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OFFICE OF ENERGY, ENVIRONMENT,
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AND

OFFICE OF ENVIRONMENT,
ENERGY, AND ENTERPRISE
USAID/ INDIA

ELECTRIC VEHICLE INVESTMENT OPPORTUNITIES IN INDIA

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Executive Summary

In many respects, India appears to be ideally suited for a potentially large electric vehicle (EV) industry because the mobility needs of Indians are quite different from those of the Americans or Europeans. The average distance that a personal transport vehicle (PTV), i.e., a car or a two-wheeler, is driven per day is very low in India, and well within the range of EV technology commercially available. Inter-city travel by PTV is also very low. At the same time, because of a very high rate of growth (25% per year for the last three years) of the automobile industry, most of the urban India is facing dire environmental consequences. This is corroborated by the fact that three of the world's most polluted cities in terms of air quality are in India. According to a recent World Bank study, poor air quality in urban areas may be costing India billions of dollars in terms of increased health care costs and lost productivity.

The economic liberalization of India that started in 1991 has given a strong impetus to the high growth of the automobile industry. It has also created a better environment for foreign investments to flow into the Indian automobile industry. The automobile industry output is projected to reach five million per year by the year 2000. Almost 80% of it would consist of two and three-wheelers which are extremely polluting because of their two-stroke engines.

India's resource balance is also in favor of EV. India's dependence on imported oil (currently at 50%) is steadily increasing with the growth of the conventional automobile industry. On the other hand, India has abundant reserves of coal and access to environment-friendly technologies to produce power from coal.

In order to characterize the potential for EV in India and to determine how US businesses should position themselves with regard to this potential market, the Center for Environment in USAID's Office of Energy, Environment and Technology, and USAID/India's Office of Environment, Energy and Enterprise, sponsored the preparation of this *Business Guide* under the Energy Technology Innovation Project (ETIP) The *Guide* is expected to provide US businesses with information to assist them in understanding the current trends in the Indian automobile industry and provide practical insight into the emerging EV market in India. It also provides tips on an appropriate business strategy for India and profiles some potential collaborators for US investors from among Indian companies. Most of these companies have proven capability and desire to establish business links with US companies.

Glossary

AIAM	Association of Indian Automobile Manufacturers
BHEL	Bharat Heavy Electricals Ltd.
CEERI	Central Electronics Engineering Research Institute
CII	Confederation of Indian Industry
DEDA	Delhi Energy Development Agency
DoE	Department of Electronics
EV	Electronic/Electric Vehicle
FICCI	Federation of Indian Chambers of Commerce & Industry
GOI	Government of India
JV	Joint Venture
MNES	Ministry of Non-conventional Energy Sources
MoEF	Ministry of Environment & Forest
MoST	Ministry of Surface Transport
PSU	Public Sector Undertaking -- a government owned corporation in India
Raj	Rule, as of a king
Rs.	Short for Rupees, the Indian currency. Exchange rate: US$1 = Rs. 35.90 approximately (Jan 31, 1997)
USAID	United States Agency for International Development
USAEP	United States Asia Environmental Partnership

CONTENTS

1. INTRODUCTION

1.1 Objective of the Report

This Guide is specifically directed to the executives of US Automobile and related industries.

The objective of this report or ***Business Guide*** is to provide US businesses and investors clear, crisp and practical insight into the emerging market for electronic/electric vehicles (EV) in India.

This *Guide* will identify emerging business opportunities in a potentially vast market. It will also apprise US firms of the potential pitfalls. In addition, it will provide some tips on an appropriate business strategy for India in general, and the EV market in particular. Finally, the *Guide* will profile some potential collaborators for US investors from among the Indian companies. Most of these companies have proven capability and the desire to establish business links with appropriate US companies.

After you go through this Guide, you will be able to decide whether you want to explore the potentially vast Indian market now and how to go about doing it.

The purpose of this *Business Guide* is to help US companies identify potential *long-term* business opportunities in India. The focus of this *Guide* is only on the marketing and technical aspects of the EV industry. For further information on specific opportunities, readers are advised to contact the relevant Indian companies directly.

1.2 Why India?

India has the largest market-based economy (in terms of number of participants) in the world and the second largest pool of technically-trained manpower in the world. *The Wall Street Journal*, the World Bank and several international agencies estimate the size of India's middle class at about 200 million. According to *Fortune* magazine, India's growing middle class is 300 million and it will propel the economic boom of India. With a vast pool of technically-trained manpower and low-cost human resources available within the country, and a steadily-growing domestic market, India's potential for growth in the next few decades is extremely positive.

With a population of close to a billion, and with liberalization of economic, industrial and trade policies that are currently underway, India's economic potential is enormous.

The liberalization of economic policies announced by the Government of India over the past five and one-half years, coupled with enthusiastic endorsement of those policies from the World Bank and the IMF, has created a better environment for foreign investments to flow into the country. *The Economist* magazine has described the post-liberalization Indian economy as a "tiger uncaged". At the same time, the need for the US and other developed economies to find new markets

In sharp contrast to many other developing countries, India has a well-established judicial system and the language of business here is English. These factors increases the comfort level of foreign investors.

for sustaining economic growth of their own economies has increased. In many respects, there is a high degree of synergy between India and the US. Because of their common colonial heritage, and democratic form of governments, there are a lot of institutional similarities between the two countries. In sharp contrast to many other developing countries, India has a well-established judicial system and the language of business in India is English. All of these factors go a long way in increasing the *comfort* level of foreign investors.

1.3 Why the Electric Vehicle (EV) Market in India?

An EV market is most likely to develop in India out of sheer necessity, if nothing else. The air quality in many parts of urban India is extremely poor. Most of India's metropolitan cities rank among the worst polluted cities in the world --- Delhi having the dubious distinction of being the fourth most polluted city. Vehicular emission accounts for up to 65% of air pollution in the cities. The impact of this pollution on public health, and health-care costs has been enormous, according to a World Bank study.

Because of the dire environmental situation in many parts of India, the need for economically affordable zero emission vehicles (ZEV) is increasingly felt by policy makers and urban authorities.

There are several factors that point to the emergence of a potentially very large EV market in India. Some of these are described below:

- Because of the dire environmental situation in many parts of India, the need for economically affordable zero emission vehicles (ZEV)

is increasingly felt by many urban authorities and policy makers.

- India's dependence on imported oil is increasing (close to 50%, currently) and, at the current rate of consumption growth, the known level of crude reserves is not expected to last long.

- On the other hand, India has abundant reserves of coal (though of very high ash content) for producing thermal power using clean-coal technologies and other environment-friendly technologies such as circulating fluidized bed boilers. Although India has an acute shortage of power, load factors of power plants are generally low and the off-peak demand for power is much lower than the peak demand. This situation leaves considerable room for developing a system where electric vehicles could be charged overnight at a lower cost and without straining the power system capacity.

- Unlike in the US, all forms of personal transport (passenger cars, motorbikes and scooters) in India are mostly driven within a single urban area, and inter-city travel by car is low. Moreover, average distance driven per personal vehicle per day is within 40-70 km. The average speed of the Indian traffic is also low because of narrow roads and inadequate number of highways. Thus, the Indian market for personal vehicles is almost perfectly suited for EV-s, as depicted in Chart 1.1 in the next page.

Significant opportunities exist for technology cooperation and business collaborations between US and Indian companies in developing the Indian EV market to its fullest potential. These are outlined in greater detail later in this *Business Guide*.

Market for Personal Transport Vehicles (PTV) in India: Appears to be Ideally Suited for Electric Vehicles (EV)

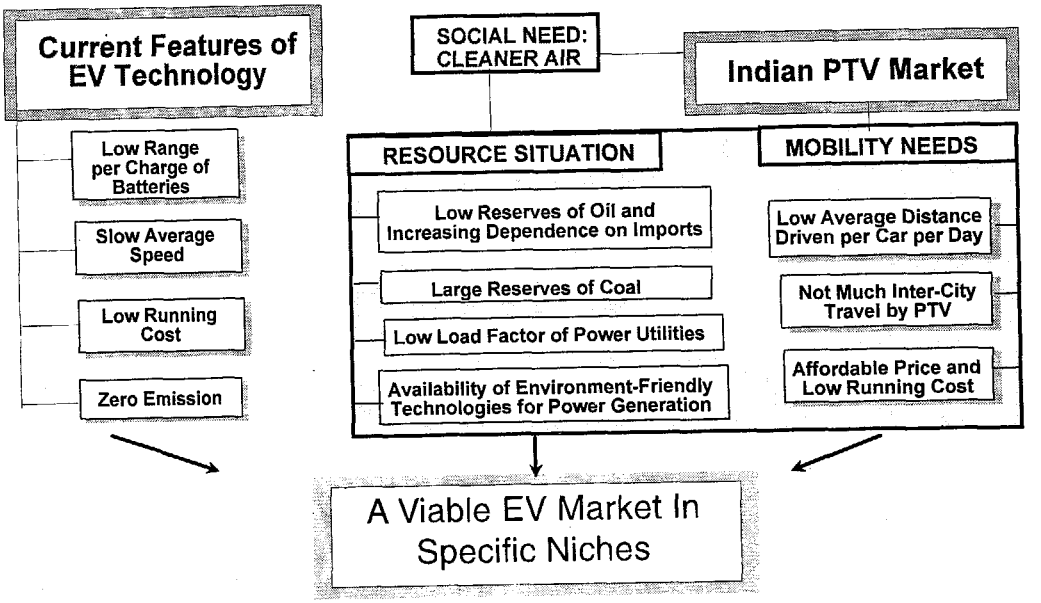

Chart 1.1

2. BUSINESS ENVIRONMENT IN INDIA

2.1 General Economic Profile

The Indian economy, even until a decade ago, had been a textbook example of a *dual economy* where a modern, organized sector existed side by side with a traditional unorganized (mostly agricultural) sector with very little interaction between the two. For almost forty years since her independence in 1947, India had embraced the model of a *socialistic pattern of society* where the government played a dominant role in the economy through a myriad of state-controlled enterprises managed by bureaucrats and technocrats, often far removed from the realities of the markets they were supposed to serve. The *licence Raj*, in which industrial licences were controlled by the government, supposedly to direct private sector investments to industries deemed *desirable* by them, and which provided a protected environment with high tariff barriers, led to the development of many inefficient and high-cost industries. The government domination in the economy, however, had some positive effects as well in the early stage of development of modern India. Huge investments were made by the government, often supplemented by foreign aid, in many infrastructure industries such as transportation,

The end of the "licence Raj" and the high tariff barriers that had resulted in many inefficient and high-cost industries and a scarcity-driven "anything-will-sell" market environment, is considered a very welcome part of the liberalization process.

The Indian economy is now on the verge of a full-fledged take-off from a traditional agriculture-based economy to a potentially giant industrial economy. It is already the tenth largest industrial nation of the world.

communications, power development, technical education, steel, heavy engineering and electrical industries. Some of these investments are paying dividends now. Table 2.1 presents some major indicators of India's economic growth over the past fifteen years.

Table 2.1

Major Economic Indicators for India
(% Change from the Previous Year)

Year	GDP	Agricultural Production	Industrial Production	Electricity Generation
1981-82	6.1	5.6	9.3	9.9
1982-83	3.1	-3.8	3.2	7
1983-84	8.2	13.7	6.7	7.6
1984-85	3.8	-1.2	8.6	12.1
1985-86	4.1	2.5	8.7	8.4
1986-87	4.3	-3.7	9.1	9.8
1987-88	4.3	-0.8	7.3	8.8
1988-89	10.6	21	8.7	10.2
1989-90	6.9	2.1	8.6	11.2
1990-91	5.4	3.4	8.2	7.8
1991-92	0.9	-2	0.6	8.5
1992-93	4.3	4.1	2.3	5
1993-94	4.3	2.8	5.6	7.4
1994-95	6.2	4.7	8.4	8.5
1995-96	5.8	2	9.5	8.5

Source: Statistical Outline of India, 1995-96, Tata Services Ltd.

A large measure of growth, however, had been eroded by a rapid rise (at 2.1 to 2.3% per year) in population. With the "green revolution" that ultimately made India self-sufficient in food in the 1980's, the agricultural sector started to become more organized and integrated with the rest of the economy.

2.2 Economic Reforms and Liberalization

When the previous government came into power in 1991 with Mr. P.V. Narasimha Rao as the Prime Minister, the Indian economy was in a precarious condition with regard to foreign exchange reserves and the country was on the verge of defaulting on its debt obligations to the rest of the world. The situation forced the then finance minister, Dr. Manmohan Singh, to make some drastic economic reforms and liberalize the economy. The main planks of the new economic policy were to:

Today, India can boast of the second largest railway system in the world, the second largest pool of technically trained manpower in the world, a highly sophisticated space research programme, an indigenously developed super computer and an economy that is more self-sufficient than many in the developed world.

i) eliminate the licence requirements for most of the industries except a few strategic ones;

MAIN PLANKS OF ECONOMIC REFORM

- ***end of the "Licence Raj" in the industrial sector***
- ***divestiture of Government holdings in public sector undertakings (PSU)***
- ***significant reduction in import tariffs***
- ***incentives for export promotion***
- ***greater role for the private sector and multi-national corporations; special incentives and benefits to foreign business collaborators***

ii) reduce the role of the government in the economy by divesting government ownership in many PSUs;

iii) open up the economy to foreign investments and encourage foreign business collaborations by providing incentives including tax concessions.

iv) reduce customs duties drastically on imports;

v) promote exports by providing a variety of incentives;

The main objective behind these new measures was to begin the globalization of the Indian economy.

These economic reform measures received very enthusiastic support from the World Bank, IMF and other international organizations as well as most of the leading nations of the world. The United States also welcomed the new economic liberalization of India.

STRENGTHS OF THE INDIAN ECONOMY

- ***about 250 million middle class consumers***
- ***vast human resources***
- ***low-cost engineering and technical manpower***
- ***high national savings rate***
- ***international aid and financing***
- ***high level of technology absorption capacity***
- ***near other emerging markets in Asia***
- ***a mature stock market with 7000 listed stocks***
- ***world's fifth largest economy in terms of domestic purchasing power***

The international support to India's economic reforms started to pay dividends within a very short time. The inflow of foreign direct investments (FDI) into the country increased dramatically, as reflected in Chart 2.2 . Within less than two years of the introduction of the reforms, the foreign exchange reserves of the country improved sufficiently to allow the government to make the Indian currency (Rupee) fully convertible on the trade account and later on the current account. An IMF study on the comparative economic strength of nations based on the real purchasing power of the economy describes India as the fifth largest economy following the USA, China, Japan and Germany.

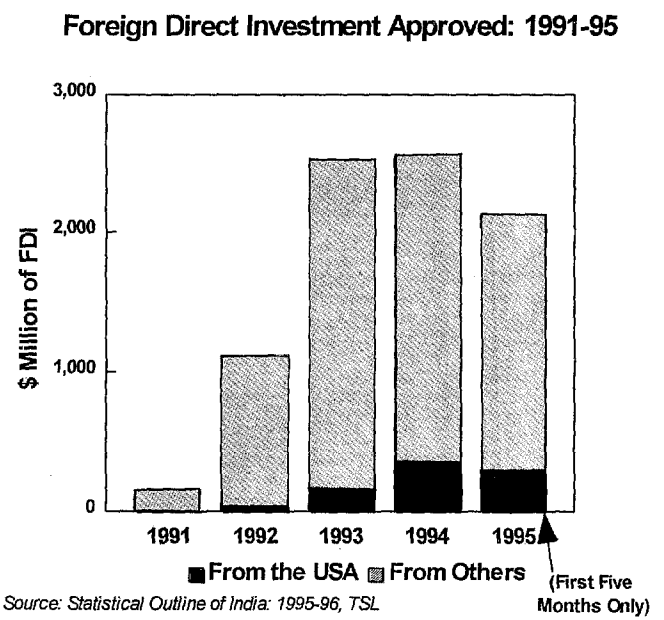

Chart 2.2

In the first few years of economic reform, the greatest need for new and massive investments are in the infrastructure industries, such as power, telecommunications and information technology, transportation and also in development of environment-friendly technologies. The government has realized that it cannot generate adequate resources by itself to make the massive investments required in these industries for a "take-off" into self-sustained growth. So, it has thrown most of these sectors open to private sector participation including that from the multi-national firms.

2.3 Current Socio-Political Environment

The current minority coalition Government in India came into power in 1996 with somewhat brittle support from the Congress Party, the largest political party of India. The pace of economic reforms has, however, slowed down under the current thirteen-party coalition government. It is expected to improve after a consolidation phase.

Although nobody is sure how long this Government will last, most of the economic reform measures adopted by the previous Congress government are expected to stay on.

3. INDIAN AUTOMOBILE INDUSTRY

3.1 A Brief History of the Industry

The automobile era in India began in 1898 with the Bombay Cycle and Motor Agency importing four cars into the country. For the next thirty years, all motor vehicles were imported. Interestingly, there is an American connection in India's automotive history. It was an American company that started a public taxi service in 1903. Later, in 1928, General Motors India Ltd. began an assembly operation in Bombay for trucks and buses from imported CKD (completely knocked down) parts and components from the USA. The Ford Motor Company of India Ltd. began CKD assembly of automobiles in Madras in 1930 and in Calcutta in 1931. Prior to the second World War, the combined capacity of these companies was 96,000 units of vehicles per year.

Interestingly, there was an American role in the foundation of India's automobile industry.

The foundations of the Indian automobile industry were laid in the inter-war period with the advent of Hindustan Motors Ltd. (HML) in 1942 and Premier Automobiles Ltd. (PAL) in 1944. Both began operations by assembling CKD vehicles. HML produced Studebaker trucks and buses and Morris cars while PAL collaborated with Chrysler to produce commercial vehicles and with Fiat for cars. Ashok Motors Ltd. commenced assembly of Austin cars and Leyland trucks in 1950.

Manufacture of motor vehicles, as distinct from assembly operations did not start until 1948 and the first partially manufactured Indian car rolled out of Hindustan Motors Ltd. factory in 1949. By 1953, the Government of India announced a policy that in the automobile sector,

only companies with a manufacturing program would be allowed to continue operations. Only five firms were recognized by the government as manufacturers. General Motors India Ltd. and Ford Motor Co. India Ltd. considered market demand too low to warrant manufacturing and, therefore, decided to withdraw. Convinced of the economic and strategic importance of the automotive industry, the Government of India sought to control and channel investment in this industry via a complex system of rules and regulations and an elaborate network of policies.

By the mid-sixties, there were seven manufacturers of motor vehicles in India but none of them manufactured more than one basic model. During the second half of the seventies and specially in the 1980s, there had been a gradual relaxation of controls over the automobile industry

The structure of the Indian automobile industry has changed significantly over the years. Until the early seventies, there was a preponderance of commercial vehicles and the market was small and stagnant. By the end of the seventies, personal transport vehicles were nearly three times the commercial vehicles. During the eighties, as a result of diversification and segmentation, personal transport vehicles constituted more than eight times the commercial vehicles. The two-wheelers segment was virtually non-existent in 1950, had grown phenomenally and accounted for more than 80% of total production of vehicles by 1989.

also, echoing economic liberalization in the rest of India's industrial economy. Consequently, there was a severe shortage of passenger cars in the country and buyers had to wait for years to get a new car. The idea of a small and low-cost *people s car* was mooted at this time , and finally Maruti Udyog Ltd. was incorporated as a public limited company to launch the *people's car* -- with the Government owning a majority share and Suzuki Motor Co. of Japan owning 26%, which was later raised to 40% and finally, in the wake of the New Industrial Policy

(NIP) announced by the Government of India in July, 1991, to 50%. The Maruti project eventually turned out to be a roaring success.

Table 3.1

Indian Automobile Industry: 1986-95
Production of Vehicles in Recent Years

Year	Cars and Jeeps	Commercial Vehicles & Tractors	Two Wheelers	Three Wheelers	Grand Total	Annual Growth Rate
1986	143,787	170,549	1,358,114	53,094	1,725,544	16%
1987	180,861	171,892	1,401,819	60,224	1,814,796	5%
1988	195,079	219,667	1,574,646	69,132	2,058,524	13%
1989	219,527	234,810	1,750,406	83,204	2,287,947	11%
1990	218,765	274,403	1,875,522	95,528	2,464,218	8%
1991	209,347	297,792	1,603,108	79,429	2,189,676	-11%
1992	192,069	281,323	1,477,217	66,332	2,016,941	-8%
1993	243,869	261,720	1,664,427	77,498	2,247,514	11%
1994	286,394	338,812	2,080,518	121,289	2,827,013	26%
1995	393,698	427,406	2,551,166	153,318	3,525,588	25%

In 1995, its market share of the passenger car market in India was close to 78%. During the same time, the growth in two-wheeler vehicles has

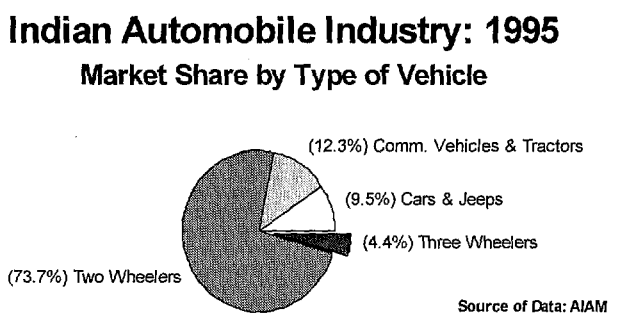

Chart 3.1

been phenomenal as a result of increasing collaboration with foreign firms. Table 3.1 portrays the growth of the Indian automobile industry over the past decade or so. The dominance of the two-wheeler segment in the automobile market is very clear from Chart 3.1. This dominance is expected to continue in the foreseeable future. The growth pattern of all the major segments over the past decade or so is presented in Chart 3.2. Interestingly, in each of these segments or in some sub-segments thereof, there is still one dominant market leader as reflected in Table 3.2. This can probably be interpreted as a legacy of the *licence Raj*, the old days of Government control and regulation.

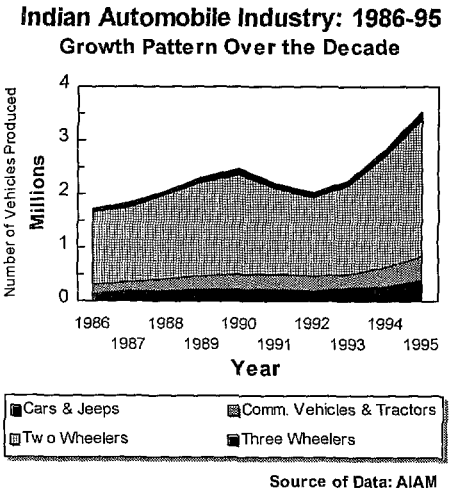

Chart 3.2

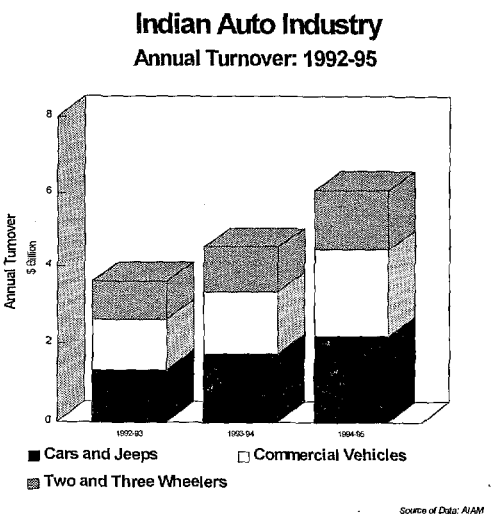

Table 3.2

Market Leaders in Indian Automobile Industry: 1995-96					
	Company with the Largest Market Share		Company with the Second Largest Market Share		Others
Segment	Name	Share	Name	Share	Share
Cars	Maruti	77%	Hind Motors	8%	15%
Scooters	Bajaj Group	68%	LML	20%	12%
Multiutility Vehicles	Mahindra & Mahindra	87%	Maruti	13%	0%
Med/ Heavy Vehicles	TELCO (Tata's)	73%	Ashok Leyland	26.7%	0.3%
LCV	TELCO	59%	Bajaj Tempo	22%	19%
3 Wheelers	Bajaj Auto	90%	Scooters India	7%	3%

Source of Data: AIAM

Chart 3.3 in the previous page provides data on annual turnover of the Indian automobile industry since the current economic reform began in mid-1991. It should be noted that each of the market segments grew by 21% to 44% per year during this period -- clearly establishing the enthusiasm with which the policy reforms were welcomed by this sector. The level of investment in productive assets in the industry was about $1.2 billion in 1991 and $2.5 billion 1995, and the AIAM forecast for investment in the year 2000 is $8.5 to $11.5 billion.

India entered the world auto exports market only a few years ago but exports of motor vehicles have already reached a respectable level of about 200,000 by March, 1996, a five times growth in four years. Destinations of exports range from Australia and New Zealand to South-east Asia, South America, Middle East, Africa and Europe. Most of the Mercedes-Benz, Peugeot, General Motors plan to new Indian

Indian exports of motor vehicles have already reached a respectable level of about 200,000 by March, 1996, a five times growth in four years.

joint ventures with world automobile majors such as export half of their output. As global automobile companies and their Indian collaborators develop India as a base for export markets worldwide and for sourcing components, growth in exports and export earnings could be very large. When all the current export plans are implemented in a few years, exports may touch a couple of million vehicles and exports earnings may cross the $3 billion mark.

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3.2 Policy Environment and Market Outlook

Following Maruti's success and the announcement of the New Industrial Policy (NIP), the number of new entrants in the Indian automobile industry has been phenomenal. Many of the world's leading automobile manufacturers have started or are in the process of starting their Indian operation, in collaboration with their Indian partners. Some of these big names are General Motors, Ford, Chrysler, Mercedes,

Although there are some political uncertainty with a minority coalition Government in place in India, liberalisation policies affecting the automobile sector are very unlikely to be reversed by any political party.

Daewoo, Hyundai, Peugeot, Toyota, etc. Although there are some political uncertainties with a minority coalition Government in place, liberalisation policies affecting the automobile sector are very unlikely to be reversed by any political party and the outlook for this sector is extremely positive as the following demand projections (Table 3.3) by some well-known experts indicate.

Table 3.3

Vehicle Demand: Projections for the Year 2000	
Forecasting Agency	Forecasts (Million Nos.)
DRI/McGraw-Hill	5.1
McKinsey	4.7
Morgan Stanley	5.5
AIAM	5.1

With the economy expected to grow at the rate of 6-8% per year, the size of the middle class is expected to double by the year 2000 and triple by 2005. Generally, the interest cost in India has been very high. For example, the average interest rate for financing motor vehicle purchase used to be about 30% only about five years ago. Although it has now come down to about 18-22% range, it is still very high compared to the world standards. It is expected that in due course, the financial sector in India will also be liberalized allowing more competition which will likely reduce the significant gap between the international and Indian interest rates. Such reduction in interest will boost the growth of the automobile sector further.

With the economy expected to grow at the rate of 6-8% per year, the size of the middle class is expected to double by the year 2000 and triple by 2005.

From a traditionally railroad-dependent economy, India has moved on to a road-dependent economy in the nineties, as depicted in Table 3.4.

From a traditionally railroad-dependent economy, India has moved on to a road-dependent economy in the nineties.

A number of nationwide super highways are planned to be built in the coming decade by private investors on a BOT or similar basis. A 1995 World Bank study shows that per capita travel per year in India is 2300 km, much more than other countries, relative to their respective income levels.

Table 3.4

Rising Share of Road Traffic in India

Year	Billion Passenger km		Billion Ton km	
	Road	Rail	Road	Rail
1951	40	67	12	44
1985	920	230	240	170
1995	3000	330	700	290
2000 Projected	5000	440	1500	360

Source of Data: Ministry of Surface Transport, GOI

As in most countries, manufacturers and importers can produce and sell only roadworthy vehicles in India. The Motor Vehicles Act (MVA) and Central Motor Vehicles Rules (CMVR) require every manufacturer or importer to obtain a *Compliance Certificate* from an approved research and testing agency. The safety standards are prescribed by MVA, CMVR and their state counterparts. Once the *Certificate* is issued, it is filed with the Transport Commissioner of each state. The Transport Commissioner is the chief transport and registering authority for all vehicles in each state.

3.3 Profiles of Major Players

Table 3.2 earlier provided a glimpse of the market leaders in each of the major market segments of the automobile sector. Chart 3.4 portrays the financial strength of the automobile industry majors. Since the two wheelers commands a dominant position in the Indian auto market, Charts 3.5 and 3.6 provides a closer view of the dominant players in this segment.

Association of Indian Automobile Manufacturers (AIAM) is an apex body of the automobile industry and it has a large presence in the country. It currently has 29 members, a few of whom have become members very recently.

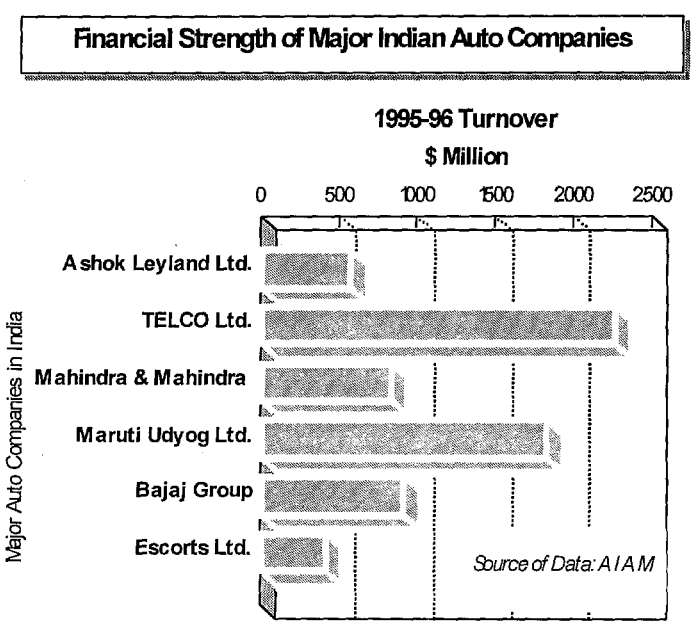


Chart 3.4

Table 3.7 on page 22 provides a brief profile of all the active players of

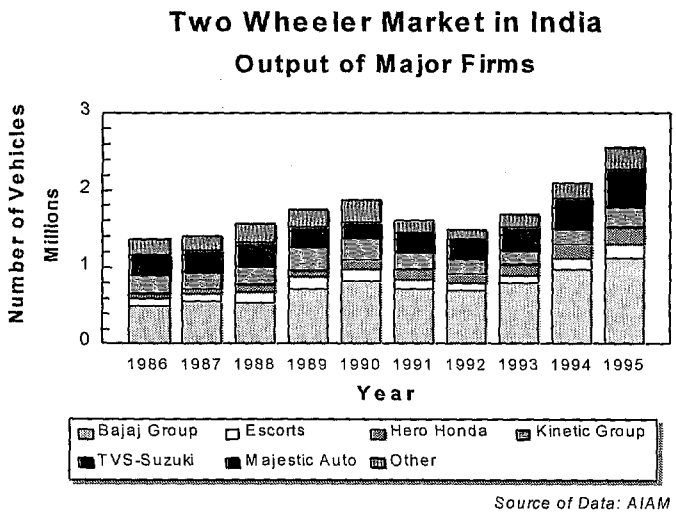


Chart 3.5

the Indian automobile industry including some recent entrants in to the market.

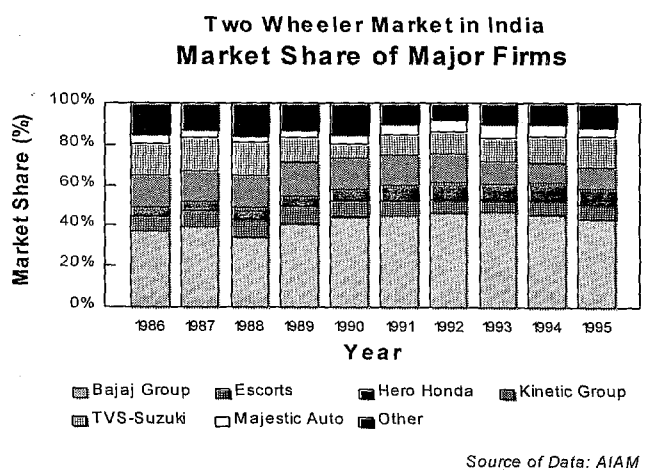


Chart 3.6

A Brief Profile of the Major Players

Sl. No.	Category/Manufacturer	Total Turnover	Total Expenses
			(Rs.
A.	**Commercial Vehicles**		
1	Ashok Leyland Ltd.	20,097	18,643
2	Bajaj Tempo Ltd.	6,956	6,408
3	Eicher Motors Ltd.	2,610	2,490
4	Swaraj Mazda Ltd.	1,822	1,776
5	TELCO Ltd.	79,097	68,051
	Sub-Total (A)	**110,582**	**97,367**
B.	**Cars and Multi-utility Vehicles**		
6	DCM Daewoo Motors Ltd.	6,055	4,346
7	Hindustan Motors Ltd.	12,141	19,083
8	Mahindra & Mahindra Ltd.	28,996	22,137
9	Maruti Udyog Ltd.	64,130	61,218
10	Mercedes-Benz India Ltd.	891	NA
11	Premier Automobiles Ltd.	8,233	7,960
12	PAL-Peugot Ltd.	3,216	3,196
	Sub-Total (B)	**123,661**	**117,940**
C.	**Two and Three-Wheelers**		
13	Bajaj Auto Ltd.	29,320	22,533
14	Escorts Ltd.	14,442	12,146
15	Greaves Ltd.	7,389	7,019
16	Hero Honda Motors Ltd.	6,407	5,988
17	Kinetic Engineering Ltd.	2,041	1,870
18	Kinetic Honda Motors Ltd.	3,168	3,092
19	LML Ltd.	5,123	4,893
20	Maharashtra Scooters	2,417	2,163
21	Majestic Auto Ltd.	1,783	1,181
22	Royal Enfield Motors	1,021	NA
23	TVS-Suzuki Ltd.	6,225	5,478
	Sub-Total (C)	**79,336**	**66,363**
	Grand Total	**313,579**	**281,670**

Table 3.7

of the Indian Automobile Industry, 1995-96

Gross Profit	Net Profit	Expenses on R&D	R&D Expenditure as % of		
...lion)			Turnover	Expenses	Gross Profit
1,882	1,131	186	0.93%	1.00%	9.88%
549	280	125	1.80%	1.95%	22.77%
720	124	26	0.98%	1.03%	3.56%
97	46	2	0.10%	0.11%	1.95%
11,046	5,300	1,107	1.40%	1.63%	10.02%
14,293	**6,881**	**1,445**	**1.31%**	**1.48%**	**10.11%**
578	482	4	0.06%	0.08%	0.61%
1,214	511	51	0.42%	0.27%	4.20%
2,794	1,623	228	0.79%	1.03%	8.16%
6,507	4,298	81	0.13%	0.13%	1.24%
NA	NA	NA	NA	NA	NA
448	273	86	1.04%	1.08%	19.13%
250	38	0			
11,791	**7,224**	**450**	**0.36%**	**0.38%**	**3.81%**
6,787	5,951	227	0.77%	1.01%	3.34%
1,697	1,004	52	0.36%	0.42%	3.04%
370	288	19	0.25%	0.26%	4.99%
419	263	20	0.31%	0.33%	4.73%
171	139	65	3.19%	3.49%	38.13%
75	51	15	0.49%	0.50%	20.42%
420	308	9	0.17%	0.18%	2.07%
254	163	0	0.00%	0.00%	0.00%
413	40	3	0.15%	0.23%	0.65%
NA	NA	28	2.72%	NA	NA
698	345	41	0.66%	0.75%	5.90%
11,305	**8,551**	**478**	**0.60%**	**0.72%**	**4.23%**
37,389	**22,656**	**2,372**			

In terms of turnover, TELCO of the Tata Group, the largest business house in India, is the industry leader.

In terms of turnover, TELCO of the Tata Group, the largest business house in India, is the industry leader, followed by Maruti Udyog Ltd. Bajaj Auto Ltd. is now the world's largest manufacturer of two wheelers, producing more than a million vehicle per year.

The R&D spending in the Indian automobile sector so far supported evolutionary and incremental changes in technology. As Table 3.7 shows, the industry as a whole spends less than 1% of total turnover on R&D.

TELCO spends by far the largest amount on R&D and it is also the only company in India that has designed and built motor vehicles entirely on its own. Among the two and three wheeler manufacturers, Kinetic Engineering is proportionately the most active in R&D work, spending over 3% of its turnover on R&D, followed by Bajaj at about 1%.

The future plans of most of the companies are based on tie-ups with foreign companies, which are poised to enter the expanding Indian market.

Industry watchers predict that R&D issues related to in-digenisation and local capacity building are going to change with global restructuring of the automobile industry. The future plans of most of the companies are based on tie-ups with foreign companies, which are poised to enter the expanding Indian market.

3.4 Two and Three Wheeler Markets: User Profiles

In India, two wheelers operate like family cars and three wheelers like light commercial vehicles (LCV).

Twenty one million two wheelers on the road are often an Indian family's first and the only personal transport. More than two-to-three million new ones are added to the stock every year. Two wheelers often carry two adults and two kids: sometimes they also carry a child in arms, shopping bags, brief cases, and in exceptional cases, some heavy luggage too! They are driven on city main roads and cross country roads. Their average daily travel is 15-25 km and average occupancy is 1.5 persons.

Similarly, three wheelers operate and operate and work like mini commercial vehicles. They carry passengers and freight and operate on the main routes of city traffic and on the intercity routes. They cover on an average 90 km a day, average occupancy is two and average load is over 0.5 ton.

Three wheelers operate like mini commercial vans, carrying passengers and freight, covering on an average a distance of 90 km a day.

As low cost taxi and delivery van, three wheelers have grown rapidly in all major cities and towns. Current growth rate of the three-wheeler market is about 40% for domestic sales and 120% for exports. About 90% of the three wheelers are used as autorickshaws. From surveys conducted some auto companies and a survey by the Centre for Environmental Planning and Technology (CEPT) in the summer of 1996, one can develop the following brief profile of the autorickshaw market:

- *In large cities, about one-third of autorickshaws are driven by owners and two-thirds are rented out to the drivers by fleet owners; in smaller cities, it is the other way around.*
- *Average net income per day of an autorickshaw owner/driver is about Rs.150 and that of a rented autorickshaw driver is Rs.120.*
- *Over two-thirds of autorickshaws mix kerosene (a subsidized fuel) with gasoline and 68% of autorickshaws exceed limits of CO emissions.*
- *Kerosene is used as a fuel because (a) it is cheap, (b) no major modifications in engine are required, (c) autorickshaws can run faster because engine gets hot.*
- *Advantage of kerosene: it is lead-free while gasoline is mostly not lead-free in India*

Table 3.8 below provides an idea of the retail prices of some best-selling models of motor vehicles.

Table 3.8
Prices of Some Popular Models: Oct-Dec, 1995

Type of Vehicle	Retail Price Without Sales Tax In US $	Type of Vehicle	Retail Price Without Sales Tax In US $
Cars		**Scooters**	
Maruti 800	5,530	Bajaj Super	673
Ambassador Isuzu	8,450	LML Vespa	793
Premier Padmini	5,748		
		Mopeds	
Motorcycles		Bajaj Sunny	446
Bajaj Kawasaki	1,149	Kinetic Engg. Luna	256
Hero Honda	1,253	TVS Suzuki	408
Escorts Yamaha	1,064		
		Three Wheelers	
Source: AIAM		Bajaj Autorickshaw F/E	1,382

4. THE ELECTRIC VEHICLE MARKET: CURRENT AND POTENTIAL

4.1 Energy and Environmental Concerns: Likely Prime Movers for the Future Growth of an EV Market in India

As noted earlier in Section 1.3, energy and environmental concerns are most likely going to be the prime movers for accelerating the development of a large EV market in India.

On the environment front, three of the world's ten most polluted cities are in India. In some parts of urban India (particularly in Delhi area), people are exposed to extremely polluted air. The transport sector is the biggest contributor to air pollution in India. Vehicular emission accounts for 30% to 70% of air pollution in urban India. This pollution is often the result of a combination of antiquated automobile technology, poor fuel quality, poor maintenance of vehicles and lack of appropriate traffic planning.

The transport sector is the biggest contributor to air pollution in India. Vehicular emission accounts for 30% to 70% of air pollution in urban India.

According to a World Bank study[1], *The Cost of Inaction: Valuing the Economy-wide Cost of Environment Degradation in India*, the health cost of ambient air pollution in Delhi alone is US $100-400 million per year. For the country as a whole, it may run into billions of dollars.

1 *The Cost of Inaction: Valuing the Economy-wide Cost of Environment Degradation in India*, by Carter Brandon and Kirsten Homman, The World Bank, 1995

The total number of registered vehicles in India is about 35 million. During the past decade, the number of two-wheelers in India has increased by 561%. The total number of two wheelers and three wheelers currently is more than 25 million. Almost all of these vehicles have two-stroke engines which, due to inadequate combustion, spit out up to 40% of the fuel as hydrocarbon emission. Two-stroke petrol engines account for almost 70% of the vehicle population and consume 60% of petrol in India and they account for 70% of the total hydrocarbon emissions.

As much as 97% of hydrocarbon emissions and 76% of carbon monoxide emissions in Delhi are from vehicles running on petrol.

In a recent publication[1], the Centre for Science and Environment (CSE), a well-respected NGO in New Delhi, has revealed the stark reality of the level of vehicular pollution in urban India. Following are some excerpts from that study:

- In Bombay (now *Mumbai*), emissions from diesel vehicles are assuming dangerous proportions --- nearly 20% of the vehicles are diesel powered and they are a significant source of particulate emissions.

- The total road length in Calcutta is as low as 6% of the total city area, compared to 10-15% in other Indian cities. Traffic jams and slow moving traffic due to insufficient road space and unfit roads aggravate the problem of vehicular pollution. Scientists from the Central Institute of Road Transport (CIRT) in Pune believe that an

1 *Slow Murder: The deadly story of vehicular pollution in India*, by Anil Agarwal, Anju Sharma and Anumita Roychowdhury, Centre for Science and Environment, New Delhi, Nov, 1996

appreciable improvement in emission levels can be achieved with traffic engineering like intersection improvements, synchronization of traffic signals, dispersion of congested traffic and pedestrian control methods.

- Vehicular emissions even outrank sources of pollution like thermal power plants, industrial and domestic coal burning, and account for as much as 64% of the total air pollution load in Delhi.

- 80-90% of lead in ambient air is attributed to combustion of leaded petrol. Since children inhale a proportionately higher volume of air than adults, their lung deposit rate is about 2.7 times higher than that of adults. Infants and children below five are particularly sensitive to lead exposure because of its potential effect on neurological development

Most of the environmental problems outlined above will almost wither away with EV because of its zero emission feature

The automobile manufacturers claim that thirty million odd poorly maintained vehicles plying on the roads negate all their efforts to clean up the air through improved efficiency of new vehicles. Proper maintenance could reduce pollution by up to 40%, an Indian Institute of Technology Delhi study claims.

Most of the environmental problems outlined above will almost wither

Delhi is the home of 29% of India's motor vehicles. According to an eminent heart surgeon of Delhi, the rate of respiratory diseases in Delhi is twelve times more than the national average. Nearly 12% of Delhi's school children have asthma, and one-third of young children have respiratory problems.

away with EV because of its zero emission feature. One may argue that the additional power generation that would be needed to charge the EVs could still cause some pollution. True, but even if thermal power stations are used to provide power to charge EVs, effective emission control systems could be employed and these power stations could be located away from urban centres. Thus, total impact of urban air pollution could be significantly reduced. Moreover, time-of-use rates could be used to encourage charging of EVs during off-peak hours, thus improving the plant load factor of existing power plants.

On the energy front, again, India can ill afford to let the conventional automobile industry (using ICE technology) grow at the rate of 25% per year it has been growing for the past three years. This type of growth will result in a huge demand for oil most of which will have to be imported. Not only will it adversely affect India's energy security, but it will also mean a significant drainage of precious foreign exchange reserve. At the moment, India's dependence on imported oil is about 50%. With not much addition to the reserve of crude oil expected in the foreseeable future, the dependence on imported oil may go up to 90% only within a few years, if demand for oil grows at the current rate.

India can ill afford to let the conventional automobile industry grow at 25% rate it has been growing for the past three years. Such growth will result in a huge demand for oil most of which will have to be imported.

On the other hand, India has an abundant stock of coal reserve, enough to meet India's requirements for more than 200 years, it is claimed. At the same time, environment-friendly technologies are available to produce power from coal. So, as Chart 4.1 shows, India's resource balance for alternate vehicular technologies comes out strongly in favour of electric vehicles.

India's Resource Balance
With Alternate Vehicular Technologies

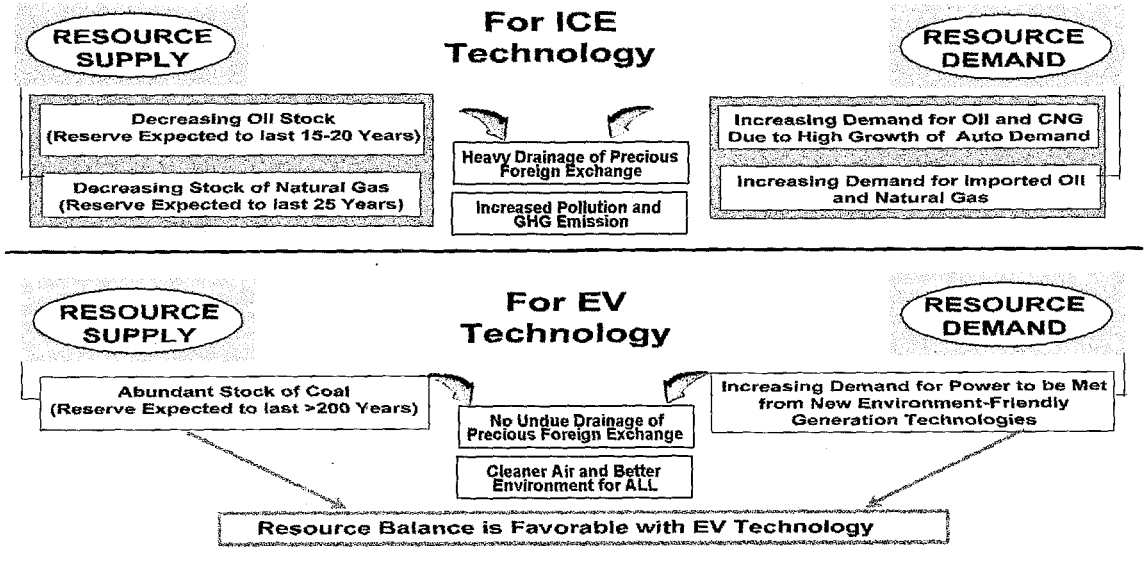


Chart 4.1

4.2 Evolution of the EV Industry in India: A Review

Electric Vehicle (EV) is not new in India. In fact, India has been one of the pioneering countries to start exploring the commercialization aspects of EV, in the early 1980s. The first EV prototype was manufactured in India in 1980. The Ministry of Non-conventional Energy Sources (MNES), Government of India, or its predecessor has been the nodal ministry in EV right from its inception of an EV program in the 1980s.

India has been one of the pioneering countries to start exploring the commercialization aspects of EV, in the early 1980's.

In pursuance of a national strategy for finding alternative sources of energy for surface transportation, MNES sponsored a project under which, during 1981 to 1984, Bharat Heavy Electricals Ltd. (BHEL), a public sector undertaking (PSU) which is the largest electrical equipment manufacturer in the country, designed and manufactured ten prototypes of an eighteen-seater electric vehicle. These were used by different government agencies.

With a view to conserving oil and providing pollution-free and noiseless means of surface transport, MNES introduced in 1986, a Battery Operated Vehicles (BOV) demonstration program. Under the BOV program, a capital cost subsidy is sanctioned by MNES to various government organizations and public or private sector firms. Under this program, BHEL has so far produced about 200 EVs of different models, 18-seater buses, 40-seater buses, vans, etc.

Two private sector companies, Chatelec of Bombay and Eddy Current Control of Coimbatore have also manufactured and marketed EVs, both passenger and commercial models with financial assistance from the

MNES. A major customer of BHEL for their electric buses has been the Delhi Energy Development Agency (DEDA). DEDA is the nodal agency in Delhi for promoting use of non-conventional sources of energy, and facilitating eventual commercialization of these energy sources, through various programs of subsidy and incentives.

DEDA has been running BHEL electric mini buses in several parts of Delhi since 1987. They started with about 100 buses (most of them are 18-seaters except five that are larger 40-seaters) that use lead acid batteries and DC motor drive. They require 10-12 hours of charging overnight. There are six charging stations scattered over the city and buses are routed around a specific charging station. The buses have gears and clutches like conventional buses. The average speed of the buses is 40 km/h. The range of the buses, when fully charged, is about 70 kms when the battery set is up to one year old, 60 kms for up to two years and 50 kms for up to three years, after which a battery set needs to be replaced. About 25% of DEDA costs are recovered through fares, the rest is subsidized by the government. DEDA also uses some of these buses to provide free shuttle service to civil servants travel from one government office to another in the core of the city.

DEDA now has about ten years of experience of running these electric buses and their experience can provide many clues for improvement.

DEDA now has about ten years of experience of running these electric buses and their experience can provide many clues for improvement. According to DEDA, the buses are not commercially viable under ordinary circumstances. Cost per passenger km for these buses comes to about double the cost for conventional diesel buses. The payload is only 25% as opposed to about 60% for diesel buses.

Only 40% of the original fleet are now functional because of a high

incidence of brake downs. Chopper controller is the main bottleneck. It needs regular repair. Imported choppers have been found to be not appropriate for Indian conditions. Because of unreliable power supply in Delhi, there have occasionally been problems in charging the batteries.

DEDA experience shows that the challenges for this kind of EVs lie in developing: (a) better chopper controllers, and (b) high energy batteries. What is also required is an appropriate policy support from the government, e.g., designating some congested areas as clean-air islands where nothing but ZEVs should be allowed.

DEDA experience shows that the challenges for this kind of EVs lie in developing: (a) better chopper controllers, and (b) high energy batteries.

Chart 4.2 in the next page provides the broad structure of the Indian EV sector. The subject of EV had attracted a lot of attention of the previous government that wanted to examine it from various perspective. For this purpose an Inter-Agency Steering Committee was set up in 1993 with the Secretary of the Department of Electronics, Mr. N. Vittal, as the Convenor. The Committee had members from MNES, the Ministry of Surface Transport (MoST), Ministry of Environment and Forests (MoEF), Department of Industrial Development, Council of Scientific and Industrial Research (CSIR), concerned industries and other experts in the field.

The Steering Committee has so far met seven times. The last meeting was held in December, 1995. The next meeting is planned for the near future. Because of the

The general feeling among many members of the Steering Committee is that there is no viable EV technology yet, other than EV for material handling.

The Structure of the
Indian Electric Vehicle Sector

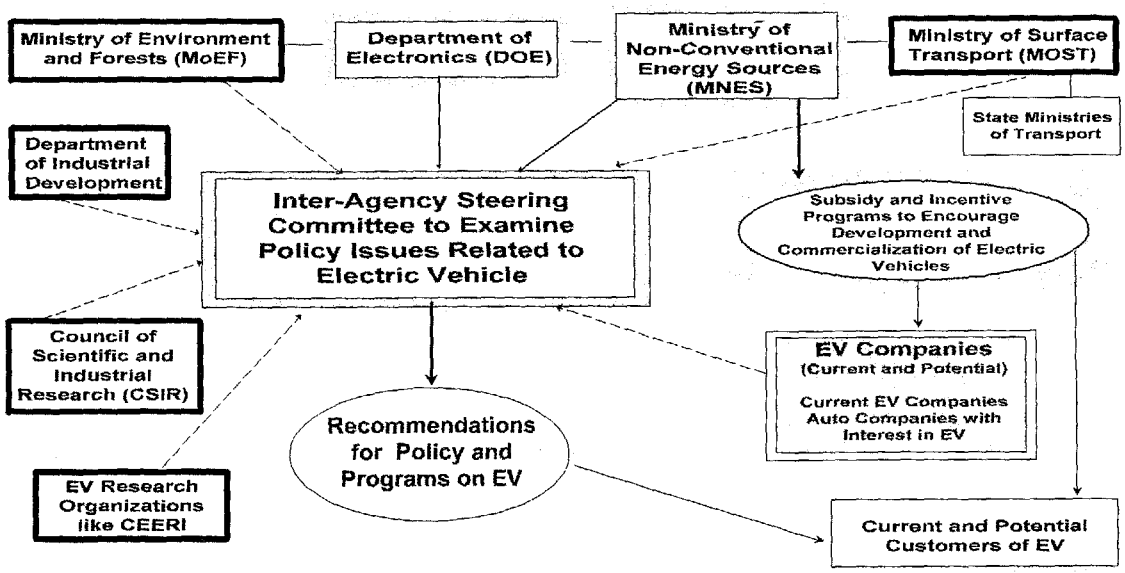


Chart 4.2

change in government and subsequent changes at senior level of bureaucrats in almost all the relevant ministries, it would be necessary to secure commitment from the top to the cause of EV again and that is why it is taking time. The general feeling among many committee members is that there is no viable EV technology yet, other than EV for material handling (forklift, trolleys, etc.). In the last meeting of the committee, held on Dec 26, 1995, a proposal was made to implement a national program in a *Mission* (meaning urgency) mode. MoEF had prepared a policy note regarding declaration of pollution-free zones in all major cities and towns where only clean vehicles such as EVs, bicycles and other eco-friendly vehicles would be allowed. The Secretary of the MNES stated that MNES had an on-going program on EV since 1986. A provision of about $1.5 million was kept every year for which there were not many takers.

The Secretary of the MNES stated that MNES had an on-going program on EV since 1986. A provision of about $1.5 million was kept every year for which there were not many takers.

One of the decisions taken in that last meeting was that fresh project proposals for development of high energy batteries, electronic devices, hybrid EVs, etc. would be welcome from the industry and R&D institutions.

Fresh project proposals for development of high energy batteries, electronic devices, hybrid EVs, etc. would be welcome from the industry and R&D institutions.

Minutes of the Steering Committee meetings indicate that the Transport Development Council (TDC) had recommended amendments to Motor Vehicles Act to exempt EVs from passenger and road tax for a period

of five years. Following this, about five states had announced the exemption and more are expected to follow.

Interestingly, although two and three wheelers account for almost 70% of the Indian automobile market, the Steering Committee deliberations so far hardly had any focus on these vehicles.

Generally, whenever it is possible, Indian policy makers look to the West for precedents before taking any important policy decisions. That is probably a major factor why EV does not figure prominently yet in Indian policy makers' deliberations.

Often, western technologies are not directly applicable to Indian conditions because of the differences in climate, infrastructural support, cultural habits, etc.

After Mr. Vittal's retirement from the Department of Electronics, MNES appears to be claiming back its role as the lead agency for EV initiatives. According to a senior MNES official, there have been mainly three players in EV arena so far. These are: BHEL, Chatelec of Bombay, and Eddy Current Control of Coimbatore. The latest entry is the Maini-Amerigon collaboration of Bangalore to manufacture REVA passenger car on a commercial scale by the end of this year. The REVA prototypes (4 nos.) were manufactured by Amerigon of California. These were imported to India free of customs duty at the recommendations of MNES, for officially launching the model in December 1996. The car is planned to be manufactured and marketed in India by the end of 1997.

MNES officials feel that the greatest barrier to commercialization of EV so far is the low energy density of batteries. Manufacturers of batteries want some sort of a guarantee about the market size before they make any investments in producing better batteries.

Often, western technologies are not directly applicable to Indian conditions because of the differences in climate, infrastructural support, cultural habits, etc. But, with sustained cooperation, many of these technologies could probably be adapted to the Indian conditions.

The Government of India and some state governments have some programs to support commercialization of EV but the difficulty is that these programs are often administered on an *ad hoc* or case-by-basis.

Current Government Programs to Support Commercialization of Electric Vehicle

- **100% Depreciation Allowance in the first year;**
- **Partial or Full Exemption from Customs and Excise Duties;**
- **Varying Amount of Subsidy Based on the Size and Capacity of the Electric Vehicle;**
- **Exemption from Road Tax for Five Years in Many States.**

4.3 Outlook on the Supply and Cost of Energy

The current shortfall in system capacity is said to be 25% of peak demand and more than 10% of total energy requirement.

A reliable power supply at reasonable cost is a must for EV market to develop. However, over the last decade or so, India has suffered from an acute power shortage. Since the current spate of liberalization of economic policies beginning in 1991, the demand for power has been growing steadily beyond any growth in the supply situation. The current shortfall in system capacity is said to be up to 25% of peak demand and more than 10% of total energy requirement.

Chart 4.1 shows that more than 98% of India's power come from coal

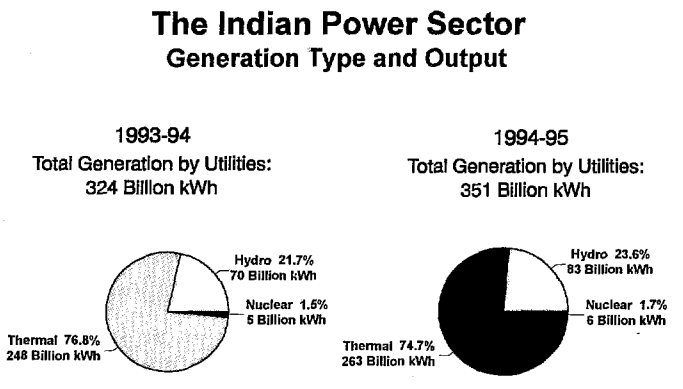


Chart 4.2

and hydro resources.

The power sector has generally been under the control of the government, mostly the state governments. Most of the state electricity boards (SEB) are in a dire financial situation now with huge financial losses and inadequate system capacities. Along with other liberalization measures in 1991, the Government opened up the power sector also to private sector investments including foreign investments. For a long time since then, mainly due to administrative delay and political interference, there had not been any perceptible difference in the power situation in spite of a significant level of interest from private sector and foreign investors to enter into power generation.

Things have started moving only recently with several high-profile power projects on stream, including the Enron mega project in

Power tariffs in India have generally been kept artificially low for most of the customers except industrial customers.

Maharashtra by a consortium of Enron Corporation, General Electric and Bechtel Corporation of the US in collaboration with Indian investors. So, it is hoped that in a few years from now, the power situation in the country may reach a stable phase.

There are a couple of aspects of the Indian power situation that may have a bearing on the growth of the EV market. Power tariffs in India have generally been kept artificially low for most of the customers except industrial customers. There was hardly any link between the cost of service and tariff. Moreover, there is generally no time-of-use tariff. With the World Bank, Asian Development Bank and other big financiers of the power sector in India insisting more and more on rational pricing, privatization of SEBs, etc., this situation may change

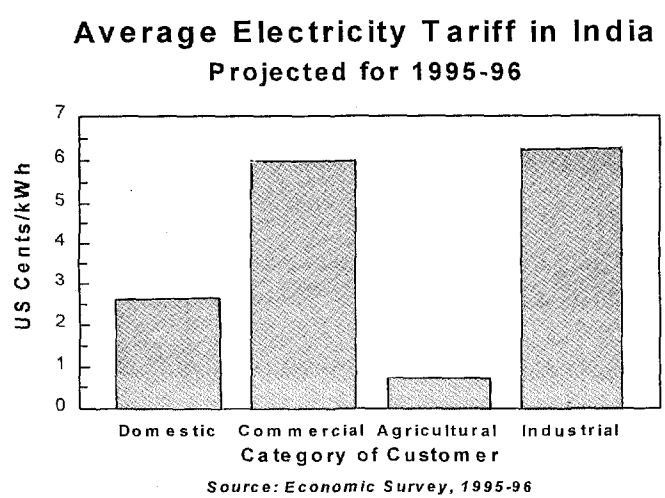
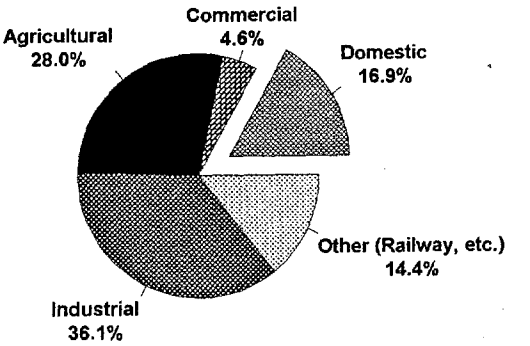


Chart 4.4

Sale of Electricity by Customer Category
Projected for 1995-96



Source: Economic Survey, 1995-96

Chart 4.5

in the foreseeable future.

The second aspect is that Indian power plants traditionally have a very low plant load factor. So, there is considerable room for increasing the supply by as much as 30-40% by improving the plant load factor and the inherent level of efficiency, and without adding to the system capacity.

Indian power plants traditionally have a very low plant load factor (PLF), partly due to demand characteristics but largely due to mismanagement and breakdowns. The national PLF currently is 60%.

By introducing time-of-use rates, future EV customers can be effectively encouraged to charge their EVs in the off-peak hours at a considerable discount in tariff.

At present, the cost of charging an EV is considerably less (almost one-tenth currently) than the cost of equivalent quantity of gasoline. So, even if the power tariff is rationalized and the rates go up, the operating cost would still be considerably cheaper for an EV.

By introducing time-of-use rates, future EV customers can be effectively encouraged to charge their EVs in the off-peak hours at a considerable discount in tariff.

4.4 Indo-US Initiatives on EV: the Track Record

Lack of awareness about each other's capability and interest was a barrier in the past to the development of successful business linkages between the two countries in EV area.

An examination of the track record on US-India initiatives in EV area shows that until a few years ago, lack of awareness about each other's capability and interest was a barrier to development of fruitful business linkages between the two countries in this area. In automobile industry in general, Indian businesses appear to look more toward Europe and Japan for technology collaboration. Partly toward bridging the information gap between the US and India, the USAID office in India had organized in February, 1995, a *Workshop on Electronic/Electric Vehicles - Technology & Policy Issues* in New Delhi. It was co-sponsored by the Department of Electronics, MNES, and the Council for Scientific and Industrial Research (CSIR).

The *Workshop* generated interest and participation at the highest level of the Indian and US Governments and the private sector. The seminars were attended by the Ministers of the sponsoring Indian Ministries and the US Secretary of Energy. About 160 participants representing over

fifty different organizations attended the *Workshop* in which fifteen different papers, including five from the US, covering EV technology and policy issues were presented and discussed.

After the *Workshop* was successfully completed, the USAID Mission in India was invited by the Government of India to be an observer member of the Inter-Agency Steering Committee on Electric Vehicle.

Subsequent to the *Workshop*, Indian interest in exploring US technology and investment in EV area seems to have gone up significantly. Talks have been taking place between several US and Indian companies, occasionally supplemented by visits. The USAID/USAEP played an important role in bringing some of these parties together. Although several efforts are under way, not much concrete progress has yet been made in US-India business collaborations in EV, except for a successful collaboration agreement between a California company and an Indian company in Bangalore and the subsequent formation of a joint venture by them to manufacture and market in India an electric car before the end of 1997.

This apparent lack of success seems to point more to the need for an appropriate and sustained business strategy that should be followed by US businesses and the supporting institutions, than to the lack of real opportunities in this field.

5. OPPORTUNITIES IN THE EV SECTOR IN INDIA FOR THE US INVESTORS

5.1 Potential Market Niches for the Future

As mentioned earlier in Sections 1 and 4 that from a rational perspective, India is almost ideally suited in all respects for Electric Vehicle, at least in some market niches -- right now. The point becomes evident if one looks at the data presented in Tables 5.1 and 5.2 below.

Table 5.1

Occupancy and Distance Travelled Daily in the Metros

Cities	Average Occupancy (Persons)			Effective Distance Travelled Daily (km)		
	Two Wheelers	Three Wheelers	Cars	Two Wheelers	Three Wheelers	Cars
Bombay	1.6	1.8	2.4	25	68	26
Calcutta	1.6	1.8	2.6	25	68	26
Delhi	1.7	1.8	2.4	25	68	26

Source of Data: Tata Energy Research Institute (TERI)

Table 5.1 provides travel data of the three largest cities of India that together account for almost 50% of total motor vehicles in the country. It shows that average distance travelled daily by two-wheelers and passenger cars is 25-26 kms, which is well within the range (per charge) of commercially electric vehicle technology. Moreover, 70% of total travel is for work and education,

Reason for Travel	
Work + Education	*70%*
Leisure	*22%*
Other	*8%*

reflecting routine travel. Tables 5.2 gives an idea of the nature and extent of emissions from these vehicles.

Table 5.2

INDIAN AUTO EMISSIONS			
	Emissions (Grams per km)		
Automobile	CO	HC	NO_x
Car	24.03	3.57	1.57
2 Wheeler	8.30	5.18	N/A
3 Wheeler	41.50	25.90	N/A

Source: Indian Institute of Petroleum, Dehradun

When one puts these figures against the projected vehicle population in India as presented in Table 5.3, one can easily guess the dreadful environmental consequence that not only India but the world as a whole will have to face. The share of two and three wheelers which are fitted with absolutely no emission control mechanism, will rise to 80% by 2006-7 in a *business as usual* scenario.

Table 5.3

Projected Vehicle Population in India (In Million)			
Year	Gasoline Driven		Diesel Driven
	2 & 3 Wheelers	4 Wheelers	
1993-94	15.9 (74%)	2.7 (13%)	2.9 (13%)
1995-96	19.5 (75%)	3.0 (12%)	3.3 (13%)
2000-01	32.2 (78%)	4.2 (10%)	4.7 (12%)
2006-07	53.3 (80%)	6.3 (9%)	7.2 (11%)

Note: Figures in parentheses are % of total in the year.

Source: "Outlook for New Refining Capacity in India: 1995-2005", S.N. Jha, 1995 (*mimeo.*), presented at the Indian Oil and Gas Conference, New Delhi, 1995

Gradual replacement of these highly polluting two and three wheelers

with EVs will have a significant impact on reducing urban air pollution and improving public health. Contrary to a popular belief, an electric two-wheeler may be less expensive than corresponding gasoline driven vehicles. In a study[1] presented at the Indo-US *Workshop on Electronic/ Electric Vehicle*, it was established that even if the initial cost of an EV is almost double that of its gasoline counterpart, the extra cost may be offset by EV's longer life and lower operating and maintenance costs. The CEERI study had shown that if only a 20% subsidy is given on the initial cost, the life cycle cost per km per passenger for an EV comes to about 35% of that of an equivalent gasoline driven vehicle. Based on these figures, no subsidy for EV would be required, if some innovative financing mechanism could be devised.

With only a 20% subsidy on the initial cost, the life cycle cost per km per passenger for an EV comes to about 35% of that of an equivalent gasoline driven vehicle.

In spite these obvious benefits, EV has not yet received appropriate attention from the highest level of decision makers in India both in the Government and the private sector. Somehow, we feel the western perspective has clouded the thinking of the Indian decision makers. Although the EV technology is generally considered unviable now from the US or European perspectives because of the nature of their mobility needs, there is no logical reason to consider EV unviable from an Indian perspective because mobility needs of most of the Indians are different and there appears to be a very good match between what the current EV technology can deliver and what most Indians need.

It is believed that there is a major policy in force like in California, Indian industry may not make any serious move regarding EV.

Electric Vehicles and its Drive Technology, by V.N. Walivadekar, CEERI, Pilani

However, even with existing policy support and programs as summarized earlier in Section 4.2, there are some niche markets for interested US businesses to target.

Although the EV technology is generally considered unviable now from the US or European perspectives because of the nature of their mobility needs, there is no logical reason to consider EV unviable from an Indian perspective because mobility needs of most of the Indians are different and there appears to be a very good match between what the current EV technology can deliver and what most Indians need.

India is already the world's largest market for two and three wheelers and will remain so in the foreseeable future. The market share of these vehicles is going to grow at least for the next decade or so reaching about 80% by 2006. So, the biggest potential for EV obviously lies in this segment of the auto industry. It must be recognized in this regard that the US and others have not yet had a significant breakthrough in technology for two wheelers. Even the global giants have not been able to develop a commercially viable fuel injection system for two wheelers..

India is already the world's largest market for two and three wheelers and will remain so in the foreseeable future. So, the biggest potential for EV obviously lies in this segment of the auto industry.

Two-stroke vehicles in developed countries consume only about 2% of all available petrol, whereas in India, the figure is as high as 60% of the total petrol consumption.

The reason for the slow progress in two-wheeler technology is most likely due to the fact that the market share of two stroke

vehicles in the developed countries is very low. So, the biggest potential for EV obviously lies in this segment of the auto industry. Two-stroke vehicles in developed countries consume only about 2% of all available petrol, whereas in India, the figure is as high as 60% of the total petrol consumption. (Estimates of Indian Oil Corporation Ltd.). In Europe and the US, the two-strokes motor cycles are used in sports and cross country riding, making high-powered engines a necessity. As a result, emission norms in these countries are lax.

At present, Taiwan has the strictest norms for two-wheelers at 3.5 gm of CO emission per km and 2 gm of HC per km. India's proposed norms for the year 2000 are more stringent than this as shown in Table 5.4.

Table 5.4

Progressive Revision of Emission Standards for Indian Vehicles: 1991- 2000

Types of Vehicles and Pollutants	April, 1991 Standard	April, 1996 Standard	April, 2000 Standard
Petrol Vehicles: 2 Wheelers			
CO (gm/km)	12-30	4.5	2.0
HC (gm/km)	8-12	-	-
HC + NO_x (gm/km)	-	3.6	1.5
Petrol Vehicles: 3 Wheelers			
CO (gm/km)	12-30	6.75	4.0
HC (gm/km)	8-12		-
HC + NO_x (gm/km)	-	5.4	1.5
Petrol Vehicles: Cars			
CO (gm/km)	14.3-27.1	8.68-12.40	2.72
HC (gm/km)	2.0-2.9	-	-
HC + NO_x (gm/km)	-	3.0-4.36	0.97

Source: BP Pundir, AK Jain and DK Gogia, 1994, *Vehicle Emission and Control Perspectives in India: A State of the Art Report*, Indian Institute of Petroleum.

Several of the successful market products like Maruti's Gypsy, Mahindra & Mahindra's jeeps, and Hindustan Motor's petrol-run Ambassador cannot meet the 1996 emission standards and they may

have to go off the market. The passenger car industry as a whole is also concerned about the indicative norms for 2000 and is already lobbying hard to dilute the norms. Most of the technical barriers to meeting these emission norms would wither away for electric vehicles.

5.2 Scope for Technology Cooperation in R&D

The scenario described above clearly indicates that the US R&D organizations and EV companies should at present focus on technology cooperation with appropriate Indian companies. In other words, they should try to match their R&D capability and experience with R&D needs of their Indian counterparts and engage in joint technology development, specifically in two and three wheeler EV. Such technology cooperation could be accompanied by an MOU to form joint ventures later on if technology development is successful. The focus should be on long term gain and not on any short term pay-off. Because of low-cost engineering and technical skill available in India, joint technology development will be less costly and consequently amenable to faster commercialization. Offer for joint technology development should also be more readily acceptable to Indian partners because it would be less risky for them than buying untested new technologies from someone else.

The US R&D organizations and EV companies should at present focus on technology cooperation with appropriate Indian companies.

Because of low-cost engineering and technical skill available in India, joint technology development will be less costly and consequently amenable to faster commercialization.

People often tend to look at an EV from the conventional perspective, i.e., they expect an EV to perform like an ICE vehicle, rather than trying to identify all possible situations where an EV could be considered a more natural option.

Some of the niches that may be suitable for four-wheeler EVs are:

- second family cars in metro cities that are normally used for short distance commuting
- Movement of material and men in large industrial estates
- Utility services such as postal delivery vans, municipal services, etc.
- Applications in airports and large tourist areas
- Short to medium range vehicles belonging to governments
- Pick-up vans for passengers, cargo, repair services, etc.

Many of these niches had been suggested by the former Chairman of the GOI Steering Committee on EV, Mr. N. Vittal, at the last Indo-US Workshop on EV in New Delhi.

Brief profiles of some of the potential Indian partners for US businesses are provided in Table 5.5 in the following two pages. Most of these are established companies with a good track record. Many of them had in the past seriously explored the possibility of diversifying into EV business and did a considerable amount of homework like market research, technology search, etc. but somehow they were discouraged. These firms are still open to new ideas. Others have expressed keen interest in exploring the EV technology.

Brief profiles of some of the potential Indian partners for US businesses are provided in Table 5.5.

A major Indian manufacturer of two-wheelers has done extensive market research for EV -- to find out the potential market size, who

PROFILES OF POTENTIAL COLLABORATOF

No.	Company	Products	Address	Chief Executive
1.	**Ashok Leyland Ltd.**	Commercial Vehicles, Diesel Engines	Grindlays Centre, 19, Rajaji Salai, Chennai 600 001	Mr. R.J. Shahaney, Vice Chairman and Managing Director
2.	**Bajaj Auto Ltd.**	Two, three-wheelers	Mumbai-Pune Road Akurdi, Pune 411 035	Mr. Rahul Bajaj, Chairman and Managing Director
3.	**Bajaj Tempo Ltd.**	LCVs, tractors & engines	Mumbai-Pune Road Akurdi, Pune 411 035	Mr. Abhay Firodia, Chairman & Managing Director
4.	**DCM Daewoo Motors Ltd.**	Commercial vehicles and cars	Kanchenjunga Building 18, Barakhamba Road New Delhi 110 001	Mr. S.G. Awasthi, Managing Director
5.	**Eicher Motors Ltd.**	Light commercial vehicles	Eicher House 12, Commercial Complex GK II, New Delhi 110 048	Mr. Subodh Bhargava Chairman
6.	**Escorts Automotives Ltd.**	Motorcycles, mopeds, tractors	Corporate Centre 15/5 Mathura Road Faridabad 121 003	Mr. Anil Nanda, Vice Chairman and Managing Director
7.	**Greaves Ltd.**	Three-wheelers	1, Dr. V.B. Gandhi Marg P.O. Box No. 91 Mumbai 400 023	Mr. Shekhar Datta, President and Managing Director
8.	**Hero Honda Motors Ltd.**	Motorcycles	34, Basant Lok Vasant Vihar New Delhi 110 057	Mr. Brijmohan Lall, Chairman and Managing Director
9.	**Hindustan Motors Ltd.**	Cars and commercial vehicles	9/1, R.N. Mukherjee Rd. Calcutta 700 001	Mr. S.L. Bhatter, Senior President
10.	**Kinetic Engineering Ltd.**	Two and 3-whelers, mopeds	D-1 Block, Plot No. 18/2 Chinchwad Pune 411 019	Mr. Arun Firodia, Vice Chairman and Managing Director

Table 5.5

TORS FROM THE INDIAN AUTOMOBILE INDUSTRY

ve	Telephone Country Code: 91	Fax No. Country Code: 91	1994-95 Turnover (Rs. Million)	1994-95 Exports (Rs. Million)	No. of Employees (3/31/95)	Foreign Collaborators, if any
ey, nd or	44-534-1110 44-534-2141	44-534-2493	15,402	1,310	13,616	IVECO FIAT, Italy; Perkins Technology, UK; Hydrocar SpA, Italy
or	212-77-2787 212-77-2851-58	212-77-3399 212-77-3398	22,871	1,302	19,400	Kawasaki, Japan; Kubota Corporation, Japan; AVL, Austria
a, or	212-77-4488 212-77-6381-89	212-77-3017	5,639	7	7,000	Deutsche Perrot. Germany; Zahn Passau, Germany; Bosch, Germany
or	11-332-5201 11-335-2334	11-371-5190	1,502	342	497	Daewoo Corporation, Korea; Toyota Motor Corp., Japan
	11-643-1965 11-644-5521	11-643-1929	2,090	134	780	Mitsubishi Motors, Japan; EMPL , Austria
nd or	129-27-6685 129-27-6659 129-27-5981	129-27-6713	14,227	221	NA	Motori Minarelli, Italy, Yamaha Motor Co., Japan
ta, or	22-267-1524 22-267-0336	22-202-7850	2,626		269	S A M E Spa, Italy
ail, or	11-687-2451	11-687-3321 11-688-5198	4,839	264	1,900	Honda Motor Co., Japan
t	33-248-2740	33-248-0055 33-242-0933	9,955	71	13,104	Caterpillar Inc., USA; Fermac International, UK; General Motors, USA
nd or	212-77-2715 212-77-5843	212-77-5841	1,487	85	2,500	

PROFILES OF POTENTIAL COLLABORATORS

No.	Company	Products	Address	Chief Executive	T
11.	**LML Ltd.**	Two, three-wheelers	B-17, Greater Kailash-I New Delhi 110 048	Mr. R.D. Jayal General Manager	11-
12.	**Mahindra & Mahindra Ltd.**	Commercial vehicles, tractors	Gateway Building Apollo Bunder Mumbai 400 039	Mr. R.K. Pitambar, Managing Director	22- 22-
13.	**Majestic Auto Ltd.**	Motorcycles, mopeds	601, International Trade Tower, Nehru Place New Delhi 110 019	Mr. Mahesh Munjal, Executive Director	11- 11- 11-
14.	**Maruti Udyog Ltd.**	Cars & light duty utility vehicles	Jeevan Prakash, 11 th Fl. 25, K.G. Marg New Delhi 110 001	Mr. R.C. Bharagava, Managing Director	11- 11-
15.	**Premier Auto. Ltd.**	Cars	L B S Marg, Kurla Mumbai 400 070	Mr. Maitreya V. Doshi, Managing Director	22-
16.	**Royal Enfield Motors**	Motorcycles	Unit of Eicher Ltd. P.O. Box 5284, High Road, Tiruvottiyur Chennai 600 019	Mr. P.K. Purang, Executive Director	44- 44-
17.	**Swaraj Mazda Ltd.**	Light commercial vehicles	SCO 156: 160 Sector 8-C, Madhya Marg Chandigarh 160 008	Mr. Chandra Mohan	17:
18.	**Tata Engg. & Locomotive Co. Ltd. (TELCO)**	HCVs, LCVs, Cars	Bombay House 24, Homi Mody House Hutatma Chowk Mumbai 400 001	Mr. V.M. Raval, Executive Director	22-
19.	**TVS-Suzuki Ltd.**	Motorcycles, scooters, mopeds	Jayalakshmi Estate 8, Haddows Road, Chennai 600 005	Mr. Venu Srinivasan, Managing Director	44-

ORS FROM THE INDIAN AUTOMOBILE INDUSTRY

	Telephone Country Code: 91	Fax No. Country Code: 91	1994-95 Turnover (Rs. Million)	1994-95 Exports (Rs. Million)	No. of Employees (3/31/95)	Foreign Collaborators, if any
	11-623-4405	11-623-4401	5,213	77	6,267	Piaggio & CSPA, Italy; Facind Sri
	22-202-1495 22-202-1031	22-287-5486	21,113	4329	17,629	Peugeot, France; AVL, Austria; Mitsubishi, Japan; Samoor, South Africa; Fuji Technica Inc., Japan
l,	11-621-6699 11-621-6666 11-621-6672	11-647-1230 11-647-5194	1,730	610	2,000	Daimler, Austria; BMW, Germany; Malaguti, Italy
a,	11-331-3344 11-331-6831	11-331-8754 11-371-3575	43,952	2,709	4,840	Suzuki Motor Corp., Japan
	22-511-5190	22-511-6061	4,751	13	4,123	Fiat Auto, Italy
	44-54-4442 44-54-3300	44-54-3253	724			
n	172-67-0640	172-67-0203	1,467	110	551	Mazda Motor Corp., Japan
	22-204-5500	22-283-6515	56,831	5,768	36,900	Nachi-Fujikoshi Cp, Japan; International Automotive Design, UK; AVL, Austria; Instt. For Development in Automotive Engg., Italy
	44-827-2233	44-825-7121	4,119	64	1,295	Suzuki Motor Corp., Japan

will buy them, with what features and at what prices, etc. They don't want to divulge too much of their market research data but they recognize that there may be a large market niche right now for EV in the 2-wheeler personal transport category.

A major manufacturer of two-wheelers has done a detailed market research for EV -- to find out the potential market size, who will buy them, with what features and at what prices, etc.

This company found out through a recent survey that a typical scooter in cities like Delhi is driven about 30-40 km a day, mainly for commuting to work and for shopping trips. This is within the conceivable range for electric scooters per charge. What is holding the development of this market is the cost of EV. Even if the operating cost for an EV is much lower and the life is longer, they found that customers were not willing to pay that much extra at the showroom.

On the other hand, they found that a three-wheeler (mainly auto rickshaws plus small commercial vehicles) is typically driven about 100 kms a day which may be beyond the range of a three-wheeler EV for a single charge. So, they believe electric three-wheeler is not a viable idea in big cities without a lot of infrastructural support like charging stations, battery replacement stations, etc. The average distance driven in smaller cities and towns (and some state capitals) is 60 kms or less. Three-wheeler EVs may become appropriate for this type of cities.

Electric three-wheeler is not a viable idea in big cities without a lot of infrastructural support.

5.3 Tips for a Business Strategy for India

Developing a commercially viable EV requires a successful merger of four main components: (a) battery including the charger, (b) DC Motor Drive and (c) electronic control systems and (d) the vehicle. It is our feeling that expertise in all four is not generally expected within the same company unless it is extremely large like a global giant. Access to the best technologies in all the four areas may only be feasible only through an appropriate consortium of companies. Indian companies recognize this. Some of them have good experience and expertise in vehicle manufacturing. They are keen on developing an appropriate consortium with companies that have expertise in the other broad areas required for successful development of an electric vehicle.

Indian companies believe the barriers to commercialization of EV can be removed in two ways: (a) in the short run, funding needs to be provided through appropriate and effective subsidy schemes, along with necessary policy support; (b) in the long run, when the market expands, EV will be commercially viable on its own provided there is Government for necessary infrastructural support.

Some of these firms have expressed interest in R&D collaboration with appropriate US firms on equitable terms with both partners bringing in equity. Risk and return should be commensurate with each other. However, they feel that if any funding support is available from any donor agency, it should be made available to the joint project itself and not just to the US partner. Otherwise, the US partner may not be serious, they believe.

A major two wheeler manufacturer, for example, is strongly in favour of a pilot project to test out the suitability of electric three-wheeler auto rickshaws in a city like Bombay, where there is a good public transportation system with many clear-cut hubs or mini downtowns for

different neighbourhoods. People use auto rickshaws for a short ride, up to five or six km, generally within a large neighbourhood. To travel from one part of the city to another, people generally prefer the trains for their faster speed.

An Indo-US pilot project involving 30-40 electric auto rickshaws and 30-40 three-wheeler commercial vehicles (delivery vans) would be a very good idea for Bombay, according to this company. Such a project may provide very useful lessons to manufacturers of EV as well as city planners and policy makers.

Essentially, the strategy for US firms and the supporting Institutions should be to focus on:

- ***Appropriate opportunities for technology cooperation for long term gain in market share.***
- ***Serving market niches in the short and medium term, when feasible through joint ventures with Indian companies.***
- ***Enhancing policy advocacy efforts in a sustained and effective manner [If conventional fuel such as petrol, diesel, etc. are priced at their full cost, that includes environmental damage abatement cost --through the imposition of a pollution tax -- EV would be economically viable today in many countries.].***
- ***Identifying and cultivating some champions for EV in key decision making positions in the country [It is widely believed that one single champion, Late Prime Minister Indira Gandhi, was the key reason for Maruti's success.].***