Mercury flows in Europe and the world:

The impact of decommissioned chlor-alkali plants

-- Draft final report 22 August 2003 --

Executive summary

Purpose of this report – impact of mercury from the chlorine industry

As stated in the project documents, the key objectives of this investigation were:

1. to get as good a picture as possible of the current mercury flows in Europe and the world; and

2. to get an idea of what impact the mercury obtained from decommissioned European mercury-based chlor-alkali plants might have on the world mercury market, and the resulting consequences in terms of mercury use patterns.

This analysis is intended to support policy recommendations that will appear in the European Commission Mercury Strategy, which should also contain the main elements of a sustainability impact assessment (SIA), to be published in 2004 under the lead of the Commission's Directorate General for Environment, DG Environment. The SIA needs to consider, among other things, such questions as whether there appears to be any increased environmental, health or other social risk due to the diffusion of mercury from decommissioned mercury cell chlor-alkali plants.

Mercury cell chlor-alkali plants and chlorine production capacities in Western Europe, 2001

Country	Mercury-cell process		Total chlorine capacity ('000 tonnes)	Mercury cell process as a percent of total capacity
	Number of installations	Chlorine capacity ('000 tonnes)		
EU & EFTA countries				
Austria	0	0	55	0%
Belgium	3	550	752	74%
Finland	1	40	115	35%
France	7	874	1686	52%
Germany	10	1482	3972	37%
Greece	1	37	37	100%
Ireland	0	0	6	0%
Italy	9	812	982	83%
Netherlands	1	70	624	11%
Portugal	1	43	89	48%
Spain	9	762	802	95%
Sweden	2	220	310	71%
United Kingdom	3	856	1091	78%
EU total	**47**	**5746**	**10521**	**55%**
Norway	0	0	180	0%
Switzerland	3	104	104	100%
EU+EFTA total	**50**	**5850**	**10805**	**54%**
Accession countries				
Bulgaria	1	105	105	100%
Czech Republic	2	183	183	100%
Hungary	1	125	125	100%
Poland	3	230	460	50%
Romania	1	88	633	14%
Slovak Republic	1	76	76	100%
Turkey	0	0	168	0%
Accession countries total	**9**	**807**	**1750**	**46%**

Background – decommissioning of chlor-alkali plants

In the last 15 years at least 34 sites in the Netherlands, Germany, United Kingdom, Finland, France, Sweden, Norway, Italy, Portugal,

Belgium, Spain, Austria and Denmark have shut down all or part of their mercury-cell production processes. These decommissioned installations have either re-used the residual mercury in other operating mercury-based chlor-alkali installations, in order to make up for mercury lost to air, water, products and waste during operation, or they have sold the residual mercury on the open market.

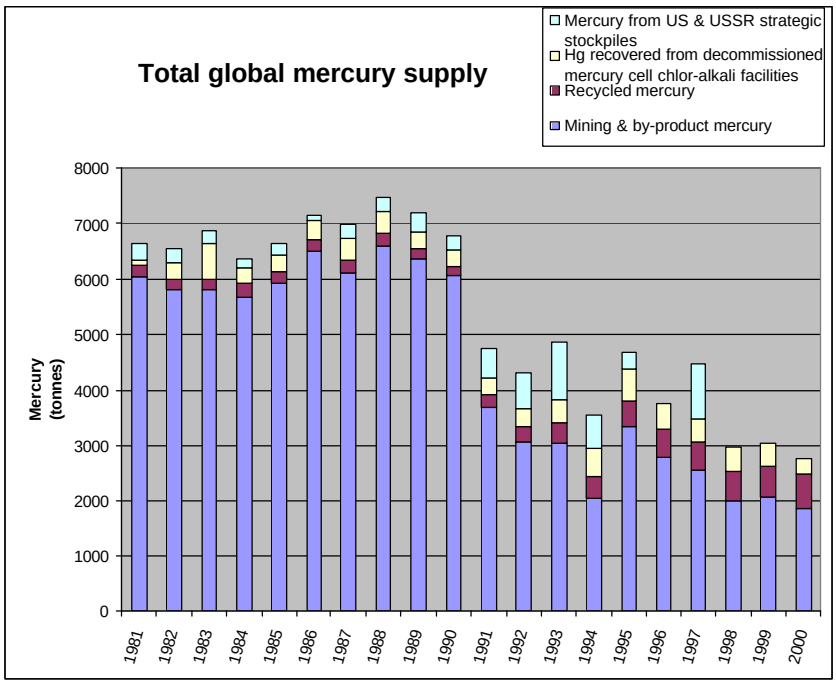
In the EU and EFTA there are presently about 50 operating mercury cell chlor-alkali plants, with a combined chlorine production capacity of 5.8 million tonnes per year. According to a Euro Chlor members' estimate (Euro Chlor, 2002c), they will all be decommissioned and/or converted to an alternative mercury-free process by 2020, along with a number of other mercury cell chlor-alkali plants in the US and elsewhere. Considering only the European mercury cell chlor-alkali plants, this decommissioning activity will release some 12 thousand tonnes of relatively pure process mercury, and nearly all of the mercury will end up on the international mercury market, since industry's only obligation about how to dispose of it is a Euro Chlor sponsored agreement that it should be purchased from industry by an "established mercury producer," i.e., for all intents and purposes, the Spanish mercury mining and trading company, MAYASA.

Euro Chlor's 2020 estimate for mercury cell chlor-alkali plant phase-out is not supported by all parties. The chlor-alkali industry is covered by the IPPC Directive, which requires installations to have permit conditions based on best available techniques (BAT). The mercury-cell process is not considered to be BAT for the chlor-alkali sector. The IPPC Directive states that existing installations should operate in accordance with the requirements of the Directive by 30 October 2007. Alternatively, a number of EU countries have announced that their mercury cell chlor-alkali plants will be decommissioned and/or converted to mercury-free technology by 2010, in line with a more flexible interpretation of the IPPC Directive, as well as a previous OSPAR Decision.

Context – mercury market structure

The approach taken in this analysis was to understand as well as possible the different facets of the EU and global mercury markets - imports, exports, supply , demand, key players, prices, etc. Then a "baseline" scenario was developed, along with two possible variations on that scenario, to suggest at what rate residual mercury from decommissioned mercury cell chlor-alkali plants might come onto the market. Finally, the impact of each of those scenarios on the international mercury market was assessed.

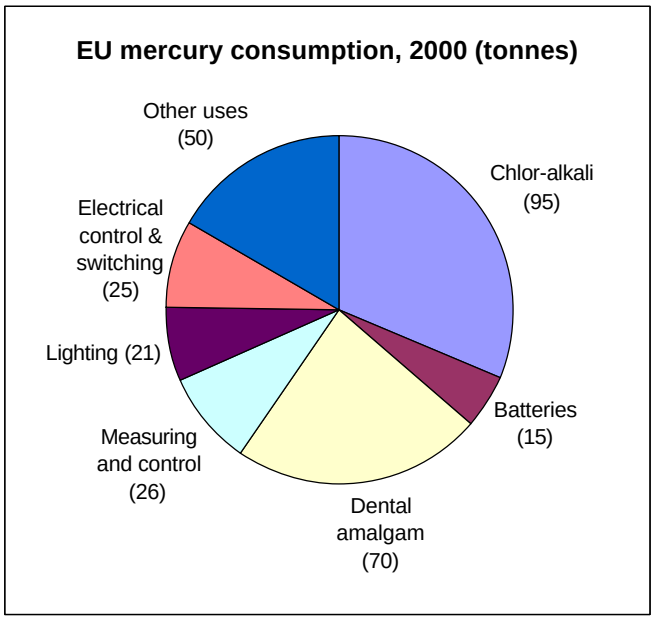
Global mercury **supply** to the markets is dominated by three main nations that mine mercury for export (Spain, Kyrgyzstan and Algeria), and China, which has long supplied its own robust home market. Both Spain and China may be in the process of closing their mines, especially as other sources seem to be growing, and mercury remains so inexpensive on the international market.



Due to an influx of stockpile mercury, first from the US, and then from the USSR in the early 1990s, and more frequent closure and release of mercury

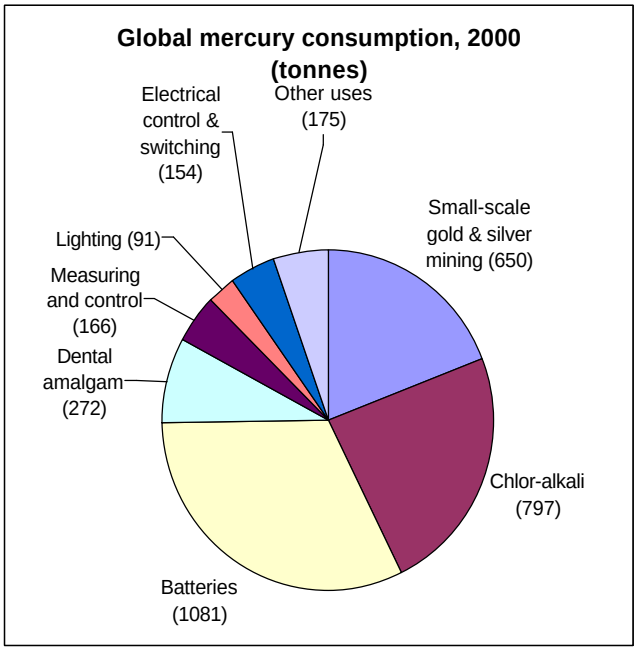
inventories from mercury cell chlor-alkali plants since the 1980s, combined with increasing recovery/recycling of secondary mercury, there has been a relative surplus of mercury on the market during the last ten years, holding prices down and fuelling speculation. This has led to declines in most mine output, and closure of any but the lowest cost (or State-owned) operations. As calculated for this paper, the mercury supply from 1994-2000 has averaged 3600 tonnes per year, and from 1996-2000 the average has been about 3400 tonnes per year, which one could take as a rough estimate of global mercury supply in 2000.

Demand for mercury has long been widespread but never completely understood. Just when analysts believe they have developed an understanding of the markets, another surprise seems to await them – increased use of mercury in artisanal gold mining (which mostly bypasses formal record keeping), mercury in toys, mercury in lighthouses, mercury in cosmetics or paints, uses that were thought to have been largely phased out, etc.

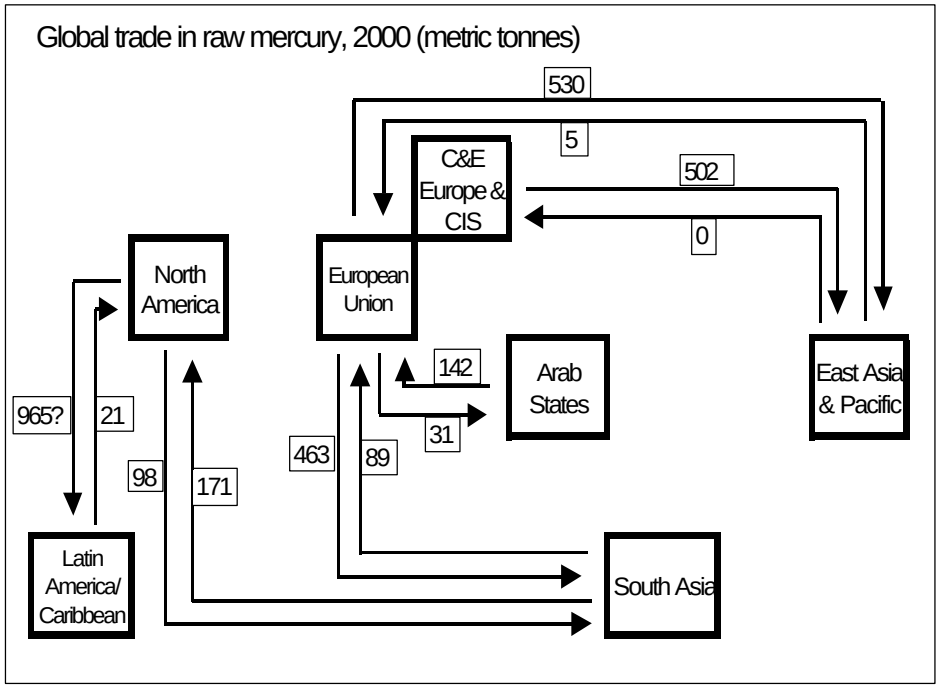


Mercury demand has been dominated by a range of products and processes over the years, but recently it is mostly used in the chlor-alkali industry, small-scale gold mining, dental amalgams, switches and relays, measuring equipment, lighting, etc., as well as a significant continued use in batteries. At the same time, it is found in a dizzying array of other uses, such as some 1000 homeopathic products identified by the US Food & Drug Administration, not to mention spiritual cleansing rituals, etc. Despite the wide range of applications, demand for mercury continues to decline overall, and the general market surplus persists.

Through all of the above, especially in light of gradually increasing scrutiny and regulation, the global demand for mercury has declined from over nine thousand tonnes annual average in the 1960s, to over eight thousand tonnes in the 1970s, to just under seven thousand tonnes in the 1980s, down to an average of around four thousand tonnes in the 1990s, and well below that today.

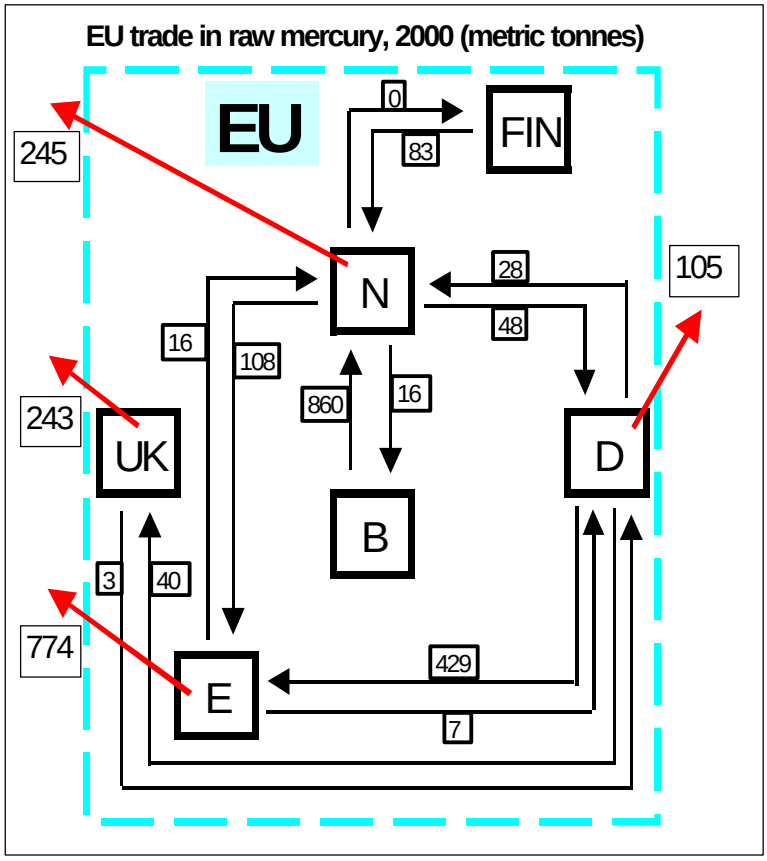


At the same time, while the last 15-20 years have shown a significant reduction of mercury use in the OECD countries, mercury consumption in many developing countries, especially South and East Asia (in the case of mercury use in products), and Central and South America (in the case of artisanal gold mining) has increased considerably. The main factors behind the shifts in mercury demand in the OECD are the reduction or substitution of mercury content in some products and processes in some regions (paints, batteries, chlor-alkali, etc.), a general shift of mercury product manufacturing operations from OECD countries to third countries (thermometers, batteries, etc.), and continuing robust supplies of mercury, combined with a long-term decline in mercury prices.

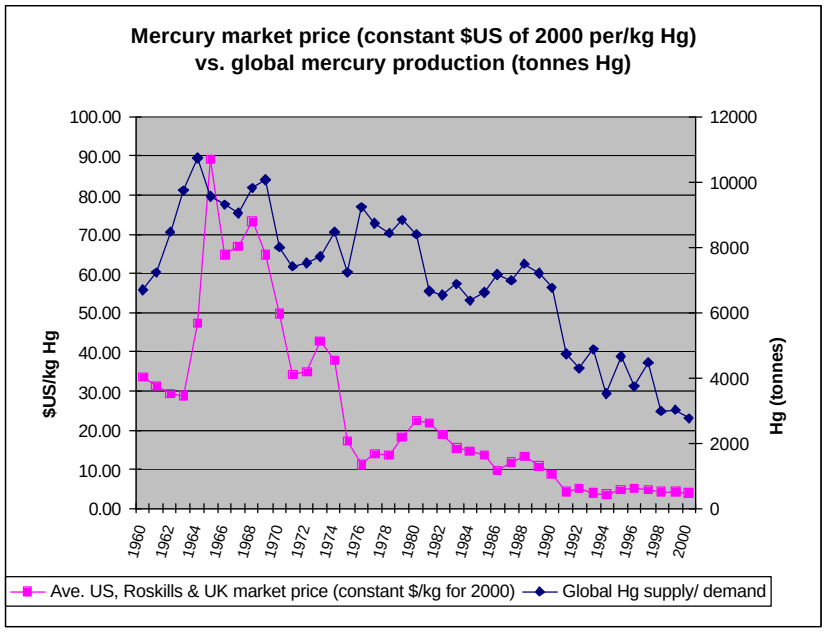


An analysis of mercury **trade** statistics confirms that regionally, North America and Europe have dominated mercury consumption in the past, but in recent years they have been overtaken by East Asia, especially China, and South Asia. However, the EU and the US retain general control over the majority of global trade in raw mercury. Four EU Member States shipped nearly 1400 tonnes of raw mercury out of the EU in 2000, while global movements of raw mercury amounted to more than 6000 tonnes – much of it changing hands repeatedly. In fact, on average, two tonnes of raw mercury appear in international trade statistics for each tonne of mercury consumed during the same year.

Trade statistics concerning mercury are far from perfect, but they frequently reveal surprises, such as the evidence that there remains a very active trade in mercuric oxide batteries, especially through China, but also through the EU and the US. Tracing the flows of mercury through the economy demonstrates how fluid and global mercury trade really is. It is not unlikely that residual mercury could be recovered from a Western European mercury cell chlor-alkali plant, sold to the world-renowned mercury mining/trading company in Spain, shipped to Germany for further purification and conversion into mercuric oxide, sold to mainland China for the manufacture of button-cell batteries, and the batteries sold to Hong Kong for incorporation into cheap watches for re-export to the European Union and the US.



Mercury **prices** have been on a downhill slide for most of the past 40 years. During the last 10 years they have stabilised at about their lowest levels ever, reflecting, in addition to a chronic supply surplus, the regulatory pressures on industry and others to responsibly dispose of mercury waste at hazardous waste sites, or alternatively, to send it to recyclers. However, for a long time mercury prices have been only a small fraction of the prices of goods they are used in, so it would be misleading to contend that low prices have spurred significant demand that would not have appeared otherwise.



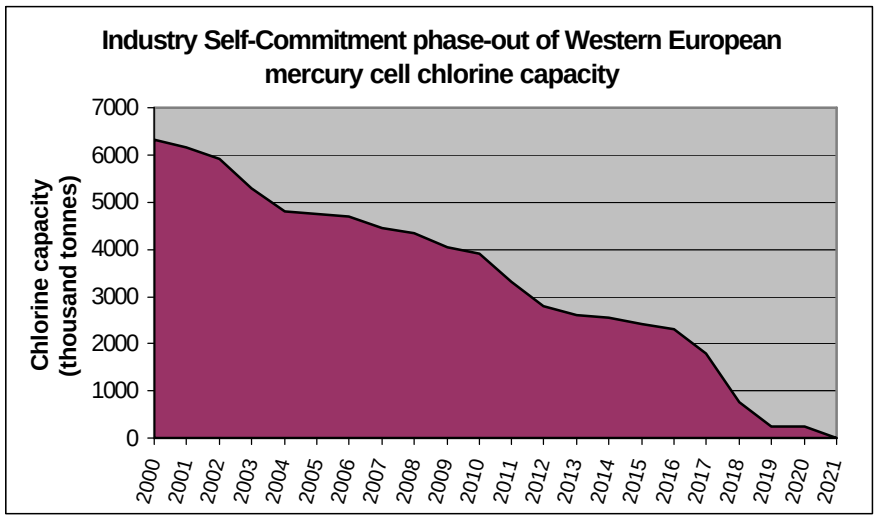
Regulatory measures influence mercury movements and markets by encouraging educational programs, collection and recycling programs, substitutes for mercury products, etc. In fact, it is argued that regulatory programs keep mercury prices low by putting an effective negative value on mercury wastes, so that recyclers could theoretically give recovered mercury away for free (no specific evidence has been seen of this extreme case) and still make a profit. One might ask whether, in such a regulatory environment, a free market in mercury still exists. But one could also ask whether a free market in a toxic substance is really in the best interest of society.

The market for elemental mercury is dominated by a limited number of virgin and secondary producers and mercury brokers. The same companies buy and control inventories, and trade mercury to influence the market and prices – in recent years less successfully. MAYASA, the Spanish mercury mining and trading company, purchased most or all of the USSR stockpile in the 1990s. In recent years MAYASA has also purchased residual mercury inventories from Western European chlor-alkali plants as they close or convert to mercury-free processes. Meanwhile the market surplus looks set to continue and perhaps even enlarge, potentially encouraging increased mercury uses and demand outside the OECD countries (European Commission, 2003).

Impact assessment – three decommissioning scenarios

Three scenarios were developed to describe a range of decommissioning alternatives. The main difference among these scenarios lies in the basic assumption of the decommissioning schedule, which affects the rate at which residual mercury from chlor-alkali plants comes onto the market.

Scenario 1 – Industry Self-Commitment

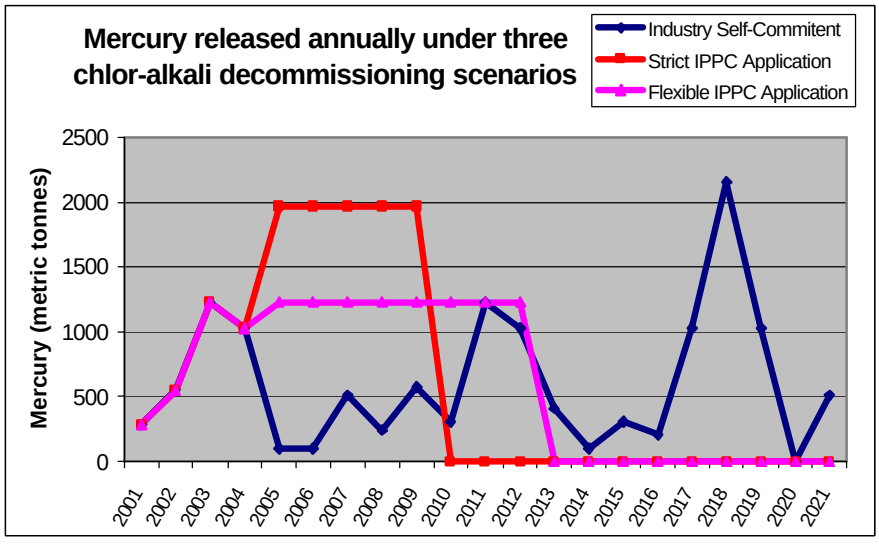


A logical baseline scenario has been developed around the Western European industry estimate for conversion of mercury cell chlor-alkali plants by 2020, which is roughly based on business-as-usual assumptions that take into account the economic lifetime of existing mercury cell chlor-alkali installations. This Industry Self-Commitment scenario assumes no major new legislative initiatives (that would significantly alter supply or demand) with regard to mercury, and a more or less "natural" or "economically realistic" phase-out of Western European mercury cell chlor-alkali production. This scenario reflects work done for Euro Chlor by Stanford Research Institute Consulting in a 1998 study, one objective of which was to describe in detail the normal economic lifetimes of the Western European mercury cell chlor-alkali plants. The figure at right shows the rate at which these plants' production capacity is expected to be phased out under the Industry Self-Commitment scenario. Appendix 4 of the main report provides a list of the remaining (in 2001) chlor-alkali plants in the EU and EFTA countries, totalling about 5.9 million tonnes of annual chlorine production capacity, and containing some 12 thousand tonnes of mercury relevant to this analysis.

Scenario 2 – Strict IPPC Application

In line with a strict reading of the Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC) requirements, existing chlor-alkali installations must be operated in full compliance with an integrated permit based on BAT by 30 October 2007, and it has been argued that this may be economically feasible as well. Therefore this second scenario, which may be referred to as the "Strict IPPC Application" scenario, assumes the more rapid phase-out of Western European mercury cell chlor-alkali plants by 2007. In this scenario, over 10 thousand tonnes of mercury from chlor-alkali plants mercury could deluge the international market between about 2005 and 2010.

Scenario 3 - Flexible IPPC Application



The third scenario, which may be referred to as the "Flexible IPPC Application" scenario, recognizes that in certain cases "flexibility" is required in the application of the Directive (see Directive Article 9, paragraph 4), which could permit some installations to delay the implementation of best available techniques (BAT) for a few years. The Flexible IPPC Application scenario therefore as-

sumes a slightly less rapid phase-out of Western European mercury cell chlor-alkali plants by 2010, and a different schedule for mercury releases. The figure here summarises mercury releases for the three scenarios.

Findings – market impacts of the three scenarios

Scenario 1 - Industry Self-Commitment

The Industry Self-Commitment scenario is a reasonable baseline assessment of mercury supply and demand if current trends continue, and if no other special measures are taken. Briefly, mercury prices soften further as surpluses continue. Use patterns follow the trends suggested in the table at right. Mercury demand is cut in half by 2020, and the mercury supply shows a significant long-term surplus over demand. The surplus could reach a total of 13 to 14 thousand tonnes during the period 2005-2020, forcing more suppliers out of the market in response to steadily lower mercury prices.

Projected global mercury demand, 2020, by use category

Mercury use category	Prospects for mercury demand to 2020 (Industry Self-Commitment scenario)	Projected global demand for mercury, 2020 (metric tonnes)
Chlor-alkali industry	significant decline over next 10-20 years	280
Small-scale gold/ silver mining	unpredictable change, but present level of mining activity is not sustainable	400
Batteries	steep decline	100
Dental amalgam	some decline	250
Measuring & control	general decline	100
Lighting	gradual increase, at least in the foreseeable future	120
Electrical control & switching	general decline	100
Other uses	variable, especially mercury use in cosmetics	150
Total demand		**1500**

Scenario 2 - Strict IPPC Application

Under the Strict IPPC Application scenario, significant mercury supply surpluses appear immediately (see the following figure), whereas in the Industry Self-Commitment scenario, surpluses are not a serious issue until about 2009. The Strict IPPC Application scenario therefore severely disrupts the market equilibrium for about 10 years, from 2005 to 2015. During the period 2005-2010, mercury supply heavily outweighs mercury demand, and during the period 2010-2015, just the opposite occurs. Furthermore, the five years of exceptional mercury surpluses send a psychological message to the marketplace that international authorities do not put a high priority on restricting the marketing and use of mercury, which basically endorses business-as-usual, and undermines the range of mercury reduction efforts that are already in place in various parts of the world. Therefore, while the Strict IPPC Application scenario does not necessarily imply increased consumption of mercury through 2020, it certainly slows mercury reduction efforts, which effectively results in a relatively higher consumption compared to the Industry Self-Commitment scenario.

The Strict IPPC Application scenario results in a lower mercury price during the years of exceptional surplus 2005-2010, and a higher price during the subsequent years of relatively low supply 2010-2015. Furthermore, the early massive surplus of chlor-alkali mercury stunts many recycling efforts as well as primary mining activities, so that the total supply 2005-2020 is less overall for this scenario than it is for the two other scenarios. These supply sources would take some years to recover once the supply-demand imbalance shifts back in the other direction. In fact, due to its suppression of mercury supply sources, this scenario results in the closest long-term balance between estimated mercury supply and estimated mercury demand (both accumulated 2005 to 2020), although this comes at the expense of serious market shocks, and it also results in an increased overall demand (perhaps up to 10 percent increase) relative to the Industry Self-Commitment scenario.

Scenario 3 - Flexible IPPC Application

The Flexible IPPC Application scenario is something of a mix of the other two scenarios. It shows some mild disruption of the supply-demand market balance, but only for a few years (see figure at right). It does not much hinder other supply sources, nor does it significantly slow down existing mercury reduction efforts. It influences mercury market prices or use patterns relatively little. And while it leads to slightly higher long-term mercury demand than the Industry Self-Commitment scenario, its long-term (2005-2020) surplus supply over demand (less than 3,000 tonnes) is significantly smaller than that of the Industry Self-Commitment scenario, while somewhat larger than that of the Strict IPPC Application scenario.

Global mercury supply vs. demand (2001-2021), including percentage supply from decommissioned Western European chlor-alkali facilities

	Industry Self-Commitment			Strict IPPC Application			Flexible IPPC Application		
	Annual Hg supply (tonnes)	Western Europe chlor-alkali supply (%)	Hg market demand (tonnes)	Annual Hg supply (tonnes)	Western Europe chlor-alkali supply (%)	Hg market demand (tonnes)	Annual Hg supply (tonnes)	Western Europe chlor-alkali supply (%)	Hg market demand (tonnes)
2001	2907	10	3294	2907	10	3300	2907	10	3299
2002	3159	17	3201	3158	17	3214	3158	17	3212
2003	3827	32	3109	3827	32	3129	3827	32	3125
2004	3610	28	3016	3610	28	3043	3610	28	3038
2005	2676	4	2924	4168	47	2957	3430	36	2950
2006	2665	4	2831	3668	54	2871	3030	41	2863
2007	3063	17	2739	3368	58	2786	2930	42	2776
2008	2785	9	2646	3268	60	2716	2830	43	2689
2009	3101	19	2554	3268	60	2646	2830	43	2602
2010	2823	11	2461	1400	0	2576	2830	43	2520
2011	3734	33	2369	1500	0	2507	2830	43	2437
2012	3518	29	2276	1600	0	2437	2830	43	2355
2013	2891	14	2179	1700	0	2361	1700	0	2268
2014	2572	4	2082	1800	0	2285	1800	0	2180
2015	2765	11	1985	1900	0	2209	1900	0	2093
2016	2651	8	1888	1900	0	2134	2000	0	2005
2017	3460	30	1791	2000	0	2058	2100	0	1918
2018	4576	47	1694	2000	0	1982	2100	0	1830
2019	3437	30	1597	2100	0	1906	2200	0	1743
2020	2400	0	1500	2100	0	1830	2200	0	1655
2021	2912	18	1403	2200	0	1753	2300	0	1567
Total 2005-2020	49117	19	35514	37740	26	38261	39540	25	36884

Observations and conclusions

Mercury markets

To fully appreciate EU and global mercury markets, a number of observations should be brought together from the discussion and analysis presented in this paper:

- The markets for mercury are global, and the EU is a key player. The EU provides 20-30 percent of the global mercury supply, it is a partner in over 50 percent of global mercury trade, and it consumes some 10 percent of global demand;
- Raw mercury is extensively traded around the world, at the rate of at least three times the annual consumption;
- World mercury markets are dominated by a relatively few key players, whose dominance, however, is weakening as primary mine production decreases (primary mercury mining in Western Europe has now ended, private mines are closed), by-product and other ocean