Assessing the Impacts of the Mercury Export Ban Act of 2008 on the U.S. Mercury Recycling Industry – 11163

Cliff Carpenter*, Letitia O'Conor**, John Elmer***, and Darlene DePinho***
* U.S. Department of Energy Office of Legacy Management, Morgantown, West Virginia 26505
** U.S. Department of Energy Office of Environmental Management, Morgantown, West Virginia 26505
*** S.M. Stoller Corporation, Grand Junction, Colorado 81503

ABSTRACT

Because of a large surplus of commodity mercury and the health and environmental issues associated with it, the United States and other countries are engaged in a concerted effort to reduce its use and presence in the environment. The United States, the European Union, and the United Nations are taking measures to control the distribution and long-term management of mercury as it transitions from a commodity to a liability. In the United States, the Mercury Export Ban Act of 2008 (MEBA) is a part of this control process and prohibits exports of elemental mercury from the United States to foreign countries. When the prohibition on export of elemental mercury (enacted under MEBA) becomes effective on January 1, 2013, the U.S. Department of Energy (DOE) is required to provide long-term management and storage capabilities for domestic sources of discarded elemental mercury. DOE is also required to determine the impact of the long-term mercury storage program on the domestic mercury recycling industry and to provide a report to the U.S. Congress by July 1, 2014. The recycling industry retorts and recovers mercury waste from chemical, medical, and other industries; imports; and gold-mining byproducts. Imports and byproducts are the main sources of domestic commodity mercury. The manufacture of chlorine and caustic soda (chlor-alkali) using the mercury cell process is the largest industrial use of mercury in the United States. As these chlor-alkali plants retrofit their manufacturing processes with non-mercury cells, excess mercury will need to be managed in an environmentally sound manner.

There are four major mercury reprocessing companies that manage commodity mercury (defined as 99.99 percent pure by volume) in the United States. These companies have historically made recycling mercury a viable industry because of worldwide demand. Changing the supply and demand markets may influence the recyclers, especially if they can no longer sell the mercury and must pay for its long-term storage. This study discusses the domestic and international perspectives of the current supply and demand of elemental mercury, status of the mercury recycling industry, and potential impacts of long-term storage on mercury recycling.

INTRODUCTION

Mercury is considered a global pollutant that persists in the environment and cannot be broken down into less harmful forms. It is found worldwide in the atmosphere, soil, and water, and its presence results from both anthropogenic and natural sources. Mercury that has bioaccumulated in fish has resulted in a significant source of exposure in humans [1].

The United States and other countries have accumulated a large surplus of commodity mercury (defined as 99.99 percent pure by volume), and based on human health and environmental concerns there is a worldwide effort to reduce its use [2]. As a result, the federal government, the European Union (EU), and the United Nations are taking measures to control the distribution and long-term management of mercury as it transitions from a commodity to a liability. In the United States, the Mercury Export Ban Act of 2008 (MEBA), Public Law 110-414, is a part of this control process and prohibits exports of domestic elemental mercury to foreign countries, effective January 1, 2013. A provision in MEBA requires the U.S. Department of Energy (DOE) to evaluate impacts of the long-term mercury storage program on domestic mercury recycling programs and companies.

World leaders have taken steps to remove commodity mercury and mercury compounds from global markets. Working in partnership with the United States, the United Nations Environment Programme (UNEP), EU, and individual countries have established strategies to significantly reduce mercury in mercury-containing products, promoted public awareness of adverse health and environmental effects, and proposed legislation to improve mercury uses and waste management [3]. This study provides a discussion of the global and domestic status of mercury supply and demand, reduction strategies, and how they impact the domestic the mercury recycling industry.

ELEMENTAL AND OTHER FORMS OF MERCURY

Elemental mercury, or “quicksilver,” is an extremely heavy liquid metal. It is the most volatile form of mercury, and with a vapor pressure of 0.3 Pa at 25 °C, it can convert to vapor at typical room temperatures. Commodity mercury is typically sold in two types of containers: 3-L flasks, which weigh about 34 kg, and 1-metric-ton containers. In relationship to MEBA, the acceptance criterion for storage of elemental mercury is defined as 99.5 percent pure by volume [4]. Mercury processing facilities that retort mercury can produce mercury at a purity level of 99.99 percent or greater by volume.

Another form of mercury that occurs in the environment is divalent inorganic mercury (Hg [II]), which can combine with elements such as sulfur, oxygen, and chlorine to form mercury salts. These compounds, as well as several man-made mercury-containing compounds, have a variety of uses, such as production of topical medicines, leather tanning, paint pigments, fungicides and germicides, catalysts in analytical reactions, organic synthesis, metallurgy, dry batteries, photography, and lithography. The mercury salt, mercury (I) chloride, also known as calomel, is a byproduct from air pollution control devices in the gold-mining industry. Mercury sulfide (HgS) is the mineral cinnabar, which was mined in the United States as a source of mercury until 1992. Mercury alloys or amalgams are mixtures made of metallic bonds of mercury combined with other metals [4].

Methylmercury is a neurotoxin and is the form of mercury that most easily bioaccumulates in organisms. Methylmercury is formed in the environment primarily by a process called biomethylation reaction, which is primarily carried out by sulfate-reducing bacteria that live in low dissolved oxygen environments, such as estuarine and lake-bottom sediments.

Mercury and its compounds are highly toxic to humans, ecosystems, and wildlife. Even relatively low doses can have serious neurotoxin effects on adults and children. New epidemiological findings indicate that toxic effects may occur at lower exposure levels than previously considered. Methylmercury can cross the placenta, entering the fetus and accumulating in its brain and other tissues. Hence, exposure of women of childbearing age and children is of the greatest concern [5].

MERCURY SUPPLY AND DEMAND

International Mercury Sources and Demand

In 2006, UNEP estimated that the average global supply (and demand) of metallic mercury was about 3000 metric tons per year [1]. Based on 2005 data, the main sources of mercury on the global market are summarized in Table I:

Table I. Sources of Global Mercury Supply in 2005 [1].

Mercury Supply Sector	Range (metric tons)
Primary mercury mining	1350–1600
Byproduct	450–600
Recycled mercury from chlor-alkali wastes	90–140
Recycled mercury—others	450–520
Mercury from decommissioned chlor-alkali cells	600–800 0–200 (in stock)
Range of Total	**2900–3900**

Mercury is currently mined only in Kyrgyzstan and China. Kyrgyzstan exports almost all the mercury it mines; China currently mines mercury primarily to meet its domestic demand. The remaining mercury supplies come from secondary sources, such as industrial wastes and scrap products, byproduct from mining of gold and other metals, and from closing mercury-cell chlor-alkali plants [1].

The European Commission (EC) estimates that current world demand for mercury is approximately 3450 metric tons per year [1]. While global demand remained fairly constant from 2000 to 2005, the distribution of mercury demand has changed. With the price of gold increasing, small-scale gold mining has increased the use of mercury by 54 percent. Artisanal mining operations are now the largest users of mercury, with estimates ranging from 600 to 1000 metric tons per year [6]. Vinyl chloride monomer manufacture (acetone process) predominantly in China increased from an insignificant use of mercury in 2000 to 700 metric tons in 2005. During this same time period, the use of mercury in products decreased from 57 percent to 32 percent, and chlor-alkali manufacture decreased from 24 percent to 18 percent [1].

The global price per metric ton of mercury has increased from about $4000 per metric ton in 2000 to over $16,000 per metric ton in 2007 [1]. In the wake of the EU and U.S. mercury export bans, it is expected that the price of mercury will continue to increase. It is also expected that

given the high price of gold, the demand for mercury by developing countries will also continue to increase [6].

Domestic Mercury Sources

According to EPA, there are five main domestic sources of commodity mercury in the United States [7]:

- Closing and retrofitting chlor-alkali plants (these plants produce chlorine and caustic sodas using mercury cells).
- Consumer product recycling and mercury waste recovery.
- Byproduct from mining gold, silver, and zinc.
- Import of commodity-grade mercury.
- Import of calomel.

These domestic sources are described in the following sections.

The chlor-alkali industry produces chlorine and caustic soda using three types of processes: mercury cell, diaphragm cell, and membrane cell technologies. If chlor-alkali plants change from the mercury cell technology to diaphragm or membrane cells, mercury use in the plants would be eliminated. Four remaining plants use mercury cell technology in the United States. Approximately 1100 metric tons of mercury will need to be managed by recycling, sale, or storage/disposal once these plants close or eliminate the use of mercury in their production processes [8]. All domestic chlor-alkali plants are scheduled to shift from their mercury cell technology by 2018.

Currently, limited recycling data are available for mercury-containing products because there are no regulatory requirements to recycle them. In addition, when the items are recycled, typically only minimal tracking systems are in place to collect product-specific data.

The National Electrical Manufacturers Association states that more than 50 million mercury switch thermostats are currently in use [9]. Thermostats are one of the main consumer products that contain mercury. About 1.8 million mercury switch thermostats are taken out of service annually, and only 1 to 5 percent of these are being recycled.

Another consumer product that contains mercury is compact fluorescent lamps (CFLs). In 2000, the rate of recycling for fluorescent lamps was about 30 percent. Of the 30 percent, 5 percent was from residential recycling; the remaining 25 percent was from commercial fluorescent lamp recycling [9]. According to these data, 70 percent of lamps and 95 percent of thermostats are disposed of as municipal waste.

Elemental mercury is produced as a byproduct from mining gold, silver, and zinc. Mercury as a mining byproduct is a significant source of elemental mercury in the United States. The mining byproduct is typically sold to three primary recyclers: Bethlehem Apparatus, D.F. Goldsmith, and Mercury Waste Solutions [10].

Byproduct mercury is produced by distilling or retorting mercury from the host rock and collecting the resulting liquid mercury during one or more of the metal extraction processes [11]. Byproduct mercury from mining gold is estimated at 4.5 to 64 metric tons per year from Nevada, California, and Utah gold mines [12]. In 2006, the total annual supply of commodity-grade mercury in the United States created as a byproduct from metal-mining industries was 118 metric tons [11].

Imports and Exports of Mercury

Table II shows recent data on imports and exports of commodity-grade mercury and calomel.

Table II. Imports and Exports in Metric Tons [13].

Year	Mercury Equivalents of Calomel Imports	Imports of Elemental Mercury	Total Imports	Total Exports	Net Exports
2002	27	210	237	324	87
2003	11	46	57	287	230
2004	207	92	299	279	–20
2005	328	212	540	319	–221
2006	58	94	152	390	238
Average	**126**	**131**	**257**	**320**	**63**

The majority of mercury imports to the United States come from Peru (approximately 60 percent); imports also come from Germany, Russia, and Chile. In addition, India exports recyclable mercury to the United States [8].

Exportation is also a part of the domestic mercury economy. The United States mainly exports mercury to Australia, Netherlands, and Peru [14]. Other exports and imports include unspecified mercury compounds such as mercuric chloride, mercuric iodide, mercurous chloride and amalgams [8].

Domestic Mercury Demand

Currently in the United States, the largest industrial use of mercury is in chlor-alkali manufacturing [15]. Four plants continue to operate; together they use approximately 1100 metric tons of elemental mercury per year [16].

Other sources of industrial uses of mercury are products and components, such as switches and relays, dental amalgam, thermostats, lamps, button cell batteries and formulated products such as coating materials, acids, alkalis, bleach, pharmaceutical products, stains, reagents, preservatives, cosmetics, and dyes [17].

Table III shows the total weight of mercury sold per specified year in consumer products and components.

Table III. Total Amount of Mercury Sold in Fabricated and Formulated Products in the United States, 2001–2007 [18].

Products/Components	Total Mercury Sold in the U.S. in Metric Tons		
	2001	2004	2007
Switches and Relays	52.44	46.97	27.91
Dental Amalgam	27.91	27.57	14.95
Thermostats	13.27	12.85	3.50
Lamps	9.22	8.67	9.64
Miscellaneous	4.64	2.18	2.52
Batteries	2.68	2.30	1.88
Other products*	5.46	4.35	2.32
Total (approximate)	**115.6**	**104.51**	**62.78**
*Chemicals, sphygmomanometers, thermometers, manometers, and barometers			

As seen in Table III, the total amount of mercury use in products has decreased since 2001. According to Northeast Waste Management Officials' Association (NEWMOA), this decreasing trend in use will continue.

INTERNATIONAL AND DOMESTIC MERCURY REDUCTION STRATEGIES

International Mercury Reduction Strategies

According to UNEP, the fact that mercury is a global pollutant makes it a matter of international concern. UNEP noted that some of the highest human exposures are in native Arctic communities, where mercury has bioaccumulated in fish, which is the main food source of traditional diets [19]. In February 2009, the Governing Council agreed that a legally binding international treaty was needed to adequately control the use and release of mercury in order to protect human health and the environment. An International Negotiating Committee is currently undertaking this initiative with an established deadline of February 2013 for completion. Storage of surplus elemental mercury is a very important issue, as it underlies all of the issues regarding mercury reduction from emissions to waste.

The EU has made significant progress in addressing the global challenges of mercury since it launched the EU mercury strategy in 2005. This has resulted in restrictions on the sale of measuring devices containing mercury, a ban on exports of elemental mercury and some mercury compounds from the EU countries that will come into force in 2011, and new rules on safe storage. The EU's mercury strategy is a comprehensive plan addressing mercury pollution both in the EU and globally. It contains 20 measures to reduce mercury emissions, cut supply and demand, and protect against exposure, especially to methylmercury found in fish [20].

The objective of the EU ban is to reduce mercury emissions, supply, and demand to a minimum as quickly as possible [21]. A primary EU concern is that mercury is going to developing countries, where it is often used without regard for safety or environmental concerns. This is resulting in contamination of workers, their families, and local community food and water supplies and is contributing to a global degradation of air quality. The EU mercury reduction strategy includes a trade tracking system; a scope that covers elemental mercury, mercury

compounds, and mercury-containing products; required conversions of chlor-alkali plants to non-mercury technologies; and a platform to encourage similar bans and some level of conformance in other countries [21].

EU regulations that relate to mercury recycling include both what is referred to as WEEE (waste electrical and electronic equipment) and RoHS (restrictions on use of hazardous substances). WEEE imposes responsibility for the disposal of waste electrical and electronic equipment on the manufacturers, which is an end-of-life management regulation. RoHS requires manufacturers to avoid using certain chemicals in their products. Each of the 27 EU member countries implements these regulations in their region. Some of the sovereign nations have been successful with WEEE. For example, in 2005, Switzerland recycled 60–70 percent of their electrical devices and electronics, and Austria recycled over 50 percent of mercury-containing lamps [22]. More information on the various recycling programs throughout EU nations and other countries is available in the NEWMOA report *Review of Compact Fluorescent Lamp Recycling Initiatives in the U.S. & International* [23].

Domestic Mercury Reduction Strategies

Domestic mercury reduction strategies started to gain momentum in the 1970s, and concern for uncontrolled releases of environmental toxins led to the passage of the Clean Air Act and the Clean Water Act, which in turn led to the development of regulations to control mercury as well as other forms of air and water pollution. The Resource Conservation and Recovery Act (RCRA) treatment requirements for wastes containing mercury are based on the concentration of mercury in the waste. High-mercury-containing wastes (wastes that contain more than 260 mg/kg total mercury) must generally undergo retorting or roasting to recover elemental mercury. This treatment requirement under RCRA was intended to allow for the recovery and reuse of elemental mercury (rather than treatment and disposal of mercury wastes). Thereafter, the mercury recycling industry had an important role in reducing the liability for other companies by recycling their mercury wastes [24].

Recently, more-specific mercury reduction regulations have been developed to aid in reducing mercury usage and waste. In 1999, EPA classified used fluorescent bulbs, including low-level mercury bulbs, as hazardous waste. This regulation applies to industrial and commercial consumers only, and was promulgated under RCRA at Title 40 *Code of Federal Regulations* Part 273 (Standards for Universal waste Management). In 2005, EPA promulgated the Clean Air Mercury Rule to permanently cap and reduce mercury emissions from coal-fired power plants. In addition to federal regulations, some states have developed mercury action plans and other mercury programs to reduce the use of mercury and improve mercury management.

EPA continues to promote procurement of non-mercury products by federal agencies and is building a national database of information on mercury-containing products. Voluntary partnerships, such as EPA's project with the health care industry to eliminate the use and purchase of mercury-containing medical devices and instruments, and its work with the U.S. Chlorine Institute to monitor mercury use in the remaining mercury-cell chlor-alkali plants, are encouraged [15].

DOMESTIC MERCURY RECYCLING INDUSTRY

All five main domestic sources of commodity mercury in the United States have a role in the history of mercury recycling. The idea of recycling mercury began in the late 20th century. Historically, mercury byproducts, consumer products, industrial products, etc. were recycled more for economic reasons than for human health or environmental concerns.

The regulations cited in the previous sections resulted in an overall reduction in the amount of mercury used in consumer products. In 1980, 2000 metric tons of mercury was used in consumer products. In 2004, consumer products accounted for 115.2 metric tons of mercury, while in 2007 the use of mercury in products was reduced to 69.2 metric tons (a 40 percent reduction from 2004). NEWMOA has stated that this will be a continuing trend in the future—many manufacturers will reduce mercury use in their products, with the exception of CFLs. Although manufacturers have been successful in reducing the amount of mercury in fluorescent lamps, the number of CFLs used is expected to increase exponentially due to the life span and energy savings advantages of these lamps [18].

According to NEWMOA, between 2000 and 2004, estimated CFL sales in the United States rose about 343 percent—from approximately 21 million CFLs sold in 2000 to approximately 93 million sold in 2004. By 2007, sales of all brands of CFLs in the United States totaled approximately 397 million [18]. Because CFL usage will continue to increase, the need for recycling, reprocessing, and storage for the mercury recovered from these products will continue.

New regulations and enforcement allowed the mercury recycling industry to develop appreciably during the 1990s. The mercury recycling industry grew during this time period to meet the needs of the mining industry and the chlor-alkali industry [25]. Production and recycling regulations for consumer products also increased the need for mercury recycling facilities. Now, under MEBA, mercury recycling facilities will continue to be necessary to manage the continuous domestic supply of mercury-containing products and commodity mercury.

Mercury Recycling Facilities

According to the Associations of Lighting and Mercury Recyclers (ALMR), more than 60 companies recycle mercury-containing products in the United States. These facilities do not retort mercury, but only recover mercury for further processing. Four main recycling companies—AERC Recycling, Bethlehem Apparatus, D.F. Goldsmith Chemical and Metal Corporation, and Mercury Waste Solutions, Inc.—specialize in retorting or reprocessing mercury waste to commodity-grade mercury. Most recycling facilities and state and local governments ship mercury waste to one of these four companies for reprocessing [3].

Since mercury recycling and reprocessing facilities, state and local governments, and mercury-containing consumer product industries, as well as industries that use these products, continue to manage, store, recycle, or reprocess mercury, all of these entities will continue to play a vital role in the mercury recycling system in the United States.

Mercury Recycling Statistics

Mercury recycling information is limited because, as noted by ALMR, companies are not required to report their recycling statistics. In addition, under regulated waste-reporting requirements, many mercury wastes may be generically reported under hazardous wastes and consequently might not be specifically called out as mercury. According to the Quicksilver Caucus, the ability to accurately track mercury uses and releases is both the biggest gap and greatest data challenge [26]. Because of these limitations, there is no national level of collective data for mercury recycling. However, some data are available from specific entities such as mercury recycling facilities, state governments, and individual corporations.

State Government Participation

The Environmental Council of the States (ECOS) established the Quicksilver Caucus in May 2001. Quicksilver Caucus's long-term goal is that state, federal, and international actions result in net mercury reductions to the environment [27]. The Caucus is a nationwide coalition of states that participate in the development of legislation, research, tracking systems, and public awareness programs for the "holistic" reduction of mercury in the environment. Thirteen states are engaged in the effort to address the reduction and management of mercury-containing thermostats, lamps, and dental amalgam [28]. States have car switch programs, local collection, recycling, school programs, and various legislation and regulations. Currently, all 50 states are participating in automobile mercury-recovery programs. Many automobiles have mercury-containing switches as part of the cars' convenience lights. In 2009, 896,232 vehicle switches were collected nationwide, equating to 0.9 metric ton of recycled mercury [29].

Many state and county governments have household hazardous waste management programs that assist in the implementation of mercury recycling, primarily with mercury-containing products. Mercury recycling can be either voluntary or required by the state government. Sznopek and Goonan [30] report that much of the recycling occurs in states with mercury recycling mandates, and in several states mercury recycling programs are subsidized.

Role of the Mercury Recycling Industry

The major mercury recycling companies that reprocess and manage commodity mercury for the United States have the capabilities to treat, purify, store, and manage mercury and sell the resultant commodity mercury in the open market. Each major facility's capacity to reprocess/recover mercury differs from that of the other facilities, and each facility's operation varies with the type and form of mercury that is received. AERC Recycling estimates that the company reprocesses 21 to 30 metric tons of mercury annually. Bethlehem Apparatus processes over 907 metric tons of mercury waste annually. Mercury Waste Solutions recovers over 363 metric tons of mercury annually from products and treats over 1633 metric tons of waste annually [31,32,33].

The amount of commodity mercury that these companies manage can vary greatly due to significant fluctuations in the mercury market. Since the volume of commodity mercury in the mercury recycling industry fluctuates widely, no accurate average amount of commodity

mercury can be calculated to establish a trend. In addition, these companies are not required to share information about the commodity mercury they manage; therefore, it is difficult to estimate how much mercury is bought or sold over time.

Although only limited data are available on commodity mercury produced by major reprocessing facilities, ALMR has data for the 60 smaller recycling companies it represents. ALMR estimates that these companies produce a total of 91 to 181 metric tons of mercury per year in the United States [34].

POTENTIAL IMPACTS OF MEBA AND LONG-TERM ELEMENTAL MERCURY STORAGE

International Perspective

Because the United States is part of the global market, the EU ban and UNEP initiatives will have an impact on the U.S. mercury market. Over the next three decades, world leaders believe that there will be excess supplies of commodity-grade mercury in the world market, and more specifically in the developed countries. This excess will result from current trends to avoid mercury use in consumer and industrial products and from the shift to non-mercury technologies in the chlor-alkali industry [3]. However, demand for mercury in the production of vinyl chloride monomer (in China) and use in small-scale artisanal mining (in developing countries), which is a major source of mercury emissions, is expected to increase during this same time frame. A report prepared for the EC in 2006 stated that nearly a third of the global mercury supply is used for small-scale gold mining, mostly in Africa, Asia, and South America. This trend will result in increased human exposures and mercury releases to the environment. Thus, it is likely that effective regulatory mechanisms will need to be in place for the safe, long-term management and storage of excess mercury [3].

Global economics is a significant factor in the transfer of hazardous wastes from one country to another. International transfer of hazardous wastes is based on the potential value of some hazardous wastes as secondary raw materials and the capabilities of certain countries to process these wastes. According to UNEP, “Hazardous wastes with an economic value are treated as a tradable commodity and are exported for resource recovery, recycling, reclamation, reuse or alternative use” [35]. The ability to make a profit by reprocessing hazardous wastes is the reason there is a substantial trade industry on an international level that invests in hazardous wastes destined for recycling and recovery. Recycling slows down the depletion of limited natural resources and reduces the quantity and hazardousness of wastes going to landfills. When the country importing the wastes has more environmentally sound facilities, higher environmental standards, and more effective law enforcement than the country of origin, export of hazardous wastes for recycling can result in an overall reduction of environmental pollution. From an economic standpoint, recycling of certain wastes leads to the recovery of valuable raw materials. When this is the case, there usually is an established market for the wastes in question, and the relevant trade has substantive economic significance. Recently, with the increase in gold prices, mercury has established itself as a highly traded commodity in the global market [35].

EPA's research concludes that, barring any new restrictions on supply, a significant shortage of elemental mercury is not likely to occur in the near future, mainly because of the large supply of secondary mercury in the global market; however, price swings are likely to occur, especially following the EU export ban implementation [7].

Domestic Perspective

In general, because MEBA is curtailing elemental mercury exports, the Act itself will have a negative effect on the mercury recycling industry. For example, the Congressional Budget Office recently estimated the revenue from mercury sales to commodity markets to be about $10 million per year [36]. If mercury recyclers can no longer sell mercury in commodity markets, profits decrease. The long-term storage program impacts arise when the new costs for storage (estimated by recyclers to be about $6 million per year) are added to the lost revenues. Both of these factors would likely mean the difference between success and failure for the mercury recycling industry [36].

Currently, the industry does not charge fees for recycling consumer mercury products because it sells the elemental mercury it recovers as a commodity. If there is no longer a market or mercury commodity prices drop too low to make a profit, the industry will be required to make price adjustments for treating or reclaiming mercury. Monetary impacts will vary from company to company based on their position in the commodity mercury market.

Recycling stakeholders are urging the federal government to develop a coordinated position to address government surpluses and large private-sector stocks of mercury. These stakeholders foresee an increasing need for a coordinated approach to safely manage mercury supplies over the long term, and they are looking to the federal government to address this issue with increased regulatory requirements for recycling mercury wastes and products, regulated emission controls on the dental industry and oil and coal electrical plants, and regulated releases to land and water from municipal and industrial wastewater treatment systems and the mining industry [36,37]. EPA's 2009 Report to Congress states that companies in this sector could leverage and expand their existing elemental mercury purification capacity and technology to disposal abroad, but only if they perceive sufficient market demand to justify the adoption of new technologies, processes, and permits [7].

Federal long-term storage/disposal is an option for all companies. The storage option may affect their business, depending on how much storage will cost, and the impact will vary among the companies. If the cost of storage is high, it will not be economically feasible for the companies to store mercury. If the cost of storage is nominal, it will not change the company's management of mercury [31].

The long-term storage program for elemental mercury is likely to impact mercury recycling by consumers as well as nonprofit mercury collection organizations and local recycling facilities that funnel their mercury through the major reprocessing companies. For companies to be able to afford storage, they will increase the cost to the consumer. According to AERC [31], MEBA will artificially increase the cost of recycling mercury. This inadvertently decreases mercury recycling, since customers are not required to recycle mercury-containing products. Customers

will choose not to recycle to avoid costs. As an AERC Recycling representative explained, mercury reprocessing facilities will increase the charges to the industry's customers, and if this happens, local collection facilities may choose not to accept mercury products, and consumers might not recycle. This can adversely affect the small and large recycling company and consumers [31].

REFERENCES

1. European Commission, *Requirements for Facilities and Acceptance Criteria for the Disposal of Metallic Mercury*, 07.0307/2009/530302, final report, Brussels (April 16, 2010).
2. Balistreri, Edward J., and Christopher, M. Worley, *Mercury: the Good, the Bad, and the Export Ban,* Colorado School of Mines (March 2008).
3. U.S. Environmental Protection Agency, *Background Paper for Stakeholder Panel to Address: Options for Managing U.S. Non-Federal Supplies of Commodity Grade Mercury* (March 14, 2007).
4. U.S. Department of Energy, *Interim Guidance on Packaging, Transportation, Receipt, Management, and Long-Term Storage of Elemental Mercury* (November 13, 2009).
5. World Health Organization, *Health Risks of Heavy Metals from Long-Range Transboundary Air Pollution* (2007).
6. Maxon, Peter, *Mercury Flows and Safe Storage of Surplus Mercury,* Report for the European Commission (August 2006).
7. U.S. Environmental Protection Agency, Report to Congress: *Potential Export of Mercury Compounds from the United States for Conversion to Elemental Mercury,* Washington, D.C. (October 14, 2009).
8. Brooks, W.E., and G.R. Matos, "Mercury Recycling in the United States in 2000," Chapter U of *Flow Studies for Recycling Metal Commodities in the United States*, U.S. Geological Survey Circular 1196-U (2005).
9. National Electrical Manufacturers Association, "The Impact of Mercury Legislation on the Lighting Industry," presentation at the LightFair International conference, San Francisco, CA (June 2–5, 2002).
10. Miller, Glenn, "Byproduct Mercury Production in Modern Precious Metals Mines in Nevada," Department of Natural Resources and Science, University of Nevada, Reno(2004), available online at http://www.epa.gov/hg/stocks/Byproduct%20Mercury%20Production%20in%20Modern%20Precious%20Metals%20Mines%20in%20Nevada.pdf, accessed May 27, 2010.
11. U.S. Environmental Protection Agency, *Commodity Grade Mercury: U.S. Supply, Demand, and Reduction*, presentation by Maria J. Doa, Ph.D., at the Commodity Grade Mercury Stakeholder Meeting (May 8, 2007), available online at http://www.epa.gov/mercury/pdfs/U.S.%20Supply,%20Demand,%20and%20Reduction.pdf, accessed May 27, 2010.
12. Quicksilver Caucus, "Mercury Stewardship Storage of Mercury," EPA/State Workgroup (October 2003).

13. Mercury Stakeholder Panel, "Updated Supply Data and Sources of U.S. Mercury," Meeting of Commodity-Grade Mercury Stakeholder Panel (September 20, 2007), available online at http://www.epa.gov/hg/stocks/Supply%20Presentation%20v.10-9-07.pdf, accessed May 27, 2010.
14. U.S. Geological Survey, *Historical Statistics for Mineral and Material Commodities in the United States*, T.D. Kelly and G.R. Matos, U.S. Geological Survey Data Series 140 (2010), available online at http://pubs.usgs.gov/ds/2005/140/, accessed June 1, 2010.
15. U.S. Environmental Protection Agency, *EPA's Roadmap for Mercury*, EPA-HQ-OPPT-2005-0013 (July 2006).
16. U.S. Department of Energy, *The Long-Term Management and Storage of Elemental Mercury Environmental Impact Statement* (October 2010).
17. Northeast Waste Management Official's Association, *Northeast States Succeed in Reducing Mercury in Environment* (2007), available online at http://www.newmoa.org/prevention/mercury/MercurySuccessStorySummary.pdf, accessed February 24, 2010.
18. Northeast Waste Management Official's Association, "Trends in Mercury Use in Products: Analysis of the IMERC Mercury-Added Products Database, Wienert, Adam, IMERC Coordinator (November 17, 2009), available online at http://www.newmoa.org/prevention/mercury/conferences/sciandpolicy/presentations/Wienert_Session3B.pdf, accessed May 27, 2010.
19. United Nations Environment Programme and Arctic Monitoring and Assessment Programme, *Global Mercury Emission Inventory for 2005* (2008).
20. European Union, "Report on the International Mercury Conference, How to Reduce Mercury Supply and Demand," Brussels (October 26–27, 2006).
21. Hontelez, John, and Michael Bender, letter to members of the European Commission, Brussels, "Environmental and Health NGOs Call for Immediate Adoption of Regulation Proposal on EU Mercury Export Ban and Storage of Surplus Mercury," Brussels (September 6, 2006), available online at http://www.zeromercury.org/EU_developments/060907Letter_%20to_Commissioners_Mercury_Export_Ban.pdf, accessed May 27, 2010.
22. Hilkene, C, and K. Friesen, *Background Study on Increasing Recycling of End-of-Life Mercury-containing Lamps from Residential and Commercial Sources in Canada* (October 31, 2005).
23. Northeast Waste Management Official's Association, *Review of Compact Fluorescent Lamps Recycling Initiatives in the U.S. and Internationally* (updated July 23, 2009), available on the Internet at http://www.newmoa.org/prevention/mercury/lamprecycle/CFLRecyclingReport.pdf, accessed August 11, 2010.
24. Buscher, Brad, "The Role of Private Enterprise in the Reclamation, Recycling, and Storage of Mercury," conference presentation: Breaking the Mercury Cycle, Boston, MA, (May 1−3, 2002).

25. Mercury Waste Solutions, Mercury Waste Solutions & Brimark Consulting Group (2009), http://www.mwsi.com/new/, accessed February 24, 2010.
26. Quicksilver Caucus, Compendium National Overview: "Compendium of States' Activities," The Environmental Council of the States, Washington, D.C. (2005).
27. Environmental Council of States (2010), available online at http://www.ecos.org/section/committees/cross_media/quick_silver, accessed July 30, 2010.
28. Quicksilver Caucus, *Mercury-Added Product Work Plan* (2007).
29. End of Life vehicle Solutions, National Vehicle Mercury Switch Recovery Program (NVMSRP), Mercury Switch Recovery Program Reporting: All Years (2010). http://www.eqonline.com/services/ELVS-Mercury-Switch-Recovery-Program/annual-report.asp?year=all, accessed July 2010.
30. Sznopek, J, and T. Goonan, *The Materials Flow of Mercury in the Economies of the United States and the World,* U.S. Geological Survey Circular 1197 (2005), available on the internet at http://pubs.usgs.gov/circ/c1197/, accessed February 23, 2010.
31. Personal communication, AERC Recycling Executive Officer and H. Pagano, S.M. Stoller Corporation (May 2010).
32. Personal communication, Bethlehem Apparatus Company executive officer and H. Pagano, S.M. Stoller Corporation (May 2010).
33. Personal communication, executive officer with Mercury Waste Solutions and H. Pagano, S.M. Stoller Corporation (May 2010).
34. Association of Lighting and Mercury Recyclers, *Lighting, Mercury, and the Environment* (2010), http://www.almr.org/mercury.html, accessed August 2, 2010.
35. United Nations Environment Programme, *Draft Technical Guidelines on the Environmentally Sound Management of Mercury Wastes,* Fourth Draft, (April 2009).
36. Association of Lighting and Mercury Recyclers, Letter from Paul Abernathy, ALMR Executive Director, to David Levenstein, EIS Document Manager, DOE (August 20, 2009).
37. Fortuna, Richard, *Report: Export of Recyclable Mercury Related Wastes to Canada for Landfilling and Barriers to Mercury Recycling in the U.S.*, Strategic Environmental Analysis, L.C., Maryland, prepared for the Association of Lighting and Mercury Recyclers (2004).