Does lead have a future? A twenty-year vision

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Abstract

There is a clear interdependence between the lead-producing industry and battery producers. An ever-increasing percentage of total lead production is consumed in batteries. Trends in lead production, consumption and uses, as well as lead prices are reviewed. A discussion is given of the impact of environmental pressures from government authorities and public opinion. A number of significant future opportunities are identified for the battery industry (and, hence, the lead industry) that together with the convenience and the cost competitiveness of the lead/acid battery ensures a strong future for the industry into the 21st century.

Trends

Lead is the fourth most widely used non-ferrous metal and can boast the highest recycling rate of any of them. Its various applications are of significant usefulness in modern society, but the metal is coming under increasing attack from a number of quarters. Increasing public awareness of health and environmental issues poses a significant challenge to the lead-producing industry, at a time when the price, in real terms, is at an historical low.

Traditional uses of lead for gasoline additives, rolled and extruded products, solder alloys, cable sheathing, pigments and compounds (e.g., paint additives) have been declining since the late 1960s as a result of both the introduction of alternative products and the increasing environmental pressure on the use of lead.

The lead/acid battery has become the largest end use for lead, and now accounts for 64% of the total usage (Fig. 1).

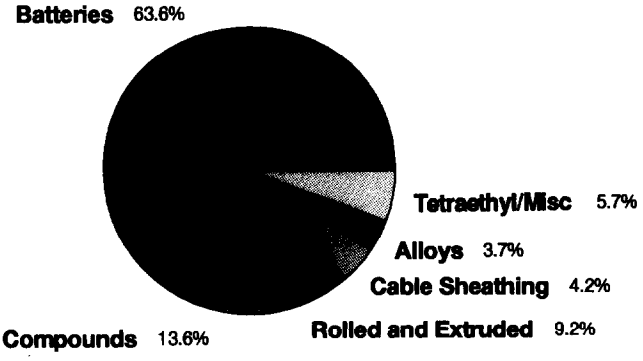

Fig. 1. Current end-use consumption of lead in the Western World.

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The remaining applications are under significant threat. In particular, uses such as fuel additives, cable sheathing, and rolled and extruded products are all targeted for either replacement by alternative products, or for total phasing out (e.g., lead in gasoline). It is anticipated that the total use of lead for these items will decline from today's 1.67 million tonnes to 1.57 million tonnes by 2010. At that time, batteries will represent more than 70% of the outlet for lead (Fig. 2).

Clearly, this position has put pressure on the lead-producing industry. Total Western World lead consumption peaked in 1989 at 4.58 million tonnes. The forecast for 1993 suggests that consumption will improve only slightly over the 1992 level to 4.45 million tonnes. Despite the decline in the total Western World production of refined lead since 1989, the breakdown in the economies of Eastern Europe has seen an influx of refined metal into the market, which has tipped the supply/demand balance into surplus. The output from lead mines in the Western World peaked at 2.6 million tonnes in 1980, and since then has remained generally static at about 2.3 million tonnes.

At the same time, increasing emphasis on the recycling of batteries, combined with historically low prices, has reduced in incentive for the exploration and development of new lead orebodies. New mines brought into operation are essentially zinc mines with lead as an associated by-product. New capacity coming into operation has therefore done little more than replace production from the closure of older, lead-only mines.

In 1992, preliminary figures estimated net exports from Eastern Bloc countries (e.g., ClS) at 200 000 tonnes. Exports are expected to continue in 1993 and 1994 at reduced levels of 150 000 and 100 000 tonnes, respectively. The effect of these exports on the overall market balance (as indicated by London Metal Exchange (LME) warehouse stocks) has been to increase those stocks to more than 270 000 tonnes. These pressures have impacted prices, and the current value of around US$ 390 per tonne is at a level that has not been seen for more than a decade. Indeed, the large increase in stocks has seen prices fall consistently, in real terms, to levels that cause many in the industry to question the viability of business.

In Fig. 3, the lead price is accentuated when expressed in real terms. The author's company expects the general downward pressure on price to continue over the next twenty years, even though there may be a temporary recovery in price over the next two to three years.

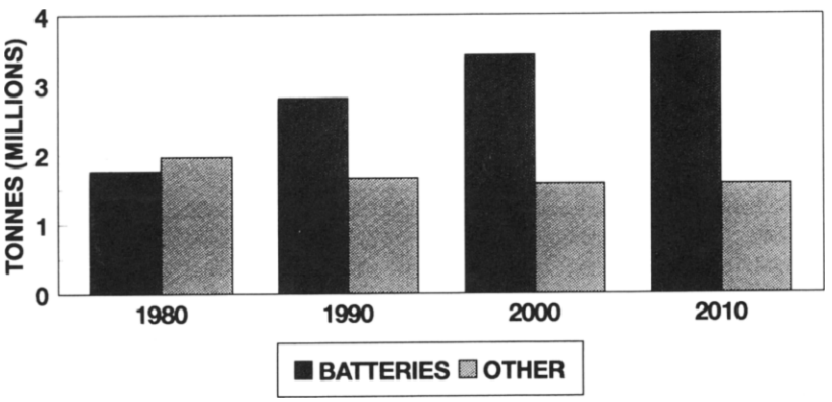

Fig. 2. Trends in lead consumption in the Western World, 1980–2010.

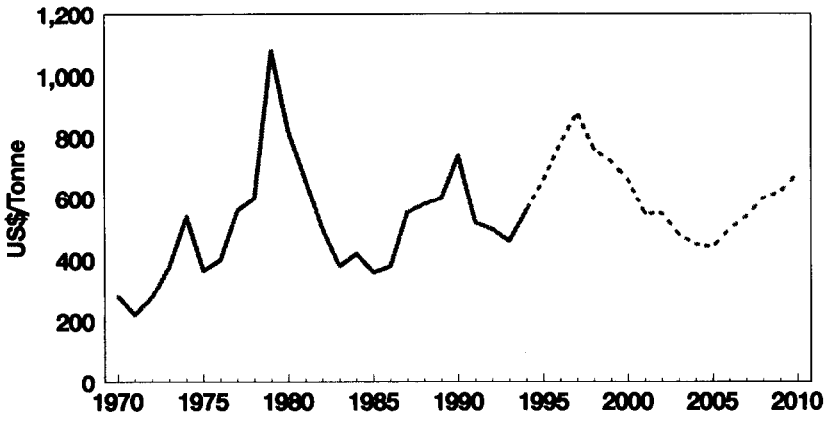

Fig. 3. Historical and forecast lead prices (source: Brook Hunt).

The strain on mining companies — always the first to bear the brunt — has been great. In response to the continued low LME lead prices, several mine and smelter closures, either temporary or permanent, have been announced (Table 1). As a result, the total production of primary refined lead is forecast to decrease by some 119 000 tonnes in 1993, with a further reduction by 20 000 tonnes expected in 1994.

The combination of low price and reduced mine output has already resulted in a tightening of the spot market for lead concentrate, and a movement in treatment charges back in favour of the mines. This tightening of the market may see a short-term lift in the lead price, when other base metals improve. Nevertheless, the overall trend will not be altered.

In contrast to the above situation, secondary production for recycling has been increasing. At present, secondary lead accounts for 40% of the Western World production of the metal. The trend for the remainder of this decade, and the decade beyond, is for secondary lead to provide 57% of total production by 2010 (Fig. 4). As recycling rates increase, primary smelters will be restricted to providing the growth in the total lead market. This situation will place significant pressure on all but the most efficient, low-cost, primary producers.

The future

The outlook for the remainder of 1993 is for the abnormally high levels of lead stock to persist, and for the prices to remain at around current levels, despite the cutbacks at mines and smelters because of low demand and continued CIS deliveries. At present, the LME stocks are equivalent to a consumption of nearly ten weeks. For this to decline to manageable levels of three to four weeks, a significant pick-up in demand is needed, despite the cutbacks in production referred to earlier.

The world economies showed promising signs of recovery at the end of 1992, but have obviously stalled again during 1993. Asia, excluding Japan, has been the only region of the world to expand. It has experienced a growth of between 6 and 8% as a result of government expenditure on infrastructure that has off-set slower export growth.

TABLE 1

Cutbacks in lead production in 1993*

Location	Operation	Ownership	Estimated capacity lost (tonnes per year)	Remarks
Mine cutbacks/closures				
Canada	Faro & Sa Dena Hes	Curragh Resources	115000	Closed for entire year
	Sullivan	Cominco	11000	
	Brunswick/Healthy Steele	Noranda	8000	
USA	Greens Creek	Kennecott (54%)	12000	
	Missouri Mines	Doe Run	15000	Cut operating rate at five mines in a bid to reduce concentrate stockpile
Spain	Aznalcollar	Boliden	9000	
Mexico	Real de Angeles	Minera Real de Angeles	15000	Closed for entire year
Peru	Santa Rita	Cia Minera Santa Rita	7000	Mine indefinitely closed
Australia	Woodcutters	Aztec Mining	5000	
	Mt. Isa/Hilton	MIM	20000	Represents 15% cutback
	Broken Hill	Pasminco	34500	Restructing of Broken HI11 operation, will result in concentrate losses, but this will be partially offset by higher ore grades
Italy	Monteponi/Masua	ENI	12000	
		Total	263000	
Primary smelter cutbacks				
Canada	Trail	Cominco	8000	Reverted earlier decision to close plant for two months
Italy	Porto Vesme	Nuova Samim	30000	Two months shutdown just announced
France/Germany	Novelles Godault Smelter (France) Nordenham Smelter (Germany)	Metaleurop	50000	Also includes shorter working hours at Oker secondary plant in Germany
Germany	Stolberg	MG	10000	Maintenance shutdown scheduled from May 1993
Sweden	Ronnskar	Boliden	10000	
UK	Britannia	MIM	3000	Secondary plant to be closed in July 1993
Japan	Various	Various	8000	Cutback in H1 fiscal 1993
		Total	119000	

*Note: Cutbacks will be partially offset by increased output from some other smelters.

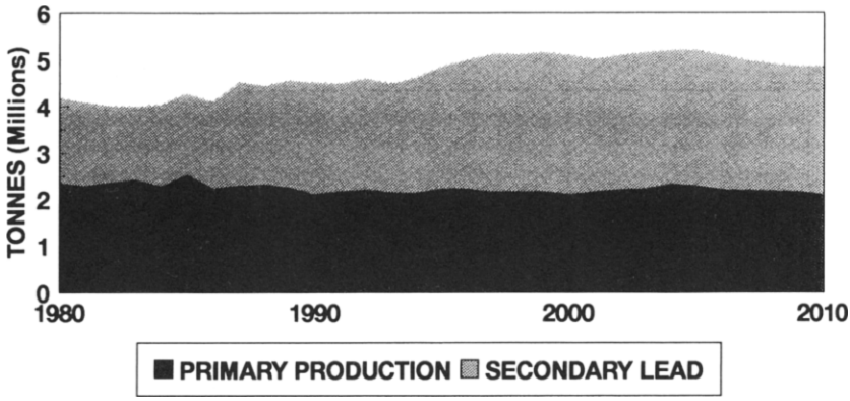

Fig. 4. Western World lead production, 1980–2010.

Tightening environmental legislation in many countries, including Asia, will mean producers will have to install new technology or face closure. On the present lead prices, this will be difficult to justify and will increase the pressure for additional smelter closures. In the medium term, this will force an increase in lead price, but the cost of recycled lead has also acted as a ceiling on the price of lead.

Secondary production

The production cost of secondary lead is largely driven by the costs of collection, separation and remelting of the scrap. Somewhat ironically, however, the lower lead price in recent years has limited the collection of recycled materials. In the late 1980s through 1990, the recycling rate of automotive batteries was approaching 100%, but fell as prices began to slide in 1991, and the impact of the Basle Convention on the shipment of scrap batteries began to hit. These factors have seen the price of scrap fall significantly, not just in absolute terms, but also in relation to the LME price.

In the mid-1970s, when scrap batteries were in short supply, the cost for battery scrap in Europe was about 35% of the LME price. At the end of the 1970s, this had risen to 45%, but over the past two decades it has fallen to its current level of between 25 and 30% of the LME price. Although the price of scrap has fallen, the decreased price of the finished product, together with tightening environmental demands, has resulted in a significant number of smaller secondary smelters going out of business. This situation has led to an increasing trend for battery producers, particularly in the USA, to provide recycling as part of their promotion and business strategy.

Environmental/regulatory issues

As mentioned above, environmental pressures on the lead and battery industries have been increasing. Since the mid-1970s, lead has been at the forefront of the environmental debate on the use of heavy metals. There is, and will continue to be, pressure from groups calling for restrictions on the industry.

The working group of the Nordic Council of Ministers has even come up with a proposal to eliminate the use of lead altogether. In the USA, representative Ben Cardin introduced a lead-tax bill into the House of Representatives on 22 June, 1993. The Bill 'Lead-based paint hazard abatement trust fund act of 1993 (HR2479)' intends to levy a massive 45 c. per pound on all lead produced in the USA and on all lead

imported or contained within imported products. The proposal envisages that the tax raised by used to provide funds for remediation in the community. The Bill has raised many objections, not just from the lead-producing and commissioning industries. Among those objecting are the proponents for a greater use of electric vehicles, who realize that without low-cost lead/acid batteries, such vehicles will be too costly to produce and operate.

Although the above proposals are unlikely to be passed, these are just two examples of the sorts of demands with which the lead suppliers and battery manufacturers are going to have to cope. If there is no response from industry, then new applications for batteries, such as electric vehicles, battery energy storage for uninterruptible power supplies, peak shaving and remote-area power supplies, will be severely curtailed.

Recycling

Increasing environmental awareness and pressure from governmental authorities and public opinion will require lead/acid battery manufacturers to become increasingly involved with the recycling of use units. This suggests that action, taken either individually or in partnership, will be required to:

- create recovery facilities that are both environment-friendly and cost-effective
- reprocess used batteries through the production of recycled lead and plastics
- use larger quantities of recycled lead and plastic in the manufacture of batteries

Only financially-sound and well-structured groups will be capable of meeting the challenges that the battery industry will face over the next decade.

In Europe, lead/acid batteries are covered by a European Community directive, issued in March 1991, that requires member states to put into place systems for the recovery and recycling, or controlled disposal, of accumulators that contain dangerous substances. The directive allows the imposition of a levy and deposit system to facilitate recycling. Such a procedure has been introduced in both Sweden and Italy, and is proposed by industry in Germany.

The legislation enacted in Italy may become a model for the recycling of spent lead/acid battery and lead-containing wastes. COBAT, the Compulsory Consortium for spent lead/acid batteries and lead-containing wastes was established in Italy in 1991. The act obliges everyone possessing spent lead/acid batteries to give them to COBAT, either directly or through its appointed collectors. In accordance with the principle of 'paying for pollution', the act envisages that users be charged the cost relative to the disposal of spent batteries and lead-containing wastes. The Consortium has two main sources of revenue, the first resulting from the sale of spent batteries to recycling firms, the second being a levy charged on new batteries.

In the USA, the Battery Council International (BCI) has developed model legislation that has been widely adopted by most of the states. The BCI model: (i) requires retailers, distributors and wholesalers to accept junk batteries; (ii) requires retailers to advertise this to their customers; (iii) prohibits the disposal of junk batteries in landfills. Many states have added a deposit or levy to their legislation to ensure that batteries are recycled even during times of low lead prices.

In the Asian region, secondary lead activity that utilises spent batteries will be facing a challenge in the future. The Basle Convention ensures that unless the processing of lead-battery scrap is environmentally safe, the scrap cannot be exported. This convention has been ratified by most developed nations and will severely restrict feed to secondary smelters that do not conform to internationally acceptable standards.

Opportunities

Despite the above-mentioned pressures on the usage of lead, it remains the only viable basis for the storage of electric power for mobile applications. Increasing demands for mobility and convenience, as well as demands for a replacement of the internal combustion engine, provide opportunities for the expansion of the lead/acid battery industry.

Demand for batteries will grow significantly in the next twenty years, and much of this growth will occur in developing nations. Asia and Eastern Europe will feature prominently in the shorter term as the respective local economies develop. Spearheading battery demand will be a steady growth in the vehicle population. The total number of internal-combustion-engine vehicles (ICEVs) will not increase at the same rate in the next two decades as in the past twenty years (Fig. 5). Nevertheless, significant potential exists for increasing the penetration of vehicle ownership in the economies of Asia, the former Eastern Bloc and Latin America. On a conservative estimate, it is envisaged that the world's automobile fleet will increase from 500 to 630 million by 2010, with Asia more than doubling its share to 11%.

Automotive electrics

In addition to the increase in ICEV population, there is likely to be increasing demands on the electrical capacity of each vehicle. Power requirements are accelerating with the introduction of more and more electrical and electronic functions for engine control to meet tighter emission standards as well as increased load for electrical features that are fast becoming standard attachments.

A higher voltage may be necessary in the future and most battery manufacturers and auto-electricians believe the present 12-V system will be replaced by a higher voltage. Such a trend would obviously increase the number of 2-V cells per vehicle. A single voltage system of 24 V, or even 36 V, could be used. Alternatively, a dual system might be employed in which a 12-V unit is used for some operations (e.g., lighting) and a higher voltage circuit for heated mirrors, rear window defrosting, electric windows, etc. The various alternative systems are being analysed by the automotive industry and a likely direction should emerge in the near future.

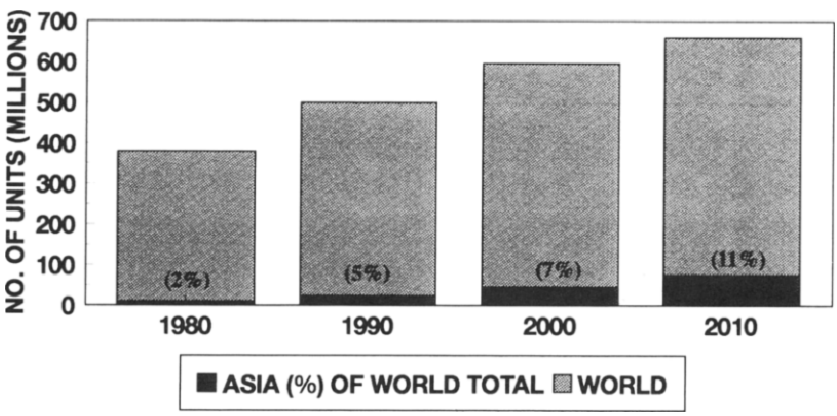

Fig. 5. World vehicle population, 1980–2010.

Electric vehicles

A switch from internal combustion to either fully electric, or hybrid, vehicles will add significantly to the demand for batteries and, therefore, for lead. The market for electric vehicles is being driven more by governmental regulations and legislation than by consumer demand. For example, the targets set by the California Air Resources Board are that 2% of all vehicles registered in 1998 should incur zero emissions. This level is set to increase to 5% in 2001, and 10% for all registrations two years later, in 2003. A market will thus be created, and all the major car manufacturers are presently involved in the competition to develop a cost-effective vehicle with acceptable performance.

TABLE 2

Global electric vehicle sales, 1998–2010 [1]

	1998	2000	2005	2010
North America				
Total light vehicle sales	16800000	17000000	17200000	17250000
Electric vehicle sales	47000	80000	570000	864000
Electric vehicles as % of total sales	0.3	0.5	3.3	5.0
Japan				
Total light vehicle sales	7780000	7780000	7850000	7900000
Electric vehicle sales	20000	49000	338000	525000
Electric vehicles as % of total sales	0.3	0.6	4.3	6.6
Western Europe				
Total light vehicle sales	16140000	16300000	16700000	17100000
Electric vehicle sales	28000	70000	503000	742000
Electric vehicles as % of total sales	0.2	0.4	3.0	4.3
Global light vehicle sales	40720000	41100000	41750000	42250000
Global electric vehicle sales	96000	199000	1411000	2132000
Electric vehicles as % of global sales	0.2	0.5	3.4	5.0

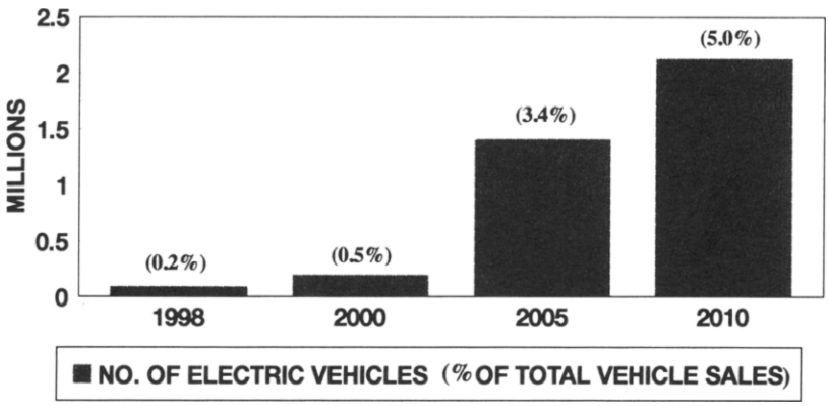

Fig. 6. Global vehicle sales, projections 1998–2010.

Global demand for electric vehicles is likely to increase from the current 96 000 per annum to around 2 million by the year 2010 (Table 2 and Fig. 6). At that level, electric vehicles would command 5% of total annual vehicle sales.

It is most likely that, at least initially, the electric vehicle battery market will be shared between lead/acid and nickel/cadmium batteries, with lead/acid commanding 75% of the market. Whether the lead/acid and nickel/cadmium technologies survive in this application in the longer term depends in part on the outcome of research being funded by the US Advanced Battery Consortium. At present, it is too early to anticipate the outcome of this research programme.

The impact of electric cars will be felt most significantly in the USA and Europe. In Asia, however, it is likely that a large market for electric motor cycles will develop.

Electric motor cycles

Electric motor cycles will be seen initially on the roads in Taiwan, but usage will follow quickly in countries such as Thailand, Indonesia and The People's Republic of China. Within the next two decades, the number of automotive-size batteries used for electric motor cycles could exceed the requirement for automotive usage.

Taiwan is an island of about 36 000 km in area with a population of about 20 million people. Motor-cycle registration exceeds 10 million, so it would appear that 50% of the population owns a motor cycle. The Ministry of Economic Planning and Development has determined that the introduction of battery-powered motor cycles will have a significant impact on improving air quality, and will also provide a domestic industry with significant export potential. An account of the development programme is given elsewhere [2].

Looking at the most populous country in the region, namely, the People's Republic of China, a little mathematics shows that even if electric motor-cycle penetration reached only 5% of the population, the battery market for 12-V, 35-Ah units would exceed 240 million units.

Industrial battery market

The industrial battery market is also likely to gain from environmental pressure to improve air quality in factories and warehouses. This will lead to a change from gas- and petrol-driven forklift trucks to battery-powered equivalents.

In the stationary battery sector, there should be a dramatic increase, particularly in Asia, because of the considerable expansion in telecommunications. An idea of the potential growth in telecommunications can be gained by comparison of the number of people per telephone in some developing nations with that in some western nations. The data in Table 3 indicate that the demand for communications in Malaysia is likely to increase four-fold, to match the current level of telephone ownership in Singapore. By contrast, the potential in Indonesia, with a population of 188 million, is an increase of fifty-fold from the current level.

Turning briefly to other areas of potential growth, continued improvement in the sealed valve-regulated battery (VRB) means that this product is likely to dominate supply into the stationary battery market. The VRB technology will be used predominantly for large units of between 100 and 3000 Ah.

On the other hand, it will be difficult for very small VRBs to maintain their share of the consumer product market, both because of competition from rechargeable lithium and nickel/metal hydride, and because of environmental concerns over the difficulty of collecting and recycling very small spent lead/acid units. Nevertheless,

TABLE 3

Telephone ownership

Country	People per telephone	Population ($\times 10^6$)	Country	People per telephone	Population ($\times 10^6$)
Switzerland	1.1	6.9	Saudi Arabia	8.5	17.4
Canada	1.3	27.8	Malaysia	8.8	18.8
USA	1.3	256.2	Brazil	10.0	159.2
Australia	1.5	17.7	Egypt	23.8	57.1
France	1.5	57.5	Thailand	28.5	58.5
Japan	1.5	124.9	Philippines	52.5	64.1
Hong Kong	1.6	5.9	China	76.9	1180.4
Germany	1.8	80.2	Pakistan	89.3	122.5
UK	1.9	57.8	Sri Lanka	100.0	17.7
Italy	1.9	57.8	Indonesia	107.7	188.2
Singapore	2.0	3.1	Nigeria	125.0	92.7
Taiwan	2.4	20.9	India	126.6	883.1
South Korea	2.9	44.1	Vietnam	435.0	71.7
Turkey	6.6	59.5	Bangladesh	455.0	123.1
Mexico	7.6	84.6	Burma	476.0	43.1

VRBs in the range 4 to 24 Ah will hold on to their market share and continue to be the most cost-effective product for many applications.

Almost rivalling the potential for battery usage in electric motor cycles is the exciting prospect of battery application associated with solar and wind energy storage. At present, two billion people on this globe are still without power to their households. These people live mainly in the developing nations where abundant power from the sun and wind is available. The remote-area power-supply (RAPS) market has been slow to develop because of the lack of the initial capital outlay for installation coupled with the high costs of photovoltaic cells for energy conversion. Change is, however, occurring because the cost of photovoltaic cells is falling.

Development of a RAPS market has commenced in the Philippines. The systems will provide households with direct current for two fluorescent tubes, a radio cassette recorder, and two hours of TV. The basic system uses a single 12-V, 100-Ah battery with an average lead content of 20 kg. This application for batteries will provide basic power to 15 million households in the Philippines and Indonesia within the next decade. If even 10% of the two billion people mentioned above are provided with power, the number of batteries required in developing nations will be much larger than those required for automotive purposes.

Although substantial numbers of large batteries are expected to be used by power utilities and large industrial consumers of power for load-levelling and peak-shaving, another exciting possibility exists for the application of automotive-size batteries to provide back-up electronic controls in the 'intelligent' home of the future.

Future demand for lead

Overall, the above factors are likely to cause an increasing demand for lead/acid batteries. Total demand for battery lead is envisaged to increase by 33% to 3.7 million tonnes by 2010. Figure 7 illustrates that, although automotive applications will continue

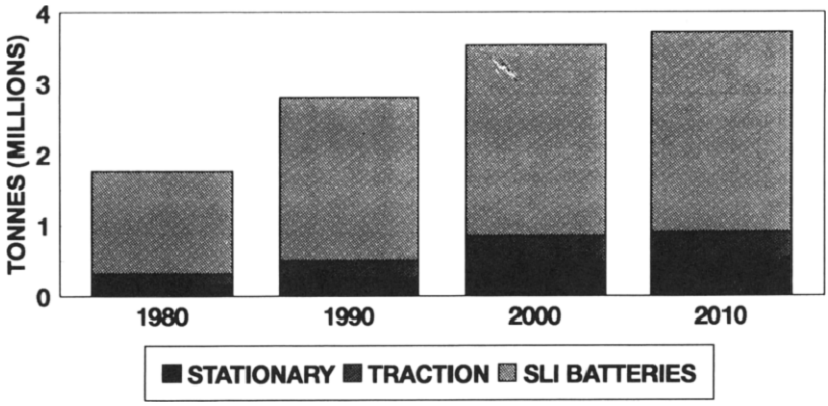

Fig. 7. Trends in battery lead consumption in the Western World, 1980–2010.

to dominate demand, steady growth in both stationary and traction applications can be anticipated. The latter two sectors will increase their share of lead demand from 17.8% in 1990 to 24.1% in 2010.

Conclusions

In summary, although there are significant pressures on the lead industry, the convenience and cost-competitiveness of the lead/acid battery should ensure a strong future for the industry, provided attention is paid to the concerns (both real and imagined) that are being raised with respect to the continued use of lead into the 21st century.

The lead industry does have a future, and that future is in batteries!

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