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MARKETING FORECAST — THE INDIAN SCENE

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Introduction

This paper focusses on the important segments of the Indian battery industry and concentrates on the salient features governing the supply and demand of batteries.

Lead/acid, nickel/cadmium, and silver/zinc are the three types of secondary battery produced in India. The lead/acid battery industry is predominant for the following reasons:

- ease of fabrication
- comparatively low manufacturing cost
- existence of indigenous sources of raw materials: although lead often needs to be imported and government support has made lead procurement convenient
- more or less standardized production technology, but needs updating from time to time
- recycleability of material.

The consumer prefers the lead/acid battery system because of its low cost, high working voltage per cell, superior reliability in most power requirements, and tolerance to abuse.

Lead/acid batteries

The Indian lead/acid battery industry is a mix of three sectors:

(i) large-scale sector — approximate sales turnover Rs. 1.80 billion;

(ii) medium-scale sector }
(iii) small-scale sector } approximate sales turnover Rs. 1.50 billion.

The major large-scale battery manufacturers in India are listed in Table 1 [1].

Traditional applications

The traditional applications of the lead/acid battery are too well known to merit a detailed discussion. They can, however, be broadly classified into the following groups:

(i) SLI function on vehicles;

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TABLE 1

Major large-scale battery manufacturers in India [1]

Name of the firm and location	Licensed capacity (units)	Collaboration
Chloride India Limited (Calcutta)	1 554 600	Chloride Group Limited (U.K.)
Standard Batteries Limited (Bombay)	981 200	Oldham Batteries Limited (U.K.)
Amco Batteries Limited (Bangalore)	300 000	Yuasa Battery Company (Japan)
Willard India Limited (Bulandshahar)	461 200	ESB (U.S.A.) and later Japan Storage Battery Company (Japan)
UB-MEC Batteries Limited (Bangalore)	N.A.	Sonnenschein International (F.R.G.)
NICCO Batteries Limited (Dadri)	200 000	Globe International (U.S.A.)

N.A. = not available.

(ii) applications requiring standby power;
(iii) motive power for forklift trucks and electric vehicles;
(iv) railway applications including train lighting, air-conditioning, EMU Service, diesel-engine starting, signalling, and railway electrification (see Table 8);
(v) defence uses incorporating stringent requirements.

Tables 2 - 4 illustrate the growth of the automotive industry. Table 5 gives the production figures for automotive and industrial batteries and Tables 6 and 7 present the 1985 - 1990 targetted plan for power generation and substation power, respectively [1].

TABLE 2

Number of lead/acid battery manufacturing units and vehicle production in India

Vehicle type	No. of units	Vehicle production	
		1982	1988
Passenger cars	5	42 674	157 277
Buses & trucks	4	61 393	72 842
Light commercial vehicles	10	28 853	45 812
Jeeps	1	19 660	35 658
Motorcycles	6	129 990	410 109
Scooters	9	250 727	656 178
Three-wheelers	3	30 585	68 551
Mopeds	8	212 562	451 833
Tractors	8	67 579	80 000

TABLE 3

Export: automotive industry of India
(Rs. in millions)

	1985 - 86	1986 - 87	1987 - 88	1988 - 89
Vehicles (including chassis) two- and three-wheelers	588	530	590	950
Automotive components	772	735	802	920

TABLE 4

Total vehicle population in India

Period	Total vehicle population (millions)
1986 - 87	11
1989 - 90	14.6
1990 - 95	16.4
1995 - 2000	19.1

TABLE 5

Annual production figures for automotive[a] and industrial[b] lead/acid batteries in India

	Millions of units	
	Automotive	Industrial
1 Organised sector (large-scale production)	2	0.5
2 Medium-scale production	1	0.2 (2 and 3)
3 Small-scale production	1	
Total	4	0.7

[a]Taking 12 V, 60 A h as standard unit.
[b]Taking 12 V, 88 - 250 A h as standard unit.

TABLE 6

Target plan for power generation (MW) in India 1985 - 90 [1]

Power type	Installed capacity	Target
Hydro	16 189	20 000
Thermal	32 276	44 293
Nuclear	1 330	1 800
Total	49 795	66 093

TABLE 7

Target plan for substation power in India for 1985 - 1990 [1]

Substation type (kV)	Numbers	Battery requirement
400	49	220 V, 500 A h
220	135	220 V, 500 A h
132	1000	110 V, 200/300 A h
66	900	110 V, 200/300 A h

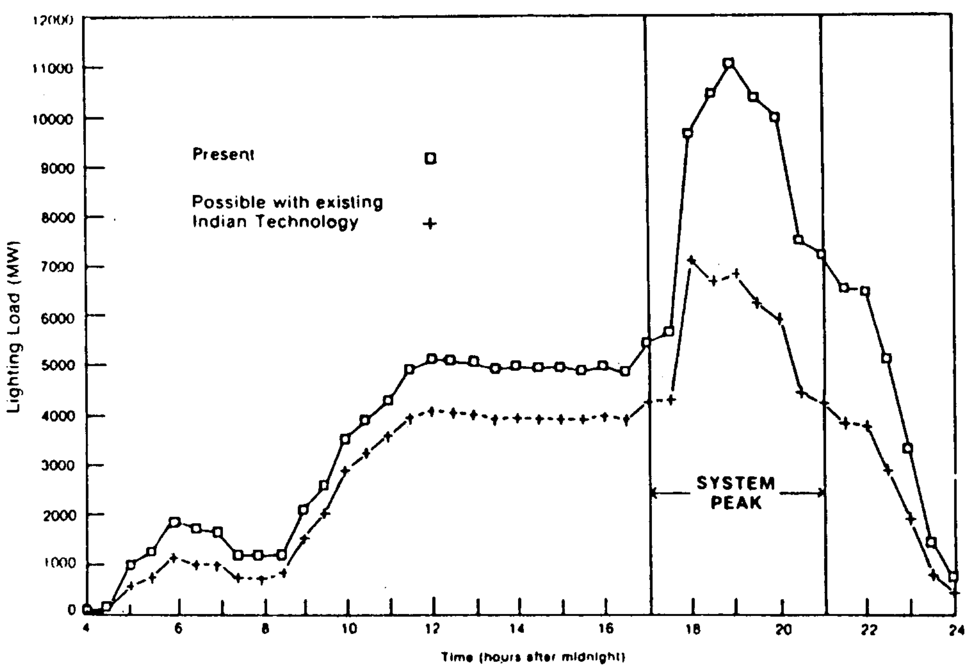

Fig. 1. All-India lighting load curve: maximum potential savings with existing Indian technology.

Fresh challenges are foreseen from the following areas:

- load levelling (Fig. 1)
- computer memory backup (Table 9)
- solar energy storage (use of non-conventional energy sources in remote areas (Table 10))
- special applications in spacecraft

In these new requirements, alternative battery systems to lead/acid may find application in the near future and thus challenge the market supremacy of the lead/acid battery.

TABLE 8

Target plan for railways in India for 1985 - 1990

(A) Stock

	Target numbers	Present numbers
Locomotives	3500	1370
EMU	950	500
Coaches	6970	30000
Diesel engines	1235	N.A.

(B) Signalling and telecommunications facilities available at about 5000 stations, each having 60 cells ranging from 16 A h to 400 A h.

(C) Railway electrification

Year ending	Total (km)		Running track (km)		Total track (km)[a]	
	electrified	total available	electrified	total available	electrified	total available
1985 - 1986	6517	61 836	12 367	77 153	16 086	106 502

[a] This includes track in yards and sidings.

TABLE 9

Estimated demand of UPS systems per annum in India

Industry/sector	Ratings range (kV A)	Requirement
Computer installations	1 - 2	100
	5 - 10	50
	>10	20
Hospitals	1 - 2	100
	5 - 10	30
	10 - 30	250
	10 - 20	250
	50 - 100	50
P & T communications	50 - 100	100
	>100	20
Process/industry	10 - 50	100
	50 - 100	60
Oil sector	>100	10
Power sector	5 - 10	30
	10 - 50	20
Railways	1 - 5	30
Nuclear power plants	1 - 5	50
Space	5 - 20	50
Academic institutes and others	1 - 10	100

Note: there are about 800 computers larger than the super-mini types in India of which about 320 have UPS facilities. Recently, however, India has acquired high-powered computers that offer tremendous potential for battery requirement.

TABLE 10

Energy generation/saving (in MW) from selected non-conventional energy sources during the 7th, 8th and 9th five plan periods

S. No.	System	7th plan (1985 - 90)	8th plan (1990 - 95)	9th plan (1995 - 2000)	Total
1	Power from solar systems	60	440	1500	2000
2	Photovoltaic pumps	1.5	4.5	9.0	15.0
3	Wind pumps	5.0	15.0	30.0	50.0
4	Small battery chargers & stand-alone systems	1.0	3.0	6.0	10.0
Estimated (rough) lead/acid battery needs in terms of 12 V, 60 A h as standard unit		50 000	150 000	300 000	500 000

Battery parameters

The important parameters that govern lead/acid battery prospects are as follows:

Life

The desirable life is in excess of three years (average) for automotive application and over 12 years for industrial applications. Although a service of 10 - 15 years is common with Planté-type industrial batteries, as a result of certain operational problems coupled with the high cost of the Planté battery, tubular-plate batteries are now preferred.

Energy density

In India, energy density is considered to be of secondary importance except in special applications requiring weight and/or volume restriction. Use of poly(propylene) containers and through-the-partition intercell connectors have resulted in energy densities of 30 - 35 W h kg^{-1} for automotive batteries.

It is worthwhile pointing out that although the active material makes up 40% of the battery weight, it represents 100% of the useful energy that can be either stored in, or removed from, the system. Since it is a well-known fact that less than 50% of the active material is presently utilized, it is obvious that any increase in this utilization would result in an increase in the energy density.

Resistance to abuse

This quality is of the utmost importance in Indian conditions. It includes: (a) vibration on Indian roads; (b) electrical abuse such as overcharging and deep-discharge in a discharged condition, improper maintenance, or use in applications other than those intended for the batteries; (c) climatic abuse under extremes of temperature.

Maintenance

The concept of 'very-low-maintenance' batteries for automotive and non-automotive applications would certainly find a prominent market share. The grid alloy has an important role in the retention of charge and the maintenance properties of the battery. The alloy used in India normally contains between 3.5 and 5 wt.% antimony. The major manufacturers, however, have moved towards reduced antimony levels, generally to between 2.5 and 2.8 wt.%. It should be noted that batteries produced with reduced levels of antimony content are categorised as 'low maintenance'. These batteries normally exhibit a service life of between 2 and 2.5 years.

Development work

Grids

It is suggested that development work be carried out on alloys containing less than 2 wt.% antimony on the lines of the alloy formulated by NL industries in the U.S.A. This alloy is easy to cast, has low drossing losses, and is harder than a 2.5 wt.% antimonial alloy. The approximate composition is 1.8 wt.% Sb, 0.18 wt.% As, 0.2 wt.% Sn, with the remainder being lead and small amounts of grain refiners.

Active material

As mentioned earlier, this is perhaps the most important area. Detailed research into new additives/compositional changes to increase the active material utilisation will be of immense practical significance. The work should be carried out by the industries themselves.

Separators

Suitably patterned separators, and use of envelopes, instead of the conventional leaf types, would certainly be advantageous towards improving performance and life. Table 11 compares failure modes of evelopes *versus* conventional leaf separators.

TABLE 11

Possible battery failure modes due to separators

	Leaf separators			Envelope separators
	Cellulose	Glass fibre	PVC	Polymeric
Missing separators	Yes	Yes	Yes	No
Shorts through separators	Yes	Yes	Yes	No
Mossing (side, bottom)	Yes	Yes (No)	Yes	No
Broken/cracked separators	Yes	No	Yes	No
Mis-alignment of group	Yes	Yes	Yes	No

Retention of charge

Further factors that must be considered are the ability of the battery to retain an applied charge when not in use, and the portion of the original capacity that can be retained by the battery after a period of charge/discharge cycling. It is an unfortunate fact involving all types of batteries that the capacity to store electricity and subsequently to convert it to useful work is continuously reduced as the battery is cycled. In addition, the charge already within any type of battery, at any given time of its life, is slowly lost while the battery stands unused. The amount of energy lost by self-discharge varies with the different electrochemical systems.

Design changes

Design changes in the battery itself could somewhat, but marginally, affect the maintenance properties of the batteries. It has become increasingly evident, however, that the required increase in performance cannot be expected from engineering changes alone. Stress should be placed on understanding the fundamental operational processes.

Alternatives to lead/acid batteries

As mentioned earlier, the other types of secondary batteries being manufactured in India, in addition to lead/acid, are nickel/cadmium and silver/zinc. Table 12 lists the major manufacturers in India of such systems. Most importantly, the batteries are in use for defence aviation, and communications equipment. Silver/zinc cells have been indigenously available since 1979 from High Energy Batteries (India) Limited in collaboration with Yardney Electric Company, U.S.A. They have applications in meteorological balloons, electronic equipment, photographic apparatus, communication sets, spacecraft instruments, military vehicles, and in special defence applications. Table 13 projects the estimated demand of cadmium batteries in India.

The future

A major shift from lead/acid batteries is not foreseen for the near term. Among the new battery applications of electric vehicle (EV) propulsion, with primary requirements of high energy and power density, long cycle-life and flat discharge characteristics, alkaline systems such as nickel/cadmium and silver/zinc cannot be used. None of the potential systems for EV propulsion (metal/air, zinc/bromine, sodium/sulphur) has reached commercialization: the sodium/sulphur system is seen as the strongest candidate. In the meantime, high performance lead/acid batteries are the best option.

TABLE 12

Major manufacturers of nickel/cadmium and silver/zinc batteries in India

Name of company and location	Type of cells/ batteries	Capacity[a] licensed (as of 1985) (million A h)
Electronics Corporation of India Limited (Hyderabad)	Rectangular sintered plate	0.35
Tamil Nadu Alkaline Batteries Limited (Madras)	Rectangular sintered plate (vented type)	1.0
Coralie Electronics Limited (Delhi/Gurgaon)	Rechargeable cylindrical cells	0.7
Punjab Power Packs Limited (Mohali (SAS-Nagar)/Chandigarh)	All types of Ni/Cd cells	0.7
High Energy Batteries (India) Limited (Trichy/Mathur)	All types of cells	4.4 (includes Ag/Zn & Ag/Cd systems also)
Hyderabad Batteries Limited[b] (Hyderabad)	Rectangular sintered plate (vented type)	0.4
Power Packs Pvt. (Hyderabad)[b]	All types	1.0

[a] The capacity utilisation has been in the range 25 - 30% only, corresponding to a total production of 2.25 - 3 MA h.
[b] Small-scale unit.

Portable electric gadgets

At present, the portable power industry is totally dominated by the Leclanché dry cell. Nickel/cadmium could break new ground because it can be completely sealed and has longer life. The system is, however, more expensive than lead/acid. Competition could come from sealed, recombination type lead/acid batteries.

Solar energy storage

Nickel/cadmium could be considered for cases where the cost penalty is permissible. Important parameters that govern the selection of nickel/cadmium are: (i) better low-temperature performance; (ii) better resistance to overcharging and over-discharging; (iii) longer life.

Defence and space applications

Here, cost is less important. Conventional and advanced lead/acid batteries will continue to cover and extend the range of applications. Besides the use of nickel/cadmium and silver/zinc batteries, however, more applications may rely on power from sodium/sulphur, lithium/solid electrolyte, nickel/hydrogen, metal/air and other systems.

TABLE 13

Estimated demand of cadmium-based batteries in India

Application	Silver/ cadmium	Pocket plate nickel/ cadmium	Sintered plate nickel/ cadmium	Estimated annual requirement (Million A h)	Use of cadmium (Tonnes)
Aircraft use					
24 V, 23 A h & 40 A h	x		x	0.20	0.90
Naval use					
1.2 V - 24 V, 15 A h - 100 A h		x	x	0.50	2.25
Military use					
24 V, 400 A h		x		0.48	2.15
Electricity boards					
30 V, 15 A h			x	19.15	86.18
24 V, 150 A h - 400 A h		x			
Rural electrification					
12 V - 110 V, 7 A h - 30 A h		x	x	0.19	0.86
Railways					
6 V - 12 V, 2.2 A h - 75 A h			x	32.20	145.00
12 V - 112 V, 90 A h - 800 A h		x			
Electric vehicle					
24 V, 800 A h		x		1.50	6.75
Uninterrupted power supplies (UPS)					
12 V - 48 V, 15 A h - 250 A h		x		0.72	3.24
Industrial traction and oil rigs					
24 V, 150 A h - 400 A h		x		15.0	67.50
Communication sets					
12 V, 150 A h - 400 A h	x		x	0.87	3.92
Medical electronics					
3.6 V - 24 V, 2 A - 10 A h			x	0.55	2.48
Commercial applications					
2.4 V - 24 V, 0.5 A h - 10 A h			x	0.11	0.50
Satellite power systems					
6 V - 12 V, 6 A h - 15 A h			x	0.05	0.23

Conclusions

Three types of secondary power systems are presently being manufactured in India, namely: lead/acid, nickel/cadmium, and silver/zinc. The oldest of these — lead/acid — remains by far the most popular with the highest rate of growth. This is due to certain inherent advantages that are specific to Indian conditions. Nevertheless, selective areas of application, demanding requirements of long life, high energy, very low maintenance/maintenance-free operations, may herald the emergence of new types of batteries.

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Reference

1 A. Raychaudhuri, *J. Power Sources, 23* (1988) 25 - 32.