# Requirements for Environmentally Sound and Economically Viable Management of Lead as Important Natural Resource and Hazardous Waste in the Wake of Trade Restrictions on Secondary Lead by Decision III/1 of the Basel Convention: The Case of Used Lead-acid Batteries in the Philippines



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## 1. Introduction

1. Since coming into effect, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal has gone through several important changes. The control regime of the Convention has mainly[1] been based on prior information and consent (PIaC) for each transboundary movement of hazardous waste, allowing the importing and exporting countries to make a decision on consenting to or opposing a shipment on the basis of information on the source, nature, composition, destination, disposal/recuperation method and the need for such waste as raw material. Most recently, decisions II/12 and III/1, which introduce an outright export ban on hazardous waste shipments destined for final disposal and re-use/resource recovery/recycling from Annex VII countries (the OECD, EU and Liechtenstein) to non Annex VII countries (all other Parties) have been superimposed on PIaC.[2] This Ban Amendment of the Convention assumes the form of a multilateral export ban which is enforced by the countries of Annex VII.

2. The net effects of the Ban are uncertain. On the one hand, assuming that it is enforced,[3] the Ban will drastically reduces the risk of illegal dumping or sham recycling[4] of hazardous waste in poor developing countries. On the other hand, developing countries will find it difficult to continue to import certain forms of hazardous waste from Annex VII countries which contain much-needed and valuable recoverable material. It is this character of the Ban Amendment which determines whether, for a specific developing country and specific sector/material, the Ban is likely to have positive or negative economic and environmental consequences. In general, one can say that rapidly industrializing countries in South and East Asia as well as South America, which embark upon a material-intensive path of economic growth, may encounter some adjustment problems in the wake of the Ban Amendment, whereas the less and least developed countries mostly[5] stand to benefit from the Ban since they have less demand for the materials recovered from hazardous waste and less capacity to process the waste effectively.[6]

3. The drafters of the Basel Convention, and in particular the Ban Amendment, assumed a close relationship between reduced trade flows of hazardous waste and the minimization of health and environmental risks, in particular in developing countries. While this is largely true for many low income developing countries, this causality is not likely to hold for a number of developing countries which (i) play an increasingly significant role as generators of hazardous waste; (ii) have high demand for secondary material due to high rates of economic growth and material-intensive growth patterns; and (iii) import large amounts of scrap from other developing countries, which will not only remain unaffected, but may also be further encouraged by the Ban Amendment.

4. If all hazardous waste shipments from OECD countries were destined for final disposal in low-income developing countries only, the Ban would mostly be socially beneficial. However, the bulk of hazardous waste shipments from Annex VII countries are destined for recovery and recycling in a few rapidly industrializing developing countries, including the Philippines. Most of this trade is demand- and not supply-driven. More specifically, it is not high disposal fees or the explicit prohibition of final disposal in OECD countries which are propelling such trade but rather a high material intensity of growth, a limited stock of domestically accumulated scrap and a propensity towards the use of secondary material instead of the more expensive primary resources in the newly industrialized countries.[7] This is why, recuperation of such materials is an issue of proper natural resource management as much as a problem of sound management of waste. This conclusion is something which will accompany the reader throughout the analysis in this paper. Natural resources or material which get lost are not only a serious source of environmental contamination and unnecessary human exposure, but also a prime cause for generating a domestic supply-demand gap of the material or natural resource in question, which is difficult to bridge.

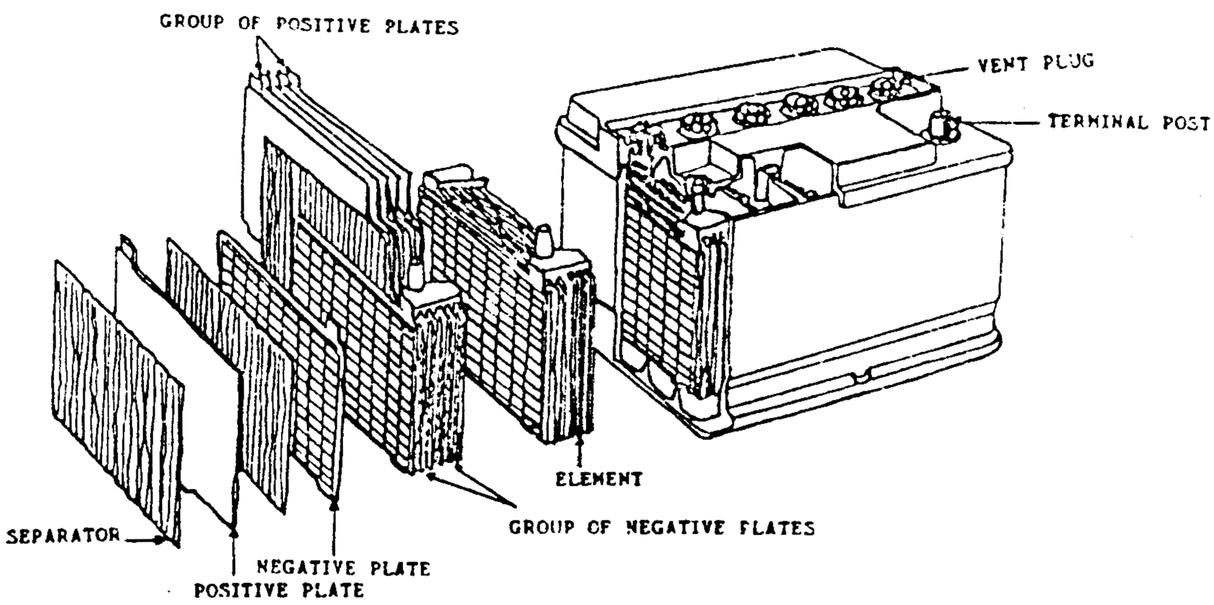
5. The 4th Conference of the Parties to the Basel Convention, held in February 1998, adopted Annex VIII of the Convention, which contains those wastes which are characterized as hazardous under the Convention and that are subject to the Ban Amendment. Most items, which figure in Annex VIII, appear to be of little significance in economic and trade terms. Their characterization as hazardous waste thus provides a good shield against dumping attempts by waste generators and exporters in Annex VII countries. However, about a handful of hazardous waste items in Annex VIII seem to play a significant role as source for recoverable material for approximately a dozen rapidly-industrializing developing countries, including the Philippines, in accordance with Article 4.9. (b) of the Basel Convention.[8] Though few in number, these items[9] and countries account for the bulk of all hazardous waste shipments from OECD to non-OECD countries. The effects of their inclusion in the list need to be studied and governments and other stakeholders in the affected developing countries need to take preventive measures to reduce the adjustment costs and avoid undesirable economic and environmental effects of the trade restrictions of the Ban Amendment on natural resource management. Failure to act in this regard might lead to a situation in which the environmental and economic costs of the distortionary effects of the Ban Amendment outweigh or even override its direct environmental and occupational health benefits, thus contradicting the objectives of sound managment of natural resources and waste.

6. Against this background, this study will attempt to identify the distortionary effects of the Basel Ban Amendment for the case of lead-acid battery recycling in the Philippines. The study will serve as a background paper for the deliberations of the multi-stakeholder advisory panel on encouraging environmentally sound and economically viable management of lead, as a natural resource and problematic waste in the Philippines, which will be jointly organized by the Asian Institute of Management, UNDP and UNCTAD.

## 2. The Material Composition of Lead-acid Batteries and Methods of Their Recycling

7. A standard lead-acid battery for starting, lighting and ignition of vehicles (SLI) has an average gross weight of about 15 kg, which falls into the following material parts (for an illustration of the physical structure of a lead-acid battery, see figure 1):

***Figure 1***
Structure of a Lead-acid Battery



- lead metal and metal oxide – 63%;
- cell separators, made of PVC, polypropylene or a fibrous glass mat – 2%;[10]
- electrolyte (dilute sulfuric acid) – 30%;
- polypropylene casing (or hard rubber casing for truck or large industrial batteries) – 5%.

40 per cent of the lead in a SLI battery is in metallic form, whereas 60 per cent is in oxide form. As will be explained below, recovering the latter requires a complex process which is usually beyond the technical capabilities of backyard (s)melters.[11]

8. Batteries normally consist of multiple cells that are electrically connected. For example, a 12-volt automobile battery consists of six 2-volt lead-acid cells connected in series. All lead batteries, or rather their cells, work on the same set of reactions and use the same active materials. At the positive electrode, lead dioxide ($PbO_2$) is converted to lead sulfate ($PbSO_4$) and at the negative electrode, sponge metallic lead (Pb) is also transformed to lead sulfate. The electrolyte is dilute sulfuric acid that provides the sulfate ion for the discharge reactions.

9. The latest generation of SLI batteries, valve-regulated batteries or sealed or gas-recombinant batteries, consist of a positive and negative electrode and their accompanying separators. The electrodes consist of lead grids. The negative grid consists of hard lead (either being antimonial lead -- with reduced antimony levels of 2-2.5% or less -- or, more recently, lead calcium alloys -- of 0.1% calcium content -- to make the battery maintenance-free). The electrodes are pasted with mixtures of lead oxides as active material within the metallic grids of the battery plates.

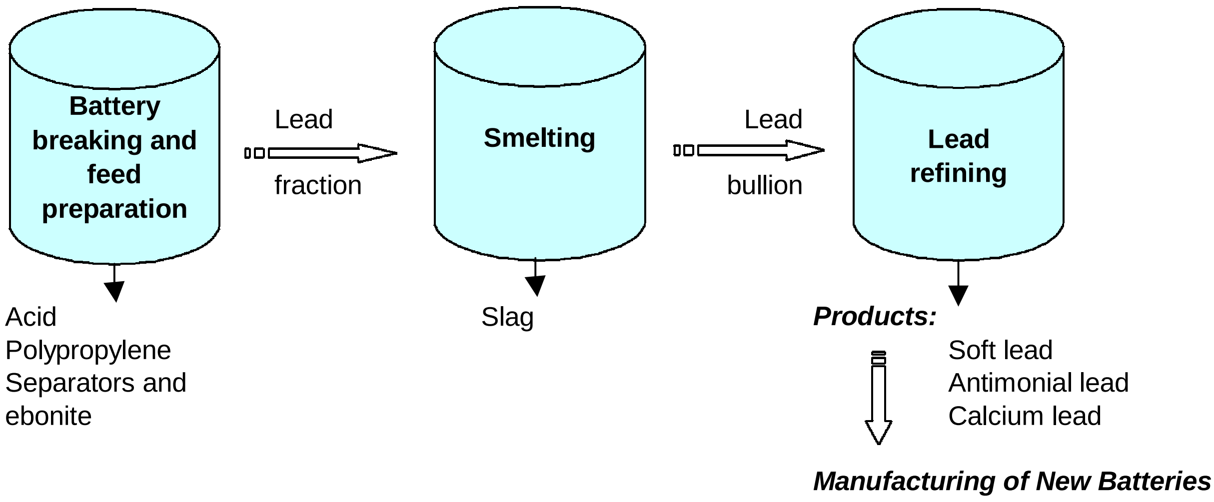
10. The cell system is closed, i.e. for every electron generated in an oxidation reaction at the negative electrode, there is an electron consumed in a reduction reaction at the positive electrode. As the process continues, the active material (i.e. the paste of lead oxides) becomes depleted and the reaction slows down until the battery is no longer capable of supplying electrons. The major part of the paste of lead oxides is converted into lead sulfate. Over time the lead sulfate contaminates the oxide paste and forms a sludge which accumulates at the bottom of the battery. This battery sludge consists of the following components:

- lead sulfate ($PbSO_4$) – 55 - 60 %;
- lead oxide (PbO) — 20 - 25 %; and
- lead metallics — 1 - 5 %.

11. So far, pyro-metallurgical processes dominate the recycling of used lead-acid batteries (ULABs) worldwide. Only recently, hydro- and electro-metallurgical processes have received more attention. However, none of such processes has yet reached full scale commercial operation. There is still some concern both about the nature of chemical processes employed, and potential lead-in-water and lead-on-land emissions. Compared to pyro-metallurgical processes, these alternative technologies however have the potential of significantly simplifying environmental and occupational control systems and thus reducing environmental costs compared to the traditional processes.[12]

12. The three key processing stages of the pyro-metallurgical recycling route are: (a) separation and recovery/recycling of all constituents of the scrap battery, i.e. dilute sulphuric acid, polypropylene, separators and ebonite, metallic and non-metallic lead fractions; (b) smelting of the metallic and/or non-metallic fraction with minimum gaseous and particulate emissions and a stable slag; (c) refining of lead bullion to generate soft lead and/or lead alloys of desired purity and composition.

13. A typical flow sheet of a pyro-metallurgical plant of scrap lead batteries is as follows:




14. Whereas the metallic lead of the grids can be readily melted at relatively low temperatures and cast into ingots of secondary lead bullion, the battery sludge requires a more complex recovery operation of three steps:

(i) desulfurization, i.e. removal of the sulfur in the lead sulfate by conversion of lead sulfate ($PbSO_4$) into lead carbonate (the most common desulfurization process used is with soda ash — sodium carbonate — mixed with the oxide and sulfate paste at pH 8-10).[13] The basic desulfurization equation for the conversion of lead sulfate to lead carbonate is:
$PbSO_4$ (in paste) + $Na_2CO_3$(aq.) -> $PbCO_3$(solid) + $Na_2SO_4$(aq.);

(ii) reduction (lead carbonate and un-reacted PbO into metallic secondary lead bullion (i.e. unrefined and impure lead metal); and

(iii) refining of secondary lead bullion into soft (i.e. low antimony or antimony-free) lead, lead-calcium alloy and/or antimonial lead (i.e. hard lead).

## 3. Short Overview of the Philippine Lead-acid Battery Recycling and Manufacturing Industry

15 The Philippine lead-acid battery recycling and manufacturing industry can be sub-divided into three divisions: the secondary lead smelting industry; the battery manufacturing industry; and the domestic collection of scrap batteries. These will be reviewed in turn.

### *3.1. Secondary Lead Smelting Industry*

16. The lead-acid battery recycling industry consists of one large, about 8-9 small and a large number of battery reconditioners and probably also some “backyard (s)melters”. Table 1 shows the estimated size and current capacity utilization of those secondary smelters, for which production figures were available, excluding cottage lead (s)melting. According to these estimates, Philippine Recyclers Inc. (PRI) accounts for almost 80 per cent of the Philippine non-cottage smelting capacity and current secondary lead production.

17. PRI is the only secondary lead smelter in the country which can operate at a scale well in excess of what is widely considered the critical mass for making currently employed pyro-metallurgy-based battery recycling technology economically and environmentally sustainable.[14] PRI runs two furnaces, a blast and a reverberatory furnace, and internally re-processes the by-products gen-

erated, including flue dust, slag and lead drosses. The lead recovery rate is therefore about 98 per cent.[15]

18. PRI's feedstock material composition is approximately as follows:

- internally circulated scrap from battery manufacturing – 5%;
- domestically collected scrap on the basis of PRI's special battery collection program ("Balik Baterya") – 25%;
- scrap bought from other domestic sources – 5%; and
- imported scrap batteries – 65%.

19. In addition, PRI buys unrefined (recovered) lead bullion from other small smelters for further refining. Furthermore, the feedstock breakdown above does not reflect internally recycled drosses, with a lead content of at least 85 per cent, which currently approximately account for 10 per cent of total lead-bearing feedstock (calculated in terms of lead content).

20. In terms of output, soft (i.e. low antimonial) lead for lead oxide, i.e. battery paste, production accounts for about 60 per cent of PRI's production. Hard (antimonial) lead represents the other 40 per cent of output.

***Table 1***
Secondary lead smelters in the Philippines

| Company | Location | Estimated capacity (metric tons per annum and % of all) | Estimated current output (in metric tons per annum and % of all) |
|---|---|---|---|
| Asia Pacific Lead Smelters | San Simoun, Pampanga | 3,000 – 6% | 2,100 – 6% |
| Silver King | Iba, Meycauayan, Bulacan | 1,800 – 4% | 1,500 – 5% |
| Guevarra/Magsuet | Marilao, Bulacan | 1,800 – 4% | 1,400 – 4% |
| Celica Batteries | San Simoun, Pampanga | 950 – 2% | 600 – 2% |
| Tower Lead | Bacolod City | 1,450 – 3% | 1,200 – 4% |
| Honest Parts | Paranaque, Metro Manila | 950 – 2% | 600 – 2% |
| Philippine Recyclers | Marilao, Bulacan | 36,500 – 79% | 25,000 – 77% |
| all | | 46,450 | 32,400 |

21. The principal feedstock material of the listed small smelters is cells from cannibalized scrap batteries of reconditioners. Only one smelter seems to process a small quantity of whole scrap batteries. The small smelters do not recycle imported used lead-acid batteries.[16]

22. Technology and expertise vary a great deal among the small smelters. Most units have only one furnace (generally a small reverberatory furnace) into which all lead-bearing feedstock is fed. None of the small smelters is capable of producing refined hard and soft lead. The small smelters cast the recovered lead directly into lead ingots, which contain drosses. Firstly, this unrefined lead ingot or bullion is used to supply the small battery manufacturers (mentioned below) with the lead required for connectors and posts. Such quantity accounts for probably 50-60 per cent of the output of the small smelters. Second, most of the remaining recovered lead is sold to PRI for further refining. PRI adds the unrefined ingots to their own furnace metal during the lead refining process for the removal of impurities. Third, a minority of small recycling plants ship their recovered unrefined

lead to producers of other small lead products such as fishing sinkers, wheel weights, shims for roofing or sewer pipe connections.

23. The small smelters generally recycle the self-generated furnace slag, but not very effectively. Most small smelters do not recycle the flue dust, which has a lead content of 90 per cent and more. This is becaus the majority of small smelters do not have baghouse filtration systmens to capture the fume and furnace dusts. They also do not conduct an effective desulfurization process. Some of the sulfur is removed during the smelting process as iron sulfides, but it is most likely that a considerable amount is discharged as sulfur dioxide gas.[17] On the basis of field visits of several small smelters, one can reckon with an approximate recovery rate of some 90 per cent (excluding cottage/backyard lead (s)melting).

24. There is reason to believe that a good number of small smelters do not have an environmental compliance certificate from the Environmental Management Bureau (EMB) of the Ministry of Environment and Natural Resources. It remains to be clarified, however, whether such facilities have indeed no valid EMB certificate, and thus should no longer have an operating permit, or have not been designated as environmentally critical projects by local EMB staff.[18] Even if they had no valid environmental complicance certificate, small smelters would not automatically fall into the informal sector as many of them are likely to pay taxes. There is also uncertainty about the exact number and capacity of the small smelters. According to information gathered during field visits, up to nine small smelters might operate in the country. As can be seen from trable 1, however, reasonably accurate information was only available for six small smelters.

25. Secondary smelters can in principle process all (non organic) metallic lead-containing materials coming from sources such as rolled and extruded products, cable sheathing, sludges, drosses, ashes, turnings, cuttings, and stampings. Although battery scrap is becoming more and more important as principal feedstock material, secondary smelters may use other lead-bearing feedstock as a function of scrap prices, feedstock availability and lead demand.[19] The more diverse the feedstock material and its composition, however, the more complex the recovery operation and the higher the risk of environmental and health hazards caused by tramp elements and contamination of feedstock material. One effective way of reducing such risks is through rigorous pre-selection of scrap types and sources which assures a relatively uniform composition of feedstock material. For instance, as mentioned above, PRI, only feeds ULABs and, as a minor percentage (i.e. some 5 per cent), manufacturing (circulating) scrap from the battery plant of its principal purchaser of refined lead (Oriental and Motolite Corp.).

26. The informal sector will usually attempt to "recondition" a scrap battery. Batteries with defective cells require those cells to be replaced or the sulfate layers on the active surfaces of a used lead acid battery to be removed. There are chemicals that certain reconditioners will add to the battery electrolyte to remove the lead sulfate layer from the active surface on the battery plates.[20] In some cases, removal of the inactive sulfate layer will allow the battery to be recharged and effectively reconditioned. When chemicals are ineffective, recyclers will usually cut through the rubber or polypropylene weld at the top of the battery case and remove the lid complete with the positive and negative terminal connections. Using simple measuring and observation techniques, the battery cell or cells that are "spent" are identified and replaced by cannibalizing another battery with some "good" cells. The top will then be replaced, glued to the base section and the battery recharged prior to re-sale. The expected battery life from this exercise will be short (according to interviews with taxi drivers in Manila, reconditioned batteries may last up to six months) as some or all of the cells will fail fairly soon after re-sale.[21]

27. Those cells that are "spent" and batteries that are beyond "reconditioning" will be broken open, the acid washed down the drain or allowed to percolate into the soil, the case thrown away or sold to a plastics plant, and the battery plates set aside. The "backyard recyclers" will then either sell the plates to small licensed smelters or melt the battery plates in a large open kiln or pot of some description.[22] It is most unlikely that any "backyard recycler" will have a furnace capable of recovering the lead from the paste and the sludge of scrap batteries. The most likely scenario is that once the metallic lead in the battery grids has been melted and cast into ingots of unrefined lead, the melting pot or kettle will be emptied ready for the next batch. The waste tipped from the pot will be in the form of a heavy slag or residue with a lead content of over 90%. The most likely destination for this waste material is the river, the rear of the dwelling housing or some remote part of the countryside. Recovery rates of cottage melting are thus hardly higher than 40% of the available lead in a scrap battery and consequently there will be a serious pollution problem.[23]

28. The elaborate description of alternative lead recovery processes illustrates the importance of the distinction between formal recycling with collection and controlled smelting, and informal activities involving "reconditioning" and "melting". The latter is perhaps more accurately described as "uncontrolled melting" or "uncontrolled partial recovery", rather than as "smelting".

29. Estimates suggest that up to 2000 "uncontrolled partial lead recovery" units may exist in the informal sector. A reconditioner seems to employ some 4 people whereas "backyard melters" might employ up to 10. On the basis of these assumptions, almost 20,000 people might earn a living by uncontrolled partial lead recovery in the country.

30. Table 2 summarises the input-output balance of the various segments of the Philippine battery recycling industry. It is important to appreciate the differences in terms of feedstock material and lead recovery rate because this has major implications for ascertaining the environmental effects and the national supply-demand balance of lead for SLI battery manufacturing.

***Table 2***

Input-output overview of the segments of the battery recycling industry in the Philippines

| **Segments** | **PRI** | **Small smelters** | **Informal sector reconditioners/cottage melting** |
|---|---|---|---|
| Feedstock | imported, drained and domestically collected whole, undrained scrap batteries | battery cells from broken batteries, minor percentage of whole undrained, domestically collected scrap batteries | domestically collected whole scrap batteries -- for reconditioning; cannibalized scrap batteries of reconditioners -- for cottage (s)melting |
| Output | refined lead bullion | unrefined lead bullion | unrefined lead bullion |
| Lead recovery rate | 98% | some 90% | about 40% |

### *3.2. Battery manufacturing industry*

31. The formal battery manufacturing industry of the Philippines consists of one big battery plant – Oriental and Motolite Corp. (OMC) and some small licensed producers: Standard Batteries, Mercury Batteries, Imarflex Batteries and Honest Parts and Metal Enterprises. Table 3 shows the estimated battery production volume for each company in recent years. Total domestic production volume has been close to 2 million units per annum, of which OMC accounted for between 70-80 per cent and Standard Batteries for almost 10 per cent.

***Table 3***

Estimated production volume of new lead-acid batteries in the Philippines (number of units)

| | 1995 | 1996 | 1997 |
|---|---|---|---|
| Mercury Batteries | 76,500 | 66,200 | 89,250 |
| Imarflex Batteries | 54,600 | 99,000 | 107,000 |
| Standard Batteries | 165,300 | 157,500 | 180,000 |
| Other local manufacturers | 101,000 | 171,500 | 151,500 |
| OMC | 1,550,000 | 1,450,000 | 1,330,000 |
| Total | 1,947,400 | 1,944,200 | 1,857,750 |

32. As will be shown at more length below, it is reasonable to assume that about 400,000 - 500,000 reconditioned SLI batteries are brought onto the domestic market annually. Reconditioned batteries are sold at most at about half the price of a new battery. They meet a specific demand in a segment of the national battery market characterized by special payment conditions. For instance, a certain percentage of these batteries are loaned on a short-term or even daily basis to drivers of jeepneys, other light trucks or private cars.

33. Aggregate demand for new batteries is relatively unresponsive to changes in battery prices in the light of the fact that battery replacement purchases are generally emergency purchases and there are no substitutes.[24] However, as the Philippine economy is open to foreign battery suppliers and there is permanent competition from battery reconditioners, a significant part of additional production costs would have to be internalised by domestic battery recyclers and manufacturers.[25]

***Table 4***

Estimated import and export volume of new lead-acid batteries in the Philippines (number of units, derived from UN COMTRADE data base)

| | 1995 | | 1996 | |
|---|---|---|---|---|
| | Import | Export | Import | Export |
| SLI batteries | 40,000 | 575,000 | 50,000 | 354,000 |
| Industrial batteries | 10,600 | 200 | 66,200 | 250 |

34. Table 4 depicts estimates of the export and import quantity of new batteries in the Philippines for the period 1995-1996. As far as SLI batteries are concerned, on average about a quarter of domestic production is exported, whereas imports only account for about 2-3 per cent of domestic demand for new batteries. Small and very small lead batteries for telecommunication devices represent the bulk of imports in the industrial battery group.

### *3.3. Domestic collection of scrap batteries*

35. Domestic collection of scrap batteries falls into three segments: (i) collection by private individuals for battery reconditioners and “backyard melters” in the informal sector; (ii) collection of scrap batteries by licensed smelters, as far as PRI is concerned, primarily on a buy- or take-back basis; and (iii) scrap dealers who serve as intermediaries by purchasing ULABs and then selling them on to PRI or small smelters, depending upon who offers the best price.

36. There is no specific Government regulation or incentive which encourages collection, safe temporary storage and transport of ULABs. PRI has significantly expanded its domestic battery collection in recent years. Since 1994, for instance, PRI has doubled the volume of battery collection from 7.2Kt to 14.1Kt of gross scrap weight. Since November 1995, PRI has concluded buy-

back arrangements with retailers, through the company's Balik Baterya (battery return) programme. This serves as both a marketing tool for new batteries and as a means of ensuring feedstock for its smelter and downstream manufacturing operation. The programme encourages licensed retailers of new batteries to insist on returning a used battery for every new piece sold. In addition, purchasing prices of ULABs were significantly increased to encourage private individuals, scavengers or waste buyers to turn in ULABs without replacing them. Mid-1998 walk-in prices of ULABs varied from 75 to 155 Pesos for car and truck batteries (some 2-4 US dollars).[26] To put this in perspective, such purchasing prices are virtually the equivalent to an average daily salary in the provinces of the country. Apart from attractive purchasing prices and relatively high margins for the battery retailers for collected ULABs (some 30%), PRI's Balik Baterya programme guarantees that all collected scrap batteries are purchased by the company. The programme exploits economies of scale by turning the sales network into an effective collection infrastructure, covering much of the archipelago at little additional costs.

37. As can be seen from the map in the annex, PRI's network of over 800 collection points virtually covers the whole archipelago. Although 29 provinces of the 95 of the Philippines are not included in the collection network, these 29 provinces concern sparsely populated parts of the country, accounting altogether for 17 per cent of the population only (a list of not covered provinces can be found in table A-1 in the annex). The number of registered vehicles in these areas is low. It should not remain unmentioned in this regard, that, as can be seen from table A-2 in the annex, the Metro Manila area accounts for about half of all registered vehicles in the Philippines; some 80 per cent of all Philippine vehicles are registered on Luzon island (i.e. NCR, CAR and Regions I to V). Apart from the mountain provinces in Northern Luzon, Bataan and the islands of Mindoro and Masbate, the Luzon area is very well covered by PRI's collection system. In sum, it can be concluded that the collection infra-structure put in place by the largest Philippine battery recycler is sufficiently well spread to gather the bulk of scrap SLI batteries.[27]

38. The small licensed secondary smelters do not run comparable collection programmes as cells of broken batteries from reconditioners are the principal feedstock material. In fact, none of the small smelters visited during field trips had the necessary plant and equipment to receive and process whole case batteries in an environmentally and occupational health acceptable manner.[28] The exact volume of thus acquired domestically generated battery scrap is unknown and must be estimated, as done below.

39. While information is scarce, battery reconditoners are widely regarded to be very successful in collecting scrap batteries. They appear to offer slightly higher purchasing prices for scrap batteries than recyclers in the formal sector - including PRI's Balik Baterya programme - for those few battery sizes which make up the bulk of reconditioned batteries. The reasons for being able to offer such attractive ULAB purchasing prices is the particular profitability of reconditioning. Reconditioners have low operating costs as they usually do not pay any taxes and have low or no expenses on environmental and occupational safety equipment. Furthermore, reconditioners do not incur significant transport costs for collected ULABs as their catchment area is locally-focused. Conversely, PRI incurs transport costs for ULABs collected outside Luzon, where approximately 15-20 per cent of the feedstock is sourced from.

## 4. Estimated Supply and Demand of Lead for SLI Battery Manufacturing in the Philippines

40. Supply and demand of lead for SLI battery production is influenced by the following factors:

a) vehicle population related
- number and kind of motor vehicles in use in the country;
- domestic production volume of new vehicles;
- number of scrapped motor vehicles;
- number of batteries per vehicle;

b) battery life related
- average battery life;

c) trade related
- import and export volume of motor vehicles;
- import and export volume of new batteries;
- import and export volume of scrap batteries;
- import and export volume of non-battery lead scrap;
- import volume of lead concentrate and refined (primary) lead;
- import and export volume of non-battery lead products;

d) lead recovery related
- collection volume and lead recovery rate of domestically collected scrap batteries;
- collection volume and lead recovery rate of of non-battery lead scrap;

e) "misuse" of SLI batteries as industrial batteries for uninterrupted power supply.

41. As can be seen from table A-3 in the annex, at the end of 1996, almost 2.9 million motor vehicles were in use in the Philippines. This figure includes some 822,000 motorcycles and motorized tricycles which are only equipped with small 6 volt lead-acid batteries containing about 2 kg of lead. The number of motor vehicles in use in the Philippines increased by almost 80 per cent in the period 1990 - 1996; without motorcycles/tricycles by 67 per cent. Commercial vehicles (i.e. utility vehicles, trucks, and buses) account for about half of all motor vehicles in use in the country, as compared to only 26 per cent in North America and 13 per cent in Western Europe.[29] The high share of commercial vehicles has major implications for battery type and battery lead load per car. Diesel engine-powered commercial vehicles, in particular the light utility vehicles – the so-called jeepneys – are generally equipped with large batteries of some 11-12 kg of lead weight; trucks and buses tend to be equipped with two batteries, having a combined average lead weight of some 20–21 kg because these vehicles run on 24 Volt systems. As a result, the average battery lead load of a vehicle (without motor- and tricycles) in the Philippines is about 11 kg, almost a third higher than the average in developed countries.[30] Combined with much shorter average battery life (1.5 - 2 years as compared to about 5 years in developed countries), this leads to a significantly higher lead demand for the same quantity of vehicles in use.

42. Figures 2 and 3 show the flow charts of supply and demand for lead in the Philippines related to the recycling of SLI batteries. To facilitated the interpretation of the flow charts, a few technical observations on the interrelationships between the key components of lead supply and demand need to be made.

43. First, whenever reference is made to "vehicles", the estimates for lead supply and demand include small batteries for motorcycles in the charts. Their lead content has been converted into standard battery units, which have an approximate lead weight of 11 kg.

44. Second, supply and demand estimates of lead are mostly linked to the life cycle of SLI batteries in the Philippines. The interrelationship with other segments of the lead market (i.e. non-battery lead products and the market for industrial batteries) has only partly been reflected. There is

however reason to believe that currently, with one exception, such relationships have no critical bearing on the supply and demand volume of lead for SLI battery recycling and manufacturing.

45. The market for stationary batteries for telecommunications and uninterruptible power supply of computer or emergency systems, for instance, has been growing twice as fast as the SLI battery market in recent years and as such has not released lead scrap for other applications, on the contrary.[31] Furthermore, compared to the size of the SLI battery market, the market of industrial batteries is very small (according to estimates by PRI management only some 120 metric tonnes per year at the moment). The interrelationship with the non-battery lead market segment can also be assumed to be small. Non-battery uses account for not more than some 10-12 per cent of total recoverable lead consumed in the country.[32] Furthermore, pigments and compounds have been the most important and most dynamic end use segment in the non-battery lead market; an end use which makes the lead not recoverable. And finally, a significant share of demand for non-battery products of recoverable lead is met by the informal sector or small lead producers/manufacturers which tend to have high production and manufacturing losses of lead. This generates additional demand for lead rather than an increase in recoverable supply. The material flow charts therefore assume no or little exchange of recoverable lead between SLI battery recycling and the markets of non-battery lead uses.

46. There is one market segment, however, which is of quite some importance as source of lead scrap and demand for batteries: SLI batteries which are “misused” as uninterruptible power supply devices. Such batteries are, production wise, SLI batteries, which are however used as industrial batteries. The magnitude of this “misuse” is difficult to estimate, but surveys for Indonesia, for instance, suggest that this market segment might be as big as 50 per cent of all sold SLI batteries.[33] According to sales staff of PRI, the share of thus used SLI batteries was indeed very high in the Philippines at the beginning of the 1990s in the light of political and economic instability and frequent power cuts. Ever since, demand has significantly shrunk and it is assumed in the supply and demand flow charts of lead that about 10 per cent of produced SLI batteries are predominantly used as power backup devices. It is important to note that scrap supply and battery demand in this regard are independent of the development of vehicle population.

47. Third, in the supply flow chart, the interrelationship between the informal sector and small smelters leads to a certain variation in the volume of totally recovered lead in the country. As mentioned before, scrap batteries collected by the informal sector are usually reconditioned. The informal sector will attempt to “recondition” a scrap battery by either (chemically) removing sulfate layers from the active surface of the battery plates or by manually replacing defective cells. The latter is done at the expense of cannibalizing another battery with some “good” cells. Defective cells and lead parts of cannibalized scrap batteries are either handed over to backyard (s)melters for further partial lead recovery or sold to small smelters. In fact, this forms the core feedstock of most small smelters as such smelters do not have battery breaking equipment (any such breaking would have to be manually conducted). Depending on who gets most of the lead-bearing fallout of battery reconditioners, either 2 Kt (backyard melters) or 4.5 Kt of lead (small smelters) are recovered of the 5 Kt lead-bearing material surrendered by reconditioners. The variation is a function of the different recovery rates (40% for backyard melters and about 90% of small smelters). Consequently, total national lead recovery is subject to a variation of 2.5 Kt of lead.

48. Fourth, on the supply side, the complex relationship between cottage, small smelters and PRI regarding exchange of feedstock and supplementary recovery of lead is hidden. From a conceptual and technical point of view, one may assume that there is some flow of lead-bearing drosses (having a lead content of 85% and higher) and slag from primitive (s)melters to more sophisticated

**Figure 2** Estimated annual supply of lead for the production of SLI batteries in 1995/1996 (in kilo tons - Kt)

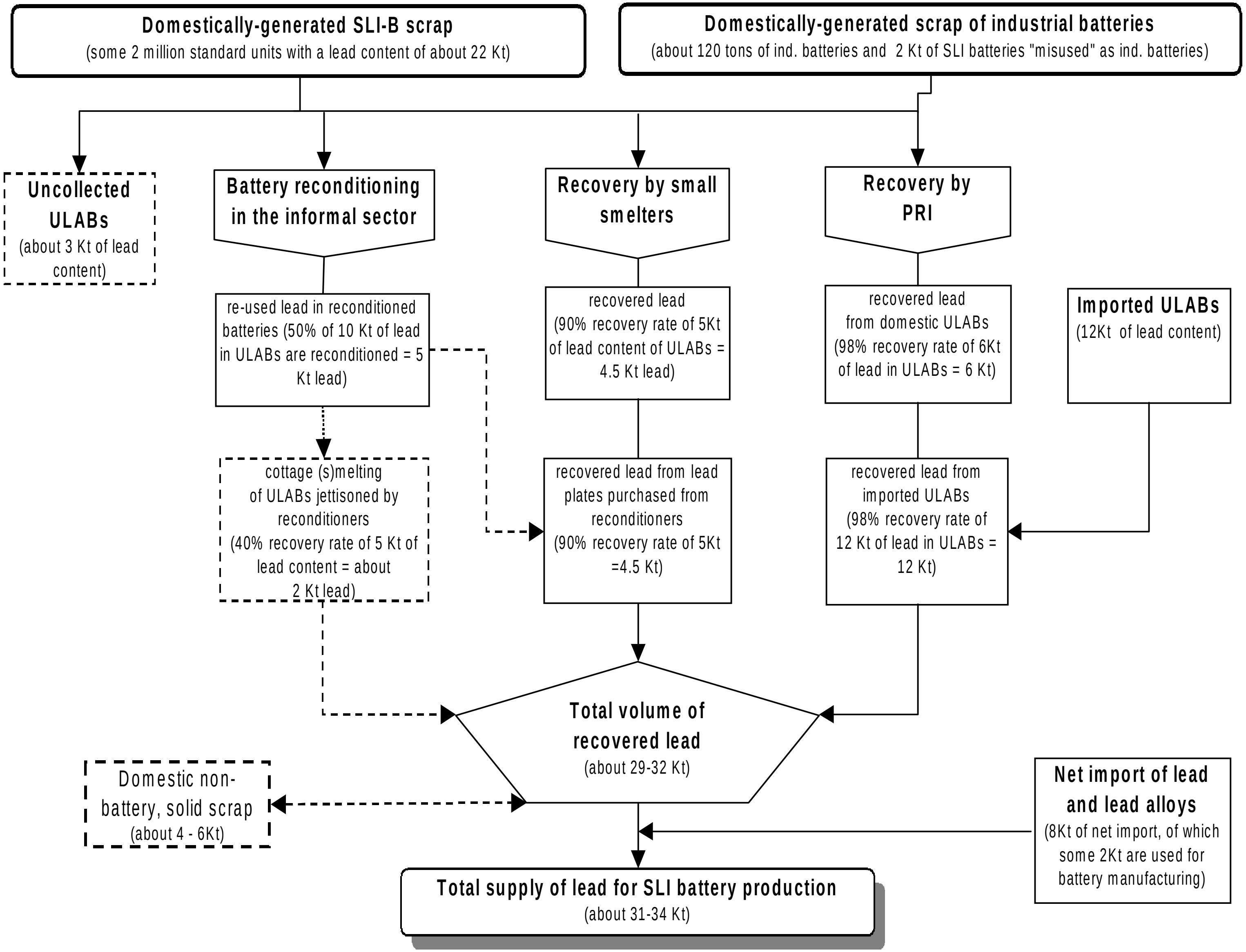
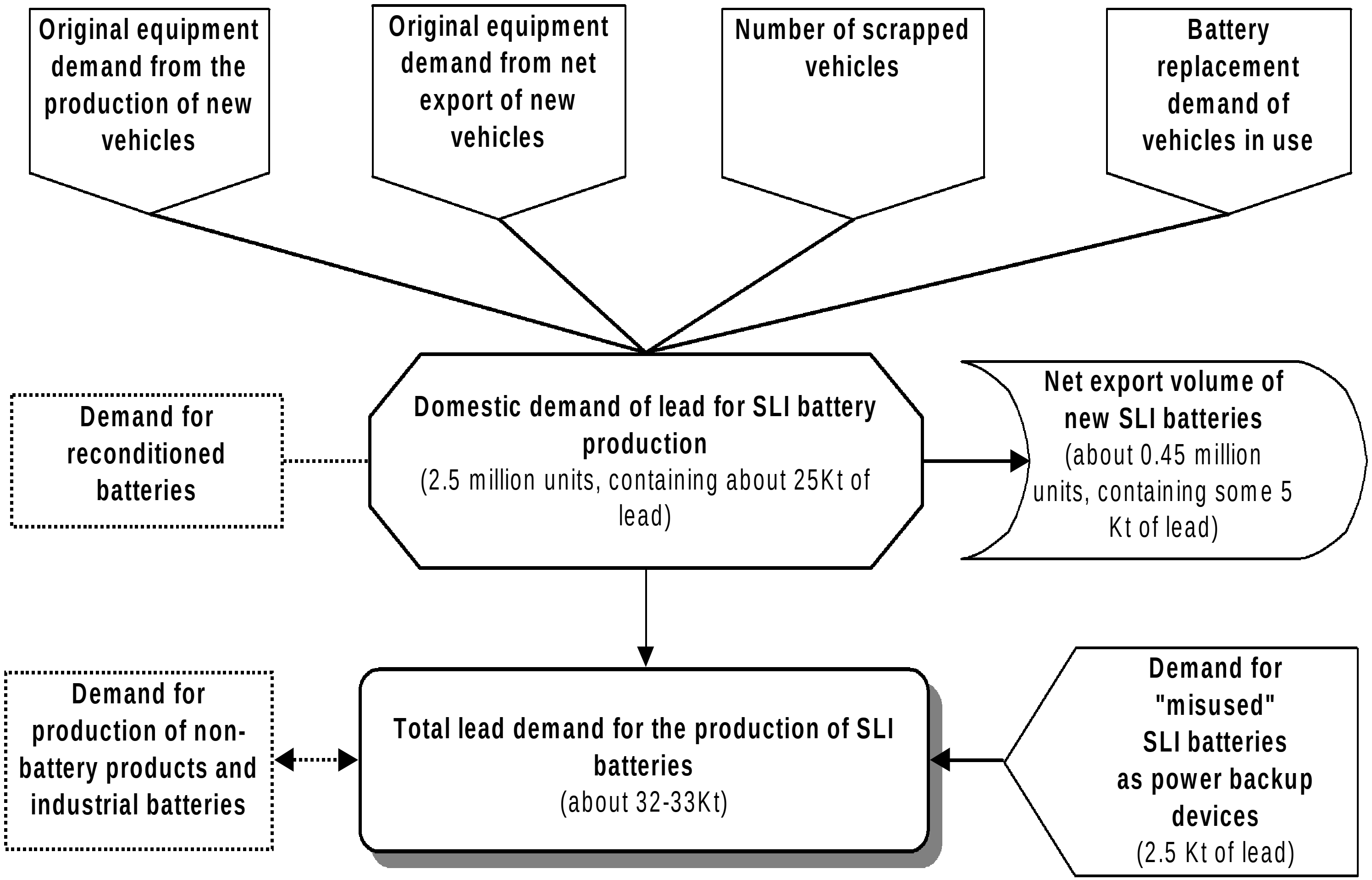


**Figure 3** Estimated annual demand for lead for the production of SLI batteries in 1995-1996 (in kilo tons - Kt)



ones in order to recover lead contained therein and thus increase the overall rate of lead recovery by all smelters in the country. This may even be done on a toll basis. Field visits have however not found any evidence for a systematic flow of lead-bearing residues among the three different segments of lead smelters. Furthermore, it is worth highlighting that small smelters cast the recoverd lead directly into lead ingots. Any drosses (mainly oxides at this early stage of the refining process) are entrained in the molten lead and subsequently in the cast ingot. They are sold to more sophisticated secondary smelters for further refining. When such ingot is molten, the entrained drosses are “liberated” in the melt and rise to the surface to be recovered and recycled. So very little dross produced by the small smelters is actually lost. There is also a further incentive for the small smelters to ensure that the dross is entrained in the ingot and that is the payment which is for gross weight of the ingot including the dross. Most of such flows of lead-bearing feedstock are reflected in the recovery rate used for the different segments of the battery recycling industry and do therefore not escape the estimates in the flow chart on lead supply.

49. Fifth, annual demand for lead used for the production of new SLI batteries can be calculated in the following way:[34]

$$[(\text{vehicle stock}_{t\text{-}abl}) - (3\text{vehicles scrapped})] * [(\text{batteries per car/average battery life})]$$
$$+ [(\text{domestic car production}) - (\text{net import of new vehicles})] * [\text{batteries per car}]$$

50. On the basis of this formula, figure 3 shows the estimated demand of lead for SLI battery production in 1995. Lead requirements for SLI batteries for domestic use are about 25 Kt; with 5 Kt for the production of SLI batteries for export[35]; and 2.5 Kt of lead for the production of new SLI batteries which will be “misused” as power backup devices. This leads to a total lead demand of some 32-33 Kt, which approximately matches the supply of lead.

### *4.1. Principal causes of the supply and demand gap of lead for battery manufacturing*

51. As is evident from figure 2, lead supply and demand for SLI battery production can only be brought in balance by an inflow of 12 Kt of lead bearing battery scrap and imports of refined (primary) lead and lead alloys in the order of 2 Kt.. It is important to understand the reasons for the supply-demand gap in order to determine whether the gap can be closed by domestic means without resorting to imports of scrap batteries. What are the principal causes of the domestic supply-demand gap?

52. There are three key causes for the supply-demand gap: (i) the very high rate of growth of vehicle population in the Philippines; (ii) the significance of the informal sector in battery recycling; and (iii) the high volume of scrap batteries which remains uncollected.

*a) The dynamics of vehicle population*

53. As can be seen from table A-3 in the annex, the Philippine vehicle population has grown by almost 80 per cent in the period 1990-1996 (by 67% without motor- and tricycles). This translates into an average annual rate of growth of 9-10 per cent. As the bulk of newly registered vehicles in the Philippines per annum is domestically assembled,[36] high rates of vehicle population growth have led to high battery demand growth. As can be seen from table A-3 in the annex, battery demand-relevant changes in vehicle population have been in the order of some 10-12 per cent per annum in 1991-1996. Converted into standard battery units and reflecting average battery life, this generated an annual rate of growth of lead demand of about 10 per cent.

54. The volume of domestically generated battery scrap, however, lacks behind the dynamics of lead demand. The available battery scrap in a year is a function of the battery consumption volume one average life time of a standard battery in the Philippines ago, i.e. 1.5 to 2 years. In other words, the volume of domestically generated battery scrap in 1996, for instance, is determined by the battery consumption volume of 1994. In the light of the demand growth rates outlined above, this creates a supply-demand gap of about 15-20 per cent in volume terms.

55. This cause of the supply-demand gap is confined to countries with very high rates of vehicle population growth, not based on significant imports of vehicles, equipped with new batteries. In contrast, in most OECD countries, growth of vehicle population has been low in the 1990s. Furthermore, battery life has gradually been extended, which has contained growth of battery replacement demand. Even in the principal vehicle producing countries of OECD, a similar supply-demand gap has therefore not occurred.

*b) The significance of the informal sector in battery recycling and associated lead losses*

56. As can be seen from figure 2, the quantity of domestically-generated scrap batteries can be estimated at 2.2 million standard battery units (2 million from the use in vehicles and 0.2 million SLI batteries "misused" as power backup devices) having a total lead content of about 24 Kt. All non-cottage smelters recover between 45 to 65 per cent of this lead. The informal sector recycles about 5 Kt of lead as (or rather in the form of) reconditioned batteries, and partly recovers up to 2 Kt of lead from battery cells and parts jettisoned by battery reconditioners. A certain percentage of jettisoned battery cells of reconditioners is also sold to small smelters. Consequently, up to about 3 Kt of recoverable lead in domestically-generated scrap batteries gets lost or is spilled into the environment and therefore unavailable for meeting demand.

57. It is very important to appreciate the seriousness of this situation and its consequences. Cottage lead (s)melting has a recovery rate of at best 40 per cent, and the small smelters have an average rate of recovery of about 90 per cent. This has a four-fold negative implication: the more domestically generated scrap batteries end up among battery reconditioners, "backyard" (s)melters and "antiquated" small smelters,

(i) the more acute the risk of spillage (deliberate or otherwise) of the electrolyte, dilute sulfuric acid, and thus caused environmental pollution;
(ii) the higher the emissions of sulfur dioxide gas and related environmental damage by small smelters, which in general do not conduct a well controlled desulfurization process;
(iii) the higher the risk of human and environmental lead contamination caused by emissions from unregulated lead (s)melting and final disposal of the sludge of scrap batteries; and
(iv) the bigger the gap between domestic supply of recovered lead and demand for lead for SLI battery production.

58. It is the latter which exerts the pressure on battery recyclers in the formal sector to bridge the domestic supply and demand gap by imports of ULABs and/or refined (primary) lead.

*c) Uncollected scrap batteries*

59. Figure 2 shows a volume of 3 Kt of lead (approximately 300,000 batteries) which remains uncollected and thus unavailable for recovery. This figure has been estimated as residual on the basis of all other known variables in the supply and demand flow charts. Besides the loss for the national lead material balance, thus discarded batteries are a serious potential source of environmental contamination with lead and acid.

### *4.2. Technical and economic aspects of SLI battery recovery*

60 Before reviewing further the individual components of lead supply and demand for SLI battery production, a few observations need to be made on the economics of SLI battery recycling.

61. First, as has been pointed out by several recent reviews on the technological requirements for enhancing environmental performance of pyro-metallurgical secondary lead smelters, a tonnage of around 15 Kt of refined lead output per annum is widely regarded as the minimum scale for a conventional pyro-metallurgical secondary lead smelter in order to absorb increasing pollution control, prevention and abatement costs.[37] The lead content of scrap input for such production volume in a modern smelter is about 15.5 Kt. As was shown in figure 2, of the total volume of recovered lead in the Philippines (some 29-31 Kt), as little as 11-16 Kt is currently domestically accessible by the formal recycling sector. Only if a significant percentage of presently uncollected ULABs and the battery scrap processed by the informal sector were made available for licensed smelters could the requirements for economics of scale of modern pyro-metallurgical smelters be met in the country.[38]

62. Second, as can be seen from the overview below, scrap feedstock accounts for almost 60 per cent of total production costs for ULAB lead recovery in the United States. Total US production costs for 1998, incorporating the revenues from the sale of plastic scrap from casings, are 26.70 cents/lb. of refined lead output. As will be shown below, secondary US smelters were unable to make any profit from secondary lead smelting.

***Table 5***

Production costs of secondary lead smelters using ULABs as feedstock
(US cents/lb. at the beginning of 1998)[39]

| | EXIDE | |
|---|---|---|
| | Cents/lb. | % |
| Fixed costs | **7.45** | **26.42** |
| - wages and salaries | 3.20 | 11.35 |
| - depreciation | 2.22 | 7.87 |
| - maintenance | 2.03 | 7.20 |
| Variable costs | **20.75** | **73.58** |
| - energy | 1.38 | 4.89 |
| - ULAB scrap, including freight | 16.70 | 59.22 |
| - pollution control, water treatment and waste disposal costs | 2.67 | 9.47 |
| Total production costs | 28.20 | 100.00 |
| minus revenues from sale of plastic scrap | 1.50 | 5.32 |
| Net production costs | 26.70 | 94.68 |

63. On the basis of field visits[40] and interviews, it can be safely assumed, that several items of the above production cost overview are considerably lower for Philippine producers. This concerns the cost item “wages and salaries”, which is about a quarter below the US level; depreciation and maintenance that are 20 to 50 per cent lower; pollution control, prevention and abatement costs,

which seem to be 30-40 per cent below the US level[41]; and lead scrap costs, that appear to be some 10 per cent lower. Conversely, energy costs are three to four times higher than in the US (which is not very conducive to the use of electro-winning processes as new recycling technology) and revenues from sale of plastic scrap may only be half as high as in the US. On balance, net production costs of key Philippine recyclers may therefore oscillate around 25-26 cents/lb. The question which needs to be posed is: Is recycling by the key Philippine smelter economically viable on the basis of these production costs?

64. Recycling of scrap vehicle batteries and other lead scrap is not an end in itself, but will be conducted as long as there is an economic incentive. This incentive is the price differential between refined lead produced from secondary versus primary sources. The LME price plays the role of the barometer in this regard, because producers of refined lead from primary and secondary sources are free to sell to LME warehouses at the LME price getting the cash without the need to “go out” to the market. Furthermore, the LME warehouse system was established to provide stability to the lead market and a cushion for the hard pressed producers. Primary or secondary producers require hugh amounts of working capital and the LME provides a safe haven for those hard pressed at times.

65. Unfortunately, although improved long life SLI battery technology demands ever higher standards of purity for an increasing number of lead based battery components, the LME standard for deposit to the warehouse has remained at 99.97%. Very problematic in this regard is that the 0.03% impurities are unspecified, which renders the stock unsuitable for even battery grid casting alloys. In fact, such lead would only be suitable for the connecting lugs and bridges on the top of the battery, and as bulky as they are, they are only a fraction of the total lead weight in the battery. Consequently, most battery manufacturers would never use this quality of lead bullion for oxide paste or grid alloy production without additional treatment.

66. Primary lead is normally refined to 99.985% or 99.99% purity, and the remaining impurities are know and at a predictable level, which makes their extraction easy to program and implement. To bring LME-stocked lead bullion to this level of purity, comes at a price of about US$100-150 per ton of refined lead over the LME base price, which one may call the “refinement price premium”. Battery manufacturers want to ensure that they have a guaranteed supply of 99.9% lead for a full year of production and consequently both primary and secondary lead of such quality are sold in advance at the end of each year on a private contract basis, LME base price plus “premium”. Very little primary lead actually finds its way into LME warehouses.

67. Besides the “refinement premium”, there are additional charges per ton that should be added to the LME base price for warehouse release, shipping, and import costs from the LME warehouse in Singapore to the Philippines. These costs amount to about US$100 per ton of lead bullion. To ascertain profitability of battery recycling by the key lead smelters in the Philippines, the reference price for imported substitute feedstock on the basis of an LME price of some US$500 would be some 700-750 US dollars (LME base price + “refinement premium” + shipment and import costs).

68. However, in recent past the “refinement premium” has significantly shrank after Pasminco, the world’s largest primary lead producer, came on stream with an enormous increase in supply of primary lead from its Port Pirie facility in Australia. This glut has caused a dramatic fall in premium rates for high quality lead bullion and it would appear that the difference in delivered 99.99% pure Pasminco lead and LME lead purchased from the Singapore warehouse may be as low as US $10 per ton at the beginning of 1999. Therefore, the current reference price for imported lead of suitable purity is slightly above US$600. This is the figure against which profitability of recycling has to be judged.

69. The LME price of lead in recent months[42] has oscillated around 23 US cents per pound, to which about 4-5 cents have to be added for covering warehouse release, transport and import costs of imported substiute lead as well as a slim “refinement premium” (for US producers this surcharge is probably only half as high). While American battery recyclers have production costs which equal the thus calculated price of substitute feedstock and thus cannot make any profit on their operation, the key Philippine producers remain about 6-8 per cent below the reference price for substitute feedstock.[43] These cost estimates are based on a low capacity utilization, which is currently very close to the break-even point of profitability of about 60 per cent.

70. It is evident from the above, that any significant fall of the LME lead price below the benchmark of US$500 per ton, will make battery recycling in the formal sector in the Philippines economically unsustainable.

71. Even under current conditions, from an economic point of view, there is virtually no room for accommodating additional costs for enhancing environmental and occupational performance and improving domestic collection of scrap batteries, unless newly deployed processing technology leads to a significant reduction of production costs.

72. Third, in reviewing supply and demand of lead for SLI battery production, it is important to bear in mind that there is a differentiation of prices among the lead scrap varieties as a function of their processing requirements. The production process of secondary smelters is normally tailored to ULABs as the key feedstock material. Any other non-battery lead feedstock requires some modification (either simplification or complication) of the processing steps as a function of the composition or contamination of the scrap.[44] This may lead to production cost increases for battery recyclers, over and above scrap costs. Against this background and in the light of currently depressed international prices of refined lead, it is unlikely that ULAB-dependent secondary smelters are using non-battery lead scrap feedstock at significant scale.[45]

73. Fourth, from a technical point of view, refined lead can be produced from primary and secondary sources. Therefore, primary and secondary lead, refined to the same standard, are perfect substitutes for each other. In general, secondary lead supply is more responsive to changes in prices than the supply of primary lead. The latter is generally mined in tandem with other metals, such as zinc, copper or silver. The mined quantity is therefore only partly a function of lead-derived revenue - making supply largely price-inelastic.[46] Given this character of residual supply, international lead prices are generally very responsive to changes in demand. Since the beginning of the 1980s, Western world mine production of lead continuously declined till 1994 by about 20 per cent. Ever since, however, it has been on a rise and the opening of two big mines in Australia and Canada in 1998 can lift global production by as much as 10 per cent.[47]

74. Unlike any non-battery lead scrap, refined (primary) lead virtually requires no further smelter treatment. Unless all primary lead input is used as soft lead for battery paste, the production of lead alloys (antimonial lead or lead-calcium) is the only processing required. Therefore, any extensive use of refined (primary) lead would make secondary smelter operations redundant. As mentioned above, current estimates suggest that lead recovery from ULABs still enjoys a cost advantage of about 5-10 per cent compared to the import of refined (primary) lead.

75. In the course of 1998, the international lead price at the LME has fallen to historically very low levels (at times about US$450 per ton). Compared to 1996 and 1997, the 1998 average LME settlement price fell by 42 and 16 per cent respectively. As a result, since the summer of 1998, scrap battery prices have also declined by as much as 40 per cent.[48] While feedstock supply of recyclers

in countries with self-financing (e.g. disposal fee or scrap management tax) or deposit-refund system-based scrap battery collection systems largely remains unaffected by the lead price slump, collection volume of pure market- and thus scrap price-based systems, such as in the Philippines, is likely to shrink.

## 5. The General Effects of The Basel Ban Amendment on Lead Supply and Demand

76. This part of the paper attempts to review the general implications of the Basel Ban Amendment on lead supply and demand in a non-Annex VII country with a battery recycling industry and dynamic lead demand from a conceptual point of view. In the absence of any trade restrictions, demand can be met by the following sources:

- domestically collected ULABs;
- imported ULABs from
  - other non-Annex VII countries (i.e. developing countries);
  - Annex VII countries (i.e. OECD countries, EC and Liechtenstein);
- domestically collected non-battery lead scrap (in solid form or from lead-bearing residues);
- imported non-battery lead scrap
  - in solid form and as lead-bearing residues, from Annex VII countries;
  - in solid form and as lead-bearing residues, from non-Annex VII countries;
- import of refined (primary) lead and lead alloys.

77. After the Basel Ban Amendment comes into effect, two sources of supply will no longer be available for meeting demand:

- ULABs imported from Annex VII countries; and
- lead-bearing residues imported from Annex VII countries.

78. Figure 4 graphically illustrates the pre- and post-Basel Ban Amendment situation with respect to the various components of lead supply and aggregate demand for SLI battery production in a non-Annex VII country. The components of supply, which are subject to significant change by the trade restrictions of the Basel Ban Amendment, are shown as dashed curves. This concerns the imported and domestically collected ULABs in the pre-ban figure, and both domestically collected ULABs and ULABs imported from non-Annex VII countries in the post-ban figure.

79. Supply prior to the ban is met by domestically collected ULABs, supplemented by imported ULABs from OECD and other developing countries. With most recoverable lead coming from spent lead-acid batteries, which have relatively uniform collection and processing costs over a large range of volumes, supply of secondary lead is likely to be highly sensitive to lead price changes at lower output (implying a relatively flat supply curve). However, as the proportion of used batteries being collected and recycled approaches limits, and secondary lead producers need to seek raw material from less accessible sources (i.e. old lead scrap[49] and lead bearing residues, such as slag and drosses), the cost of supplying additional amounts of lead scrap is likely to rise quickly. This is reflected in the steeper slope of the secondary supply curve at higher volumes of output.

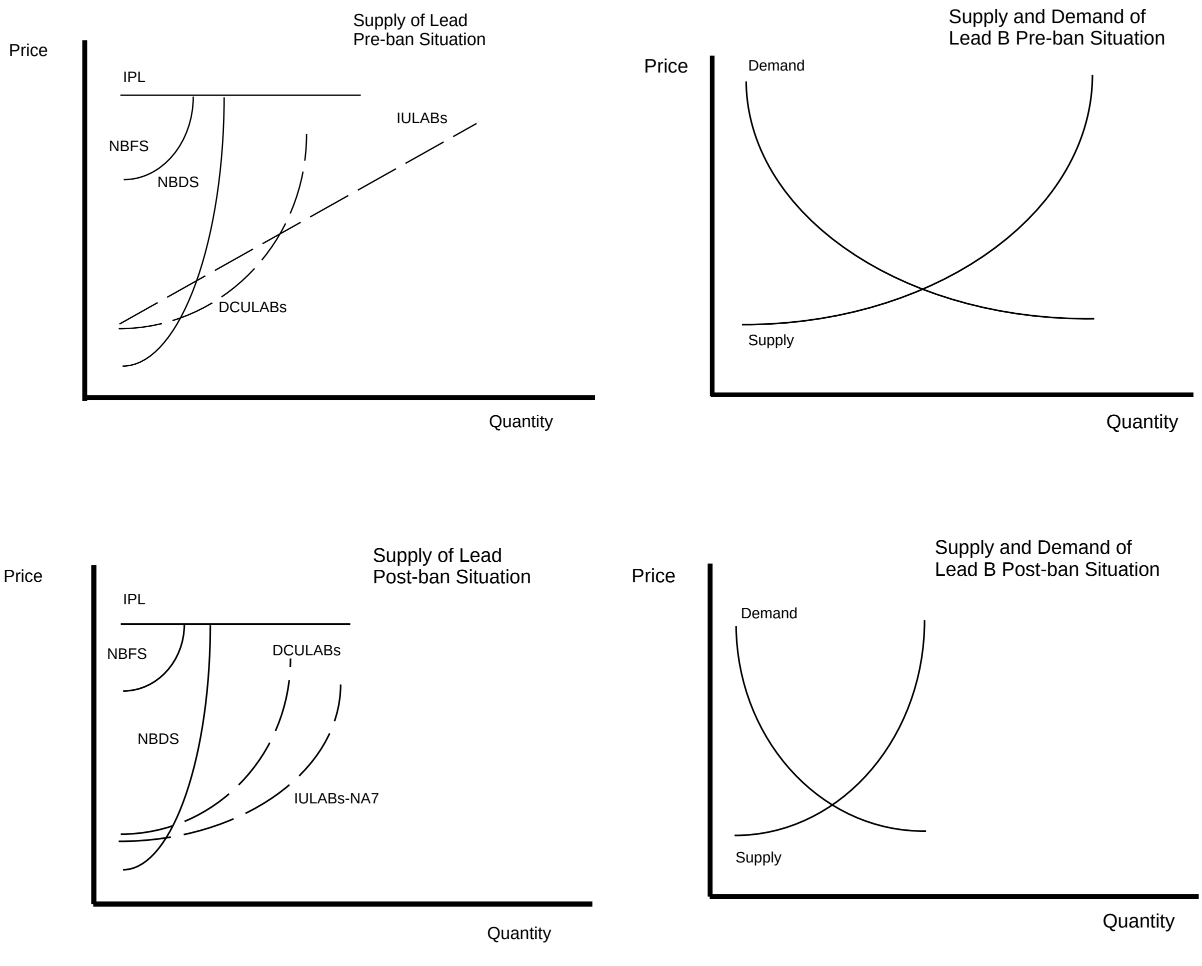
80. Recoverable non-battery domestic scrap (i.e. old lead scrap and lead-bearing residues), imported non-battery scrap and imported refined (primary) lead and lead alloys represent the residual sources of supply. The first source of supply, likely to be resorted to in case of constrained ULAB availability, is domestic non-battery scrap (NBDS). At the lower price scale, this mainly concerns lead-bearing residues, which are acquired from small or cottage (s)melters, which are unable to recover the lead themselves. The next source of supplementary supply is domestically available old lead scrap. In the light of its unpredictable supply, resort to imports of old lead scrap is also likely.

Conversely, the import of lead-bearing residues as supplementary feedstock is not very likely.[50] Imports of refined (primary) lead and lead alloys are the last resort and represent the price cap for all secondary feedstock.

81. In the pre-ban situation, the supply and demand curves of lead for SLI battery production intersect at a relatively high quantitative level, which is largely determined by access to domestically collected and imported ULABs. When necessary, this may be supplemented by domestically available non-battery scrap. The easy access to imported ULABs exerts little pressure on secondary lead smelters to enhance domestic collection of ULABs.

***Figure 4***

Pre- and Post-Basel Ban Amendment constellation between lead supply and demand for SLI battery manufacturing in a non-Annex VII country




IPL ..... Imported (refined) Primary Lead NBFS ..... Non-battery Foreign Scrap
NBDS ..... Non-battery Domestic Scrap IULABs ..... Imported Used Lead-acid Batteries
DCULABs ..... Domestically-collected Used Lead-acid Batteries
IULABs-NA7 ..... Imported Used Lead-acid Batteries from Non-Annex VII countries

82. Following the introduction of the ban, access to imported ULABs is confined to non-Annex VII countries (i.e. other developing countries). As the world market of lead scrap will be divided into two segments by the ban (an Annex VII and a non-Annex VII part), supply of ULABs in the non-Annex VII market (i.e. the market with the highest rate of lead consumption growth) will lag behind demand, thus driving up scrap prices. Confronted with this situation, more pressure is exerted on secondary lead smelters to enhance domestic collection of ULABs. Unless these two sources

of supply can generate sufficient feedstock to make up for the loss of previously imported ULABs from OECD countries, secondary smelters will have to rely on domestic lead-bearing residues and other solid non-battery lead scrap. While imports of solid non-battery scrap are also an alternative source of supply, sharply rising scrap prices make it unlikely that these sources of supply will play any significant bridging role.

83. On balance, the situation is likely to lead to an exhaustion of easily accessible and low-cost scrap. Unless secondary smelters manage to reduce other production costs to compensate for higher feedstock costs, reductions of capacity utilization among key secondary smelters are very likely, in particular at times of low international prices of refined lead. The latter might encourage battery manufacturers in non-Annex VII countries to rely to a greater extent on imports of refined (primary) lead and lead alloys. Domestic collection of scrap batteries in marginal areas, having high collection and transport costs, is likely to suffer from such imports. The aggregate supply curve changes because some of its components are no longer available. There will not be any effects on the slope and location of other components of supply. The price rises because of a shift along the remaining components of supply.

84. Thus following the introduction of the ban, there is likely to be a reduction in the quantity of totally recycled batteries in the non-Annex VII country. However, this masks an increase in the volume of domestically collected and recycled batteries. Nevertheless, the latter is likely to fall short of making up the difference to the previously imported tonnage of ULABs from OECD countries. Rather, battery manufacturers are likely to use a higher percentage of imported refined (primary) lead as feedstock, which partially replaces recovered lead. The lower the international price of refined (primary) lead, the more pronounced this trend.

85. From an environmental and economic point of view, the situation appears to be a mixed blessing. In fact, the incentives generated by the Ban Amendment are contradictory. On the one hand, the ban encourages enhanced collection and recycling of domestically generated ULABs. It can also lead to an increase in the overall lead recovery rate in the country by using more lead-bearing residues as feedstock material, thus limiting the amount of lead which is “lost” in the environment. On the other hand, the multilateral export ban on ULABs has a number of problematic effects: It makes the bridging of the domestic supply-demand gap very difficult. In particular, the ban seems to put at risk an effective capacity utilization of modern licensed conventional secondary smelters of a size beyond 15,000 tons of refined lead output per annum. This is caused by inadequate availability of secondary feedstock and higher scrap prices (as was mentioned above, scrap prices rise because of a shift along the remaining components of supply). To assure a sustainable capacity utilization, battery manufactures have little choice but to use more refined (primary) lead as input or go out of business. In essence, this means that (i) a significant part of benefits arising from increased domestic collection of ULABs may be lost in the light of the fact that lead recovery activity by modern smelters is weakened at the expense of partial lead recovery by cottage (s)melters and small smelters; and (ii) there will be increased use of imported refined (primary) lead.

86. The undesirable effects of these two developments are fivefold:

(i) partial lead recovery by small smelters and in the informal sector is unlikely to suffer much from the ban, and related lead and acid spillage and human exposure remain unchecked;

(ii) constrained capacity utilization of modern secondary smelters discourages the improvement of their environmental and occupational health performance and investment in new processing technology;

(iii) the higher import volume of refined (primary) lead bears on the balance of trade;

(iv) higher feedstock prices of national battery manufactures will affect their competitiveness and thus lead to a higher import volume of new batteries, also bearing on the balance of trade;[51] and

(v) retail prices of new batteries are poised to increase in the concerned developing country.

87. In summary, the ban creates a short-lived improvement in domestic collection and recycling of scrap batteries which, unless reinforced by government intervention, is likely to be wiped out and even overwhelmed by the medium-term consequences of low capacity utilization and/or the more pronounced use of refined (primary) lead among modern secondary lead smelters.

88. A recent study on the preliminary implications of an import ban on used lead-acid batteries, self-imposed by Brazil in 1995,[52] revealed a number of undesirable effects which seem to confirm the validity of the picture just painted. For Brazil, the following distortionary effects were identified:

- a significant increase in the import volume of new batteries (by 200%) and refined (primary) lead (by 35%);
- a decline in capacity utilization among licensed secondary lead smelters and battery manufactures in tandem with an expansion of battery reconditioning and "backyard melting" in the informal sector, which now accounts for almost 60 per cent of Brazil's secondary lead production; and
- delays in the technological upgrading of licensed lead smelters in order to improve their environmental and economic performance.

89. The study concludes that "the major Brazilian environmental problem related to secondary lead is not the possibility whether imports of battery scrap are allowed or not, but what should be done to organize the complex structure of collecting and recycling old batteries, especially the control of small and unregulated activities."

## 6. Assessing the Effects of the Basel Ban Amendment on SLI Battery Recycling in the Philippines

90. Based on the analysis of the general effects of the Ban Amendment in the preceding section and the previous analysis of the Philippine supply-demand balance of lead for the production of SLI batteries, this section attempts to identify the specific effects of the ban on the SLI battery recycling industry in the Philippines.

91. As was shown in Figure 4, a number of key components of lead supply will be affected by the trade restrictions of the Ban Amendment. Furthermore, it needs to be borne in mind that ULAB imports play a key role in bridging the domestic supply-demand gap of lead for SLI battery production. Against this background, one or more of the following reaction scenarios by SLI battery recyclers in the Philippines are likely to occur:

a) Whole or partial replacement of Annex VII battery scrap by imports of ULABs from other (non-Annex VII) developing countries.

b) Partial substitution of domestically collected ULABs and other non-battery scrap for Annex VII battery scrap.

c) Partial replacement of imported ULABs from Annex VII countries by imported refined (primary) lead.

d) Reduced level of battery recycling.

e) Production or import of batteries with an extended life and/or being lead-free.

92. The reaction scenarios above basically fall into two categories: Scenarios (a)-(d) are evolutionary (in the sense that they are based on principally unchanged battery manufacturing technology), whereas scenario (e) represents a revolutionary reaction scenario that reduces production and consumption of lead. This study will only elaborate on the evolutionary reaction scenarios. The effects of production or import of batteries with an extended life and/or lead-free batteries are reviewed in two other background papers.[53] The reaction scenarios are likely to overlap and this is reflected in the discussion.

### *6.1. Whole or partial replacement of ULAB imports from Annex VII countries by shipments from other developing countries*

93. As highlighted above in the review of the lead-acid battery recycling industry in the Philippines, PRI is the only company which has imported ULABs from OECD countries, mainly Australia and the United States. Although this import volume varied, approximately 7-10Kt of ULABs (gross scrap weight) were annually imported from OECD countries in 1995 and 1996.[54] Such shipments accounted for about half of all imported ULABs; the rest coming from other developing countries, mainly Malaysia, Singapore, Sri Lanka and the Middle East.

94. In anticipation of the Ban Amendment, PRI has discontinued sourcing ULABs from OECD countries on a voluntary basis since the beginning of 1997 and sourced battery scrap from other developing countries. In the short term, it is unlikely that PRI will encounter significant hurdles or incur much higher private costs in sourcing ULABs from other developing countries. Likewise, it is improbable that there are other sectoral or macro-economy adjustment costs caused by the sourcing shift. However, once the amendment of the Basel Convention takes effect, a dual international market of ULABs will be created, making lead scrap in developing countries scarcer and scarcer.

95. In the light of buoyant growth of car and motorcycle fleets in the rapidly industrializing developing countries, demand for new lead-acid batteries has been and will remain high.[55] In Southeast Asia, for instance, battery demand has increased by some 17 per cent annually in the first half of the 1990s. Although strong lead demand in developing countries - mostly fueled by demand for batteries - creates its own supply with a time lag of about two years, inefficient lead recovery, a significant quantity of uncollected scrap batteries and very high annual rates of lead consumption growth cause a significant gap between supply and demand. It is therefore logical to assume that ULAB imports from other developing countries will gradually become more expensive, forcing PRI to scale down such imports over time. This will imply that, all in all, imported scrap with a lead content of up to 12 Kt would have to be replaced by other sources of supply.

96. Given the critical importance of the economics of scale of currently used battery recycling technology, from a conceptual point of view, several developing countries could agree on a regional management of battery scrap and its recycling. Recycling could thus be focused on few countries. Such system, however, would require a good deal of government intervention and inter-governmental co-ordination. Furthermore, there is the risk of supply dependence and the emergence of monopolistic market structures.

### *6.2. Increased domestic collection and recovery of ULABs and non-battery lead scrap*

97. As was illustrated in figure 2, the quantity of domestically-generated ULABs can be estimated at about 2.2 million units, having a total lead content of about 24 Kt. PRI recovers about 6 Kt of this quantity, whereas the small smelters recuperate between 4.5 and 9 Kt. The informal sector, “recovers” about 5 Kt of lead destined for (or rather in the form of) reconditioned batteries, and up

to 2 Kt as a result of primitive "backyard (s)melting". Used batteries with a lead content of about 3 Kt are estimated to be jettisoned and/or remain uncollected. As a result of imperfect recovery in the informal sector, up to 3 Kt of lead gets lost in the informal sector, about 1 Kt among small smelters.

98. Against this background, the principal recyclers are faced with the following situation with respect to material feedstock (all figures in lead content):
The following import volume of ULABs needs to be replaced

| | | |
|---|---|---|
| - | from Annex VII | 6 Kt (require immediate replacement) |
| - | from non-Annex VII countries | up to 6 Kt (to be gradually replaced) |

Potential feedstock substitutes

| | | |
|---|---|---|
| - | ULABs from battery reconditioning and cottage (s)melting | 10 Kt |
| - | uncollected ULABs | 3 Kt |

99. If one assumes that up to 12 Kt of imported ULABs will gradually have to be replaced by other feedstock, PRI would have to make significant inroads into the quantity of battery feedstock which is currently absorbed by the informal sector and which remains uncollected. Although theoretically there is sufficient substitute feedstock, its adequacy,[56] accessibility and collection costs are unclear. Furthermore, the substitution demand of up to 12 Kt of lead is based on a relatively low capacity utilization of PRI at the moment, which is in fact very close to its break-even point of profitability of about 60 per cent. In addition, any further upgrading of PRI's environmental performance would require a higher capacity utilization and thus feedstock demand.

100. Without government intervention (as outlined below) PRI is unlikely to gain access to a significant percentage of ULAB feedstock currently appropriated by the informal sector. In particular, unless demand for inexpensive batteries can increasingly be met by licensed battery manufacturers, the informal sector will not lose much of its current share of ULAB collection and partial lead recovery.

101. As note above, on the basis of its new domestic battery collection program (Balik Baterya), PRI doubled the volume of domestically collected ULABs between 1994 and 1997. Some 14.1 Kt (gross scrap weight) or almost 40 per cent of domestically generated ULABs in the Philippines was collected in 1997. The program, launched by PRI in November 1995, is based on a one-for-one exchange system and a very attractive refund scheme implemented through the battery retailers of the battery manufacturer, Oriental and Motolite Corp. (OMC). As the collection system is based on the existing sales network of battery retailers, the enhanced collection performance achieved so far has not entailed significant private costs.[57] However, in this way, collection does only increase in line with higher domestic battery sales of OMC. In the absence of any government regulation of ULAB collection, PRI has resorted to very attractive purchasing prices of ULABs for enhancing collection. By way of illustration, in mid-1998, the Balik Baterya program of PRI offered purchasing prices for ULABs between US$2 for a regular car battery and US$3-4 for a truck battery. It appears doubtful, however, that domestic battery collection by PRI can significantly be driven up further without regulatory and financial support by the government.

102. First, as was mentioned above, PRI's collection system covers all parts of the Philippine archipelago which bear on SLI battery consumption. As can be seen from the map and table A-1 in the annex, provinces not covered by PRI's collection system account for only 17 per cent of the population. Their share in car population can even be assumed to be lower. The density of collection points in the map correlates with the regional pattern of vehicle population (table A-2 in the annex). Although some regional expansion of the collection system might be justified upon careful

analysis, the current physical spread of collection points is capable of catching most of the domestically generated vehicle battery scrap. One can therefore draw the conclusion that an adequate physical spread of the collection system of licensed recyclers is a necessary but not sufficient condition for effective collection of domestically generated ULABs. Unless supplementary measures are taken, the informal sector remains very efficient in collecting scrap batteries and thus keeping away much needed feedstock from the formal recycling sector.

103. Second, there is also not much more room for lifting domestic ULAB purchasing prices further to bring more domestically-generated ULABs into the Balik Baterya program. As mentioned before, ULAB purchasing prices for the most frequently sold batteries are already almost equivalent to a daily salary in the Philippine province. Therefore, a further increase in collection prices is likely to encourage theft of still functioning or even new batteries from cars and trucks. Moreover, purchasing prices of domestic ULABs will not remain unscathed by the recent weakness of international lead prices. Against this background, informal sector collectors, which already offer very competitive ULAB purchasing prices for mainstream battery types destined for reconditioning, will most likely increase rather than decrease collected tonnage.

104. The use of more domestic non-battery lead scrap is another way of replacing some imported ULAB tonnage. According to figure 4, PRI would first resort to lead-bearing residues before tapping domestic non-battery solid scrap. Most of the drosses that could be recovered will be produced at the battery manufacturing plants. As the alloys are melted into the casting pots to cast the battery grids, a dross forms at the surface and this dross will be skimmed and removed. It is these drosses that PRI could acquire. However, as PRI already acquires the lion's share of such drosses from OMC's battery manufacturing plant, the remaining tonnage of drosses from small battery producers is insignificant.[58] The only as yet untapped source of further supply of lead-bearing feedstock is slag, containing up to 5% of lead, generated by the small smelters. However, even if one assumed that slag accounted for about 30% of the volume of refined lead output of small smelters, i.e. about 2 Kt on the basis of the estimates in figure 2, the low lead content of the slag would not result in more than some 100 tons of supplementary lead supply.[59]

105. Figure 2 gives an estimate of the supply of domestic non-battery solid lead scrap of some 4-6 Kt. In the light of its high material and collection costs, however, it is unlikely that a significant part of this scrap finds its way into the largest secondary smelter, in particular at times of historically low international lead prices.[60] Furthermore, such migration would divert lead supply from non-battery lead products. And finally, compared to currently depressed international prices of lead, high costs would also make it unattractive to resort to imported non-battery solid scrap or lead-bearing residues (the latter only from non-Annex VII countries) to replace imported ULABs.

### *6.3. Partial substitution of imported refined (primary) lead for imported ULABs*

106. As collection and smelting costs of ULABs are relatively constant over a wide range of capacity utilization, the lower the LME price of primary lead,[61] the higher the inclination of battery manufacturers to partially use refined (primary) lead as feedstock material. In addition, considerations of sufficient capacity utilization of battery manufacturers at times of tight supply of refined or alloyed lead by secondary smelters are also likely to reinforce the partial use of refined (primary) lead.[62]

107. Under prevailing conditions, battery production costs on the basis of imported refined (primary) lead are only some 5-10 per cent higher than on the basis of ULAB-recovered lead.[63] In the light of this narrow difference, each supply constraint faced by PRI will lead to substition in favour of imported refined (primary) lead.[64]

108. It should not go without comment that, from an overall ecological point of view, the production of primary lead is very waste- and energy-intensive. Every tonne of lead concentrates mined generates about 20 tonnes of mining waste (i.e. tailings),[65] whereas the production of refined lead from ULABs generates about 300 kg of slag per ton of refined lead output.[66] Furthermore, the production of primary lead takes about four times as much energy as the production of refined lead from scrap.[67] Economically, the import of refined (primary) lead, for example in the order of 6 Kt, increases the import bill of the Philippines by about US$3.8 million, compared to US$1.5 million for some 10 Kt of ULABs (having a lead content of about 6 Kt).

109. As noted above, PRI has a break-even point of profitability of about 60 per cent of installed capacity of some 37 Kt of refined lead output. In other words, feedstock shortage-induced reduction of capacity utilization could be driven close to about 22 Kt, without jeopardizing the sustainability of the recycling operation. However, given that current PRI sales (and thus capacity utilization) are already oscillating around the break-even point of profitability, there is no room for further ULAB feedstock shortage-induced capacity reduction without undermining the viability of the recycling operation.

110. The current import volume of refined (primary) lead and lead alloys is about 8 Kt (lead content), of which some 2 Kt are estimated to find their way into battery manufacturing. Any further significant replacement of ULAB-derived lead by imported refined (primary) lead would discourage PRI from stepping up efforts to further increase domestic collection of ULABs. While it may be argued that lower capacity utilization of PRI's smelter might reduce some environmental and occupational harm, this gain would most likely be far outweighed by the lead spillage caused by quantitatively unchanged or higher battery reconditioning and partial lead recovery in the informal sector. Low capacity utilization would also discourage further investment by PRI into pollution prevention and abatement technology.

111. As production costs of new batteries tend to increase with the use of imported refined (primary) lead for battery manufacturing, OMC will attempt to pass some of the cost increase onto consumers.[68] In the light of the fact, however, that imported new batteries currently meet about 3 per cent of domestic battery demand only, it is reasonable to assume that retail prices of new batteries would only slightly increase in the face of import competition in the short term. However, the general level of retail prices of new batteries in the Philippines is poised to increase.[69] The higher price level, in turn, is likely to encourage the demand for reconditioned batteries. Reconditioners will enjoy a twofold advantage: on the one hand, they stand to profit from more ample ULAB supply (in the wake of less vigorous collection by PRI) and thus lower scrap prices; on the other hand, they can increase prices of reconditioned batteries in the light of the higher retail price level of new batteries.

### *6.4. Quantitative reduction of battery recycling by PRI*

112. If PRI fails to replace a significant percentage of imported ULAB feedstock by domestically collected ULABs, supplemented by access to some non-battery scrap, in a quantity sufficient to surpass the benchmark of profitable capacity utilization, the company might decide to discontinue battery recycling and even close the battery plant. As highlighted in connection with the discussion linked to table 5 above, current production costs of secondary lead differ no longer much from costs for imported refined (primary) lead. Any significant use of primary lead input, however, would harm the company's competitiveness compared to small battery manufacturers in the country and foreign suppliers of new batteries, in particular from OECD countries.

113. The assumption of a discontinuing of battery recovery and even battery manufacturing is by no means hypothetical, because RAMCAR, the parent company of PRI, is a powerful conglomerate with diversified business interests. If the secondary smelter of PRI therefore became unprofitable over a long period of time, it could be well conceivable that company management decides to shift capital to more lucrative sectors. As a consequence, it is also not unlikely that RAMCAR closes the battery plant as battery manufacturing on the basis of imported refined lead from primary sources jeopardizes the firm's competitiveness in domestic and foreign battery markets. As mentioned before, battery manufacturers in OECD countries can take full advantage of this situation and regain market shares in the Philippines.[70] However, in this situation, it is unlikely that any foreign investor will take over RAMCAR's battery and collection activities.

114. Under this scenario, the Philippine economy would become very import-dependent for new lead-acid batteries, a product which, in the light of its importance for transport, stationary and emergency power supply, is of strategic importance. Such massive import would also be a drain on foreign exchange revenues. The import of about 2.2 million new batteries would cost about US$55-60 million. Moreover, the loss of a current export volume of 0.45 million new batteries would create an additional foreign exchange loss of US$11-13 million. This compares to a current import bill of US$3 million for 20 Kt of ULABs (gross scrap weight) from other developing countries.

115. If battery recycling and collection by the biggest licensed secondary smelter were given up, prices for domestically collected ULABs would fall, having a three-fold effect: (i) battery reconditioners would enhance their competitiveness, making it likely that their share in meeting domestic replacement demand of batteries increased; (ii) expanding activities in the informal sector would result in a dramatic increase of uncontrolled discharge of waste dilute sulfuric acid and high lead content solid waste residues from the partial recovery of lead from ULABs; and (iii) lower ULAB prices and an ill-run collection infrastructure would encourage dumping of waste batteries.

116. In the light of this danger, the Government would have to set up a collection infrastructure or provide significant financial incentives to such facilities to make export of ULABs possible and financially profitable. Importers of new batteries would have to be obliged to take over Oriental and Motolite's network of battery retailers/collectors and export the collected ULABs to recycling facilities abroad. The costs for operating the collection system must take into account the bureaucracy required to maintain the system and the additional costs for shipping out of the country the collected ULABs to a suitable recycling plant (in a manner similar to Singapore, but on a much larger scale). Government intervention and public financial support in this regard must be interpreted as preventive measures which avoid a situation in which a significant part of disposal, collection and recuperation of ULABs is driven "underground" into the informal sector thus creating serious environmental and human exposure to lead.

### *6.5. Development of SLI batteries with extended life and without lead*

117. It is not very likely that the Basel Ban Amendment encourages the development of longer-lasting or lead-free batteries, both in developed and developing countries. In OECD countries, low vehicle population growth, combined with a trend towards increasing use of longer-lasting batteries will generate a supply-demand surplus of ULABs, which, in turn, puts pressure on international lead prices. New hydrometallurgy- and electro-winning-based recycling technology will drive the lead recovery rate of batteries to virtually 100 per cent, while reducing pollution abatement costs and improving environmental performance. Taken together, these factors provide little incentive to battery manufacturers in OECD countries to develop lead-free SLI batteries despite their financial capacity to do so.[71]

118. Conversely, despite the incentives of SLI battery manufacturers in developing countries to develop lead-saving products in the face of constrained supply, they may not be in a financial position to undertake the required research and development activities.

119. There is also the risk that SLI battery manufacturers in developing countries lose shares in their domestic market and overseas. On the one hand, they find it difficult to keep pace with the introduction of long life, maintenance-free batteries. On the other hand, competitiveness even of normal battery lines suffers from high-cost feedstock material. As a result, profitability of the main producers of SLI batteries in the Philippines suffers from a two-fold phenomenon: (i) constrained supply of scrap feedstock; and (ii) eroding competitiveness in domestic and foreign markets. The latter has significant implications for the trade balance of the Philippines.

### *6.6. Conclusions*

120. The scenarios described above have been presented as alternative strategies. In practice, however, it is likely that they merge or overlap. While it is not possible to predict with a high degree of certainty the response of PRI and the small smelters to the changed economic conditions in the wake the ban, the following sequence of events appears to be most likely.

121. First, at the beginning and on a transitional basis, ULABs imports of the principal secondary smelter from Annex VII countries will entirely be replaced by imports of ULABs from non-Annex VII countries without incurring significant additional (private and social) costs. Over time, however, ULAB supply from other developing countries will become tight, exerting pressure on PRI to enhance domestic collection of ULABs and thereby make inroads into the ULAB scrap reservoir of the informal sector as well as get access to currently uncollected jettisoned batteries.

122. Second, as ULAB supply from other developing countries becomes tight, a significant percentage of the imported tonnage will have to be replaced by domestic sources of scrap supply. Although PRI already operates a geographically well-spread collection system, this is not a sufficient condition for siphoning away a significant part of battery scrap currently appropriated by the informal sector. Without government intervention and support, it is unlikely that PRI will gain access to a quantity of domestically-generated ULABs sufficient to gradually replace a large part of imported ULABs. As long as the demand for inexpensive new batteries, sold under specific payment conditions, cannot be met by licensed battery manufacturers in the Philippines or by imported batteries, it is improbable that PRI and other licensed smelters make sufficient inroads into scrap feedstock currently appropriated by battery reconditioners and “backyard” (s)melters.

123. Third, even if PRI did manage to gain access to the ULABs and lead-bearing residues currently untapped by the principal recyclers, the resulting lead content of the total feedstock (some 19Kt), excluding imported ULABs, would only allow a capacity utilization of the PRI plant below the break-even point of profitability (some 22Kt). Either supplementary battery feedstock would have to be siphoned away from small smelters (which would imply a sectorial concentration of recycling capacity and thus the reinforcement of monopolistic market structures) or ULAB imports from other developing countries (or a combination of both) would have to make a sufficient capacity level possible. Any problem in smooth domestic feedstock substitution or in sourcing from other developing countries would aggravate the capacity utilization problems and make ULAB recycling uneconomic. Low capacity utilization, however, would provide little incentive to PRI (and other remaining small smelters, which are ill-equipped to recycle whole scrap batteries) to invest in equipment which enhances the environmental and occupational performance of the plants.

124. Fourth, in the light of (i) the current low level of capacity utilization among licensed secondary lead smelters caused by feedstock shortage and (ii) the historically low level of international prices of lead, the cost advantage of lead recovery from ULABs versus refined (primary) lead has virtually disappeared. Any further complication of scrap sourcing in the wake of the Basel Ban Amendment will encourage the use of imported refined (primary) lead, which in turn discourages scrap collection by licensed smelters and drives increasing parts of domestically generated battery scrap underground into the arms of the informal sector.

125. Finally, as outlined in section 4.1. above, from a macro-economic point of view, high rates of lead demand growth in the Philippines tend to outpace lead supply by about 20 per cent per vehicle battery cycle (i.e. two years). This is currently a volume of about 6-7 Kt of lead. Imports of refined (primary) lead, lead-bearing scrap or products are therefore required to bridge this demand-supply gap. Under market-dictated conditions, it has so far been lucrative to import ULABs for closing most of the gap. If these imports are partly or entirely out phased, they will have to be replaced by imports of refined (primary) lead and new lead acid batteries, at a higher import and environmental cost (caused by less vigorous collection of domestically generated ULABs by the formal recycling sector and brisker partial lead recovery by the informal sector).

## 7. Policy Implications

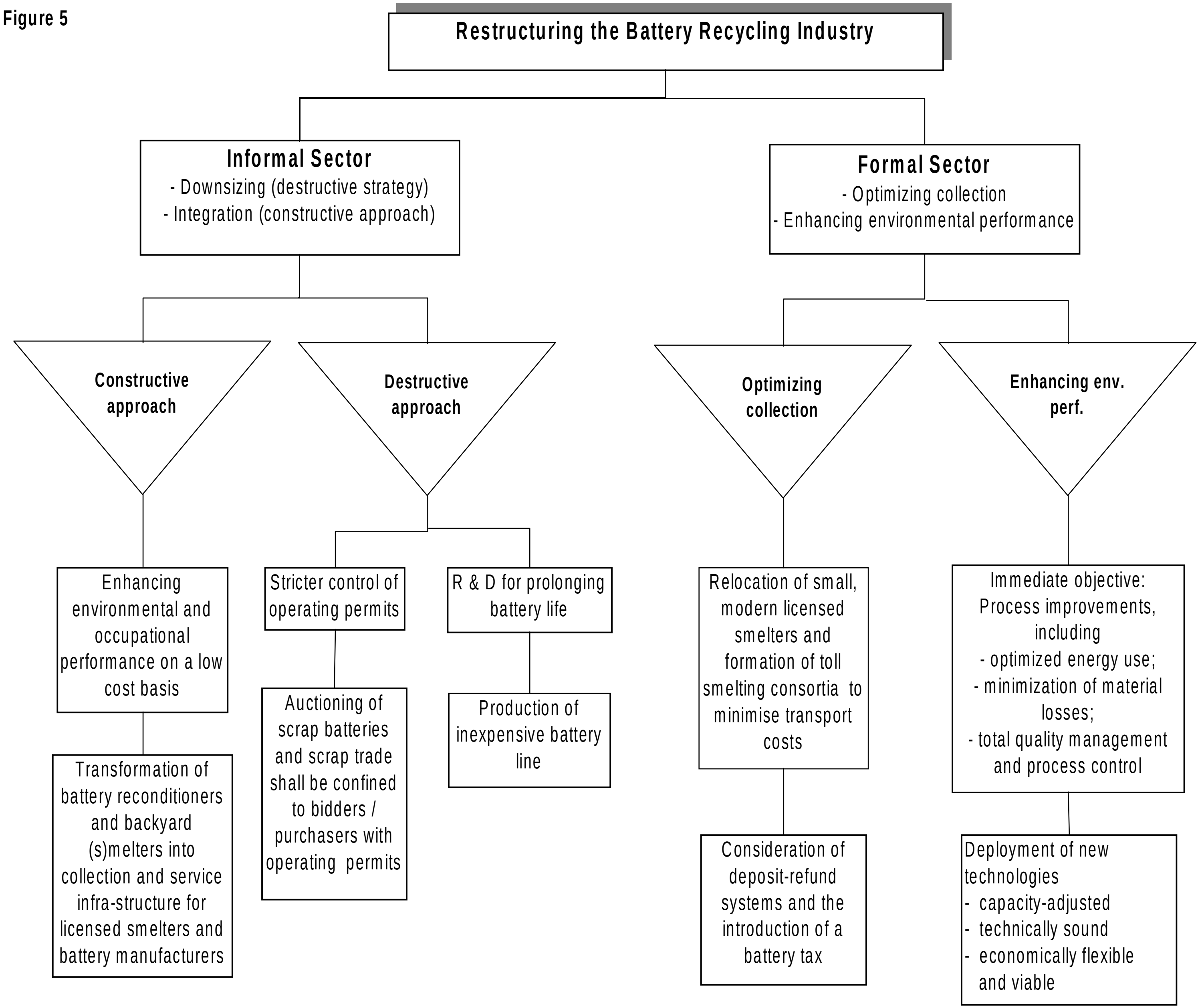
### *7.1. The need for and approaches to a restructuring of the battery recycling industry*

126. While the Basel Ban Amendment was primarily designed to ensure that hazardous wastes generated in Annex VII countries were not being exported to non-Annex VII countries for indiscriminate dumping and sham recycling, it is likely to have some other positive environmental effects. In particular it has the potential to enhance the average rate of lead recovery in the Philippines and thus reduce the amount of lead (by about 3-6 Kt) which is currently lost into the environment. However, the extent to which this occurs is primarily dependent upon two factors: (i) whether the input substitution response of firms primarily takes the form of increased use of imported refined (primary) lead or enhanced domestic collection of lead scrap (ULAB and other), and; (ii) the extent to which there is a shift in production between the “formal, modern” smelters and the more environmentally-damaging smelters, in particular in the informal sector. Unless certain measures to restructure the recycling industry, in particular constructively deal with the informal sector, are taken by the government and some access to import of lead scrap is further assured, it is likely that the environmental and economic effects of the ban will be negative.

127. For instance, if the ban encourages PRI and some other small smelters to adopt a production strategy based upon the use of refined (primary) lead,[72] then it is possible that their use of domestic lead scrap may fall, even relative to the pre-ban situation. This would have the direct adverse effect of reducing domestic collection rates for ULABs. More importantly, it will release lead-bearing scrap (ULABs and other scrap) to the informal sector, with all of the attendant environmental and health implications.

128. Although the ban may encourage collection of domestically generated ULABs, it will make it very difficult for the Philippines to bridge the domestic supply-demand gap, principally created by very high rates of demand growth, in a way which makes domestic battery recycling environmentally and economically sustainable. In particular the use of new modern processing technology will be in jeopardy. Some import of ULABs might be required to resolve this problem.

**Figure 5**


Restructuring the Battery Recycling Industry
Informal Sector
- Downsizing (destructive strategy)
- Integration (constructive approach)
Formal Sector
- Optimizing collection
- Enhancing environmental performance
Constructive approach
Destructive approach
Optimizing collection
Enhancing env. perf.
Enhancing environmental and occupational performance on a low cost basis
Transformation of battery reconditioners and backyard (s)melters into collection and service infra-structure for licensed smelters and battery manufacturers
Stricter control of operating permits
Auctioning of scrap batteries and scrap trade shall be confined to bidders / purchasers with operating permits
R & D for prolonging battery life
Production of inexpensive battery line
Relocation of small, modern licensed smelters and formation of toll smelting consortia to minimise transport costs
Consideration of deposit-refund systems and the introduction of a battery tax
Immediate objective: Process improvements, including
- optimized energy use;
- minimization of material losses;
- total quality management and process control
Deployment of new technologies
- capacity-adjusted
- technically sound
- economically flexible and viable

129. In sum, unless a good number of the above mentioned issues are addressed by the government, the undesirable economic and environmental effects of the Basel Ban Amendment are likely to override the positive implications of the Ban.[73] What pro-active measures can the government take to avoid such situation?

130. Figure 5 illustrates the major components of a restructuring of the battery recycling industry, which aims at (i) resolving the supply-demand gap; (ii) making battery recycling both environmentally and economically sustainable; and (iii) meeting the objectives of the Basel Convention. The restructuring has two main thrusts:

(a) the downsizing of the informal sector and its integration into the collection infra-structure for the formal recycling industry aimed at enhancing collection of domestically generated scrap batteries (and avoiding social conflict);
(b) optimizing collection of scrap batteries and enhancing the environmental performance of licensed smelters.

131. Regarding the informal sector, a twin stick and carrot policy is required to gradually downsize the sector and simultaneously integrate it into the collection- and servicing infra-structure of licensed recyclers. The twin approach should particularly avoid social hardship and employment problems as well as temporary shortages of reconditioned batteries required for meeting a certain demand. Furthermore, there is ample evidence that suggests that a regulatory (only stick-confined) approach is unlikely to be very effective in the light of the nomad character of the informal sector and the high profitability of unlicenced battery reconditioning and "backyard" (s)melting.

132. The destructive facet of the approach falls into a command and control segment and market-based tools. The command and control measures include stricter control of operating permits; closure of particularly problematic "backyard" (s)melters in densely populated areas; and legislation that requires that only whole, undrained scrap batteries are collected and delivered to secondary smelters. Economic instruments need to be employed to gradually dry out demand for reconditioned batteries. This can be done, on the one hand, by investing into research and development for prolonging battery life. The longer the life of a battery, the smaller the incentive to buy a reconditioned battery that might only last a couple of months, even at just one-third of a price of a new battery. As this cannot be achieved in the short term, the licensed battery manufactures should be enabled to produce an inexpensive battery line which competes with the bulk of reconditioned batteries. Besides a competitive price, such batteries need to be sold under attractive payment conditions which take account of the cash flow problems of many ordinary Filipinos.

133. The constructive approach towards the informal sector falls into a short- and medium-term strategy. In the short term, a collaborative approach can be pursued to enhance environmental and occupational performance of the reconditioners and "backyard" (s)melters based on low cost measures. This may range from improving housekeeping, over the free distribution and collection of acid storage drums, to the wearing of protective clothing as well as changes in occupational behavior.[74] In the medium term, efforts should be made to integrate reconditioners and backyard (s)melters into the collection and servicing infra-structure of the formal sector. Besides information campaigns and the collaboration of licensed smelters, this will require some financial incentive and support to meet transition costs.

134. As far as the formal recycling sector is concerned, the restructuring aims at reducing collection and recycling costs in tandem with an improvement of the environmental performance of battery recycling.

135. One thrust for reducing collection and transport costs is the geographical relocation of some small smelters. The current concentration of most recyclers on Luzon island causes significant transport costs for the 20 per cent of scrap batteries which are collected elsewhere in the Philippines in the light of the huge geographical spread of the country. As suggested by Wilson, PRI and several thus relocated small smelters could form consortia in which locally collected battery scrap from PRI's collection points and independent battery dealers is toll smelted by small smelters and then shipped to the main PRI smelter for further refining. This would significantly reduce shipment costs and could also be done at a scale which is conducive to the use of more environmentally sound technology. The consortium approach would also satisfactorily deal with management and disposal of the battery electrolyte.[75]

136. Another possible basket of measures for enhancing collection and reducing its costs is the introduction of a nation-wide deposit-refund system and the imposition of a battery tax. A deposit-refund system aims at enhancing collection volume; it does not reduce collection costs. If combined with an information or awareness campaign, as already practiced by PRI autonomously, it may significantly reduce the tonnage of uncollected jettisoned batteries. The introduction of a (collection) tax on sales of new batteries aims at internalizing part of the collection costs and thus reduces costs of secondary smelters for the procurement of domestically generated battery scrap. As the imposition of the tax involves many parties, such as secondary smelters, battery manufacturers, battery retailers, scrap dealers, and importers of new batteries, the system might require the forging of a consortium, as done in Italy and Sweden.

137. The phrasing "consideration" of such systems has been intentionally used, because they might be a mixed blessing. While deposit-refund and a battery tax have been pretty effective instruments in a number of developed countries, the low income and the widespread cash flow problem of many battery buyers in developing countries require careful consideration in determining the usefulness of these tools and the magnitude of the fees employed in this regard. If deposit and tax levels on new batteries, for instance, were set to high, they would most likely encourage higher sales and production of reconditioned batteries – a counterproductive incentive. Also, both instruments will incur transaction costs. For all these reasons, it might be worth considering operating a well-attuned deposit-refund system, supplemented by direct public financial support to reduce collection costs of certified recyclers (for example in the form of a subsidy per collected scrap battery). The public financial support could be fuelled by a minor surcharge on gasoline taxes or vehicle sales taxes.

138. Optimizing scrap battery collection should go in tandem with efforts to enhance the environmental and occupational performance of the licensed secondary lead smelters. This includes, on the one hand, end-of-pipe pollution containment and in-process minimization of material losses, and, on the other hand, the deployment of new, clean process technologies which, besides improving the environmental record, also need to reduce production costs. In this regard, it needs to be borne in mind that investment into pollution abatement technology, in general, and new process technology, in particular, will only be made by the private sector, if the economic sustainability of recycling is assured. This is why environmental and economic sustainability are inseparably interlinked.

139. Enhancing environmental performance falls into a short- and medium-term approach. In the short term, improvement of management and process control can enhance environmental performance. In the medium term, new process technology will have to be considered. In this regard, a careful review of the technological and economic potential of the recycling facilities is required. If, for example, a number of small smelters indeed had no valid environmental compliance

certificatates and an analysis of their technical potential revealed that an upgrading was hopeless, such facilities should be closed by the government.

140. What are the most suitable policy approaches, in particular at central government level, for bringing about the restructuring of the Philippine battery recycling industry outlined above?

### *7.2. Possible policy approaches*

141. As shown in figure 6, there are principally three policy packages that could be employed by the government to restructure (or encourage restructuring of) the industry with a view to enhancing sound recycling of used lead-acid batteries; better management of lead as a natural resource and mitigating the economic, social and environmental adjustment costs of the Basel Ban Amendment. The first conceivable policy package is based on heavy-handed public regulation, intervention and financial support. The second policy scenario would require far less government intervention and financial support, but implies a high capacity utilization of licensed smelters and thus the generation of sufficient private profit which is re-invested in research and development and the enhancement of environmental performance. The third policy basket is a blend of package one and two, which can accommodate "extreme" circumstances, without jeopardizing the objective of making battery recycling environmentally and economically sustainable.

*a) Significant government intervention and financial support*

142. This policy package is based on the assumption that the domestic supply-demand gap of lead for SLI battery manufacturing is only imperfectly bridged by imports of battery scrap from other developing countries. The secondary smelters in the formal sector therefore suffer from low capacity utilization and thus profitability. Imports of refined (primary) lead and new batteries are resorted to in order to bring lead supply and demand in balance.

**Figure 6**

**Possible Packages of Policy Approaches**

1

**Significant Government Intervention and Financial Support**

a) collection
b) R&D for prolonging battery life
c) production of low-price battery line
d) facilitating use of environmentally sound technologies

2

**Allowing High Capacity Utilization at Licensed Smelters**

a) supplementary regulation and public financial support for collection
b) private sector investment in new smelting technology and R&D for prolonging battery life
c) public support for improving sales conditions of inexpensive battery line
d) allowing scrap imports by suitable and certified secondary smelters

3

**Combination of Approaches 1 and 2**

a) if international lead price fell much below US $500 for quite some time
b) if foreign or domestic battery demand significantly shrunk

143. In order to enhance collection of domestically generated scrap batteries by licensed recyclers, the following regulatory measures should be taken:
- mandatory return of scrap vehicle batteries to licensed battery dealers;
- strict control of operating permits of recycling facilities;
- regular control of environmental performance of recycling facilities; and
- trade and auctioning of scrap batteries shall be limited to operators with a valid license.

144. In addition, the government might consider the introduction of a carefully calibrated deposit-refund scheme for enhancing collection volume and the imposition of a tax on new batteries, which can be used for lowering collection costs of licensed recyclers. To be effectively levied, administered and used, the battery tax may require the forging of a consortium by the government or in a government-assisted way, rallying smelters, battery manufacturers, importers, and scrap traders. As mentioned above, such battery tax may be replaced by direct public financial support fuelled by a surcharge on gasoline or car sales taxes.

145. To undermine demand for reconditioned batteries, the government will have to provide significant financial support to (i) research and development into new batteries with an extended life under tropical conditions;[76] and (ii) enable licensed battery manufacturers to produce and sell an inexpensive battery line, which competes with reconditioned batteries. Besides subsidizing production, there will also have to be provisions for running a credit scheme which offers very attractive sales conditions to cope with the cash flow problem of many Philippine customers. There will also be the need to financially support the transformation of battery reconditioners and "backyard" (s)melters into collection and service points for licensed secondary lead smelters.

146. As far as the facilitation of the restructuring of the formal sector is concerned, the geographical relocation of some small modern smelters will have to be financially eased. In the light of the low capacity utilization and therefore investment reluctance of the formal recycling sector, public financial support will also be required for more costly process improvements and the deployment of new process technology. In this regard, tax and duty free import of equipment might be one measure to be considered by the government.[77]

147. The overall amount of public financial support inversely correlates with the level of international lead prices. This policy package is likely to be the most effective, but also the most inefficient, i.e. expensive.

*b) Allowing high capacity utilization at licensed smelters and battery manufacturers*

148. This package of policy measures aims at allowing a high capacity utilization among licensed secondary smelters and battery manufacturers so that generated profits can be reinvested into
- enhancing collection;
- R&D into prolonging battery life;
- the production of an inexpensive battery line;
- process improvement for pollution abatement; and
- the use of new process technology.

149. Such reinvested private profit by licensed recyclers substitutes for public financial support under policy package one. Profits tend to increase with capacity utilization because overheads, such as salaries and wages, maintenance costs, pollution control and abatement costs as well as depreciation remain unchanged, thus lowering production costs per unit of refined lead output.[78]

The higher the capacity utilization and the international price of refined lead, the lower the need for public financial support.

150. The government will however still have to provide some supplementary regulation and public financial support. The former concerns the imposition of mandatory return of used lead-acid batteries to licensed battery dealers and strict control of operating and scrap trading licenses, whereas the latter implies support to battery reconditioners and “backyard” smelters for easing their gradual integration into the collection infra-structure of licensed smelters and the sales and service infra-structure of licensed battery manufacturers. The government may also consider the use of some economic instruments for enhancing collection of domestically generated scrap batteries, such as a well-calibrated deposit-refund scheme and the imposition of a battery tax, or alternatively surcharges on gasoline and car sales taxes.

151. Although this policy package will enlarge the collection volume of domestically generated battery scrap for licensed smelters, domestic lead supply will still fall short by at least about 20 per cent of meeting demand for SLI battery manufacturing. Furthermore, to achieve a high capacity utilization among the principal recyclers and battery manufacturers, additional supply of lead will most likely be required. As closing this supply and demand gap by imports of refined (primary) lead or new batteries is undesirable, both from an environmental and economic point of view (as outlined above), imports of battery scrap will be required. Some of this imported tonnage will have to come from sources in OECD countries as battery scrap shipments from other developing countries become too expensive. The government may therefore have to consider the option of concluding, based on Articel 11 of the Basel Convention, bilateral agreements with Annex VII countries to allow certain recyclers the import of battery feedstock from OECD countries. Such agreements should be confined to recycling facilities which meet OECD environmental and occupational performance standards, based on regular verification and certification.

*c) Combination of approaches one and two*

152. This package of policy measures should be regarded as partial shield for assuring the continuity of the restructuring of the battery recycling industry against the worst whims of international lead prices and economic recession in Asia.

153. To avoid any misunderstanding, the economic rational for recycling, i.e. being more cost-efficient than primary lead extraction, cannot be uncoupled from the medium-term trend of international lead prices. Therefore, the government can only provide some assistance so that the drive towards environmentally sound recycling and management of lead as a natural resource is not jeopardized by brief periods of very low international lead prices. From a conceptional point of view, the related government support could be counter-financed by an additional import tax being put onto lead-bearing products and refined (primary) lead. Such measure might however be regarded a technical barrier to trade under GATT rules.

## NOTES

1 PIC has been the core of the management system, supplemented by some other management tools, such as specific requirements for packaging and labeling, take-back requirements and liability.

2 The trade ban of the Ban Amendment will be an additional measure for those Basel parties subject to it (i.e. for exports from Annex VII to non-Annex VII parties). The Convention continues to operate in its original form for trade between Annex VII parties, between non-Annex VII parties, for export from non-Annex VII parties to Annex VII parties anf for trade between Basel Convention parties who have not ratified the Ban Amendment.

3 According to the legal advisor of the secretariat of the Basel Convention, the Ban Amendment will enter into force when some 63 Parties of the Convention ratify it. As of February 1999, twelve parties (Denmark, Ecuador, the European Union, Finland, Luxembourg, Norway, Paraguay, Slovakia, Spain, Sri Lanka, Sweden, and the UK) had ratified the Amendment.

4 The export of hazardous waste destined for final disposal under the guise of recycling.

5 The Ban Amendment undoubtedly complicates future investment in recycling activities and may thus compound sound future management of waste in some of the poor developing countries.

6 For an overview of probably Ban-affected metal wastes, see: Hoffmann, U., *A statistical review of international trade in metal scrap and residues*, part I (general overview), part II (metal-bearing residues from iron- and steelmaking and non-ferrous metal bearing ash and residues); part III (scrap of non-ferrous metals and alloys), UNCTAD/ICME, Ottawa 1995 and 1996.

7 For more information in this regard, see: Johnston, N., <u>The implications of the Basel Convention for developing countries: the case of trade in non-ferrous metal-bearing waste</u>, *Resources, Conservation and Recycling*, Vol. 23(1998), pp. 1-28.

8 Article 4.9.(b) of the Basel Convention states that "Parties shall take the appropriate measures to ensure that the transboundary movement of hazardous wastes and other wastes only be allowed if the wastes in question are required as a raw material for recycling or recovery industries in the State of import."

9 This concerns used lead-acid batteries, zinc compounds, waste oils and old computer boards.

10 Batteries produced in OECD countries mostly use polyethylene separators because polyethylene does not produce HCl gas if incinerated and does not "blind" the mesh screens in the gravity based battery crushers. PVC separators are cheaper than the polyethylene separators (but produce HCI gas in pyro-metallurgical recycling) and are currently used by Philippine battery manufacturers.

11 However, such recovery using small-scale reverberatory furnaces is feasible for small smelters. Ideally a reverberatory furnace should be used in conjunction with a blast furnace in order to minimize antimony levels and produce a discard slag.

12 While grids of scrap batteries will most likely continue to be treated by pyro-metallurgical processes, hydro- and electro-metallurgical processes are likely to be used for recovering the lead from battery sludge in ULABs and lead-bearing waste from pyro-metallurgical treatment, i.e. slack and dross. A hydro-metallurgical process converts the sludge into soluble form, and the lead is recovered from the solution by electro-winning. For an overview of hydro- and electro-metallurgical processes and a comparison of their environmental and economic performance with the classical pyro-metallurgical route, see: Technology Information, Forecasting and Assessment Council (TIFAC) of the Department of Science and Technology, *Techno-market survey on recovery from industrial waste – scrap batteries*, New Delhi, September 1997, pp. 109-172; Premchand, R. K., *Lead and zinc recycling technologies*, and Raychaudhuri, A. , *Indian experience with environment friendly technologies — case study of recycling of batteries*, papers presented at the National Conference on Lead and Zinc Recycling – Technology and Environment, New Delhi, 17-18 December 1998.

13 Adding soda ash is currently the most effectively used desulfurization process, but it is not the only method. The sulfur can also be removed in pyro-metallurgical processes by adding iron to the furnace feed material. During the smelting process, the iron removes the sulfur as iron sulfides, which are discharged from the furnace in the slag. This is the process most small recyclers use. Unfortunately, unless the iron additions are calculated carefully, there is no guarantee that all sulfur will be removed as iron sulfide and that is why sulfur dioxide emissions from small smelters can still be considerable.

14 15,000 metric tonnes of refined lead output are considered the minimum capacity for making secondary smelting viable. UNEP, *RECYCLAGE DES BATTERIES PLOMB-ACIDE ET ENVIRONNEMENT*, draft report by TEC INGENIERIE for UNEP, Paris, March 1998, p. 25; and Venkateswaran, K. and J. Prabhakar Rethinaraj, *Recycling of lead*, paper presented at the National Conference on Lead and Zinc Recycling – Technology and Environment, New Delhi, 17-18 December 1998, p. 10.

15 2 per cent of the lead content of a scrap battery get lost with organic materials of the separators and casing and in the slag, which contains between 2-15 per cent of lead. UNEP, ibid., p. 117.

16 At the beginning of the 1990s, one small smelter, Asia Pacific Lead Smelters, imported a batch of about 500 tonnes of ULABs as trial. On the basis of the interviews conducted, there are no other reported or known imported shipments of ULABs by the small smelters.

17 For more detail in this regard, see the background paper of Wilson, B., *A review of the options for restructuring the secondary lead-acid battery industry in the Philippines, in particular the smaller licensed smelters and the informal sector, with a view to enhancing their environmental performance and improving occupational health standards*, section 1.3.

18 Such suspicion is voiced by Ross on the basis of training seminars he conducted on the environmental impact statement (EIS) system in the Philippines. Ross, W.A., Environmental impact assessment in the Philippines: progress, problems, and directions for the future, *Environmental Impact Assessment Review*, Vol 14 (1994), p. 227.

19 In this context, it needs to be borne in mind that almost 20 per cent of lead consumption goes into non-recoverable applications such as gasoline additives, paint pigments, glass and ceramic glazes. Conversely, lead-acid batteries account for about 75 per cent of total lead consumption in South-east Asia. This leaves about 5-10 per cent of old scrap and lead-bearing residues from metallurgical operations which can theoretically be captured for lead recovery for battery manufacturing. International Lead and Zinc Study Group, *Principal uses of lead and zinc, 1989-1994*, London, January 1996.

20 Such additives may contain cadmium and thus complicate future recycling of reconditioned batteries.

21 Reconditioning or regeneration of used batteries should not be considered an ecologically and economically unsound practice, mostly prevalent in developing countries, per se. If based on appropriate technology and practice, battery reconditioning may well play a useful role. Reconditioning is therefore a practice which is also not alien in many OECD countries. For instance, Swedish company RGK Charger Systems, which provides a regeneration service at its facility near Göteborg, claims that 70% of all used lead-acid batteries the company receives can be regenerated and are sold with a six-months guarantee for 30-50% of the price of a new battery. According to German company MicroLog, which is also engaged in providing reconditioning services, the cost of reconditioning a battery - including transport - is less than about 5% of the price of a new battery, as long as no cells have to be replaced. Proceedings of the $4^{th}$ International Battery Recycling Congress, cited in: Beck, M., Battery recycling moves up the industrial league, *Recycling International*, Vol. 1, No. 4 (September 1998), p. 21.

22 It is assumed that most cottage melters sell the ingots of thus recovered lead to small battery manufacturers for connectors and posts.

23 In a Greenpeace study of 1994, entitled *Lead astray – the poisonous lead battery waste trade*, it is claimed that cottage melters treat collected or bought slags from large smelters. According to the information gathered for our review, “backyard melters” in the Philippines have no capability to treat dross and slag from licensed smelters. Backyard units melt off the metal from battery plates and produce slag and dross, which they either throw away or sell to small licensed smelters. Large smelters treat drosses for lead recovery. Their only solid waste is slag. Greenpeace, *Lead astray – the poisonous lead battery waste trade*, Washington D.C., March 1994, p. 22.

24 A certain part of commercial vehicles are likely to be part of car fleets which probably are backed up by an inventory of batteries. This tends to make batteries more price-responsive.

25 As imports currently account for only about 2.5% of SLI battery consumption volume, in the near term, consumers will also bear some of the additional production costs.

26 The purchasing price of domestically collected ULABs is fixed by PRI as a function of the price development of primary lead at the London Metal Exchange.

27 According to Wilson, there are at least another 500 independent battery retailers. They do not necessarily collect scrap batteries when a new one is sold and even if they do, they might not sell the scrap battery to PRI or any other small smelter. In any case, it is doubtful that shipments to PRI of thus collected batteries in small quantities from outside Luzon island are profitable. For more detail, see: Wilson, B., op.cit.

28 For more detail, see: Ibid.

29 International Road Federation, *World road statistics 1995*, Washington, D.C.; Society of Motor Manufacturers and Traders Ltd., *World automotive statistics 1997*, London.

30 International Lead and Zinc Study Group, *Lead in batteries*, London, January 1996, p. 16; Hawkes, N. Influences and trends in lead-acid battery demand, lead supply and prices, Journal of Power Sources, Vol. 67 (1997), pp. 213-218; UNEP, op.cit., p. 23.

31 As electricity supply backup batteries age they will fail and enter the secondary lead market. As most of such batteries are installed in air conditioned environments, battery life is about 5 years or more and it will therefore

take some time before the secondary lead supply will benefit from current expansion of the industrial battery market segment.

32 If one assumes an average life time of non-battery products containing recoverable lead of about 25-30 years, the volume of lead which may currently be theoretically recoverable can be estimated at some 4-6Kt . This estimate results from two assumptions: (i) Filipino lead consumption of about 5-6Kt per annum in the second half of the 1960s and the assumption that about 50% of lead consumption was used for manufacturing of batteries, pigments and lead compounds; (ii) 2-3Kt of lead are recovered from lead-bearing capital goods and consumer durables imported per annum in the second half of the 1960s. Estimated on the basis of Metallgesellschaft, Metal Statistics 1966-1976, Frankfurt, 1977, p. 20.

33 Venkateswaran, K., Lead recycling, paper presented at the National Conference on Lead and Zinc Recycling – Technology and the Environment, 17-18 December 1998, New Delhi, pp. 3-4.

34 “abl” in the formula represents average battery life.

35 In fact, only the volume of export surplus.

36 Net imports of vehicles (which are equipped with new batteries) account for only 5-10 per cent of newly registered vehicles per annum in the Philippines.

37 UNEP, op.cit., p. 25 and 190.

38 Conceptionally different technological solutions, for example hydro-matallurgical and electro-wining processes, seem to offer more flexibility regarding the scale of production, because pollution abatement costs and energy consumption appear to be significantly lower. However, the few available economic feasibility studies on such new technological approaches base themselves on even higher capacity of 25 or 35 Kt of annual lead output. For more information in this regard, see: Technology Information, Forecasting and Assessment Council (TIFAC), op.cit., pp. 169-171.

39 Parker, Thomas H. (EXIDE Corporation), *The economics of secondary lead smelting*, paper presented at the 7th International Recycling Conference of ILZSG, Toronto, 25-29 May 1998. Exide Corporation is the world’s second largest producer of refined lead.

40 Wilson, B., op.cit.

41 Pollution control, prevention and abatement costs are currently underestimated, because two items are not yet reflected in production costs: (i) disposal of now stable slag and previously accumulated unstable slag; and (ii) sorting and disposal of the mix of plastic and hard rubber waste created during battery crushing and material segragation, which may soon no longer be incinerated under Philippine legislation. While some preliminary estimates for the former are available which suggest a slight increase in pollution abatement costs, estimates for the latter are not yet available. These costs might however be much higher than the slag disposal costs because capital costs for material sorting equipment will be important.

42 The most important reference price in national and international markets of primary and secondary lead is the settlement and cash seller’s price at the London Metal Exchange for lead of 99.97% purity.

43 Once the pollution prevention costs of satsifactory treatment and disposal of slag and the plastic-hard rubber mix are factured into the production costs, the cost advantage of lead recovery versus primary lead will be much smaller (see footnote 40).

44 By way of illustration, sorting and crushing of non-battery scrap might have to be manually done. The removal of tramp elements in non-battery scrap may require an additional step at the metal refining stage.

45 Scrap prices for mixed hard-soft lead are some 30-50% higher than ULABs, whereas scrap prices of soft lead and mixed hard lead are 50-80% higher than ULABs.

46 In Australia, the world’s second biggest producer of primary lead, for example, most mine production of lead comes from mines that are also rich in zinc. Some also contain silver or copper. On average, revenue from lead therefore accounts for only 20% , whereas zinc-derived revenue accounts for 65%, silver for 10% and copper for 5%. Cox, A., St. Beil and M. Neck, *The OECD risk reduction strategy for lead*, research report 94.12, Australian Bureau of Agricultural and Resource Economics, Canberra, 1994, pp. 24-25.

47 Minerals and Metals Research Services, Metals Analysis and Outlook, No. 74, 4th Quarter 1997,Exton, p. 12; *World Metal Statistics*, November 1998.

48 Recycling International, Vol. 1, No. 6 (November 1998), p. 25.

49 Old scrap comes from a wide variety of damaged, obsolete and worn-out products, including bearing metals, sheet and pipe, cable sheathing and solder. Unlike lead acid-batteries, which have a short life and predictable supply, other old lead scrap generally has a very long life and supply which is difficult to predict. For example, much of the solder and sheathing purchased by secondary lead smelters worldwide is purchased from secondary copper smelters, which strip cable and sweat radiators for their copper values.

50 In the light of the high ratio between transport and scrap costs, it is not very likely that supply-demand gaps are plugged by imports of lead-bearing residues. This may change in cases where the exporter intends to finally dispose of such residues and is thus prepared to cover transport costs.

51 An increase in such imports is not undesirable per se. If imported new batteries and primary lead for battery manufacturing replace unproductive and polluting domestic production and reduce retail prices of new batteries such imports are desirable. The opposite holds if such imports destroy an otherwise sound domestic industry and/or significantly lift retail prices of new batteries, without significantly improving the environmental situation.

52 Gomes Serrão, A. and D. Melhen, Present overview of lead recycling in Brazil, *Proceedings of the 7th International Recycling Conference of the International Lead and Zinc Study Group*, Toronto, 25-29 May 1998, pp. 35-40.

53 Wilson, B., op.cit. It is also planned to prepare a study on the general effects of the Basel Ban Amendment on the development of long life lead-acid and lead-free SLI batteries in developed and developing countries.

54 Information provided by PRI management and International Lead and Zinc Study Group, *Impact of the Basel convention and the Basel "Ban" on lead and zinc industries – statistical report* (LZ/EC.97/2b), London, April 1997.

55 Asia's current financial and economic crisis may temporarily dampen lead demand growth; the fundamentals however suggest unchecked medium-term demand expansion.

56 Adequacy in this context is defined as quantitatively sufficient feedstock for supporting economics of scale which allow environmentally and economically sustainable recycling.

57 Higher scrap purchasing prices offered by PRI in the context of the Balik Baterya program cause higher private costs which, however, have to be discounted by extra costs which would have been incurred by ULAB imports of the same volume.

58 As can be seen from table 2, the small battery manufacturers account for about 7% of SLI battery production only. Such drosses (estimated to represent about 3% of battery output, i.e. only about 150 tons in 1995, for instance) are likely to be recycled at one of the small licensed smelters which has a rotary furnace.

59 Further lead recovery from the slag of small smelters is actually more important from an environmental point of view. Most small smelters only run reverberatory furnaces which will not allow a further reduction of lead-bearing slag much below 5% lead content. This slag is very rich in antimony and cannot be landfilled. The traditional metallurgical solution is to pass this high antimonial lead bearing slag through a high temperature oxygen blast furnace (which only PRI operates in the Philippines). This furnace reduces the lead content in the final residues to less than 0.5-1% and produces a stable inert disposable slag, suitable for either landfill or sale as road hardcore or sandblast material. PRI can only treat the slag from the small smelters in a viable way if the small smelters change the fluxing agents. This issue is addressed in: Wilson, B., op.cit.

60 According to PRI management, there is practically no cable sheathing or other non-battery solid lead scrap available in the open Philippine lead scrap market.

61 Lead prices are forecast to remain at historically very low levels in the foreseeable future. The short-term price forecast of the LMI lead price is 21-24 US cents per pound. The medium-term projection suggests a few years of strongly rising lead mine output that will be difficult to digest by the market and thus further depress prices. *Metals Analysis and Outlook*, No. 78 (4th quarter of 1998), December 1998.

62 In practice, most secondary lead smelters will have long term supply contracts with battery manufacturers; a sensible decision with so much cash tied up in working capital. In order to maintain contracts and continuity in the market place, the secondary producer is usually the one to use the primary lead, purchased from the LME warehouses and supplied directly to the customer, to augment output and maintain the contract. The battery manufacturer would not necessarily be aware of the switch.

63 See observations in footnotes 40 and 42.

64 From a practical point of view, some potential imports of refined (primary) lead are likely to be replaced by imports of secondary lead alloy (probably antimonial lead) produced largely by OECD lead smelters. There may as well be imports of pure refined lead from both primary and secondary OECD producers which would be directly sold to Philippine battery manufacturers rather than secondary smelters.

65 OECD producers of primary and secondary lead as well as new batteries are not unlikely to price their product, at least in the short term, at significant discounts to undermine the supply position of Philippine secondary smelters and battery manufacturers and thus develop new sales outlets.

66 In fact, lead has the lowest average metal concentration in the earth's crust of all important non-ferrous metals (i.e. 0.0016%). Berends, W.; B. Zagema and T. Wams, *While stocks last – A case for sustainable resource management*, Friends of the Earth, Amsterdam, February 1996, p. 18.

67 Unless the slag is sold as filler, it is difficult to finally dispose of and requires a well insulated landfill site.

68 Henstock, M.E., *The recycling of non-ferrous metals*, Ottawa, 1996, p.172.

69 According to PRI management, more significant use of refined (primary) lead in SLI battery manufacturing would lift Philippine retail prices of new batteries by some US$10 (i.e. PP400).

70 Abundant availability of ULABs in OECD countries and thus low prices of lead scrap in the wake of the Basel Ban are likely to improve competitiveness of OECD battery manufacturers. It is therefore reasonable to assume that OECD producers will enhance exports of new batteries to developing countries and widen market shares there.

71 Despite intensive research on new battery technologies for the use in electric cars and computer and communication devices, a breakthrough has not yet been reached. For a recent overview of research on lead-bearing and non-lead batteries, see: New batteries required, *Economist*, 10 October 1998, p. 94. A review of the pros and cons of long life lead-acid, nickel-cadmium, nickel metal hydride, and sodium-sulfur batteries can be found in: Steele, N.L.C. and D.T. Allen, An abridged life cycle assessment of electric vehicle batteries, *Environmental Science and Technology*, Vol. 32, No. 1 (January 1998), pp. 41A-46A.

72 Besides the environmental effects, any significant use of primary lead as feedstock for manufacturing of new SLI batteries will also decrease the competitiveness of Philippine battery producers, will most likely attract foreign imports and lift retail prices of new batteries. Furthermore, imports of primary lead and new batteries put pressure on the trade balance.

73 For more information in this regard, see: Wilson, B., op.cit.

74 Enhanced domestic collection and recuperation of scrap batteries and reduced human and environmental exposure to lead, to name but the most important.

75 For more specific information in this regard, see: Wilson, B., op.cit.

76 In this regard, there is room for regional or South-South co-operation, which may significantly reduce R&D investment requirements per country.

77 A scheme on tax and duty free import of equipment expired on 31 December 1997. According to information provided by staff of the Department of Trade and Industry, one attempts to get such incentives for environmental projects back. There is the proposal to include such scheme in the Senate and House of Representatives bills that deal with environmental legislation, e.g. the proposed Clean Air Act and Solid Waste Act.

78 Overheads account for about a quarter of production costs of the principal Philippine recyclers.

## ANNEX

### Table A-1
### Provinces not covered by Balik Baterya (Collection) Programme

| | Populatioı | % |
|---|---|---|
| Ilocos Norte | 482651 | 0.70 |
| Apayao | 83660 | 0.12 |
| Abra | 195964 | 0.29 |
| Kalinga | 154145 | 0.22 |
| Mt Province | 130755 | 0.19 |
| Ifugao | 149598 | 0.22 |
| Nueva Vizcaya | 334965 | 0.49 |
| Quirino | 131119 | 0.19 |
| Aurora | 159621 | 0.23 |
| Bataan | 491459 | 0.72 |
| Occidental Mindoro | 337231 | 0.49 |
| Oriental Mindoro | 608616 | 0.89 |
| Marinduque | 199910 | 0.29 |
| Masbate | 653852 | 0.95 |
| Romblon | 244654 | 0.36 |
| Antiques | 431713 | 0.63 |
| Aklan | 410539 | 0.60 |
| Northern Samar | 454195 | 0.66 |
| Western Samar | 589373 | 0.86 |
| Eastern Samar | 362324 | 0.53 |
| Biliran | 132209 | 0.19 |
| Surigao Del Sur | 471263 | 0.69 |
| Davao Oriental | 413472 | 0.60 |
| Bukidnon | 940403 | 1.37 |
| Lanao Del Sur | 686193 | 1.00 |
| Zamboanga Del Norte | 770697 | 1.12 |
| Siquijor | 73756 | 0.11 |
| Sultan Kudarat | 522187 | 0.76 |
| North Cotabato | 862666 | 1.26 |
| | 11479190 | |
| % of total PH population | | 16.73 |
| Total Ph population | 68614162 | |

## Table A-2

## Provinical Patterns of Vehicle Registration in the the Philippines in 1996

| **Region** | **Type of Motor Vehicle** *Cars* | *AUVs** | *Motorcycles Tricycles* | *Total* | **Regional Share in Ph. Vehicle Stock** |
|---|---|---|---|---|---|
| | units | units | units | units | % |
| NCR (i.e. Metro Manila) | 493469 | 462981 | 82772 | 1039222 | 50.61 |
| CAR and Regions 1 and 3 | 62892 | 204467 | 40584 | 307943 | 15.00 |
| Region 2 | 4315 | 25504 | 9650 | 39469 | 1.92 |
| Region 4 | 43233 | 172496 | 21309 | 237038 | 11.54 |
| Region 5 | 5520 | 20380 | 6446 | 32346 | 1.58 |
| Luzon Island | 609429 | 885828 | 160761 | 1656018 | 80.65 |
| | | | | | |
| Region 6 | 20838 | 51096 | 21352 | 93286 | 4.54 |
| Regions 7 and 8 | 37483 | 70614 | 32440 | 140537 | 6.84 |
| Regions 9, 11 and 12 | 23979 | 65200 | 24621 | 113800 | 5.54 |
| Region 10 and CARAGA | 10822 | 28339 | 10544 | 49705 | 2.42 |
| | | | | | |
| Total number | 702551 | 1101077 | 249718 | 2053346 | 100 |
| Vehicle patterns in % | 34.21494 | 53.62355 | 12.1615159 | 100 | |

* Asian Utility Vehicles, i.e. jeepneys

## Table A-3

## Assessment of SLI Battery-related Lead Demand in the Philippines

| **Vehicle registration** | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|
| Cars | 465674 | 464329 | 483622 | 531240 | 572766 | 626571 | 702578 |
| Utility vehicles | 612748 | 668364 | 744190 | 834168 | 912675 | 998331 | 1101077 |
| Buses | 18332 | 20685 | 25827 | 24603 | 27595 | 28192 | 29330 |
| Trucks | 129078 | 135377 | 146689 | 165280 | 179793 | 192792 | 220388 |
| Motorcycles/Tricycles | 381413 | 409563 | 458938 | 547655 | 624292 | 708059 | 821599 |
| total | 1609235 | 1700309 | 1861258 | 2104939 | 2319115 | 2555940 | 2876968 |
| growth 1990-1996 in % | | | | | | | 78.8 |
| growth, excld. Motorcycles, in % | | | | | | | 67.4 |
| | | | | | | | |
| Share of commercial vehicles in % | 47.2 | 48.5 | 49.3 | 48.6 | 48.3 | 47.7 | 47.0 |

**Battery demand-relevant change in vehicle population***

| | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cars | 456393 | 475356 | 522160 | 562965 | 615849 | 690556 |
| Utility vehicles | 668364 | 744190 | 834168 | 912675 | 998331 | 1101077 |
| Buses | 17274 | 21569 | 20546 | 23045 | 23544 | 24494 |
| Trucks | 125427 | 135908 | 153132 | 166578 | 178622 | 204190 |
| Motorcycles/Tricycles | 412473 | 462199 | 551547 | 628728 | 713090 | 827437 |
| all vehicles | 1679932 | 1839222 | 2081554 | 2293992 | 2529436 | 2847754 |
| all vehicles, excld. motorcyl. | 1267458 | 1377022 | 1530007 | 1665264 | 1816346 | 2020317 |
| annual growth 1992-1996 in % | | 9.5 | 13.2 | 10.2 | 10.3 | 12.6 |
| annual growth, exc. Motorcycles, in % | | 8.6 | 11.1 | 8.8 | 9.1 | 11.2 |

* Registered vehicles in base year, plus domestically assembled vehicles in year one, minus net imports of vehicles in year one, minus scrapped vehicles in year one

**Standard Battery Unit Conversion Factor for the period 1994-1996**

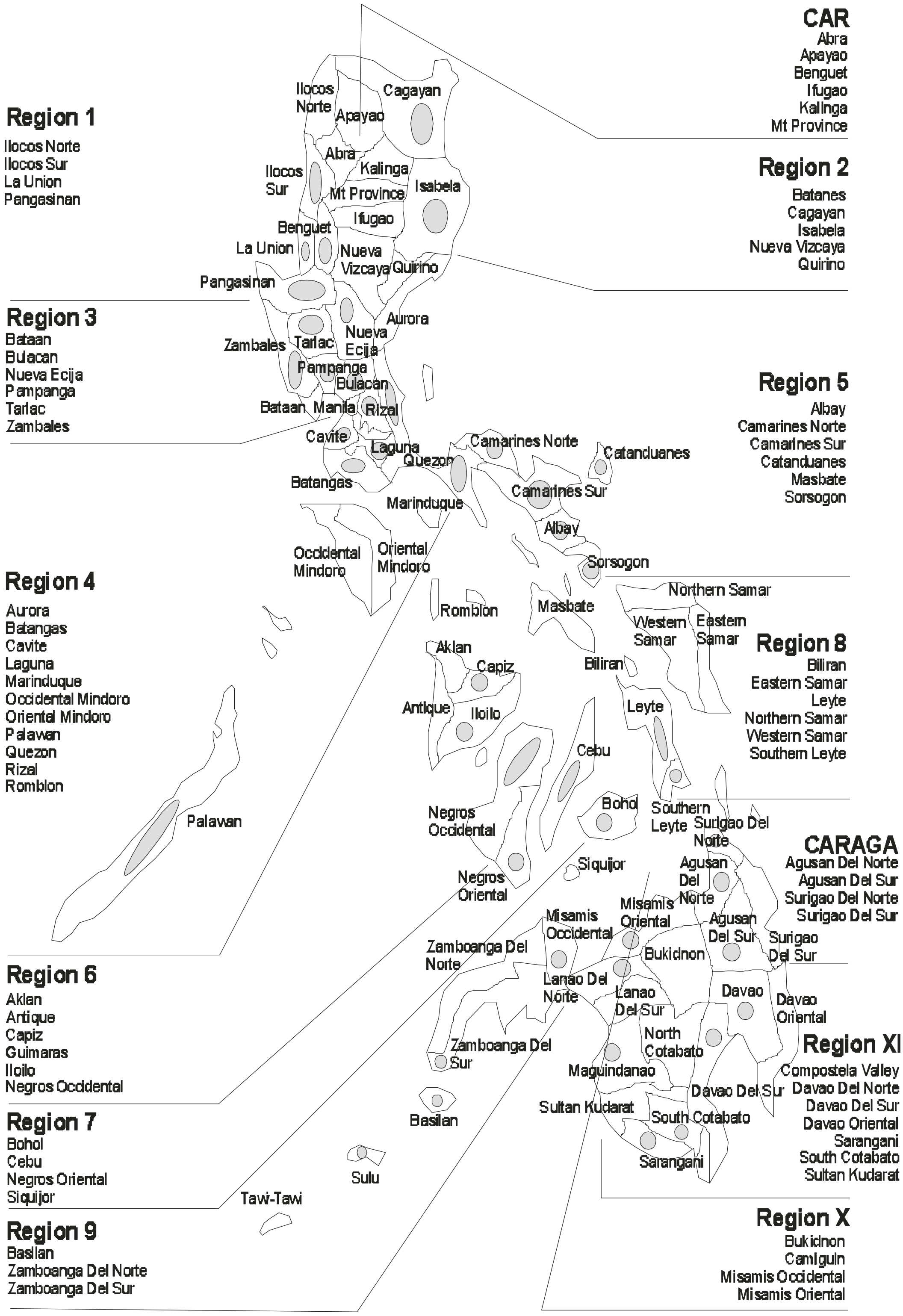
| | SBU* | SBU CF** | SBU CF-determined lead content in kg |
|---|---|---|---|
| Cars | 0.89 | 0.45 | 4.5 |
| Utility vehicles | 1.11 | 1.30 | 13.0 |
| Buses | 2.04 | 3.20 | 32.0 |
| Trucks | 2.04 | 3.20 | 32.0 |
| Motorcycles/Tricycles | 0.20 | 0.20 | 2.0 |

* Standard battery unit (per vehicle)

** Standard battery unit conversion factor per annum (reflects SBU, battery life, repair possibility and number of batteries per vehicle)

| **Battery demand (tons of refined lead)** | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cars | 2054 | 2139 | 2350 | 2533 | 2771 | 3108 |
| Utility vehicles | 8689 | 9674 | 10844 | 11865 | 12978 | 14314 |
| Buses | 553 | 690 | 657 | 737 | 753 | 784 |
| Trucks | 4014 | 4349 | 4900 | 5331 | 5716 | 6534 |
| Motorcycles/Tricycles | 825 | 924 | 1103 | 1257 | 1426 | 1655 |
| total | 16134 | 17777 | 19855 | 21724 | 23645 | 26394 |
| annual growth in % | | 10.2 | 11.7 | 9.4 | 8.8 | 11.6 |

# Provincial Catchment Area of Scrap Battery Collection within the Balik Baterya Programme of Philippine Recyclers Inc.




Provinces covered by the collection system