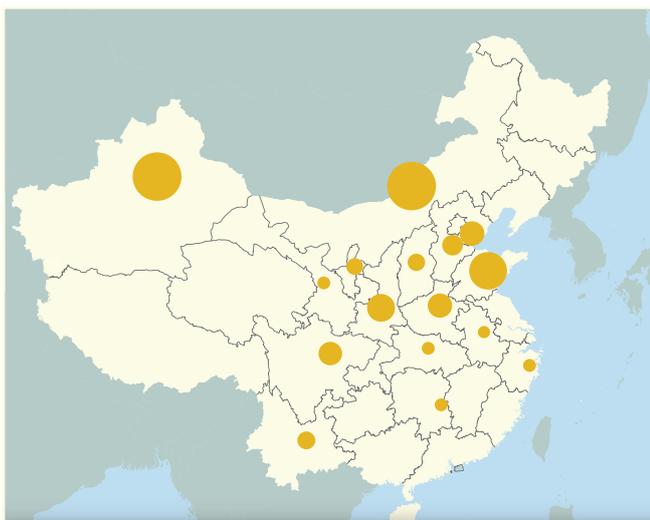
- 9 regulations revised and/or adopted
- 400 environmental management officials trained
- 1 mercury contaminated sites of VCM industry inventory developed
- 1 standard for evaluating mercury-free VCM production technologies proposed
- By the end of 2019, 289 metric tons of mercury have already been reduced annually from the VCM industry (80% of the 2020 target)
- 4 BAT/BEPs pilot demonstrations in VCM plants
- 1 expert panel on mercury-free VCM technologies
- 1 technical guide on mercury recycling from waste catalyst and activated carbon
- 1 technical guide on safe disposal and risk prevention in the VCM sector

Results and Impact

The UNIDO project's reduction target translates to an annual reduction of 360 tons of mercury from the industry. Technology upgrade will play a key role in achieving this, with low-mercury catalysts successfully demonstrated in four pilot plants, which together produce three million tons of VCM per year – 15% of China's total capacity in 2017. Drawing on this experience, the catalysts will be installed in a further 20 VCM plants, while a coal-based, mercury-free VCM production line is also being screened and evaluated.

Along with improvements in management and technical capacity, the national regulatory framework was also enhanced under the project. Changes to the national environmental management system and the development of a coordination mechanism to integrate mercury-related policy measures across government will also help China reach its ambitious target.

Furthermore, new methods for recovering mercury from waste were tested in pilot companies. In cases where mercury catalysts were considered unusable, and therefore waste, more than 90% of mercury was recovered and recycled. This work was further supported through the development of a technical guide on how to recycle and dispose of mercury in the VCM sector.



In 2017 there were 59 plants with a total capacity of 3 million tons.

● > 350 t capacity
● < 150 t capacity



The rocky path to zero mercury

Over sixty years ago, toxic mercury was released into the Boroo river basin in one of Mongolia's worst chemical accidents.

As a hotspot for (often illegal) ASGM activities, the area had fallen victim to significant mercury pollution over the years, which intensified as a result of the accident, in which a large amount of mercury was spilled into the river.

Once it is in the environment, mercury is extremely hard to bind and remove. The aftermath of this accident, combined with ongoing gold mining activities, put the communities living along the river at risk, with high mercury levels reported in the surrounding water, vegetation and species.

As one of the world's top emitters of mercury and given that the contaminated area leads to other tributary rivers, further spreading contamination, UNIDO employed circular economy practices to support the environmentally sound management of mercury and mercury-containing waste in Mongolia.

Main approach

Although Mongolia banned the use of mercury in mining in 2008, the lack of regulations for managing mercury-containing waste was hampering efforts to eliminate the use and release of mercury. The overall objective of this project was to assist the Government



FACTS & FIGURES

- Early ratification of the Minamata Convention on Mercury (first country in Asia)
- 1 draft legislation on mercury waste
- 1 guideline for the environmentally sound management (ESM) of mercury-added products and mercury waste
- 1 guideline for safe usage and handling of mercury and mercury compounds
- 2 awareness-raising workshops
- 115 participants sensitized
- 1 interim storage facility constructed
- 2 pilot demonstrations carried out

with reducing the impacts of mercury through regulatory, institutional and social reform in the form of the establishment of a regulatory framework and national guidelines for environmentally sound management of mercury containing waste. A strategic demonstration intervention in historical mercury hotspots was complemented by awareness-raising activities on the dangers of mercury handling throughout rural areas of the country. The project was funded by the GEF and executed by the Ministry of Nature and Green Development.

Results and Impact

The establishment of a regulatory framework and national guidelines for how to manage mercury-containing waste provided a solid foundation for the safe removal and treatment of mercury in the country. However, Mongolia's climate poses a challenge to the safe removal of waste: extremely cold, long winters and short, hot summers mean that standard techniques for treating mercury may not work as effectively and safely in Mongolia. The project, therefore, tested and demonstrated the best techniques for removing and stabilizing mercury in these climatic conditions.

In Mongolia, women and children take a lead role in gold mining processes, when toxic mercury is added to the gold ore and heated. Many are oblivious to the risks involved. Targeted campaigns to make miners and local residents aware of the health risks that mercury poses also formed a key component of the project.

The sound management of mercury in Mongolia could have global effects: the Boroo River is a tributary of the Selenge River, which provides nearly 80% of the water flowing into Lake Baikal, the world's largest freshwater lake.



Paving the way for a mercury-free future in Colombia

With one of the highest levels of mercury contamination per capita worldwide, Colombia has long recognized and acted upon the need to tackle the use and release of this potent neurotoxin.

One important part of circular economy is designing products and managing production processes in a way that minimizes the use of pollutants. This helps to simplify subsequent recycling, and ensures that useful resources, such as water, are contaminated as little as possible, meaning that they can be reused more easily.

Thanks to the Minamata Convention, recognition of mercury as a pollutant has grown, and reducing mercury emissions and releases from the production of goods, energy, and from products themselves has become the focus of national pollution control efforts. The first step to be able to free circular material flows from this substance

is a clear understanding on the part of each government of where and in which quantities mercury is used and released or emitted.

Colombia signed the Minamata Convention on Mercury in 2013, as a first step towards ratification. The “Minamata Initial Assessment for Colombia” project brought together various institutions to reduce mercury releases into the environment by identifying where and how reduction efforts should be focused, resulting in an update of the National Mercury Management Plan.

This work supports the circular economy in paving the way for future investment, and providing a key planning tool to enable



FACTS & FIGURES

- 1 national mercury emissions and releases inventory prepared and distributed
- 30 policy implementers trained
- 5 steering committee meetings conducted
- 2 promotional / awareness-raising campaigns conducted
- 3 recommendations of mercury-related regulations prepared
- 7 Ministries and +170 institutions involved

mercury-related policy and decision-making processes, including those related to the phase-out of mercury, the safe management of mercury-containing waste and its recyclability.

At the national level, the management of mercury is now integrated in policies that cover circular economy and recycling. With the knowledge gained through the Minamata Initial Assessment, targeted interventions with a circular economy approach can be designed more effectively.

Main Approach

In 2015, a GEF-funded project aimed to support Colombia in assessing the quantity of mercury releases, emissions and uses in the country. The assessment also evaluated both institutional settings and the policy framework to identify how these could be aligned with obligations under the Minamata Convention.

The project was implemented by UNIDO in cooperation with a range of partners, including the National Cleaner Production Centre, the Ministry of Environment and Sustainable Development and other governmental institutions.

Results and Impact

Analysis conducted under the project helped to shed light on the main sources of mercury and pinpoint key issues, including the use of mercury in gold mining and a lack of environmentally sound management of metallic mercury and mercury-added products from artisanal and small scale gold mining (ASGM) activities.

In 2019, Colombia ratified the Minamata Convention and became its 113th Party.











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