

– ASSESSMENT REPORT –

**EXCESS MERCURY SUPPLY
IN LATIN AMERICA AND
THE CARIBBEAN, 2010-2050**



JULY 2009

UNEP CHEMICALS

This paper has been researched and prepared by Peter Maxson, Director, Concorde East/West Spri, under contract to UNEP Chemicals, with all reasonable care and due diligence. While the author has greatly benefited from valuable contributions from a number of colleagues, as well as from the Proceedings of the Latin America and Caribbean Mercury Storage Project Inception Workshop (22-23 April 2009, Montevideo, Uruguay), he accepts complete responsibility for the accuracy of the paper and the stated conclusions. Nevertheless, third parties who rely on information contained in this document, or their own interpretation thereof, do so at their own risk.

Assessment report: Excess mercury supply in Latin America and the Caribbean, 2010-2050

Executive summary

The UNEP Governing Council decision GC 24/3 IV identified seven priority areas for action to reduce the risks from releases of mercury, two of which are:

- To reduce the global mercury supply, including considering curbing primary mining and taking into account a hierarchy of sources; and
- To find environmentally sound storage solutions for mercury.

Even more recently, the UNEP Governing Council decision GC 25/5 (paragraph 34) mandated member governments to take further international measures including the elaboration of a legally binding instrument on mercury, which could include both binding and voluntary approaches, as well as a range of interim activities, to reduce risks to human health and the environment.

In the Latin American and Caribbean region, the increasing capture of by-product mercury from mining operations, and the increasing use of alternatives to replace mercury, will result in excess mercury in the region. In addition, the management of mercury supplies is now seen as a valuable policy tool with which to help reduce the demand for mercury in sectors where there are viable mercury-free alternatives.

If not needed for acceptable applications, mercury must be managed properly and stored, thereby preventing its re-entry into the global market. Identifying environmentally sound storage solutions for mercury is therefore recognized as a priority.¹

Places to safely sequester the excess mercury are needed, since we know that elemental mercury, apart from being toxic, cannot be destroyed or degraded. Governments and other stakeholders need to understand how to manage this mercury over the long term in order to avoid its re-entry into the global marketplace. This understanding includes planning for the necessary storage capacity, discussing regional coordination activities, securing financial and technical support, identifying technical criteria (including site assessments) that constitute environmentally sound long-term storage, and developing the basic design of such a facility or facilities. As a first step in the planning process, this report estimates the quantities of mercury that may become available in the region for sequestration, and time horizons for taking appropriate action.

¹ Throughout this report, the terms “storage” and “long-term management” are used interchangeably, and refer to long-term sequestration of the mercury from the global marketplace. The terms are not intended to suggest how the mercury would be sequestered, or the type of facility or facilities where such sequestration would occur.

This analysis confirms that the Latin American and Caribbean region imports and exports significant quantities of mercury. The vast majority of mercury consumed in the region is used for small-scale gold mining, and lesser amounts for chlor-alkali and product applications.

This analysis observes that future sources of mercury in the Latin American and Caribbean region will include mainly mercury recovered as a by-product of mining operations, and mercury recovered from the closure/conversion of mercury cell chlor-alkali plants. Such regional sources of mercury are compared in this analysis with the regional uses mentioned above in order to better understand the mercury supply and demand equilibrium in the region.

Accordingly, this report presents a framework for better understanding future mercury supply and demand within Latin America and the Caribbean – a framework necessary to inform discussions about managing and storing mercury in the region. This analysis provides background information for the “Inception Meeting of the Latin American and Caribbean Storage Project” that is scheduled to take place in April 2009, in Montevideo, Uruguay.

UNIDO and other experts have determined that mercury supply restrictions, such as mercury storage, can contribute to significant demand reductions in small-scale gold mining. Subsequently, measures to influence supply and demand can be mutually reinforcing, and to some extent supply restrictions that precede demand reductions can be even more effective. Therefore, for this region, planning for mercury storage may be especially important as an initiative to further encourage demand reduction.

According to the Base Case Scenario assessed in this report, the mercury supply in Latin America and the Caribbean may exceed demand even before 2015, which could imply a need for storage of the excess mercury. This scenario assumes that stricter requirements will be imposed on the industrial mining sector that will lead to the recovery of additional by-product mercury. On the other hand, this time frame could be a few years longer if certain international gold mines in South America continue to export their by-product mercury to the United States.

The urgency of a Latin American and Caribbean mercury storage capability will depend on the rate of further demand reductions, the extent to which countries in the region wish to encourage these further demand reductions through supply restrictions, and the extent to which a regional storage solution is achieved (even though net supplies of excess mercury may occur in a relatively small number of countries).

The Base Case Scenario shows that the quantity of mercury that may need to be stored in the Latin American and Caribbean region between 2015 and 2050 could amount to over 8,000 tonnes. According to an alternative Minimum Storage Scenario, in which it is assumed that some by-product mercury continues to be exported, and it is assumed there is a generally slower increase in the generation of by-product mercury, the quantity of mercury accumulated may be closer to 2,000-3,000 tonnes. These scenarios do not reflect the possible adoption of an immediate or near-term regional strategy of sequestering mercury as a way of encouraging reduced mercury demand. Adoption of such a strategy would require development of storage capacity as soon as possible.

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1 Background

1.1 Aims

The overall aim of this analysis is the identification of sources and quantification of metallic mercury for storage from the Latin American and Caribbean region, i.e., to provide a better understanding of future mercury supply and demand within Latin America and the Caribbean – a framework necessary to inform discussions about managing excess mercury in the region. This analysis provides background information for the “Inception Meeting of the Latin American and Caribbean Storage Project” that is scheduled to take place in April 2009, in Montevideo, Uruguay. At this meeting, discussions are expected to revolve around the possible need for a regional mercury storage facility or facilities, as the preferred option, or the most environmentally sound option.

Therefore, mercury supply and demand needs to be better understood before any subsequent steps are taken – which may include planning for the necessary storage capacity, discussing regional coordination activities, securing financial and technical support, identifying technical criteria (including site assessments) that constitute environmentally sound long-term storage, and developing the basic design of such a facility or facilities.

Once basic estimates of excess mercury flows have been generated, governments, regional development organisations, and non-governmental organisations (NGOs) can use this information as a basis for taking the next steps toward planning for the necessary storage capacity, including regional coordination activities, securing financial and technical support, identifying a suitable location, and the basic layout of the facility. As the first step, excess or surplus mercury from identified sources will be estimated and projections will be made for the next 40 years in the Latin American and Caribbean region.

This report is the first part of the UNEP project, “Reduce Mercury Supply and Investigate Mercury Storage Solutions”, and will feed into the subsequent feasibility study that will evaluate options for the long term management (such as safe long term storage) of mercury in Latin America and the Caribbean.

1.2 Context

UNEP Governing Council decision GC 24/3 IV identified seven priority areas for action to reduce the risks from releases of mercury, two of which are:

- To reduce the global mercury supply, including considering curbing primary mining and taking into account a hierarchy of sources; and
- To find environmentally sound storage solutions for mercury.

Even more recently, the UNEP Governing Council decision GC 25/5 (paragraph 34) mandated member governments to take further international measures including the elaboration of a legally binding instrument on mercury, which could include both binding and voluntary approaches, as well as a range of interim activities, to reduce risks to human health and the environment.

The increasing recovery of mercury as a by-product of mining activities, and the mercury that becomes available when chlor-alkali facilities are closed add to the global supply. Meanwhile, the increasing use of alternatives to replace mercury-added products results in decreased regional demand for mercury. As a result, the management of mercury supplies is now seen as a valuable policy tool with which to help reduce the demand for mercury in sectors where there are viable mercury-free alternatives.

The reduction of mercury supplies, and long term management of mercury, have both been identified as priorities of the UNEP Governing Council. If not needed for acceptable applications, mercury must be managed properly and stored, thereby preventing its re-entry to the global market. Identifying environmentally sound storage solutions for mercury is therefore recognized as a priority. Repository/storage facilities are needed to isolate the mercury indefinitely to avoid it leaking into the environment. Since we know that elemental mercury, apart from being toxic, cannot be destroyed or degraded, governments and other stakeholders need to understand how to manage this mercury over the long term in order to avoid its re-entry into the global marketplace.

Present information suggests that there will be excess mercury generated in Latin America and the Caribbean as a result of phasing out mercury-containing products, the recovery of mercury used in chlor-alkali production, mercury recovered from smelting of metallic ores, etc. Therefore, mercury flows need to be better understood before any subsequent steps are taken – such as planning for the necessary storage capacity, discussing regional coordination activities, securing financial and technical support, identifying technical criteria (including site assessments) that constitute environmentally sound long-term storage, and developing the basic design of such a facility or facilities.

1.3 Scope

The investigation into the feasibility of Latin American and Caribbean regional capacity for the terminal storage of excess mercury has been structured in two initial phases. The first phase would assess the quantities of mercury that may need to be stored. Should such quantities be significant, the second phase would focus on the location, design, financing and other practical requirements of an appropriate storage facility.

This assessment addresses Phase I, and includes an analysis of the quantities of mercury arising over the next 40 years in the Latin American and Caribbean region as a by-product of mining operations, from the closure/conversion of mercury cell chlor-alkali plants, and from end-of-life products. The regional sources of mercury are then compared with regional uses over the same time period to have a better idea of the impact of mercury storage on the mercury market, and to estimate quantities of mercury that may need to be stored in the region.

2 The Latin American and Caribbean region

In order to fully assess mercury sources and consumption in the region, it is necessary to first identify the countries that will be included in this analysis. While the Latin American and Caribbean countries may be grouped in various ways, this project identifies three main subregions as indicated in Table 1:

- South America,
- Central America, including Mexico, and
- the Caribbean.

The total population of the region under study, of which 67% belongs to South America, 26% to Central America and 7% to the Caribbean, comes to 576 million persons, as in Table 1.

Table 1 Latin American and Caribbean subregions and population (2008)

<i>South America</i>	<i>Population (million)</i>	<i>Central America</i>	<i>Population (million)</i>	<i>Caribbean</i>	<i>Population (million)</i>
Argentina	40.7	Belize	0.3	Anguilla	0.01
Bolivia	9.2	Costa Rica	4.2	Antigua and Barbuda	0.07
Brasil	191.9	El Salvador	7.1	Aruba	0.10
Chile	16.5	Guatemala	13.0	Bahamas	0.31
Colombia	45.0	Honduras	7.6	Barbados	0.28
Ecuador	13.9	Mexico	110.0	British Virgin Islands	0.02
French Guiana	0.2	Nicaragua	5.8	Cayman Islands	0.05
Guyana	0.8	Panamá	3.3	Cuba	11.42
Paraguay	6.8			Dominica	0.07
Perú	29.2			Dominican Republic	9.51
Suriname	0.5			Grenada	0.09
Uruguay	3.5			Guadeloupe	0.44
Venezuela	26.4			Haïti	8.92
				Jamaica	2.80
				Martinique	0.40
				Montserrat	0.01
				Netherlands Antilles	0.22
				Puerto Rico	3.94
				St. Barthélemy	0.01
				Saint Kitts and Nevis	0.04
				Saint Lucia	0.17
				Saint Martin	0.03
				St. Vincent & Grenadines	0.12
				Trinidad and Tobago	1.05
				Turks and Caicos Islands	0.02
				U.S. Virgin Islands	0.11
Total	384.6	Total	151.3	Total	40.2

Other than occasional references in the following assessment to one of these subregions or to individual countries, the entire Latin American and Caribbean region is generally treated here in its entirety.

2.1 Recent regional initiatives

2.1.1 Inventories

Several United Nations Institute for Training and Research (UNITAR) pilot projects for the development of mercury inventories (and risk management) have been completed recently, including those for Ecuador (2008) and Panamá (2009). These documents focus mainly on atmospheric emissions but provide some useful information about different aspects of mercury supply and demand as well. Other UNITAR/UNEP sponsored inventories and related documents have recently been completed for Chile (Chile 2007; Chile 2008) and Perú, not to mention the broader USGS study of mercury in Perú published in 2007 (USGS 2007).

A mercury emissions inventory was completed in Mexico in 2008, and a mercury products inventory, prepared for the North American Commission for Environmental Cooperation (NACEC) and managed by the National Institute of Ecology in Mexico and the United States Environmental Protection Agency (USEPA) is now in draft form (NACEC 2008).

Mercury emissions and products inventories are being carried out in the Dominican Republic and Nicaragua, while an expanded assessment of mercury in health care, mercury reduction and substitution efforts is going on in Costa Rica and Honduras.

There is underway a multi-country project funded by the Strategic Approach to International Chemicals Management (SAICM) Quick Start Programme (QSP) to develop preliminary inventories of domestic sources of mercury in Argentina, Chile, Paraguay, Uruguay, Bolivia and Perú.

Finally, U.S. EPA has commissioned an update of mercury trade between Latin America and the United States in order to better understand any impacts of the U.S. mercury export ban that will take effect in 2013.

2.1.2 Artisanal and small-scale gold mining (ASGM)

In Perú and Bolivia, the above-mentioned UNEP “country strategic plan” projects funded by SAICM under its QSP are also focused on reducing mercury consumption in the ASGM sector. In each case, a national working group will be formed and a national strategic plan will be prepared. Regional collaboration and coordination will be enhanced, awareness of governments and stakeholders will be raised.

The Association for Responsible Mining (ARM) – Standard Zero proposes a process to support miners’ organisations to minimise the use of mercury and cyanide over an agreed period of time, through implementation of responsible practices and technologies to mitigate the impact on the environment and human health. ARM is working on field-testing the Standard Zero in Bolivia (two cooperatives in Cotapata), Colombia (Choco – two community councils, and Nariño – two cooperatives), Ecuador (Bella Rica), and Perú (Central Perú – three community mining companies). Both Nariño and Perú have demonstrated important mercury reductions. Choco does not use it at all.

The United States, UNIDO and UNEP, along with local governments in Brasil, have partnered to reduce mercury emissions from gold processing shops in the Amazon region. The U.S. Environmental Protection Agency and Argonne National Laboratory supported local manufacture and construction of retorting installations to capture mercury vapour released during gold processing, and global dissemination of information on this retorting technology. The Partnership has verified baseline

measurements in the Amazon. A prototype technology was installed in six gold shops in two cities in the Brazilian Amazon and achieved over 80% efficiency of mercury vapour capture. A report of the Brasil technology demonstration is available online, including case study information and a manual for building and installing the technology. A site assessment for gold refining shop applications in the Peruvian Amazon was undertaken in May 2008, with follow-up. An outreach workshop in Brasil occurred in the September/October timeframe.

A workshop of Communities and Artisanal & Small Scale Mining (CASM) was held in Brasilia on 7 October 2008 with approximately 40 participants representing a cross-section of miners and mining associations, government officials and academics. This was coordinated by NRDC and supported by UNEP's Mercury Trust Fund. The purpose of the workshop was to promote awareness and adoption of cleaner production techniques for ASGM operations.

In the Suriname Training Project, the University of Bremen, UNIDO, the government of Suriname and UNEP partnered to train small-scale gold miners in clean technology, and training of personnel to quantify atmospheric mercury emissions and their impact on health. This project was funded through the UNEP Mercury Trust Fund.

2.1.3 Mercury-added products and wastes

With financial and other support from UNEP, the World Health Organization (WHO), the United States, the North American Commission for Environmental Cooperation (NACEC), national governments, Health Care Without Harm (HCWH), the University of Massachusetts at Lowell and others, health-care projects aimed at reducing the use of mercury-containing devices – especially thermometers and blood pressure measuring instruments – have recently been, or are being, carried out in Argentina, Brasil, Chile, Costa Rica, Ecuador, Honduras and Mexico:

- Chile, Costa Rica and Honduras are developing and implementing assessments in hospitals in order to reduce and eliminate mercury-containing products.
- The Mexican government is developing a health care facility pilot project in Mexico that may be used as an example for other mercury reduction initiatives in other health care facilities.
- The First Latin American Conference on the Elimination of Mercury in Health Care was held in Buenos Aires, and organized by Health Care Without Harm in association with the United Nations Environment Program (UNEP), and was sponsored by the Pan-American Health Organization, the Ministry of Health of Argentina, the Ministry of Health of the City of Buenos Aires, the Secretariat of Environment and Sustainable Development of Argentina, and the Argentinean Association of Toxicology. This regional workshop for local/regional health care associations was held to promote alternatives to mercury in the health care sector.
- The Buenos Aires City Government is delivering mercury-free training for all city-run hospitals, and has completely eliminated mercury from two hospitals and fourteen neo-national units.
- A Health Care Cooperative Agreement is now in place to provide technical support for mercury reduction in hospitals in Brasil, Costa Rica, Ecuador and Mexico. This is a multi-year initiative to expand existing projects and launch new pilot projects in health care mercury reduction, product inventories, waste management and relevant training.

Two projects are being implemented to develop waste management strategies for mercury. The one coordinated by UNEP Chemicals will include Chile, along with other countries to be determined; the one coordinated by the Secretariat of the Basel Convention will include Argentina, Costa Rica, and Uruguay. While the separate collection and management of end-of-life mercury products and other mercury waste is an important challenge for virtually all countries in the region, it should be noted that this is not the prime focus of this report.

As mentioned in Section 2.1.1, with support from the U.S. and NACEC, the Mexican government has drafted an inventory of mercury-containing products and alternatives, and updated existing product databases.

Similarly, the Central American Commission on Environment & Development (CCAD), the United Nations Institute for Training and Research (UNITAR) and the United States government are supporting an initiative to develop mercury emission and product inventories in the Dominican Republic and Nicaragua, while expanding health care mercury assessment, reduction, and substitution efforts in Costa Rica and Honduras.

Finally, there was a regional workshop on mercury in products held in Merida, Mexico, which many Latin American and Caribbean delegates attended, as well as NACEC and USEPA.

3 Methodology

As described in detail in the UNEP Global Mercury Assessment (UNEP 2002), mercury is intentionally added to a great number of products such as thermometers and dental amalgams, and processes such as the mercury-cell process for the production of chlorine. In the case of the products, many of these can be collected and recycled to recover the mercury. Likewise, mercury can be recovered from various process uses. These and other typical sources and uses of mercury are discussed further in Sections 4 and 5 below.

All of the countries in the Latin American and Caribbean region will be analysed together as a closed system, considering the generally close commercial and political links. For the initial analysis and projections of mercury supply and demand into the future, the following assumptions are made:

- assume there are continuing transfers of mercury among the Latin American and Caribbean countries, as at present (UNEP 2006);
- assume there are no imports of metallic mercury into the region;
- assume there are no exports of metallic mercury or by-product mercury outside the Latin American and Caribbean region, although continued exports of mercury-containing products would not be prevented, under this assumption;
- assume that the main regional “sources” of mercury, other than imported mercury-added products, are closing chlor-alkali facilities, by-product mercury recovered from mining operations or from old mine tailings, eventual removal of mercury from the flue gases of large non-ferrous metal smelting operations, removal of mercury from natural gas cleaning facilities, and some recycling of mercury-added products;
- assume that if and when regional policies dictate that mercury should be removed from the market, the mercury should go to terminal storage.

The focus of this assessment is on a 40-year time frame, specifically 2010-2050. Clearly, 40-year estimates are subject to significant uncertainties, and it is understood that extreme precision is not realistic or possible for this exercise. The main goal is to develop an order-of-magnitude estimate of the quantity of elemental mercury that may need to be stored, and a rough idea of when that mercury might start being collected for storage.

4 Regional mercury consumption for products/processes

Unless otherwise noted, the main sources for this chapter are the UNEP Trade Report (UNEP 2006), which presents an overview of mercury uses globally and regionally; an extensive analysis of mercury product life-cycles published in the US (Cain 2007); and a detailed analysis of mercury applications carried out recently for the European Commission (2008). To these reference documents were added information sources regarding specific countries in the Latin American and Caribbean (LA&C) region, especially documents on Chile (Chile 2007), Perú (Peru 2007), Mexico (NACEC 2008) and two UNEP-sponsored Regional Awareness-Raising Workshops on Mercury Pollution – in Buenos Aires, Argentina (UNEP 2004) and in Port-of-Spain, Trinidad (UNEP 2005).

4.1 Present mercury consumption in the LA&C region

The main groups of mercury-containing products and mercury processes assessed in this study are described below. The base year for “current” data is assumed to be 2005. In various cases more recent data is available, but future projections are not precise enough to reflect a significant difference between using 2005 or 2007, for example, as the base year.

4.1.1 Artisanal and small-scale gold mining

Artisanal and small-scale gold mining (ASGM), an activity inextricably linked with issues of poverty and human health, remains the largest user of mercury in South and Central America. The extent of ASGM activities is further encouraged by the upward trend in the price of gold. Because nearly all of the mercury used in ASGM is eventually released to the air, water and soil, ASGM is also the largest source of releases from intentional use of mercury.

According to the UNIDO/UNDP/GEF Global Mercury Project, at least 100 million people in over 55 countries depend on ASGM – directly or indirectly – for their livelihood.² ASGM is responsible for an estimated 20-30% of the world's gold production, or approximately 500-800 tonnes per annum. It directly involves an estimated 10-15 million miners, including 4.5 million women and 1 million children. This type of mining relies on rudimentary methods and technologies, and is typically performed by miners with little or no economic capital, who operate in the informal economic sector, often illegally and with little organisation. Due to inefficient mining practices, mercury amalgamation in ASGM results in the consumption (and subsequent release) of an estimated 650 to 1350 tonnes of mercury per annum (Telmer 2008; UNEP 2008a).

² It should be noted that not all artisanal/small scale gold miners use mercury. Some use cyanide, which typically requires a greater up-front investment but permits more gold to be recovered than when using mercury. Some use both, which can be especially hazardous. Others use gravimetric methods without mercury or cyanide.



Altino Machado às 10:14 am, 17 March 2009. Elas correspondem ao Rio Guacamayo, no trecho situado na altura do km 100 da Estrada Interoceânica, que liga o Brasil ao Perú, contando de Puerto Maldonado em direção a Cusco.

Blog da Amazônia pelo biólogo e consultor ambiental Peruano Enrique Ortiz, <http://blogdaamazonia.blog.terra.com.br/>

ASGM activity in South America has been reported in Bolivia, Brasil, Chile, Colombia, Ecuador, Perú, Suriname, French Guiana, Guyana and Venezuela. In Central America and the Caribbean, ASGM activity – although relatively little, in some cases – has been reported in Costa Rica, the Dominican Republic, Guatemala, Honduras, Mexico, Nicaragua and Panamá (Telmer and Veiga 2008).

In Section 4.1.9, regional estimates of mercury use in ASGM are based on the work of Telmer and Veiga (2008), based on their long involvement in the UNIDO/UNDP/GEF Global Mercury Project.³

4.1.2 Chlor-alkali production

The chlor-alkali industry is the third largest mercury user worldwide. Many chemical companies have phased out this old technology and converted to the more energy-efficient and mercury-free membrane process, and others have plans to do so. For example, one of the facilities (34 thousand tonnes per year chlorine capacity) in Mexico has just converted to the membrane process, and one in Brasil has recently converted as well. In many cases governments have worked with industry representatives and/or provided financial incentives to facilitate the phase-out of mercury technology. Recently governments and international agencies have created partnerships with industry (for example, UNEP's Chlor-Alkali Partnership) to encourage broader and faster industry improvements with regard to mercury management and releases of mercury. Table 2 below summarizes the main characteristics of the mercury cell chlor-alkali production facilities believed to be still operating in Latin America and the Caribbean. It is possible that some additional small mercury cell chlor-alkali plants integrated with pulp and paper mills are not included on this list.

The most recent and detailed discussion of mercury consumption by world chlor-alkali facilities was presented in UNEP (2006). According to that reference, even considering that over 70% of world chlor-alkali capacity is based in the U.S. and Europe, which are reputed to have the lowest unit emissions in the world, the global average mercury consumption is on the order of 45-55 g of mercury per tonne of chlorine capacity. With regard to chlor-alkali facilities in Latin America and the Caribbean, no mercury emissions have ever been reported for plants other than those in Brasil, and there is no indication that the other plants have received much scrutiny. Therefore, a broader and somewhat higher range of consumption (~35-75 g mercury per tonne of chlorine capacity) appears to be warranted, which suggests total mercury consumption of 25-55 tonnes for all of the plants listed in Table 2.

4.1.3 Batteries

The overall consumption of mercury in batteries, while still significant, continues to decline as many nations have implemented policies to deal with the problems related to diffuse mercury releases related to batteries.

However, there remain a large number of button cell batteries manufactured in many different countries, most containing up to 2% mercury, but some containing more.

³ In Telmer and Veiga (2008), improving on past estimates of ASGM operations worldwide, the authors have reported ASGM activity in as many as 70 countries, but have also broadened previous estimates of global mercury consumption in ASGM, for which they now estimate the range may be 650-1350 tonnes per year.

These will eventually be replaced by mercury-free button cells,⁴ but for the moment these batteries, produced in the tens of billions, consume significant amounts of mercury.

Table 2 Mercury cell chlor-alkali capacity in Latin America and the Caribbean, 2005

	Approx. chlorine production capacity (tonnes Cl₂ per year)	Approx. cellroom mercury inventory (tonnes Hg per year)	Approx. mercury consumption* (tonnes Hg per year)
South America			
Argentina (up to 5 plants)	max. 120,000	240	incl. below
Brasil (5 plants)**	est. 347,000	700	incl. below
Colombia (1 plant)	16,000	32	incl. below
Uruguay (1 plant)	15,000	30	incl. below
Perú (4 plants)	max. 70,000	140	incl. below
<i>Subtotal</i>	<i>max. 570,000</i>	<i>max. 1,140</i>	<i>20-40</i>
Central America and the Caribbean			
Mexico (2 plants in 2007***)	135,000	270	incl. below
Cuba (1 plant)	16,000	30	incl. below
<i>Subtotal</i>	<i>150,000</i>	<i>300</i>	<i>5-15</i>
Total	max. 720,000	max. 1,440	25-55
<p>* The convention here is to calculate mercury "consumption" before any recycling of wastes. Some of the waste at some facilities may be recycled in order to recover the mercury, although most mercury waste is sent for disposal.</p> <p>** One of these five plants in Brasil closed in 2008.</p> <p>*** There were three facilities operating in 2005, but this update to 2007 permits a more accurate estimate of future availability of mercury from this source.</p> <p>Sources: UNEP 2006; WCC 2007; SRIC 2005</p>			

Furthermore, the global trade in mercuric oxide batteries has still not been satisfactorily explained (see discussion in UNEP 2006). In Mexico, for example, according to SIAVI, from July 2007 to June 2008 net imports of mercuric oxide batteries (Harmonized Tariff System (HTS) code 85063001) totalled over 197 tonnes. Other countries also show trade in these batteries, which are banned by many countries from commercial marketing and use – but not necessarily banned from military applications. Some explanations of a possible error are suggested by NACEC (2008) because, if accurate, the mercury content of these batteries entering Mexico would be 60-70 tonnes.

It is beyond the scope of this report to investigate such details further, but the global consumption of mercury in batteries still appears to number in the hundreds of metric tonnes annually. Latin American and Caribbean regional consumption of mercury in batteries has been estimated in UNEP (2008a), and this is the basis for the estimates in Section 4.1.9.

⁴ For example, the National Electrical Manufacturers' Association (NEMA) in the USA has called for a phase-out of all mercury in button cell batteries in the USA by 2011. In October 2008, one of the major battery manufacturers announced the launch of new zero-mercury hearing aid batteries – the first of their kind in the world.

4.1.4 Dental applications

In some countries and (especially higher) income groups the use of mercury in dental amalgams is now declining. The main alternatives are composites (most common), glass ionomers and compomers (modified composites). However, the speed of decline varies widely, so that dental amalgam use is still significant in most countries, while in some countries (e.g., Sweden, Norway) it has almost ceased. In many lower-income countries, changing diets and better access to dental care have actually led to an increase in dental mercury use.

Latin American and Caribbean consumption of mercury for dental use is presented in Section 4.1.9, based on regional estimates provided by manufacturers and exporters. This includes estimated mercury use by Macrodent S.A., an amalgam producer based in Buenos Aires, Argentina (Lowell 2008).

4.1.5 Measuring and control devices

There is a rather wide selection of mercury-added measuring and control devices, including thermometers, barometers, manometers, etc., on the market, although thermometers and sphygmomanometers dominate with regard to mercury use. As market demand has increased for mercury-free alternatives, most international suppliers now offer them as well. National and regional legislation are increasingly being considered in order to promote the shift to mercury-free alternatives since the latter are available for nearly all applications. Health Care Without Harm has been especially active in getting mercury-added devices out of the healthcare sector. In one of the most recent examples, in response to HCWH initiatives, the Argentine government has passed legislation to phase out the use of mercury-added devices in hospitals.

Thermometers and sphygmomanometers are considered to represent around 80% of total mercury consumption in the product category of “measuring and control devices.” Latin American and Caribbean regional demand presented in Section 4.1.9 is based on UNEP (2008a).

4.1.6 Lamps

Mercury-added lamps (fluorescent tubes, compact fluorescent, high-intensity discharge – HID, etc.) remain the standard for energy-efficient lamps, where ongoing industry efforts to reduce the amount of mercury in each lamp are countered, to some extent, by the ever-increasing number of energy-efficient lamps purchased and installed around the world. There is no doubt that mercury-free alternatives such as light-emitting diodes (LEDs) will increasingly become available. Nevertheless, at present, for most lighting applications the alternatives are very limited and/or quite expensive.

In addition to lamps used for normal lighting applications, a great number of fluorescent lamps are also used for backlighting of liquid crystal displays (LCDs) of all sizes – from electronic control panels to computer and television monitors.

The ranges of regional mercury consumption presented in Section 4.1.9 take account of these applications, including mercury consumption by production facilities in Brasil – Sunlc Technology produces high-intensity discharge (HID) lamps in Baueri, while Worry Tech Co. Ltd. produces HID commercial and automotive lamps in Saude (Lowell 2008).

4.1.7 Electrical and electronic equipment

Following the implementation of the European Union's Restriction on Hazardous Substances (RoHS) Directive, and similar initiatives in Japan, China and Korea, among others, there has been a marked shift to mercury-free substitutes for mercury switches, relays, etc., and overall mercury consumption for these applications appears to have declined in Latin America and the Caribbean in recent years.

In Section 4.1.9, the ranges of mercury consumption in electrical and electronic equipment are based on estimates prepared for UNEP (2008a).

4.1.8 Other applications of mercury

This category has traditionally included the use of mercury and mercury compounds in such diverse applications as pesticides, fungicides, laboratory chemicals, pharmaceuticals, paints, traditional medications, certain cultural and ritual uses, cosmetics, etc.

However, there are some further applications that have recently come to light in which the consumption of mercury is also especially significant. In particular, the continued use of mercury in the production of artificial rubber is one such use that appears to be widespread.⁵ Likewise, the use of mercury in some research and testing devices may be more significant than previously suspected. A recent study for the European Commission (2008) has also identified substantial mercury consumption in compounds used in a broad range of applications. For example, a large part of the global production of the mercury-based preservative and disinfectant known as thimerosal or thiomersal (possibly up to 5 tonnes) takes place in Argentina, and is exported to all parts of the world (European Commission 2008).

In Section 4.1.9, the estimates of mercury consumption in "other applications" of mercury are based on UNEP (2008a).

4.1.9 Summary of mercury consumption in LA&C

Table 3 below summarises the key applications of elemental mercury in the Latin American and Caribbean region, including mercury consumption for the manufacture of products for export (notably batteries, lamps and electrical and electronic equipment). It should be noted that Table 3 indicates "gross" mercury consumption, i.e., prior to any mercury recycling or recovery. Recycling and recovery are addressed separately as mercury "sources" in Section 5.1 below.

The major consumption of mercury for artisanal and small-scale gold mining, especially in South America, may again be seen in this table. Likewise, there remains a significant use of mercury for dental amalgams, and other studies have noted that the various mercury releases from this application are often poorly controlled. It should be noted that a "placeholder" row has been left in the table for vinyl chloride monomer VCM/PVC production, even though it is believed the mercury catalyst process is no longer used for this application in the Latin American and Caribbean region.

⁵ Specifically, mercury "catalysts" (basically hardening or curing agents) are sometimes used in the production of polyurethane elastomers, used as artificial "rubber" for roller blade wheels, etc., in which the catalysts remain in the final product.

Table 3 Mercury consumption in Latin America and the Caribbean, reference year 2005 (tonnes)

	South America		Central America & Caribbean		Latin America and Caribbean total	
	<i>min.</i>	<i>max.</i>	<i>min.</i>	<i>max.</i>	<i>min.</i>	<i>max.</i>
Small-scale gold mining	150	300	15	30	165	330
VCM/PVC production	0	0	0	0	0	0
Chlor-alkali production	20	40	5	15	25	55
Batteries	10	15	5	10	15	25
Dental applications	40	50	20	25	60	75
Measuring and control devices	20	25	10	15	30	40
Lamps	5	10	5	10	10	20
Electrical and electronic equipment	5	10	5	10	10	20
Other	10	20	5	15	15	35
Totals	260	470	70	130	330	600

* "Other" applications include uses of mercury in pesticides, fungicides, catalysts, paints, chemical intermediates, laboratory and clinical applications, research and testing equipment, pharmaceuticals, cosmetics, traditional medicine, cultural and ritual uses, etc.

4.2 Future mercury consumption in Latin America and the Caribbean

The objective of this section is to forecast the evolution of Latin American and Caribbean mercury consumption between 2010 and 2050, reflecting existing and reasonable expectations of national and global initiatives, as specified in partnership business plans and related UNEP and UNIDO global mercury initiatives, where available.

The production of most mercury-added products is in general decline as countries and regions in many parts of the world implement legislation or voluntary initiatives to reduce or phase out various uses of mercury.

In the near to medium term, the rate of decline in mercury consumption will depend primarily upon reductions in use by artisanal and small-scale gold miners; in the battery, electrical equipment, and measuring device manufacturing sectors; in dental applications; and in chlor-alkali facilities.

Artisanal and small-scale gold mining will be the greatest challenge – not because of the lack of alternative methods for decreasing mercury use, but because the use of mercury is so widespread; mercury is too readily available, too cheap and too easy to use. In the present circumstances there is not enough incentive for miners to seriously consider alternatives that use less or no mercury.⁶ Soon, however, the mercury supply will be greatly reduced, and miners will be obliged to change their habits.

The mercury-added product sectors also represent significant potential for decreases in consumption during this time period because alternative mercury-free products are readily available, they are of equal or better quality, and prices are generally competitive.

⁶ It was reported by Mr. Elias Pinto Martinez, Dirección de Desarrollo Sectorial Sostenible, Ministerio de Ambiente, Vivienda y Desarrollo Territorial (Colombia), at the Montevideo regional workshop on mercury storage (April 2009) that his country has been running pilot projects to reduce the use of mercury in ASGM. He mentioned one project where they worked with 36 small enterprises and reduced the use of mercury by 80% and the use of cyanide by 36%, while improving the efficiency of gold recovery by 79%. Such projects are underway in many parts of the world, but mercury use is so widespread in ASGM that it is generally agreed that significant and broad-based reductions in mercury consumption cannot be achieved without further restricting the mercury supply to the ASGM sector, and effectively driving the market price of mercury much higher (UNEP 2006).

For these sectors, the challenges are not technical, but are rather related to the extent of encouragement offered by countries or regions through awareness-raising, legal or voluntary mechanisms, etc.

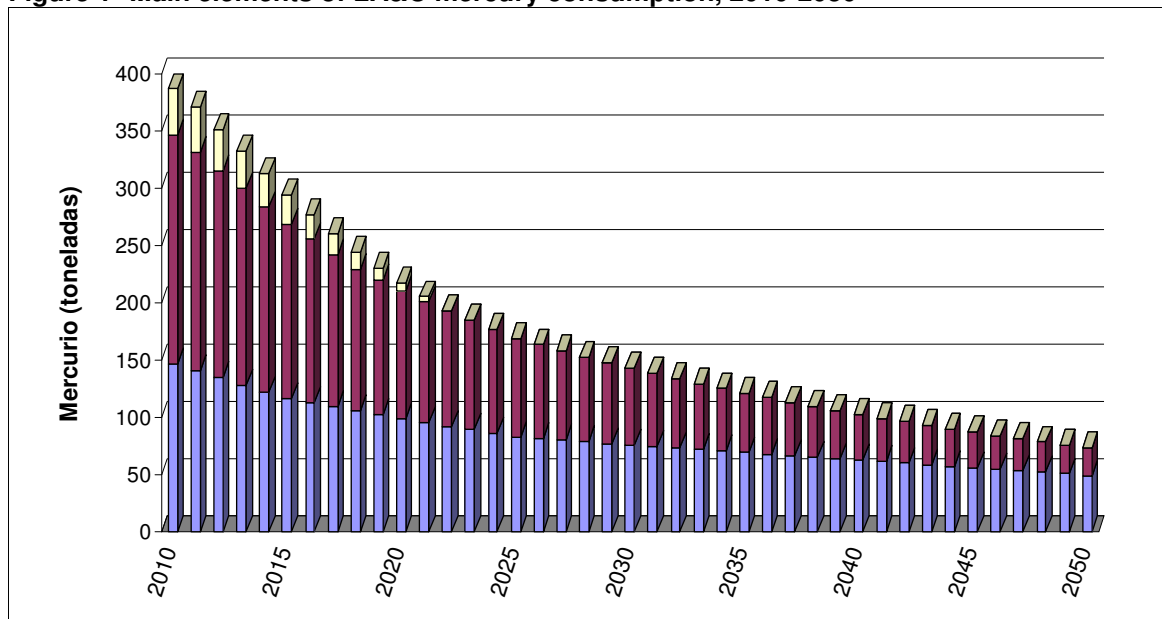
For the chlor-alkali sector as well, a more energy-efficient and mercury-free technology is in widespread use around the world, but short-term profits are higher as long as chlor-alkali plants are permitted to continue using the old mercury technology. If no pressure is applied, they will take a long time to make the shift.

For this analysis, the objectives for future reductions in mercury consumption are based on those agreed in the Mercury-Containing Products Partnership Area Business Plan (UNEP 2008b), which is also based on the “Focused Mercury Reduction Scenario” of UNEP’s Mercury Trade Report (UNEP 2006). These objectives are applied to Latin American and Caribbean regional mercury consumption during the period 2010-2050, and are summarized in Table 4.

Table 4 Basic assumptions regarding LA&C mercury consumption 2010-2050

<i>Processes</i>	<i>Assumptions regarding future consumption</i>
Small-scale gold mining	Reduce mercury consumption in small-scale gold mining globally by 50% over the next 10 years, with a subsequent decline after that of 5% per year. According to UNIDO, the 50% reduction can be met by eliminating whole ore amalgamation and encouraging greater mercury reuse (UNEP 2006). Supply restrictions are expected to help achieve this objective by raising mercury prices and otherwise encouraging greater efficiencies in mercury use.
Chlor-alkali production	Assume no new mercury cell facilities will be constructed in any region. Assume mercury cell capacity will be gradually phased out between 2010 and 2022. Therefore, industry consumption of 25-55 tonnes/yr. will gradually disappear during this period.
<i>Products</i>	<i>Assumptions regarding future consumption</i>
Batteries	Assume a 75% decrease in mercury consumption by 2015, and the remaining demand phased out gradually thereafter until 2025.
Dental applications	Assume a 15% reduction by 2015, and a gradual reduction thereafter to 50% of present consumption by 2050.
Measuring and control devices	Assume a 60% reduction of mercury consumption by 2015, the phase-out of mercury fever thermometer and blood pressure cuff manufacturing by 2017, and the phase-out of remaining demand by 2025.
Lamps	Assume a 20% reduction by 2015 and a gradual reduction of 80% overall by 2050.
Electrical and electronic equipment	Assume gradual 55% reduction of mercury consumption by 2015, and a gradual reduction thereafter to 2050.
Other applications	Assume a gradual 25% reduction of mercury consumption by 2020, and another 50% by 2050.

All of these assumptions are included as well in Figure 1 below, which shows that mercury-added products and artisanal and small-scale gold mining (ASGM) are by far the largest consumers of mercury in Latin America and the Caribbean. At the same time, since both of these applications typically represent large numbers of relatively small amounts of mercury used over wide geographic areas, it is very difficult to ensure that the mercury does not eventually end up in the environment.

Figure 1 Main elements of LA&C mercury consumption, 2010-2050

Key: blue = products and other applications; mauve = ASGM; yellow = chlor-alkali

5 Regional sources of metallic mercury

5.1 Major Latin American and Caribbean sources of mercury supply

If recycled or recovered mercury is considered a “source,” there are typically five main regional sources of mercury supply:

1. Mercury mining and/or processing of mine tailings;
2. Collection of process mercury from decommissioned mercury cell chlor-alkali plants (MCCAPs);
3. By-product mercury from the refining or processing of non-ferrous metals; and from the cleaning of natural gas;
4. Mercury recovered or recycled from products containing mercury and from processes using mercury.
5. Stocks of mercury accumulated from previous years (typically the original source would have been from mercury mining or a by-product of other mining, chlor-alkali decommissioning, or other large sources).

Following the methodology used here, mercury imported from outside the region (as metallic mercury or in products) would not be considered a regional source.

5.1.1 Mercury mining and/or processing of mine tailings

Approximately 20 mercury occurrences are known in Perú. The most well known, the former Santa Barbara Mine in Huancavelica, is now closed. There are also occurrences in southern Ecuador, near Cuenca and Azogues (Petersen 1970, as cited in USGS 2007), but there is no evidence they are being exploited at present.

According to NACEC (2008) the *Servicio Geológico Mexicano* (SGM—Mexican Geological Service) reported that three mines may be producing mercury intermittently, but no data are available about production volumes.

Mexico is a major producer of copper, silver, lead, zinc, and gold, whose ores are frequently contaminated by trace mercury. However, the Mexican Mining Association (Camimex) on 21 January 2008, sent a letter to Semarnat (*Secretaría de Medio Ambiente y Recursos Naturales* – Secretariat of Environment and Natural Resources) stating that none of its members produces mercury or uses the amalgamation technique for recovery of precious metals (NACEC 2008). This statement does not appear to cover the practices of many smaller miners who are not members of Camimex.

Secondary mercury production in tailings reprocessing facilities around Zacatecas City and around El Pedernalillo Dam – arguably contributing at the same time to local land remediation – was reported to be 33.3 metric tons annually before 1996 (Profepa 1996, as cited by NACEC 2008). While no official data are available, there is reason to estimate that some 30 tonnes of mercury per year are still produced from secondary tailings, and may continue to be produced into the future in the absence of restrictions.⁷ Furthermore, if there are no restrictions, there is the potential for increased mercury production from tailings and various other mine sources if the mercury price becomes substantially more attractive.

Future projections could therefore be somewhat complicated. It may be assumed that Mexican production will remain at some 30-40 tonnes until the EU export ban takes place in 2011, at which point the global mercury supply will tighten. By then Mexico will probably have in place a ban on primary mining of mercury, consistent with practices in the rest of the world. Production of mercury from mine tailings may then be permitted for as long as there is adequate legitimate demand in the region, but as regional demand declines (and regional exports are prohibited), this source of mercury should decline as well.

5.1.2 Mercury cell chlor-alkali facilities

There is a large quantity of process mercury at the bottom of the electrolytic “cells” that is necessary for the “mercury cell” chlor-alkali production process to function. When a mercury cell facility is closed or converted to the membrane process (“decommissioned”), the mercury may be removed. In the past this mercury has typically been reused within the industry, or it has been sold outside the industry on the international market. Lacking specific regulations or industry agreements to prevent it, it may be anticipated that the mercury recovered from the recently closed facilities in Mexico and Brasil will likewise either be reused within the industry or placed on the market during the period 2010-2012.

The mercury process is considered to be old technology (not BAT, according to the European *IPPC Reference Document on Best Available Techniques in the Chlor-Alkali Manufacturing Industry* – BREF 2001), with a variety of mercury releases and losses, some of which have proven impossible to control. No new mercury cell facilities have been constructed in Latin America and the Caribbean for more than 10 years, and the last mercury cell expansion anywhere in the world was put in service in Perú about five years ago. The Indian chlor-alkali producers have announced plans to phase out their remaining mercury facilities by 2012. The United States will reportedly have four plants left at the end of 2009. Among the major users, only the Europeans, who invested

⁷ It was reported by Sr. José Castro Díaz, Mercury Risk Management Programme of Mexico, Centro de Análisis y Acción en Tóxicos y sus Alternativas (CAATA), at the Montevideo regional workshop on mercury storage (April 2009) that China has expressed an interest in mercury coming from Mexico, and that the Chinese have already visited Querétaro mines.

heavily in mercury technology into the 1960s and 1970s, are slow to phase out mercury cells, promising to do so by 2020 at the latest.

Since there is no timetable yet for Latin American and Caribbean facilities to close or convert to a mercury-free process, it is assumed that general international pressure will encourage them to phase out by around 2022, as indicated in Table 5 below. At that time the mercury inventory held in the electrolytic cells will be recovered, and for the purpose of this analysis, the recovered mercury is allocated over the years 2013-2025.

Apart from the metallic mercury in the electrolytic cells, mercury waste is also generated by chlor-alkali facilities, which may account for 50-75% of the mercury consumed (see Table 5). It is possible to retort and recover most of the mercury from the waste, but until now this is not common practice in Latin America nor in the Caribbean.

Table 5 Mercury cell chlor-alkali capacity in Latin America and the Caribbean, 2005

	Approx. chlorine production capacity (tonnes/yr.)	Approx. cellroom mercury inventory (tonnes)	Assumed phase-out period	Mercury consumption (tonnes/yr.)	Mercury in wastes (tonnes/yr.)
South America	570,000	1,140	2010-2022	20-40	15-30
Central America and Caribbean	150,000	300	2010-2022	5-15	3-10
Total Latin American and Caribbean region	860,000	1,440		25-55	18-40

* The convention here is to calculate mercury "consumption" before any recycling of wastes, with the knowledge that, as in many industries, some waste is recycled in order to recover the mercury, while most mercury waste is sent for disposal.

Sources: UNEP 2006; EEB 2006; Euro Chlor 2007; WCC 2006; SRIC 2005

5.1.3 By-product mercury

Zinc ores may contain significant trace quantities of mercury, especially in those regions of the world where the appropriate geological conditions exist. Gold, copper and lead ores also contain trace mercury, though typically in lower quantities than zinc ores (NRDC 2007). While the mercury content may vary greatly between regions, or from one zinc mine to another, it is often significant enough that it should be removed from the flue gases or waste streams during the processing of the ores.

Several technologies are available to control and capture mercury emissions from thermal processes at ore processing facilities. The Boliden-Norzink process uses mercuric chloride to precipitate metallic mercury as calomel (mercurous chloride). In the Outokumpu process, mercury is removed with sulphuric acid and then precipitated with selenium to produce mercury-selenium sulphate sludge. Importantly, the products of these two processes can be reprocessed to recover metallic mercury. In many South American gold mines the Merrill-Crowe Process is used to precipitate gold from a cyanide solution, followed by a filter press and then retorting of the residues to recover the mercury.

Other techniques for removing mercury from ore processing gases include the Bolchem process (which uses thiosulfate to precipitate mercury), activated carbon filters, selenium scrubbers, selenium filters and lead sulphide filters.

Zinc

World zinc production grew by 4% in 2006, an estimated 6% in 2007, and a further increase to over 12 million tonnes estimated for 2008, driven by strong growth in Asia (IMSG 2008). The opening in August 2007 of Apex Silver's San Cristobal mine (capacity 167,000 tonnes a year) significantly boosted production in Bolivia. New capacity in Perú (Cerro Lindo capacity 110,000 tonnes a year), among others, contributed to increased mine output in 2008 (IMSG 2008).

However, mercury is typically recovered during the smelting and refining process, which does not always take place at the mine itself. The main Latin American and Caribbean countries engaged in smelting zinc ores and concentrates are listed in Table 6. More recent increases in smelting capacity have likely taken place in Mexico and Perú, among others (IMSG 2008).

Table 6 Latin American mine and primary zinc smelter production ~2004

Country	Mine production (tonnes)	Primary zinc smelter production (tonnes)
Argentina	37,000	31,000
Bolivia	145,000	-
Brasil	200,000	260,000
Chile	36,000	-
Honduras	47,000	-
Mexico	460,000	320,000
Perú	1,250,000	196,000
Total		~800,000

Source: Mansukh (2008)

In estimating the mercury potentially recoverable worldwide from primary zinc ores (UNEP 2006), Boliden company officials listed the zinc smelters using Boliden mercury removal technology. While two Chilean smelters were said to have installed Boliden equipment to control mercury emissions, no by-product mercury production has been documented there. It appears that in Latin America most mercury in zinc ores is disposed of with the processing waste, or released to the environment.

Mercury removal technology is most cost-effective (and most likely to be installed in the future) on the largest smelters, which are responsible for 60-80% of Latin American primary zinc smelting. As a reference for the amount of trace mercury in Latin American zinc ores, it has been shown that Finland recovered .01-.04% mercury (depending on the source of the ores) compared to its smelter production of zinc, i.e., 1-4 ppm of Hg for every 10,000 ppm of zinc. If one assumes even the lower part of that range for Latin America – .01-.02% Hg/Zn x 70% x 800,000 t – one arrives at a potential mercury recovery of more than 80 tonnes per year.

Considering the general growth in global demand for zinc (at least until the recent economic downturn), along with increases in Latin American smelting capacity as mentioned above, it may be assumed that recoverable mercury from large smelting operations could be on the order of 80-120 tonnes per year in the near to medium term.

Moreover, it is likely that by 2015-2020 Latin American governments will require mercury to be recovered from all of the larger zinc smelters, as they are frequently a significant contributor of mercury emissions to the environment. It is also assumed – in order to have an overall estimate of the mercury supply available – that all of the mercury-containing waste will then be processed to recover mercury.

Gold and other ores

With regard to recovery of mercury as a by-product of industrial gold mining (as opposed to artisanal and small-scale gold mining) operations, the main sources are South America and the United States of America. Overall there are five gold mines in South America now recovering mercury – three in Perú (Pierina, Lagunas Norte and Yanacocha), one in Chile, and one in Argentina (Veladero). The total amount of mercury recovered from mines in Chile and Perú is estimated at 100-200 metric tonnes annually (Lawrence 2009), most of which appears to be exported to the U.S. Yanacocha alone produced around 70 tonnes of Hg in 2000.

Figure 2 Shipping container with flasks of by-product mercury in preparation for transport from Yanacocha



Photograph courtesy of Newmont Mining Corporation

In addition to those countries, the mercury output of the Zaldivar copper mine in Chile and the Paracatu gold mine expansion project in Brasil remain to be confirmed. Meanwhile the large Pascua-Lama gold project (which will also produce a significant amount of Hg) straddling the Argentina-Chile border is waiting for final approval, the Cerro Casale gold/copper project and the Lobo Marte gold project are under study in Chile, and the Fruta de Norte project is under study in Ecuador.

In total, while the present production of mercury appears to be in the range of 150 tonnes/year, the potential in the near- to mid-term is significantly higher. For the purpose of this analysis it is assumed that mercury recovery from Latin American mines (other than zinc) will increase to around 200 tonnes/year by 2015 and remain more or less at that level into the future.

Natural gas

In many countries natural gas is cleaned to remove dangerous levels of mercury (UNEP 2006). Various Latin American and Caribbean countries produce natural gas, and it was reported by Mr. Martin Penna, Executive Director of the World Chlorine Council, at the Montevideo regional workshop on mercury storage (April 2009) that Brasil recovers a significant quantity of mercury from this source. However, this research uncovered no information about quantities of mercury recovered from natural gas in the region.

5.1.4 Recycling

Simply in order to facilitate the methodology described in Section 3, recycling is also considered as a “source” of mercury. Like other mercury sources, it may be exploited or managed through a variety of policies that focus on mercury-containing products as they enter the waste stream, and/or residual mercury and wastes from industrial processes.

With regard to the use of mercury in artisanal and small-scale gold mining (ASGM), since this is a rather special and diverse area of mercury use, it is not helpful to estimate how much mercury used in ASGM may be subsequently retorted or otherwise recovered. Instead, such instances are included in this analysis as simply a decrease in the consumption of mercury in ASGM, which is already accounted for in the projections presented in Table 4.

In the chlor-alkali industry, very little of the mercury in the waste stream is presently recycled in Latin America and the Caribbean. Due to the time frame during which most of the mercury cell facilities will probably be phased out (see Table 4), and the limited amount of waste that may be recycled during this period of time, it is suggested to ignore this relatively small source of recycled mercury for this analysis.

Various mercury products are collected for recycling in different parts of the world, especially measuring devices (mainly thermometers and blood pressure measuring instruments), batteries, lamps, dental amalgam, etc. For all of Latin America and the Caribbean, based on research into the waste pathways followed by mercury-added products (MPP 2008), it is estimated that about 3% of the mercury consumed in products is presently recycled, particularly blood pressure instruments used in health clinics, dental wastes and button cell batteries. It should be mentioned that even though product recycling is not a major “source” of mercury in the region, it is nevertheless an area where immediate action may be taken by governments and regional authorities to encourage mercury-free alternatives, as well as separation and responsible management of mercury waste.

The future evolution of the recycling rate for products is highly dependent on government policies – not only those dealing with end-of-life products, but also those concerning the disposal of hazardous wastes. It has been observed that as hazardous waste disposal becomes more costly, more mercury waste is diverted to recycling and less to other forms of disposal. Of course, this shift assumes that there remains a viable demand for mercury. At such point as the supply of mercury exceeds the demand, the financial incentive for recycling becomes much less compelling.

Based on the estimates that the EU and US may have achieved an overall 15% mercury product recycling rate, it is here assumed that Latin America and the Caribbean could achieve at least 10% by 2020 and 25% by 2040. It is evident that collection, recycling, and recovery of mercury from products may continue for several years after phase-out of a mercury-added product. However, such details have little effect on the outcome of this analysis, which is predominantly influenced by the large mercury flows.

Combining all recycling efforts, the baseline recycling data for 2005 and basic assumptions regarding future mercury recycling in Latin America and the Caribbean during the period 2010-2050 are summarized in Table 7 below.

Table 7 Basic assumptions regarding LA&C mercury recycling 2010-2050 (tonnes)

	Consumption	Recycling	
	2005	2005	Forecast 2010-2050
Processes			
Artisanal and small-scale gold mining	165-330	Included simply as reduced consumption.	Included simply as reduced consumption
Chlor-alkali production	30-65	Minimal	Too small to influence the analysis
Products			
All products combined	140-215	3% of consumption	10% of consumption by 2020, and 25% by 2040

5.1.5 Mercury stocks

In the past, reserve stocks of mercury held by governments or their proxies have been traded on the world market. While this no longer seems to be the case, and the recent US mercury export ban legislation specifically forbids the government from selling its stocks, there remain various mercury inventories that may be available to the market.

Other than some stocks held on-site in storage rooms by chlor-alkali producers, it is likely there are other commercial stocks remaining as well, especially in light of increased speculation by brokers, fuelled by the volatility of mercury prices since 2004. Furthermore, it is estimated that most commercial mercury users maintain inventories of two to six months' expected consumption.

In any case, for this analysis mercury stocks may not be considered in the same manner as other mercury "supplies" that are generated every year. Rather, stocks should be considered as inventories held in reserve, and brought out only as needed under special circumstances – to dampen or to take advantage of price fluctuations, to meet sudden surges in demand, etc.

While it may be assumed that various Latin American and Caribbean mercury stocks may be made available to meet modest shortfalls in supply, there are no reliable regional data on the quantities involved. Therefore, merely for the purposes of this analysis, it is assumed that the region presently maintains mercury stocks of some 300-500 tonnes.

5.2 Future Latin American and Caribbean mercury supply

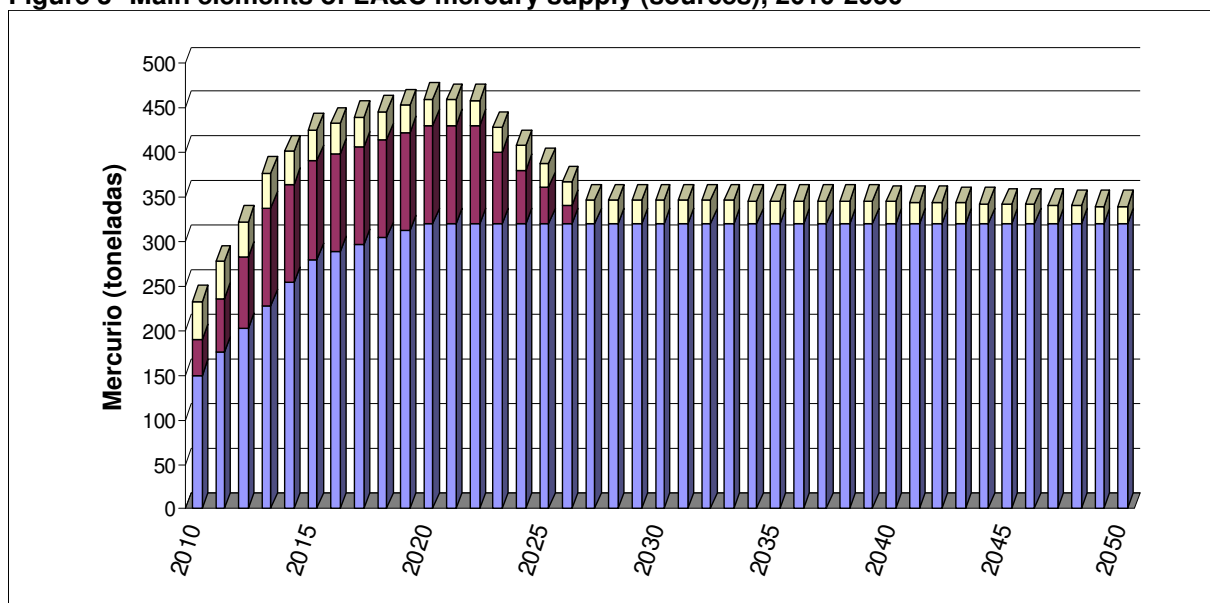
Overall, the evolution of the main Latin American and Caribbean regional sources of mercury during the period 2010-2050, as described in Sections 5.1.1 through 5.1.4, is summarised in Table 8 below. These are all sources generated within the region.

Table 8 Latin American and Caribbean “sources” of elemental mercury (tonnes)

“Source”	Quantity of Hg “produced” (2005)	Evolution 2010-2050
Mercury mining and/or processing of mine tailings	~30	30-40 tonnes/yr., decreasing as regional demand decreases
Decommissioned chlor-alkali facilities	unknown	1,480 tonnes of Hg from decommissioned Hg cells becomes available during 2010-2025
By-product mercury - zinc	0	80 tonnes/yr. by 2015 and 120 tonnes/yr. by 2020
By-product mercury - gold	~150	150 tonnes increasing to 200 tonnes/yr. by 2015
Recycled Hg from products	3% of 140-215	10% of consumption (evolving as in Table 4 for each product category) by 2020, and 25% by 2040
<i>Inventory (not a “source”):</i> Mercury stocks	unknown	as needed

The same projection is shown graphically in Figure 3 below. It is evident that by-product mercury and (for the next 15 years) mercury recovered from decommissioned chlor-alkali plants will be the main sources of mercury in the Latin American and Caribbean region, although up to now most of the recovered by-product mercury has been exported to the U.S.

Figure 3 Main elements of LA&C mercury supply (sources), 2010-2050



Key: blue = by-product mercury (zinc and gold ores); mauve = decommissioned chlor-alkali; yellow = other sources, esp. mercury mine tailings and recycling

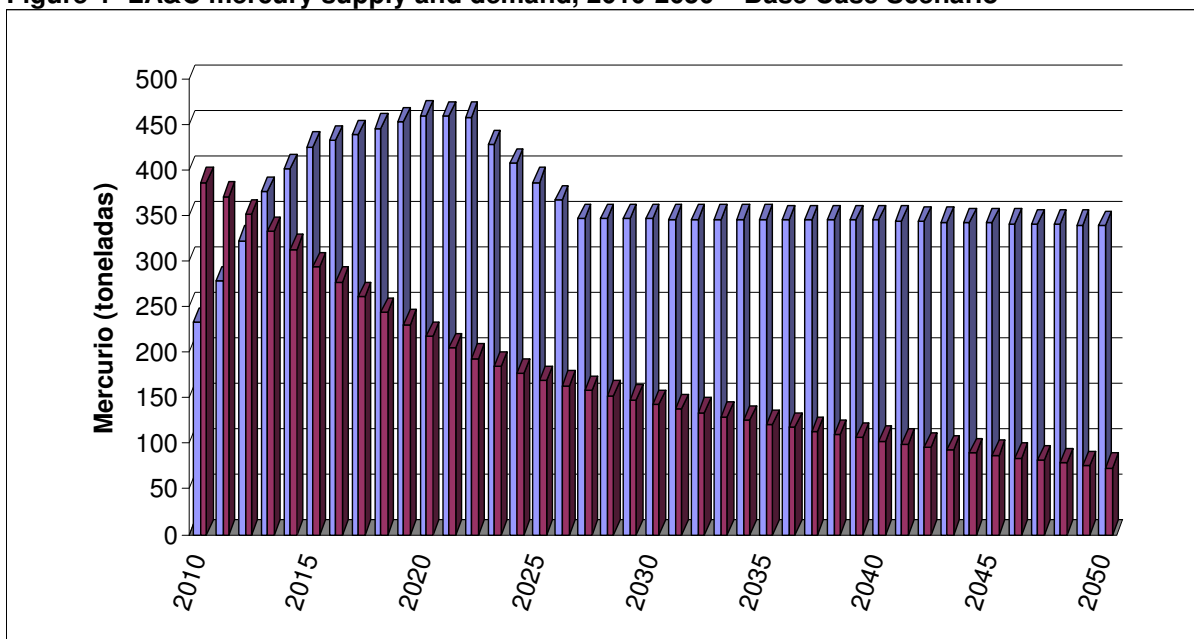
6 Excess mercury in Latin America and the Caribbean

6.1 Latin American and Caribbean Base Case Scenario

If one now combines the regional mercury supply (including by-product mercury that is now exported) with regional demand, the net or excess regional availability of mercury may be seen. Recalling the main assumptions, this “base case” scenario treats Latin America and the Caribbean as a “closed system.” The scenario is based only on domestic sources and uses of mercury, it assumes no exports from or imports to the region, it assumes that Mexico continues to produce a modest amount of mercury from small mines and tailings, it assumes a gradual increase in mercury recovered as a by-product from regional gold and other mining operations, and it assumes a more significant increase in recovery of mercury from the major non-ferrous metal smelters.

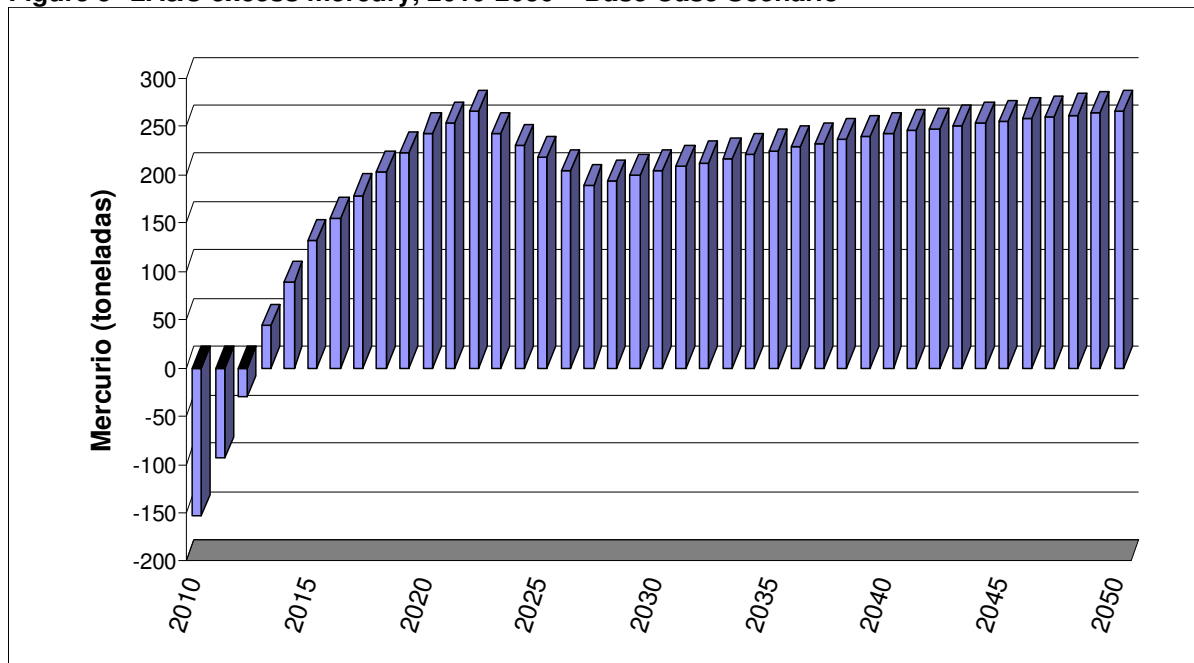
Figure 4 below combines the regional supply and demand information from the previous Figure 1 and Figure 3. Again, assuming that all by-product and other regional mercury sources remain within the region, Figure 4 shows that the regional mercury supply may be expected to considerably outweigh regional demand in the future.

Figure 4 LA&C mercury supply and demand, 2010-2050 – Base Case Scenario



Key: blue = mercury supply; mauve = mercury demand

Further combining the regional mercury supply and demand quantities, Figure 5 shows only the net difference between annual supply and demand. It concludes that a regional excess of mercury may be anticipated as early as 2013. While a relatively small amount of excess mercury will not have a visible impact on the Latin American and Caribbean mercury market, after a few years of surplus (if the surplus is not stored or otherwise removed from the market) the mercury price could be expected to decline.

Figure 5 LA&C excess mercury, 2010-2050 – Base Case Scenario

Based on the preceding assumptions and analysis, the Base Case Scenario is considered the most useful basis for further discussions of a Latin American and Caribbean mercury storage strategy. Since this is the most straightforward base case for showing excess mercury generated in the Latin American and Caribbean region during the period 2010-2050, the detailed calculations supporting Figure 5 above are included in the Appendix.

Under this Base Case Scenario, the quantity of excess mercury accumulated between 2013 and 2050, and potentially requiring storage, amounts to just over 8,000 tonnes, as detailed in the Appendix.

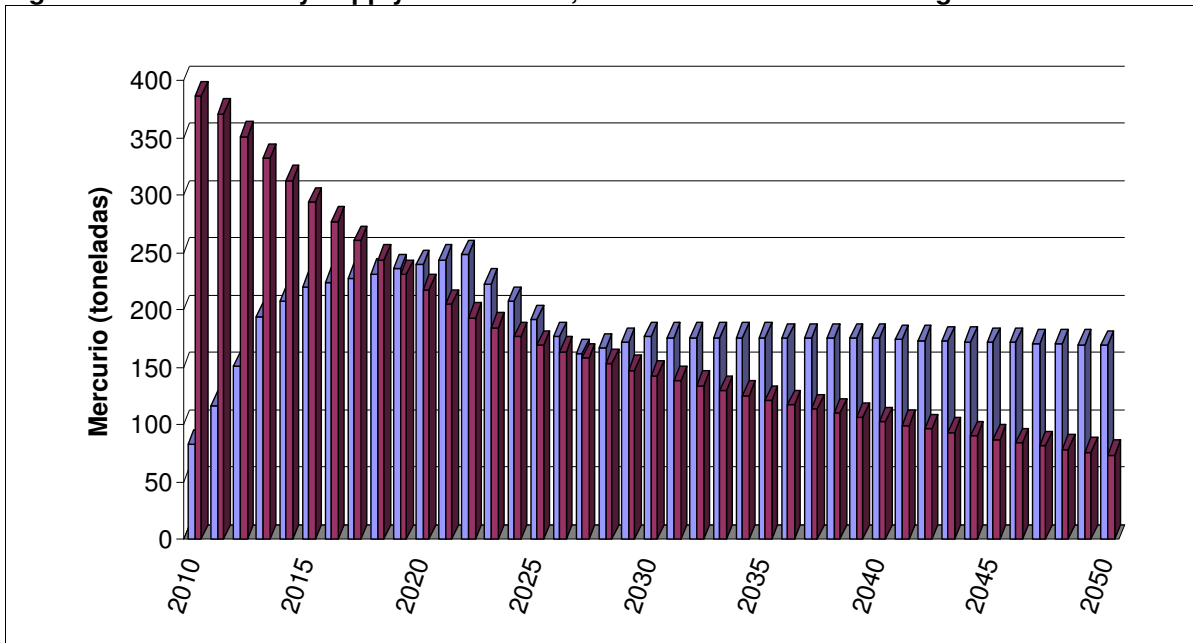
6.2 Latin American and Caribbean Minimum Storage Scenario

In order to test the sensitivity of the above analysis to a change in some of the “base case” assumptions, the following Base Case assumptions have been substantially modified:

- The Base Case Scenario assumed that the international gold mining companies would keep their by-product mercury inside South America. The Minimum Storage Scenario assumes that they will export (as they do currently) 150 tonnes of mercury per year to the U.S. or elsewhere, even if they are obliged to pay for storage when it cannot be re-exported (e.g. from the U.S., after 2013).
- The Base Case Scenario assumed that the zinc mining companies would recover 80 tonnes of mercury per year by 2015 and 120 tonnes of mercury per year by 2020. The Minimum Storage Scenario assumes that they will recover only 50 tonnes of mercury per year by 2020 and 100 tonnes of mercury per year by 2030.

Figure 6 below combines the modified regional supply and demand information for the Minimum Storage Scenario. It shows that even in a “limited supply” scenario, the regional mercury supply still exceeds regional demand after about 2019.

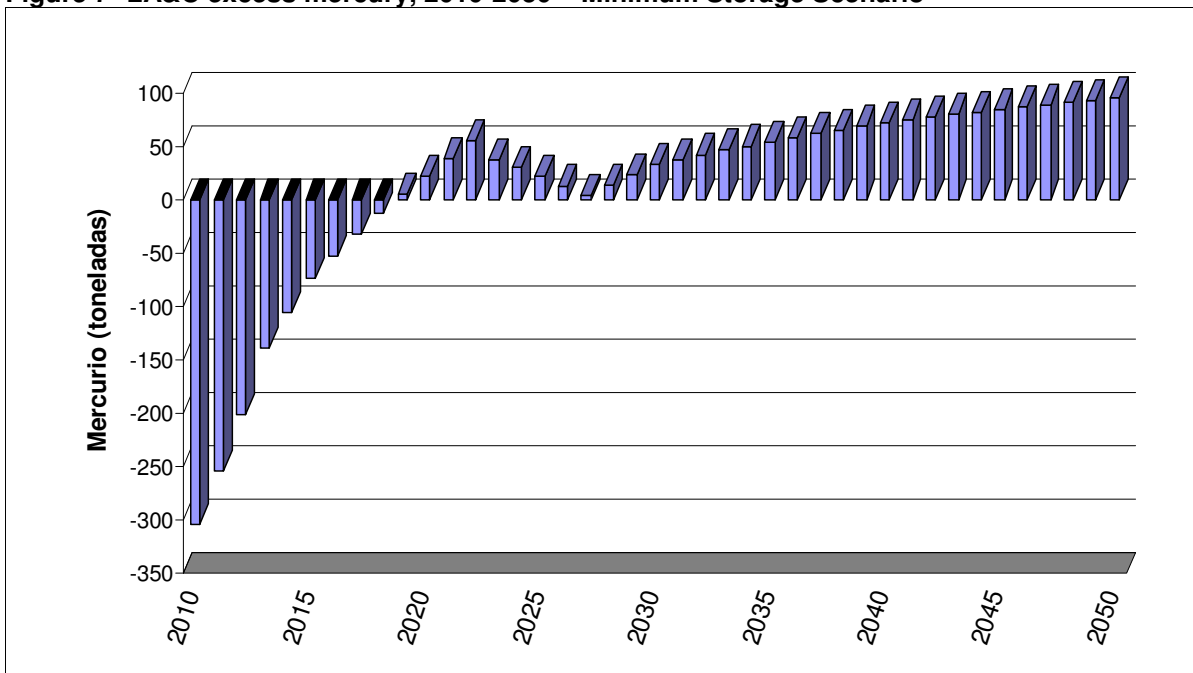
Figure 6 LA&C mercury supply and demand, 2010-2050 – Minimum Storage Scenario



Key: blue = mercury supply; mauve = mercury demand

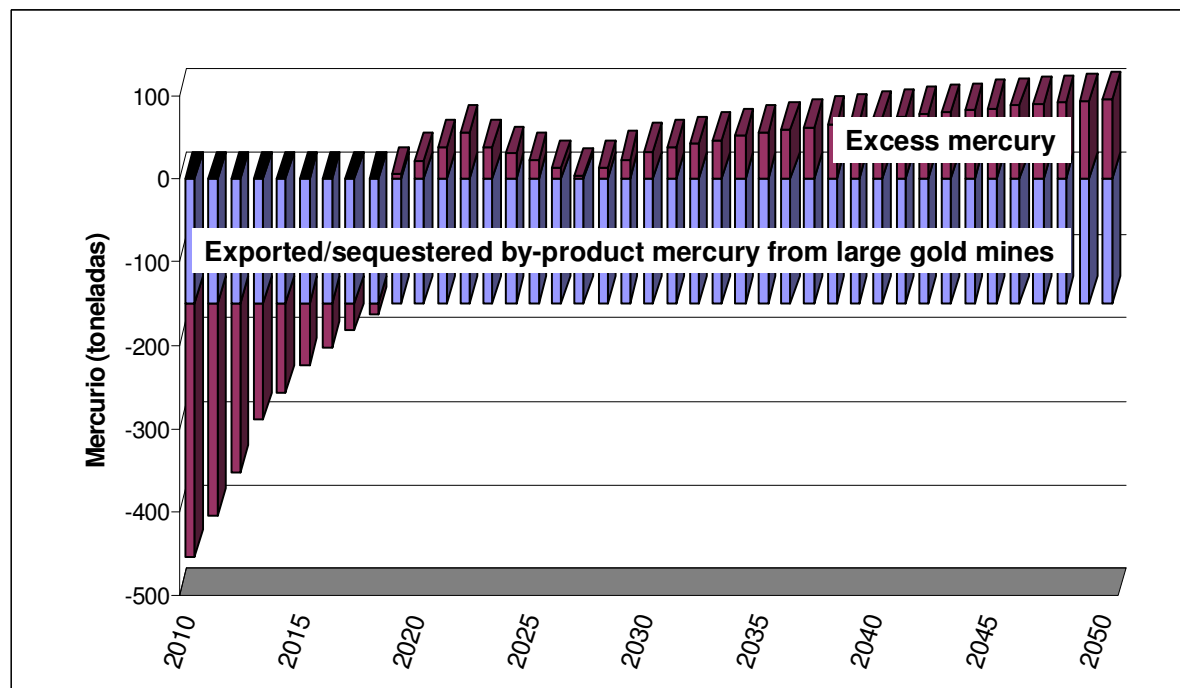
Further combining the regional mercury supply and demand quantities in the Minimum Storage Scenario, Figure 7 shows only the net difference between annual supply and demand. According to this Minimum Storage Scenario, the quantity of excess mercury accumulated up to 2050, and potentially requiring storage, amounts to nearly 2,000 tonnes. Moreover, as in the Base Case Scenario, it should be kept in mind that there are also stocks and other smaller sources that could add to this excess mercury.

Figure 7 LA&C excess mercury, 2010-2050 – Minimum Storage Scenario



An alternative presentation of Figure 7 is shown in Figure 8 below, in which the 150 tonnes per year of by-product mercury assumed to be exported or sequestered by international gold mining companies is specifically highlighted in the figure.

Figure 8 LA&C excess mercury, 2010-2050 – Minimum Storage Scenario, showing exported/sequestered by-product mercury from large gold mines



6.3 Key observations regarding the scenarios

Significantly, neither storage scenario takes into account the possibility of accelerated reductions in the mercury supply as a result of a policy of intentional storage of certain sources of mercury (e.g. by-product mercury from mining, or mercury recovered from decommissioned chlor-alkali facilities). As previously noted, such a proactive storage policy could help to reduce the availability of mercury in the region, thereby helping greatly to reduce mercury demand, particularly for the ASGM sector. If this sort of policy is adopted, mercury storage could begin as soon as regional storage capacity is available, which argues for the development of storage capacity as soon as possible – even before 2013.

Second, it is obvious that many assumptions integral to this analysis may be modified in various ways. However, the Minimum Storage Scenario already includes such substantial modifications to the Base Case Scenario that it is difficult to imagine a realistic set of circumstances that would have any greater affect on the estimated excess of mercury supply over demand. Therefore, the Minimum Storage Scenario would appear to represent the absolute minimum “laissez-faire” storage requirement.

7 Observations and conclusions

Despite its potential regional mercury excess, the Latin American and Caribbean region is a significant importer of mercury at the present time. The vast majority of the imported mercury is used for small-scale gold mining, with lesser amounts in mercury-added products and for use in the chlor-alkali industry. The timing of an anticipated mercury excess in Latin America and the Caribbean depends greatly on the timing and magnitude of demand reduction in these key sectors, as well as policy decisions about recovering mercury from zinc smelting, and about whether to keep by-product mercury in Latin America and the Caribbean.

Since UNIDO and other experts have determined that mercury supply reductions can contribute to significant demand reductions in artisanal and small-scale gold mining, supply and demand reductions for this sector are mutually reinforcing, and to some extent supply reductions must precede demand reductions in order to work most effectively. Therefore, for the Latin American and Caribbean region, planning for mercury storage may be especially important as an initiative to further encourage demand reduction.

According to the scenarios assessed in this report, an excess of mercury supply over demand in Latin America and the Caribbean is expected to be seen sometime between 2013 and 2019. This time frame could be nearer 2013 if significant by-product mercury is generated in response to stricter requirements imposed on the metal processing sector, and if by-product mercury is not exported. Or the time frame could be closer to 2019 if by-product mercury exports continue.

The scenarios assessed in this report assume gradual demand reductions throughout the 2010-2050 period. If the mercury supply is restricted at the same time in order to reduce the demand for mercury in small-scale gold mining, this would also advance the need for storage capacity. In fact, if regional storage capacity were available before 2013, Latin American and Caribbean governments would have access to the valuable policy tool of storing mercury in order to reduce the market supply, thereby also reducing demand for mercury.

In any case, substantial excess mercury may be expected in Latin America and the Caribbean during the next five to ten years. The quantity of mercury requiring storage, as accumulated between 2013 and 2050 in the Base Case Scenario, may even exceed 8,000 tonnes.

As suggested, in order to help reduce mercury consumption, it is possible that regional authorities may decide to accelerate the storage of excess mercury. In this case they would likely follow the hierarchy established by the European Union, whereby any mercury recovered from decommissioned chlor-alkali facilities would be stored first, and then by-product mercury recovered from metal ore processing would be stored as a second priority. This option would call for the development of regional storage capacity as soon as governments can reach agreement on the form that such storage would take.

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Appendix

– Most likely scenario for excess mercury in LA&C

The tables in this appendix provide 5-year snapshots of the calculations behind the Base Case Scenario (see Section 6.1) for future mercury sources and uses in Latin America and the Caribbean, showing the excess mercury that would likely be generated in the region during the period 2010-2050.

Latin American and Caribbean elemental mercury excess, 2010-2050 (tonnes) – Base Case Scenario

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Sources of mercury									
Mercury mining and/or processing of tailings	35	27	20	15	13	11	9	8	7
Decommissioned chlor-alkali facilities	40	110	110	40	0	0	0	0	0
By-product mercury - zinc	0	80	120	120	120	120	120	120	120
By-product mercury - gold	150	200	200	200	200	200	200	200	200
Recycled Hg from products	8	9	10	11	13	15	16	14	12
Mercury stocks (300-500 tonnes)	?	?	?	?	?	?	?	?	?
Total Hg "sources"	233	425	460	387	346	346	345	342	339
Consumption of mercury									
Artisanal & small-scale gold mining	200	152	112	86	67	52	40	31	24
Chlor-alkali	40	25	7	0	0	0	0	0	0
Batteries	13	5	3	0	0	0	0	0	0
Dental applications	62	57	54	51	47	44	41	37	34
Measuring and control devices	25	14	7	0	0	0	0	0	0
Lamps incl. exports	14	12	11	9	8	7	6	4	3
Electrical and electronic devices	11	7	6	5	4	3	2	1	0
Other	23	21	19	18	17	16	15	14	13
Total Hg consumption products & processes	387	294	218	169	143	121	103	87	73
Annual excess (-deficit) mercury									
	-154	132	242	218	203	225	242	255	266
Cumulative excess mercury (tonnes Hg)									
	0	264	1263	2473	3460	4543	5721	6971	8279