Journal of Power Sources, *28* (1989) 55 - 65

THE LEAD/ACID BATTERY INDUSTRY IN EUROPE

M. G. MAYER

Lead Development Association, 42 Weymouth Street, London W1N 3LQ (U.K.)

Introduction

Lead/acid batteries were invented and developed in France in the 1860s by Gaston Planté and others. Since then, commercial and technical battery activity has grown substantially throughout Europe. Today, the industry in the 17 West European countries produces annually 48 million car batteries and 6.9 million industrial cells. In addition, a considerable number of speciality small lead/acid batteries are produced. The value of battery production in Europe is now estimated to be in excess of US $ 2500 million per annum and is growing, especially in the industrial sector.

As Europe moves towards 1992 — the year in which the 12 countries in the European Economic Community (EEC) form one, tariff free, common market — the battery industry is re-structuring to form Pan European companies and alliances.

Battery Europe

1988 was the year when nearly everything went right for the European economy with gross domestic product (GDP) rising by an average of 3.7%. Germany achieved 3.4% whereas in the United Kingdom GDP grew by 4.5%. Only Japan did better with a growth in GDP of 5.9%. Most business sectors on which lead/acid battery sales depend did well. Car production reached 13 million units. In the 17 West European countries, vehicles in use on the roads rose to 132 million, or one car per 2.3 persons. Modernization and expansion of the telephone system resulted in an above-average purchase rate of stationary lead batteries for standby use. The rate of production and sales of small, sealed lead/acid batteries (SLA), less than 7 kg in weight, boomed and continue to do so.

If there was a disappointment, it was in the production and sale of motive-power batteries. The use of battery electric industrial trucks is recovering after a long period of quietness. In the United Kingdom, however, the fleet of some 35 000 battery electric road vehicles used for the daily delivery of fresh milk and other dairy products continues to decline. The level of lead/acid battery production in each main EEC country can be seen in Table 1 which summarises the consumption of lead for battery making.

0378-7753/89/$3.50

TABLE 1

Estimated total lead used in Europe for battery manufacture in 1988 in metric tonnes

Battery type	Germany	Spain	France	Italy	U.K.	Rest of EEC	Scandinavia Austria Switzerland	Total West Europe	%
Automotive	115600	56700	98600	78700	56100	28300	52900	486900	71
Traction	22000	7500	15400	9000	26000	3000	9900	92800	14
Standby	17000	2500	13500	11000	12000	2000	6300	64300	9
VRBs[a]	5000	1000	4000	3000	12600		1000	26600	4
Small <7 kg	4000	—	1000	—	8000			13000	2
Total lead	163600	67700	132500	101700	114700	33300	70100	683600	100

[a]Valve-regulated batteries.

Automotive batteries

As can be expected car battery production and sales continue to dominate the European battery scene as they do in North America with its production rate in excess of 80 million car batteries per year and similarly in Japan where the annual rate of production is about 29 million. Looking back over the last 17 years, see Fig. 1, a close relationship can be discovered between lead consumption in batteries, vehicle production, and number of cars in use.

The relationship between the original battery market for cars and subsequent replacement sales varies from market to market. In Europe replacement car batteries accounted for 73% of battery shipments in 1988. By com-

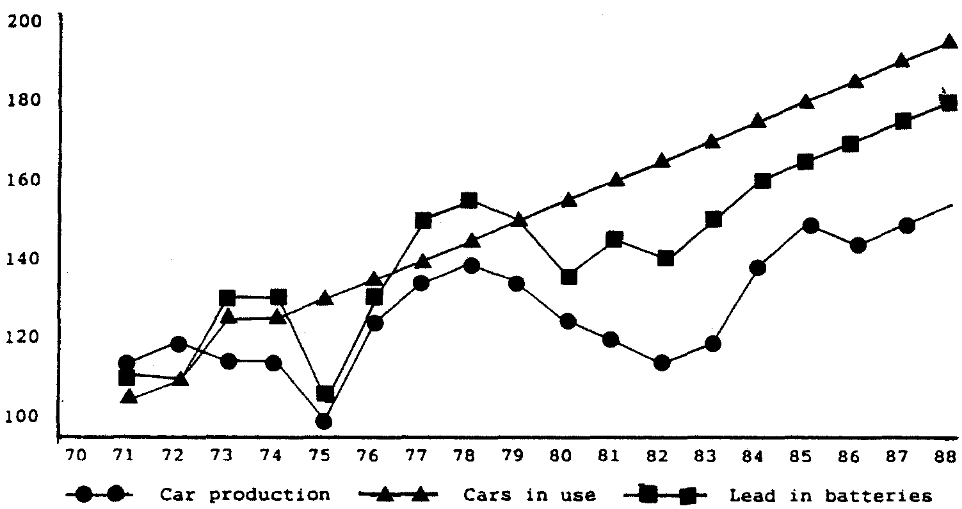

Fig. 1. Car production and number in use compared to lead used for battery manufacture.

parison, battery sales for replacement accounted for 40% of shipments in Japan. In North America it is estimated that in 1988 the replacement market accounted for 80% of shipments. In Europe, the ratio of replacement to original equipment is gradually rising as vehicle density, *i.e.*, number of cars per head of population, steadily increases. As can be expected, this is having an effect on how best to market replacement batteries. The battle rages on between manufacturers and marketers brand labels and the ever changing channels of distribution and optimum point-of-sale. As in North America mass marketers are impacting battery sales. Europe has yet to see the emergence of battery specialist outlets as is happening in the United States.

Although sales of original equipment have been good, replacement car battery sales have not. The last three winters in Europe have been relatively mild and this coupled with higher quality batteries has resulted in average battery life reaching about 48 months in Italy, Scandinavia and the United Kingdom, and around 55 months in France and Germany. The overall effect is to depress replacement sales. In addition, European summers are not sufficiently hot to have an impact on battery life. In the few exceptional hot locations of southern Spain and Italy, relatively few cars are in use.

It is important to note that from 1993 new cars sold in Europe will have to meet stringent new pollution standards. This means that most new cars will be fitted with catalytic converters, similar to those in use in the United States. As a result, the average temperature of the engine compartment where most starter batteries are located is likely to rise. Thus, battery life can be expected to shorten unless new technical initiatives enable the battery to be more temperature tolerant.

All European car batteries are of the maintenance-free type. Those for the original equipment market often have to meet the critical water loss target of 2 g/A h as compared to the IEC specification which limits water loss to less than 6 g/A h when the battery is charged at 2.4 V/cell for 500 h at 40 °C.

The majority of batteries are based on lead–antimony alloys in the range 1.5 to 2.5 wt.% antimony. About 90% are made with lead–antimony positives and either lead–antimony or lead–calcium negatives. The balance of 10% is made with lead–calcium positives and negatives. Most manufacturers make their grids with gravity-fed book moulds. Only three manufacturers use continuous lead–calcium expanded metal for grid production. One uses a continuous grid casting system. All the lead–calcium batteries use envelope separators and an increasing number of lead–antimony batteries also use them.

Lead content per battery and levels of cold cranking amps (CCAs) and reserve capacity continue to be vital matters. With the increasing use of electronics and computers in the car, higher reserve capacity is a key design objective and this should raise the lead content. Car electronics and other electrical equipment each year increase the load and reliance on the battery, see Fig. 2. In Europe, CCAs will continue to increase but perhaps not to North American levels where some top of the range batteries yield 900 CCAs.

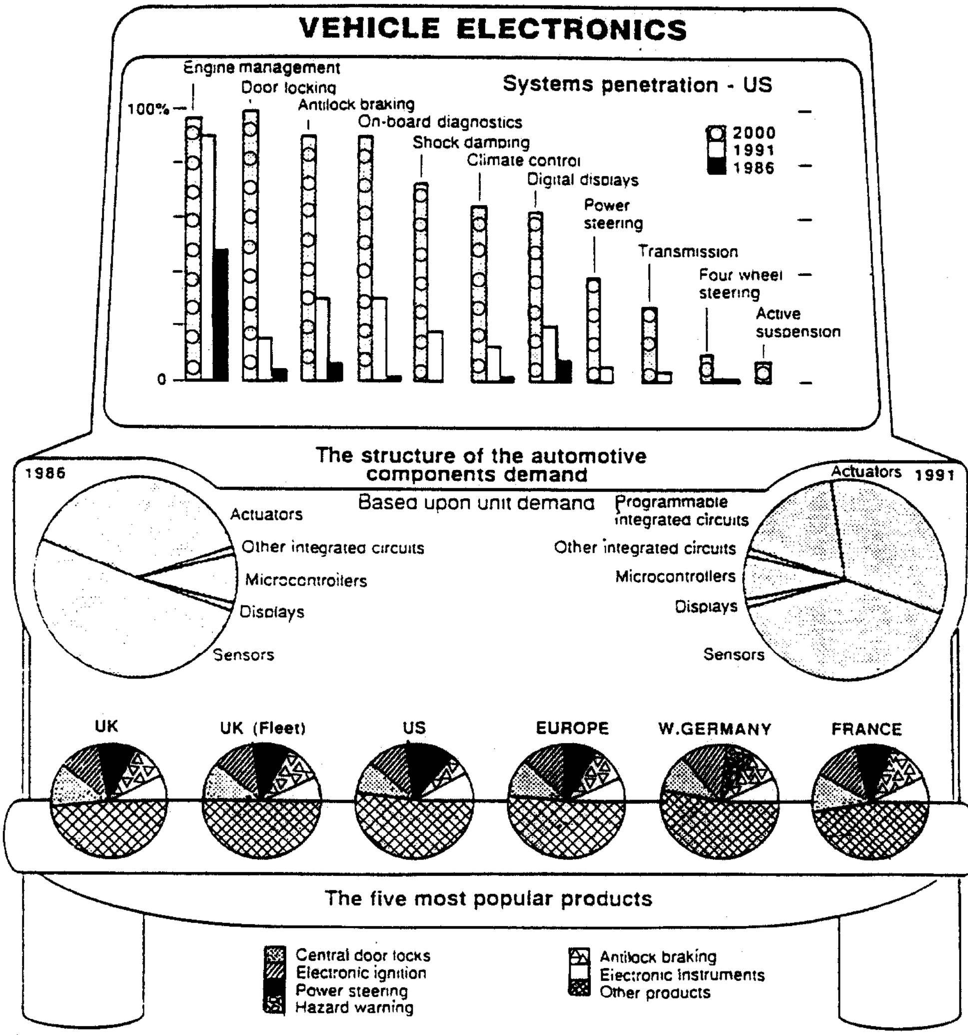

Fig. 2. Trends in vehicle electronics [2].

With generally smaller engines and a less harsh winter climate, the car companies in Europe seem satisfied with present or slightly higher levels.

As market pressures develop, the trend towards standard battery sizes is becoming more pronounced. At present, about 250 sizes account for 80% of European battery production. This number is likely to decrease, so increasing the trend towards car batteries becoming a manufactured commodity.

At the 1989 Battery Council International meeting in Orlando, Dr. Baudo of FIAMM in Italy gave a good review of likely car battery trends of the early 1990s [1]. These include:

— car battery system voltage is likely to stay at 12 V in the short term; it might increase later;

— flooded-electrolyte technology will remain the dominant chemistry for car batteries; recombinant batteries are likely to secure only a small share of the car market;

— manufacturers will continue to fit only one battery per car;

— reserve capacity and cold cranking amps will continue to increase;

— major efforts will be directed towards producing higher quality batteries; the target being a zero defect product during its guarantee period.

Traction batteries

In Europe, the use of battery electric fork lift and related industrial trucks is widespread. It is estimated that about 55% of the 1.3 million industrial trucks in use are lead/acid battery powdered. This compares to about 45% in the United States where characteristically a higher percentage of combustion engined lift trucks are in use (approximately 1.1 million in use). In recent years, the European battery truck industry has experienced a decline in demand due to a number of factors. First, the general economic constraints of the mid-1980s reduced many companies' investment in mobile material handling. Second, new factories were being designed and built with efficient material flow patterns including the widespread use of conveyor systems, so reducing the need for fork lifts. The lift-truck industry, however, has reacted strongly by cutting costs, re-designing its product to meet market needs, and by re-structuring itself. Today, fewer, but bigger, industrial truck companies are re-establishing themselves in the electric truck marketplace. Most penetration is taking place in market areas where the intrinsic attributes of cleanliness and safety of battery electric trucks are pre-eminent, such as in food and drink distribution and at airports to handle baggage and move aircraft. Lead/acid battery power is especially favoured for pallet, counterbalance lift, and some stacker trucks. The result is that motive power lead/acid battery sales are now doing quite well, especially in Germany and the United Kingdom.

Despite much effort, battery electric vehicles for road use, either as city cars or for city delivery, has not developed well. As mentioned above, the large population of slow, 30 kmph, milk delivery vehicles in the United Kingdom is on the decline. Not so much because of the limitations of this design of electric vehicle but because consumers prefer to buy their milk at hypermarkets once or twice a week instead of having it delivered fresh, each day, to their doorstep. Suffice is to say, hypermarket milk sells at a lower price than milk delivered to the door! In France and Germany, much serious effort has gone into commercializing electric cars. Although technical progress has been good, especially in terms of vehicle speed and comfort, the high cost of production and the limited range of the electric cars developed to date have severely restricted sales. Probably the most successful so far is the German City Strommer electric car based on the Volkswagen Golf. Some traffic-compatible, 65 kmph, 65 kilometre range, lead/acid battery powered city delivery vehicles based on the General Motors Bedford CF half ton van are in use, mainly in the United Kingdom.

Most electric vehicles, whether for use on the road or for industrial purposes, use lead/acid batteries made with tubular plates. Experience has shown that such cells give the user better performance overall (that is a balance of life, energy density and cost) than do flat-plate cells. Nearly all traction batteries use lead–antimony alloys. Thus, battery maintenance is still an expensive and difficult problem. The development of a deep-cycle, maintenance-free battery is proceeding well, but their use is not yet widespread. At Frankfurt Airport and elsewhere, good experience is being obtained in the use of maintenance-free traction batteries based on lead–calcium grid alloys and gelled electrolyte.

Small, low height lead/acid batteries, such as the 6 V golf-cart monobloc size, and smaller, are finding good application in a wide range of motive-power equipment. The maintenance-free form, usually based on gelled electrolyte, is used widely in electric wheelchairs for the handicapped, floor cleaning machines, toy cars for children to drive, and small two-wheel trolleys to help golfers carry their clubs around the course. It is estimated that this European market sector uses over 4000 tons of lead for battery manufacture.

Stationary batteries

Lead/acid batteries have an excellent track record of fulfilling a vital role in providing standby-emergency power for a wide range of electrical equipment. In the area of power supply, lead/acid batteries are the ultimate insurance when the mains power fails. In recent years, there has been a dramatic increase in the European use of lead/acid batteries for standby power for several reasons. First, because the evolution of gas recombination maintenance-free chemistry has resulted in batteries that are so user-friendly they can be placed almost anywhere. In previous liquid-electrolyte designs, the battery has had to be located in a special ventilated room and has also required costly routine maintenance. The modern maintenance-free battery, whether it is of the gelled or absorbed-electrolyte design, now known as 'Valve-Regulated Batteries' (VRBs), gives the equipment designer and user complete flexibility in where to place the battery. The second reason for the increase in stationary batteries is associated with the rapid growth in the use of computers. Many, if not most, are now fitted with 15 - 30 min battery power back-up should there be a problem in the mains supply. In addition, the use of telecommunications equipment has grown, resulting in the modernization of many telephone exchanges. In the United Kingdom, British Telecom is busy installing maintenance-free, absorbed-electrolyte batteries in many of its exchanges. Previously, it had extensively used, and still does use, some Planté cells, but their use is declining. The switch to recombination technology for telecommunications is not so marked in

Germany and Scandinavia where the industry prefers tubular-plate batteries in central locations. In France and Italy, the telecom authorities are beginning to use VRBs instead of earlier pasted-plate designs.

Electricity generation is a large user of lead/acid batteries in Europe. Planté, tubular cells and, increasingly, VRBs are used to provide standby power in the key areas of:

— substation and transmission switch gear;

— safe closedown of turbines in thermal and nuclear power stations;

— general power supply to monitor and control nuclear power stations in case of abnormal operating conditions.

Designer batteries

In the area of normal, small, sealed lead/acid batteries, that is, units in the weight range of 0.5 to 7 kg, Europe has lagged in production as compared to North America and the Far East. The scenario is, however, now changing. For many years, Sonnenschein in Germany was the only European manufacturer of small, sealed batteries. Their system is based on a gelled electrolyte, sometimes with the addition of phosphoric acid to aid in deep cycling. Now Yuasa of Japan are in substantial production in the United Kingdom with their proven range of small sealed batteries. In Italy, FIAMM and Japan Storage Battery (GS) are setting up a joint venture to initially produce 300 000 small batteries per month. Output is scheduled to rise to around one million units per month in 1993/94. Meanwhile, CEAC in France have started up their production line for small SLA units.

As elsewhere, no one use dominates the small battery market: they find application in a wide range of equipment, especially small computer uninterruptible power systems (UPS), burglar and fire alarm systems, toys and industrial equipment. The list is legion.

A market has yet to develop in Europe for the miniature sealed lead/acid batteries in the weight range 100 to 250 g and a power output of 0.5 to 1.0 A h now available from Japan. It seems likely that a useful market will develop as original equipment manufacturers design this interesting type of VRB into their products.

Battery manufacturers

Over the years, and especially since the end of the second world war, many car battery companies have evolved throughout Europe. Most have survived and have grown into small- or medium-sized operations, some have expanded into industrial battery production. A few have grown into large battery producers. Until recently, however, there have been few successful lead/acid battery companies with production facilities in more than one European country. The scenario is now changing as companies sell/buy battery-making facilities and/or enter into technical licence agreements. Spanish Tudor has bought control of Hagen Accumulatoren in Germany. Robert Bosch in Germany now controls FEMSA in Spain. CEAC in France has just bought the United Kingdom division of Chloride motive power. Neste in Finland now controls battery companies throughout Scandinavia and Austria. Meanwhile, Varta and Hoppecke in Germany quietly expand their pan-European battery activities. Chloride, as part of their major re-structuring operation, have also sold their battery factory in Fougeres, France to Spanish Tudor who intend to use it to make stationary batteries. From outside Europe, Pacific Dunlop via its subsidiary GNB in the United States is associated with CFEC, the number two battery company in France. Indonesian interests have recently purchased control of Chloride's automotive battery factory in England. A few years ago, Yuasa from Japan became a joint venture partner with Lucas for the manufacture of car batteries in England.

The age of the small battery making company in Europe seems to be drawing to a close. In France, Germany, Italy and Spain production is in the control of a few major companies most of which offer a comprehensive range of automotive and industrial batteries. In France and Italy, the small producers that existed 10 to 15 years ago have nearly all gone out of business. The scene in the United Kingdom is unusual. There are five major battery companies, BIG, CBS, Chloride, Hawker (Crompton, Oldham, Tungstone), and Lucas-Yuasa, together with 11 smaller companies each producing around 50 000 or fewer car batteries each year. Pb Batteries, the only small company specializing in the manufacture of industrial batteries in Britain has recently become a wholly-owned subsidiary of Deta Battery in Germany. Table 2 lists the main battery makers in Europe.

Similar consolidation is taking place in the supplier industries. The lead producers are already international in stature. Only a few battery companies still operate lead re-cycling plants, most being operated by the lead industry. Separator companies are increasingly becoming international in scope as their product becomes more hi-tech and capital intensive. An interesting development is the extension of one lead company's battery activity into the manufacture of ENTEK polyethylene separators. Since the evolution of polypropylene containers in the early 1970s and the high cost of moulds, slowly but surely pan-European container suppliers like ACCUMA, Trelleborg and ICS have evolved. Only large battery companies make their own containers.

Prospects for the 1990s

Generally, prospects are good. The still rising motor vehicle population, as well as good prospects in the medium term for car production and sales, although some economists are forecasting a short-term dip in vehicle production and sales, should ensure a steady, but unspectacular, growth in lead/acid car batteries.

TABLE 2

Main European lead/acid battery companies

Company	Country	Size[a]	No.	SLI[b]	MP[c]	SP[d]	SLA[e]	Other
Banner	Austria	D	1	Y				
Jungfer	Austria	C	1	Y		Y		
Triumph Neste	Austria	D	1	Y				
Daniel Doyen	Belgium	C	1	Y				
Tudor	Belgium	C	1	Y	Y	Y		
B I G	England	C	1	Y				
C B S	England	C	1	Y	Y			
CABL-Indonesia	England	A	1	Y				
CEAC UK	England	—	1		Y			
Chloride	England	—	1			Y	Y	
Hawker	England	B	3	Y	Y	Y	Y	
Lucas-Yuasa	England	A	1	Y				
Pb-Deta	England	D	1		Y	Y		
Yuasa	England	—	1				Y	
Neste	Finland	D	1	Y	Y	Y		
Varta	Finland	D	1	Y				
Baroclem Varta	France	C	1	Y				
CEAC	France	A	4	Y	Y	Y	Y	Ni–Cd
CFEC	France	C	2	Y		Y		
Delco	France	A	1	Y				
Tudor Spain	France	—	1			Y		
Oldham	France	C	1	Y	Y	Y		
Berga	Germany FR	C	1	Y				
Bosch	Germany FR	C	1	Y				
Deta	Germany FR	C	1	Y	Y			
Hagen	Germany FR	B	3	Y	Y	Y		
Hoppecke	Germany FR	B	2	Y	Y	Y		Ni–Cd
Mareg	Germany FR	D	1	Y				
Moll	Germany FR	D	1	Y				
Sonnenschein	Germany FR	C	2	Y	Y	Y	Y	lithium
Varta	Germany FR	A	4	Y	Y	Y		Ni–Cd
Tudor Neste	Greece	D	1	Y				
FIAMM	Italy	B	1	Y	Y	Y		
FIAMM-GS	Italy	—	1				Y	
Magneti Marelli	Italy	B	2	Y	Y			
Anker Neste	Norway	D	1	Y				
Autosil	Portugal	C	1	Y				
Tudor	Portugal	C	1	Y				
Femsa Bosch	Spain	C	2	Y				
Tudor	Spain	B	3	Y	Y	Y		
NOACK	Sweden	C	1	Y	Y			
Tudor Neste	Sweden	C	1	Y	Y	Y		
Electrona	Switzerland	D	1	Y	Y	Y		
Oerlikon Plus	Switzerland	D	1	Y				
Total			61					
Small companies	Various		11	Y				
Grand total			72					

[a]Estimated annual SLI production: A, 2 million +; B, 1 million to 2 million; C, 500 000 to 1 million; D, 100 000 to 1 million.
[b]SLI = automotive batteries.
[c]MP = motive power (traction) batteries.
[d]SP = standby power (stationary) batteries.
[e]SLA = sealed lead/acid batteries.

A not so good aspect is the poor profitability in the short term of car battery manufacturers. European battery production capacity is in excess of indigenous demand and export battery prices are low. Competition is cut throat. As a result profits are not satisfactory, except in a few companies. The knock-on effect is that many companies are cutting back research and development (R&D) into car battery technology and manufacturing techniques. The most likely outcome is that capacity will slowly reduce as inefficient companies go out of business and the number of manufacturing locations decline. Prices and profits should then rise. The big questions are how long will this process take and what long term effect will the present cut back in R&D have? In the meantime, no realistic alternative to the lead/acid battery for engine starting is visible.

On the industrial battery scene, prospects for profits are much better. First, the market is expanding and, second, the technical difference between individual company products is more than sufficient to change market share. The driving force is the market demand for maintenance-free industrial batteries — all of which so far are based on lead–calcium alloys and recombinant chemistry. Third, by adroit marketing and design it is often possible to design the industrial battery into a specific product. The industrial battery then ceases to be a 'commodity' as batteries largely are in the automotive sector.

The impact that the 1992 EEC market harmonization will have on all European battery makers, marketers (including importers) is rapidly becoming clear. Certainly there will be three major influences.

The elimination of inter-state export/import paperwork will result in an increase in the movement of batteries between member states and a reduction in prices. As an example in a related industry, FORD estimate that paperless trading in the EEC will save about US $ 200.00 per car in export documentation, or about 2.5% of the car's value. If the same principles apply to batteries, their price should reduce.

The 1992 initiative should also reduce the number of different national technical standards on lead/acid batteries. There will be considerable pressure to harmonize the relevant German (DIN), British (BS), French and IEC (International Electric Commission) standards. The prime objective of the member states is to evolve one common European set of battery standards, like the American BCI standards in concept but different in detail. Harmonization of battery standards is expected to result in higher quality batteries at a lower price.

It seems likely that all lead/acid batteries sold in the EEC will soon have to display re-cycling information. Under serious discussion is the imposition of some form of pollution tax and/or deposit to be levied on the customer at the time a battery is purchased. The objective is to bring pressure to bear on the battery user to dispose of spent batteries properly and to raise funds to police the collection, transportation and re-cycling of spent batteries. It is also possible that the places of battery sale and collection will be licenced by the authorities thus impinging on the workings of present free-market conditions. Such European initiatives to more efficient and safe re-cycling and transportation of spent batteries no longer fit for use is likely to increase battery prices. Batteries that do not contain materials deemed by the authorities to be harmful will not carry a price penalty.

Conclusions

Lead/acid batteries are often perceived as a mature product with a limited future. Due to continuing technical innovation and their price–performance ratio, lead/acid batteries continue to maintain and improve upon their market position. The European battery industry is currently experiencing major technical, commercial and environmental pressures as it re-structures to meet the dual challenge of over capacity and of becoming a world leader in power storage for the 1990s.

References

1 G. Bando, Lead battery technology in Europe, *Battery Council International 101st Convention, Florida, U.S.A., 1989.*
2 Motor Industry Review, Financial Times, London, 20 Oct. 1988.