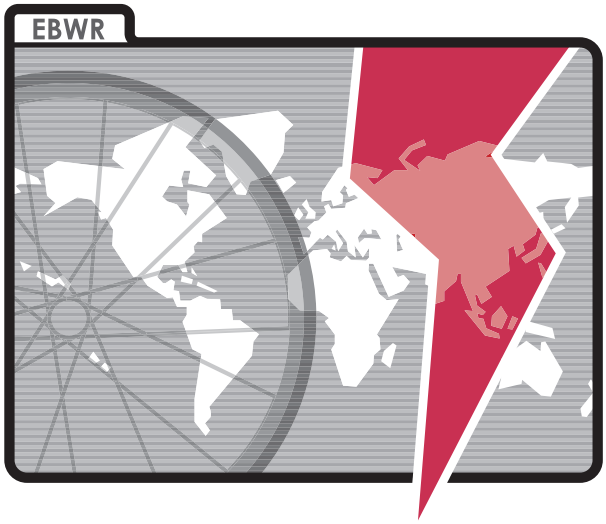


Electric Bikes Worldwide Reports

2007 Eighth Edition

20,000,000 Light Electric Vehicles in 2007

By Frank E. Jamerson, Ph.D. with Ed Benjamin • May 2007 • www.EBWR.com

Foreword

This 2007 edition is number eight of Electric Bikes Worldwide Reports. The seventh (2004) edition projected that China would produce 10,000,000 Electric Bikes in 2005, and actual sales were 12,000,000, illustrating the vigor of this market. This edition shows that China is likely to approach a top of 30 to 40,000,000 annual Electric Bike sales in a few more years with sales in 2007 projected at 17,000,000 units and total LEV sates at 20,000,000 units. Additionally, India is emerging as another China with Electric Bike sales expected in the millions in a few years. Europe and the USA appear to be ready for rapid growth of EB sales in the next few years. An important transportation market driver is the escalation of oil prices that is forcing governments to change their energy and transportation infrastructure to use less oil. Ethanol production is growing at double digit rates to displace gasoline and energy companies are moving to wind and nuclear power for electricity. The National Academy of Engineering study of the economics of hydrogen production supports hydrogen as a viable "green" transportation fuel. All of these energy/fuel trends will be positive on growing the acceptance and use of Electric Bikes. Thus EBWR projects a major increase in Light Electric Vehicle usage with worldwide annual sales at 50 to 100,000,000 units in a decade or so.

Electric Scooters appear to be ready for rapid sales growth in China and India to replace gasoline powered scooters and mopeds as well as in Europe and the USA. EBWR finds resurgence in Neighborhood Electric Vehicle offerings and new, special purpose, Pure EVs that suggests four wheel vehicles are moving inevitably into the electric power domain. Major auto manufacturers are producing flex-fuel vehicles that can use an ethanol/gasoline mixture and are working overtime to develop plug-in-hybrids that are cleaner with lower CO2 emissions. And the Electric Bike and Scooter will both be significant contributors to a "greener" world.

Published by
Electric Battery Bicycle Company
Naples, Florida / Petoskey, Michigan
elecbike@aol.com
www.ebwr.com

Contents

Section 1

Executive Summary

The EBWR 2007 headline --
The electric bike and electric scooter industry is heading toward a market size of 100,000,000 units yearly in five to ten years. We include electric scooters, now at less than 100,000 unit sales in these worldwide numbers, since the electric scooter will be the "green" vehicle of choice to replace the 70 million gasoline mopeds, motor scooters and motorcycles sold yearly. Unbelievable? No, EBWR really believes. Here is why. Consider China, with 1.3 billion people, already has close to 20 million electric bike units sales a year and India, with 1.1 billion people, is about to embark on a duplication of the China fast market EB growth. Consider the past five years. EBWR04 reported total worldwide EB sales of 1.9 million units for 2002 and in 2007 reports 18 million units, a nine times increase in sales. To arrive at 100 million units in five years (2012) from 2007 will only require a six times increase. And when electric scooter sales start to explode, this number could reach 150 to 200 million beyond ten years (2017). You learned if first here at EBWR07.

There are five independent factors that are coming together at the same time in the history of mankind that will influence this continued explosive growth of the EB market. These factors are discussed and expanded throughout this report and are:

1. Increasing market economy growth of the wealth of people all over the world, but particularly in China and India.
2. High gasoline prices with high oil prices dominated by mide ast turmoil.
3. Concern about global warming and the movement to alternative energy.
4. Higher quality products with better technology like lighter lithium batteries that provide longer range and better performance.
5. Rapid urbanization of the human race leading to high density cities with no room for parking of cars, and limited surface roads that will require two-wheelers for much of personal transport.

Factors 2/3/4/5 are impacting Europe and the USA now and the sense is that the electric bike and electric scooter will be gaining more users in those locales. The rest of the world awaits economic growth similar to the China miracle of the past ten years before EBs are affordable to the mass public in countries in Africa, South America and southeast Asia. This economic growth eventually will happen but it will take a long time. Remember that EBWR reported China EB sales at 20,000 units in 1996 and a short ten years later, 2006, sales were at 14 million units, a seven hundredfold increase! Where there is a will, there is a way, and China had the will.

Section 2 Worldwide Market Assessment, provides the big picture of the state of electric bike and mini electric scooter sales by country and region where EBWR has reliable sources of information on those numbers. Worldwide EB sales will be close to 18 million units in 2007 compared to around 70 million units of gasoline powered mopeds, motor scooter and motorcycles. We add India to the sales list for the first time since the India story in Section 6 shows major EB activities underway there. India will become a second China-like huge market for EBs it seems. The European market is projected to cross a million units in a few years and the USA market is on an upward swing. EB sales are flat in Japan and Taiwan. Mini electric scooter sales are flat in

the USA at 2 million and the rest of the world seems not very interested in this children's toy.

Section 3 Worldwide Vehicle Developments, portends a paradigm shift away from the pure Internal Combustion Engine because of the changes in worldwide oil consumption and availability and concern over carbon dioxide emissions and global warming. EBWR reviews the future of oil production and the coming energy future that will extensively use biofuels, ethanol and bio diesel in ICEs, and hydrogen in fuel cell powered vehicles. Four wheel vehicles are moving rapidly to different battery/electric motor-ICE hybrids: series, parallel, power-split and plug-in types. Pure EVs are being introduced by small companies in niche markets, sport cars and large trucks for quiet delivery in city centers, and are reviewed in Section 8. The plug-in hybrid will offer gasoline fuel economy over five hundred miles per gallon when using ethanol E85 (85% ethanol/15% gasoline) fuel. President George W. Bush set a USA ten year national goal of producing 35 billion gallons of ethanol to reduce gasoline usage 20% by 2017. The auto companies, led by General Motors, are improving fuel cell technology for vehicles and the hydrogen economy. An extensive study by the National Academy of Engineering concludes the production and distribution of hydrogen for transportation is feasible and will be economically viable. All this speaks of a paradigm shift in transportation energy utilization and propulsion systems.

Section 4 Worldwide Electric Bike Activities, are reviewed by Ed Benjamin from the experience of his extensive travels to Asia and Europe. China sales growth and large volumes dominates the world but Europe, USA and India are all expanding their presence in the EB market. By traveling in China and taking surveys, Jonathan Weinert, a graduate student, evaluated the reasons, improved technology, higher incomes and regulatory support, for the success of the electric bike there. A four day 2007 LEV Conference was organized in Taipei to promote discussion of standardization of the energy bus and battery safety in addition to technology and markets and legislation. Human Transporters, such as the pioneering Segway, are selling well into growth niche markets and serious new players, like Blue Ride, are entering the field. New, like Tres Terra, and growing, like Currie Technologies, USA companies are highlighted with other producers that are moving design and EB technology forward and growing the USA market slowly but surely.

Section 5 Marketing and Servicing Electric Bikes, has reviews of marketing LEVs in the USA and experiences of EB specialty stores. Chen Ding Wu, owner of an EV Sales Service Company in Shanghai, China, provides data on the cost of service and components for EBs in China. The typical EB owner in China spends up to one third of their total annual expense to own and operate an EB on service, emphasizing Chinese quality still needs improvement. Mike Fritz of Tres Terra provides an important and thoughtful article on the need for clear, simple Owner's Manuals in order to achieve full customer satisfaction.

Section 6 Worldwide Electric Bikes & Mini Scooters, are reviewed for the USA, Canada, China, Europe, India, Japan and Taiwan. Companies and products continue to change. USA pioneers EV Global Motors and WaveCrest are gone but Tres Terra appears. Pictures of EBs from major markets illustrate the design and technology improvements that are keys to market success. The preference in China is for the Scooter Style Electric Bike (SSEB) over the Bicycle Style Electric Bike (BSEB). The rest of the world uses the BSEB with styles reflecting the traditions of the locale where sold. The Shanghai Bike Show is reported with many EBs now dominant in the exhibitions. Europe is seeing resurgence in EB sales, particularly in Holland, that indicates the next few years could see market growth cross the million mark. Sachin Joneja discusses the growing number of both large and small companies that are starting electric bike and scooter production in India that suggests India could become as large a user of EBs as China in five to ten years. Japan is moving to incremental improvements in quality and performance to try to expand sales there. Taiwan continues as a quality producer of EBs and MESs, primarily for export, with relatively small sales in Taiwan. Many Taiwan companies now have production in mainland China.

Section 7 Electric Scooters and Motorcycles, shows that the long term effort by Vectrix may be rewarded as many test riders of their latest maxiscooter signed up to order them with production underway this year. EVT and eGO continue to show sales gains with their scooter offerings. The need to replace gasoline scooters in large Asian cities, to reduce pollution by government mandate, should start electric scooters on the road to replacing

millions of gasoline scooters and mopeds. In Europe, Oxygen has discovered that the delivery vehicle market is ready to accept a Lithium Ion powered ES which will grow the market there significantly. Several companies are offering electric motorcycles, three-wheeler Venture, Electricross and Axle. EBWR for the first time assesses the sales of electric scooters from limited data but ventures to now track this category of two-wheelers that appears to be making a move to big sales numbers in the next few years. Worldwide sales is estimated at 65,000 units for 2007.

Section 8 Electric Vehicles: Neighborhood and Pure, has a lot of new players offering Pure EVs with large lithium ion battery packs to provide over 200mile range and high speed but at a very, very high price. This may be the forerunner to the rebirth of General Motors EV1, but in the mantle of a plug-in-hybrid. The NEV leader continues to be GEM in the USA and many other NEVs, like the Kewet and Th!nk in Europe, seem to be resurging. High gasoline prices and global warming concerns may be the reason for rapid growth of both NEV and Pure EV four wheelers. In Norway, many government incentives are also helping the market.

Section 9 Battery/Fuel Cell/Motor Technology, continues to improve with better quality and new approaches. This is particularly true in the Lithium Ion battery where nanotechnology used by two new players, A123 Systems and Altair Nanotechnologies, provide batteries that can be charged faster and operate for over a thousand cycles. These are moving rapidly into four-wheel electric vehicles and plug-in-hybrids and will be ultimately used in EBs and ESs. NiMH, as well as Lithium Ion, is finding more application to EBs and ESs worldwide as prices improve and EB/ES buyers pay for longer range and performance. The PEM fuel cell continues to be used in EB and ES development efforts though none is in the market yet. A standard methanol cartridge by Direct Methanol Fuel Cell Corporation will enter the portable electronic device market soon. That approach may be also feasible for EBs and ESs powered by methanol fuel cells someday. Hub motors dominate the EB market and major companies like Heinzmann are improving controllers as well. Virtually all the EBs in China use hub motors.

Section 10 Electric Bike Regulations Worldwide, reviews the latest regulations promulgated in the USA, European Union, United Kingdom, Australia, Canada, China, India, Japan, and Taiwan. Each country has its own definition of EBs and rider/owner requirements. Motor power and maximum speed of all nations can be found in the following ranges: motor power from 200 to 750Watts and maximum EB speed from 20 to 33kph.

Section 11 Solar Bike & Car Races, lists the USA and Japan solar bike and car races and highlights the experiences of Principia College, a small liberal arts college that has been a strong competitor in the national and international solar car race circuit. Section 12 Worldwide Exhibitions / Information Sources, lists items relevant to the LEV industry that can be found on the internet and elsewhere. Section 13 Technical Definitions / Currency Exchange, also has a glossary of abbreviations. Sec-tion 14 lists Authors / Contribu-tors / Acknowledgements.

Definitions Revised

In past EBWRs, Light Electric Scooter (LES) was used to mean small platform scooters with stand-up or sit-down capability. We bend to the now more common usage of Mini Scooter, and for completeness will use Mini Electric Scooter or MES for this category. Heavy Electric Scooter (HES) is replaced by Electric Scooter (ES), again more common usage of the 'Vespa type' battery powered scooter.

Proposal for International Society of Light Electric Vehicle Engineers (ISLEVE)

This proposal in EBWR04 was received by the readership with a perfect record---zero inquiries and zero response. The proposal was a suggestion to move LEV technology forward by having a forum for LEV engineers to establish industry standards and practices. This would be useful to all companies participating as LEV developers and manufacturers. The Society of Automotive Engineers, now over one hundred years old, has international meetings in the USA that bring thousands of engineers to meetings to discuss latest automotive developments and standards. The Light Electric Vehicle (LEV) Conference in Hsinchu, Taiwan in March 2007 may be the beginning of an ISLEVE since two days were devoted to topics that could use standardization, EnergyBus and Battery Safety. The LEV Conference was organized and conducted by Hannes Neupert, President ExtraEnergy Germany, and Industrial Technology Research Institute (ITRI) Taiwan. An ISLEVE is still worthy of consideration in the

opinion of EBWR. China and India have their counterpart of the USA SAE, as do many other countries worldwide and SAE meetings are truly international. This could happen in the LEV worldwide industry as well.

Long Range Prediction

In the 2004 edition, readers were reminded that EBWR02 provided very long range sales predictions for electric bikes. These sales predictions were **200 million EB units in 2100 and 10 billion units in the year 3000.** Go to Section 2 here and learn that **100 million EBs may be reached in five to ten years** so we may be ahead of schedule. The long range prediction is thus resized to **300 million (an increase) Electric Two-Wheeler units by 2100** and **10 billion ETWs in the year 3000** (yes, one for every man, woman and child on the face of the earth). Electric Two-Wheelers in the long term future will not look like today's EBs, so the ETW is considered the EB vehicle of the future. Surely ETWs will be easier to use, pathways will be built for them, and the public will use them exclusively for short trips and use more efficient public transport for long trips. Or is all of this fiction? We will never know. But our children's children's children will know since they will be living in 2100. Leave a note for them that EBWR made this prediction.

Historical Picture

Shanghai Bike Show 1996 Frank Jamerson

Interbike 1993 Marketing Diamant citiblitz Joy, Jim, Frank Jamerson

Section 2

Worldwide Market Assessment

Worldwide Vehicle Market

This section describes the context in which electric bikes are emerging and competing with established forms of transport. Worldwide conventional bicycle ownership is estimated to be close to 2.1 billion units with China owning the largest number for a single country at around 900 million units. United States ownership is around 200 million with Europe around 275 million units. In 2006, global production of bicycles hit 105 million, or one-and-a-half times the 67 million cars produced and sold that year. During the 1950s and 1960s, worldwide bicycle and automobile production were nearly equal. In the decades following, however, bike output soared, reaching 91 million in 1990, when car production totaled 36 million. Since then, with the exception of 1997 and 1998 (when output dropped to 90 million and then 87 million), about 100 million bikes have been produced each year. China production accounts for about half that number.

Gasoline powered two wheelers include motorcycles, mopeds, and motor scooters – with a market size larger than 70 million units per year, roughly estimated for 2006. Asia Pacific is the largest user of all at around 58 million. The seventy million units include: motor scooters 50cc-29 million, mopeds-13 million, motorcycles below 250cc-27 million, and motorcycles above 250cc-1 million. For future studies of Electric Scooter sales, EBWR will assume that ESs will be a replacement for the gasoline motor scooter and moped that sold 42 million combined units in 2006. Motorcycles are more powerful and faster machines than the ES but could be replaced by battery/fuel cell hybrid motorcycles someday. For much of the world, the motorcycle, motor scooter or moped is the "step up from a bicycle" vehicle for people who cannot afford, or have no place to park and drive a car. Electric Bicycles are often a replacement for this role – powered two-wheelers that do not pollute, and are less expensive to buy and own than gasoline powered motorcycle, motor scooter or moped.

The dominant electric bike producer and user is China as yearly sales continue to climb and soon will be over 20 million units. News reports state that in some cities as many as 75% of cyclists are using electric bikes for transportation to work and shops. This phenomenal usage is taking place while the auto sales boom continues. China vehicle sales were 7 million units in 2006, a 25% rise over 2005 sales of 5.6 million. So electric bike sales continue to be ahead of auto sales in China but the reverse is true in the USA where EB sales are roughly equivalent to only two days of auto sales. Road congestion and lack of parking space continues to motivate the Chinese consumer to use the convenience of the electric bike for short trips. Reports of many India bike makers developing and introducing EBs this year suggest that market for EBs in India is about to explode similar to China. Europe and the USA are on the verge of beginning a market surge as well with Europe expected to be ahead of the USA. With the continued high price of oil and gasoline, and increasing parking and traffic congestion, Americans and Europeans are now more likely to give consideration to the use of the electric bike for short trips to market and work. Japan, where the modern EB started in 1993, has an EB market that apparently has leveled off. Nearly eigh-

teen million EBs will be sold worldwide in 2007 and the market is far from being saturated. EBs will continue to be a growth product and market.

Electric Scooters appear to be on the verge of major expansion in production and sales in China and India as well as in Europe and the USA but at a lower sales number level. This is discussed in Section 7 and includes some first estimates of ES worldwide sales projected to be in the 100,000 unit range in 2008. The combination of new Electric Scooter designs using improved Lithium Ion batteries and a marketing focus, as in Europe on the delivery vehicle market, will stimulate this expansion. EBWR will track ES sales growth for sure.

WORLDWIDE ELECTRIC BIKE AND MINI ELECTRIC SCOOTER SALES

EBWR uses worldwide sources to track production and sales of Electric Bikes and Mini Electric Scooters. These numbers are considered best estimates. The largest markets are in the following countries,

China, with sales now approaching 20 million a year, is seeing a contented public of around 30 million (through 2006) riders enjoy the benefits of a powered ride to work, or school, or to shops. These are E-Bikes and many riders use electric power only on the flat terrain of the major cities such as Shanghai. EBWR04 projected 2004 EB sales of 7.5 million units while 6.8 million units were reported in the Evolution E-Bikes 2006 magazine issued by Cycle Press, Japan. For other years, EBWR04 / Cycle Press numbers were 2003 - 4 million / 3.9 million, 2002 - 1.6 million / 1.6 million. This may be viewed as some validation of the numbers that are listed in EBWR.

Scooter-Style EBs (SSEBs) platform allows the rider to rest the feet while operating under motor power. Female riders rarely pedal their EBs in China so they favor the SSEB that still has pedals for human power effort. Some cities were beginning to prohibit the use of EBs, or restrict sales permits until recycling becomes more available, because of pollution concerns from the toxic materials in lead acid batteries. Beijing recently cancelled that restriction as it is preparing for the summer Olympic Games in 2008. Beijing will be promoting green transportation, now to include EBs. Companies in China are promoting "green" environments and this was the story in a Business Week article on China 3/27/06: "St. Louis-based Emerson has built a "green" office with solar power, ambitious recycling plans, and chargers for the electric bicycles used by many staffers." This is an important milestone with company management recognizing the importance of electric bikes to workers as a real transportation vehicle.

China newspapers report Electric Scooter sales in the multi millions but EBWR considers the numbers resulting from reporter error in judging an SSEB to be an ES. Nevertheless the ES seems to be ready to replace gasoline powered scooters in China and India as well and this is discussed in Section 7.

India, appears to be awakening to the potential of electric bikes and what EBs can do for the 1.1 billion people in India who need to travel in very congested cities to work and shops. In 2005 the India market was still closed to imports of complete bicycles and most components. However, low price Chinese complete knocked down (CKD) units are entering India so the law may not be effective or relaxed. Several of the major bicycle manufacturers have established EB projects and smaller players are starting up. The India market could see a rapid rise in sales into a million units in a few years similar to how it happened in China. The Mini Electric Scooter market is very small in India since not many children have money for Mini Scooter toys as in the USA.

Japan has seen sales plateau at around 200,000 units in recent years and is projected to remain flat with a possible small increase as technology and designs improve. Sales drop there during recessions. Japanese manufacturers are making their traditionally styled Pedelecs, the government approved EB option, lighter and many now use Lithium batteries. A baby carrier on the handlebar, one model is called the Mammy Pocket, is a popular style for young mothers. Yamaha offers the Electric Commuter EC-02 that is in the scooter class and targeted for the commuter market. Mini Electric Scooter usage in Japan is small by comparison. But Honda and Yamaha are introducing Electric Scooters that are more acceptable to the commuter market to replace gasoline scooters

and this market is expected to grow significantly now.

Europe, which also has regulated usage to the Pedelec and not E-Bikes, now has sales approaching 200,000 units and is expected to grow rapidly over the next few years. This results from newer, high quality models with Lithium batteries that provide more range. The Netherlands still has many pedal bicyclists and has seen a 60% growth in EB sales in 2006 over 2005, a portend of what will happen in the next few years all over Europe. As the European Union has expanded to 27 countries, the easternmost nations will undoubtedly discover the EB and begin to use them more, similar to the western part of Europe that has adapted to the EB. Mini Electric Scooter usage is modest in Europe.

United States, once thought to be the best market in the world for any new product, is way behind China in EB usage though it is number one in the world in Mini Electric Scooter usage. EB companies in the U.S. are primarily distributors with product made in Taiwan, China or Thailand. Large retailers have imported directly from producers in China for both the EB and Mini Electric Scooter. These have been poor quality products that resulted in a MES sales downturn, from 2 million to 1.8 million for the years 2004-2005. The number of U.S. EB companies has been reduced in the past few years but new ones, like Tres Terra, with a strong desire to avoid the pitfalls of the past are hoping to grow the market dramatically in the near future. High gasoline prices and the global warming hysteria in the press will be stimulating people out of cars and into alternative transportation like EBs for short trips.

Taiwan, Southeast Asia and other countries are beginning to emerge as real users of EBs in a small market sense. EBWR customers in Australia, and South Africa indicate EBs receiving more attention in those emerging markets. We have yet to hear from South America and Mexico. EBWR awaits news of EB developments there.

Sales Tables

Tables 2.1 and 2.3 list the estimated Worldwide Electric Bike and Mini Electric Scooter Sales respectively for the past two years with projections for 2007, 2008, and 2009. Tables 2.2 and 2.4 list the cumulative sales from when EBWR started compiling this data, 1993 for EBs and 2000 for MESs. With China booming in EB sales and the USA likewise with MES sales, the cumulative sales numbers through 2007 are 61,473,000 EB units and 12,128,000 MES units, truly remarkable growth in sales and usage that surely will continue and that EBWR will follow.

Table 2.1
Worldwide Electric Bike Sales (Estimates)

	2005	2006	2007	2008	2009
China	12,000,000	14,000,000	17,000,000	21,000,000	24,000,000
India	20,000	50,000	100,000	200,000	500,000
Japan	197,000	200,000	200,000	200,000	200,000
Europe	180,000	190,000	220,000	400,0000	750,000
Taiwan	9,000	10,000	10,000	10,000	10,000
SE Asia	25,000	30,000	35,000	40,000	45,000
United States#	100,000	120,000	150,000	180,000	200,000
Total	12,531,000	14,600,000	17,695,000	22,030,000	25,710,000

#Based on estimates of product shipped to the U.S. from Asian sources.
EB sales from past, and current, editions of EBWR are tabulated in Table 2.2.

Forever 240W/36V/10AhLA 25kph/40km Shanghai

Storm

ClassicSSEB

Table 2.2
Estimated EB Annual Sales 1993-2007

1995	*212,000
1996	133,000
1997	283,000
1998	360,000
1999	420,000
2000	440,000
2001	650,000
2002	1,890,000
2003	4,325,000
2004	7,934,000
2005	12,531,000
2006	14,600,000
2007	17,695,000

*includes 93-95

Cumulative EB Sales through year 2007 - 61,473,000 units

Table 2.3
Worldwide Electric Mini Scooter Sales (Estimates)

	2005	2006	2007	2008	2009
China	60,000	70,000	80,000	90,000	100,000
India	5,000	7,000	10,000	10,000	10,000
Japan	25,000	25,000	25,000	25,000	25,000
Europe	100,000	100,000	100,000	100,000	100,000
Taiwan	9,000	9,000	9,000	9,000	9,000
SE Asia	30,000	30,000	35,000	35,000	40,000
United States#	1,800,000	2,000,000	2,000,000	2,000,000	2,000,000
Total	2,029,000	2,241,000	2,259,000	2,269,000	2,284,000

#Based on estimates of product shipped to the U.S. from Asian sources. Mini Scooter sales from past, and current, editions of EBWR are tabulated in Table 2.4.

Currie Schwinn ST1000

Table 2.4
Estimated Electric Mini Scooter Annual Sales 2000-2007

Prior to 2000	200,000
2000	455,000
2001	530,000
2002	433,000
2003	1,621,000
2004	2,160,000
2005	2,029,000
2006	2,241,000
2007	2,459,000

Cumulative Mini Scooter Sales through year 2007 - 12,128,000 units

Section 3

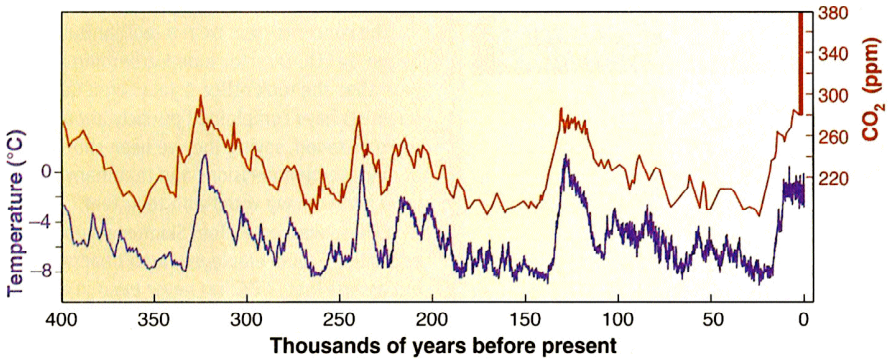
Worldwide Vehicle Developments

Overview

There are around 800 million vehicles worldwide in 2006 and that number is projected to become 1.1 billion by 2022. With documented increase in the earth's mean global surface temperature of one degree Fahrenheit since 1970 to 2005, the culprit is thought to be global increase of carbon dioxide from 285 parts per million in 1900 to 375 ppm in 2004. Each car and truck produces 12,000 pounds of CO_2 a year (a tree takes up only 50 pounds of CO_2 a year). That adds up to 10-12% of all man-made CO_2 emissions worldwide coming from vehicles with USA vehicles accounting for 45% of the vehicle total. The USA emits about 21% of all greenhouse gases in the world and the federal government is promoting an energy policy that includes moving vehicles to a greater use of biofuels and ultimately eliminating the use of oil in transportation by using hydrogen in fuel cell powered vehicles. Events are stimulating change in the automotive field big time. With oil prices having reached nearly $80 a barrel in mid-2006 and gasoline over $3 a gallon in much of the USA that summer, the driving public is about to change its behavior, or else will have to cut back on other expenditures to buy $5 a gallon gasoline in the future. Pure electric cars are coming back as reviewed in Section 8 that portends a change in behavior. In early 2007, oil dropped to $50 a barrel briefly and gasoline in the USA dropped to $2.30 a gallon, but is not expected to stay this low for very long, in April, 2007 price is up to $2.60 with California up to $3.00 and oil at $65. There will be a move into E85 ethanol fueled cars and hybrids, including Plug-in-Hybrids now on the near horizon. To put this in perspective, EBWR reviews the future of oil production from a variety of important sources and is bold enough again to discuss the Energy Future. The China and India automobile markets are expanding rapidly which creates more demand for global oil. Hybrid vehicle developments are reviewed and all major auto makers are selling hybrids. General Motors, DaimlerChrysler and BMW have a joint development project and will have Two-Mode-Hybrids cars available in 2008 as they compete with Toyota that has dominated with the Prius hybrid. The first Plug-in-Hybrids will come from GM in the Saturn Vue and Chevy Volt. The National Academy of Engineering produced a large and significant report on the technologies to implement the hydrogen economy and evaluated the cost of hydrogen produced by techniques under study. General Motors and Honda fuel cell prototype cars are being driven by families to evaluate the readiness of their FC technology. A small utility vehicle powered by a fuel cell appears to be the first commercial FC vehicle application, in Denmark. Thus the hydrogen economy appears to be on the way, while biofuel and hybrid electric vehicles sales will expand dramatically in the next five years. Thus the greening of the automobile is really on the way and it only took $78 a barrel oil to make it happen. The auto industry will really move quicker to be greener when oil hits $100 a barrel in the next five years. Then electric bikes and scooters will really take off simultaneously. You heard it first at EBWR.

Future of Oil Production

The world continues to see an uncertain future with respect to the amount of oil left in the ground that man can retrieve to make life more comfortable with gasoline powered cars and natural gas heated homes. There are various views championed by those who analyze production data, trends and technology. All agree that the world will eventually see a peak in oil production and the big question is when. The original proponent of a peak in oil production was Dr. M. King Hubbert, geophysicist, who in 1956 predicted a bell shaped curve of production versus time that peaked in 1965-1971 for US production. And Hubbert was correct, since US oil production peaked in 1971. Hubbert predicted that total oil extracted from the ground would be 2 trillion barrels and that the world peak would occur in 1995. This prediction was not validated since world production has increased since 1995. New studies now predict a world oil production peak beginning in 2006 to 2030.



Global Temperature/CO_2 History

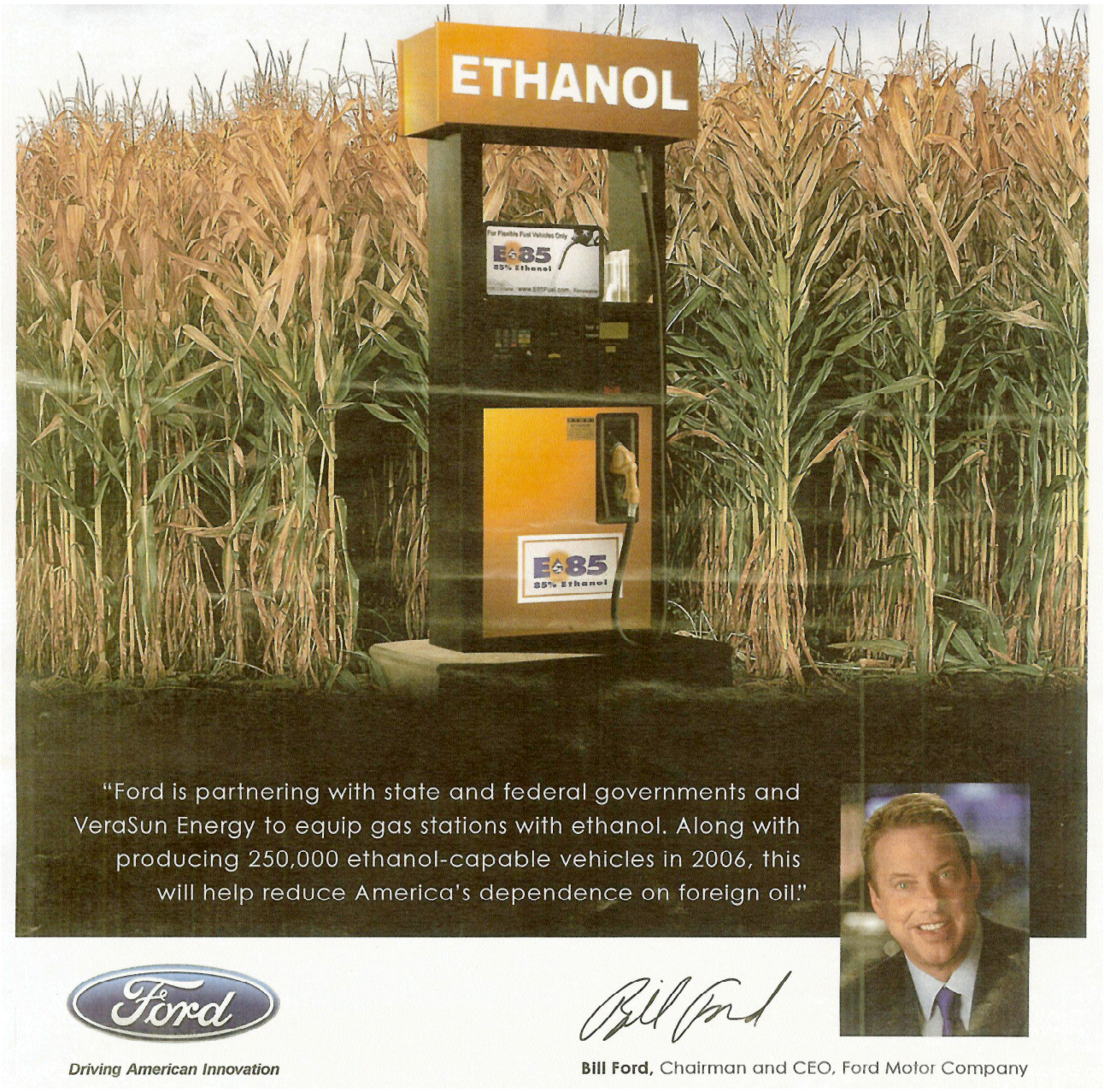
Matthew Simmons, chairman of Simmons & Co. International, a Houston-based investment banking firm specializing in the energy sector, claims that U.S. government data shows that the world oil supply has declined through the first half of 2006 so the peak occurred in 2006. Mike Rodgers, a partner at PFC Energy, predicts peaking between 2010 and 2015. The Association for the Study of Peak Oil and Gas (ASPO) predicts that world oil production will peak in 2010 at 85MBD. Thus all these sources seem to agree that world production is very near a peak around 2010 and the future will see a declining oil production, but the question is how fast will the decline occur. There is one contrary view.

The Cambridge Energy Research Associates published a study in November 2006 with a conclusion that there is no evidence of a peak before 2030. They predict global production will eventually follow an undulating plateau for one or more decades after 2030 before declining slowly. Global resources, including both conventional and non-traditional oils are adequate to support strong production growth and a production period on an undulating plateau. CERA's liquid fuels supply outlook is "not a view of endless abundance." CERA's field-by-field analysis finds that not only will world oil production not peak before 2030, but that the idea of a peak is itself "a dramatic but highly questionable image." Global production will eventually follow an "undulating plateau" for one or more decades before declining slowly. The global production profile will not be a simple logistic or bell curve postulated by geophysicist M. King Hubbert, but it will be asymmetrical – with the slope of decline more gradual and not mirroring the rapid rate of increase -- and strongly skewed past the geometric peak. It will be an undulating plateau that may well last for decades.

During the plateau period in later decades, according to the CERA analysis, demand growth will likely no longer be largely met by growth in available, commercially exploitable natural oil supplies. The gap will need to be filled by non-traditional or unconventional liquid fuels such as production from heavy oil sands, gas-related liquids (condensate and natural gas liquids), gas-to-liquids (GTL), and coal-to-liquids (CTL). All these technologies are heavy CO_2 producers with CTL at twice normal coal to electricity CO_2 production, so sequestering will be in order for these technologies, that will increase cost and risks. Fifty years ago oil wells were drilled to only 600 feet and today offshore wells are drilled to 12,000 feet. Advances in technology have assured increasing oil supply but there ultimately are limits to technology as well and the oil industry may be near that technology limit.

Energy Future

EBWR04 outlined "A Scenario for Success" regarding energy in the USA. This included a need to move to 100% nuclear power for green electricity without any CO_2 emissions and to move to ethanol from USA grown corn to reduce dependence on oil. That scenario is now being offered by President George W. Bush, who announced in early 2006 that the USA has to eliminate "addiction to oil" by moving to renewable fuels and greater use of nuclear power. This action by the federal government comes from the rise in oil prices to $78 a barrel in the spring of 2006 and the threat of oil rich hostile countries like Iran holding the USA hostage to an escalating price of oil. This has made gasoline prices at the pump rise, in the summer of 2006, to new highs, $3 to $4 a gallon in the USA, Berlin at $6.75, UK at $5.50, Taiwan at $3.30, China at $2.15 whereas Saudi Arabia lowered its price there to only 60 cents a gallon from 80 cents to "help Saudi economy". The Saudi position is laughable. They build palaces and silver plate cars instead of creating jobs outside of oil to diversify the Saudi economy.



The new government energy plan was outlined in a talk by Secretary of Energy Samuel Bodman given at MIT in Cambridge, MA in May 2006. The DOE will fund accelerated research into processing cellulosic biomass into ethanol for the domestic market. Corn based ethanol is already at 5.6 billion gallons in 2006 (ahead of a mandated figure of 4 billion) and planned to grow to a mandated 7.5 billion gallons by 2012. Total gasoline usage is 140 billion gallons a year and with increases in corn and cellulosic ethanol production, the goal is to produce 40 billion gallons of ethanol a year by 2025, around 110million gallons per day (equivalent to around 80 million gallons of gasoline).

In his state of the Union Message on 23 January 2007, President George W. Bush proposed a 20/10 plan, to reduce gasoline use by 20% in 10 years, by 2017. This accelerates the Bodman plan. To achieve that goal, the President announced that the ethanol production targets have to be substantially increased, to 35 billion gallons by 2017 that is around 6 times the 5.6 billion gallon 2006 ethanol capacity. President Bush says this is doable with the addition of cellulosic ethanol to corn ethanol. Intense R&D is underway to make ethanol from switchgrass and other agricultural and wood waste to make it a cost effective production process. Don Endres CEO of VeraSun Energy says that 15 billion gallons of ethanol can be produced from corn acreage now in place and that another 15-20 billion gallons can come from higher corn yields and planting acreage that is now in crop banks that are not planted and subsidized to not plant. Thus corn alone could produce the President's goal so if cellulosic ethanol is successful, the USA will be able to eliminate more than 20% of the petroleum gasoline by 2017.

The US government projects world oil consumption of 98MBD (Million Barrels per Day) in 2015 and 118MBD in 2030. In 2005 world consumption was 84MBD and the US consumed 22MBD with 9MBD from domestic sources and 13MBD (60%) from imports. There are 510,000 oil wells in the US while Saudi Arabia, that produces 9MBD, has only 1,500. These numbers highlight the fact that the USA is running out of new domestic oil fields. One barrel of oil, 42 gallons, will produce 21 gallons of gasoline and one acre of corn will produce 400 gallons of ethanol. Since ethanol contains 30% less energy per unit volume relative to gasoline, 400 gallons of ethanol is equivalent to 280 gallons of gasoline or 13 barrels of oil. Thus a corn field can be thought of as a source of 13 barrels of oil per acre. A million barrels of oil equivalent ethanol will require 77,000 acres of corn. And the corn field never runs dry!

What are the economic consequences of big ethanol production and usage? Since ethanol has about 70% the energy content of gasoline, 35 billion gallons of ethanol is equivalent to 25 billion gallons of gasoline. Around 140 billion gallons of gasoline is used yearly so 25 billion is close to 20% of 140 billion as President Bush proposed. The 25 billion gallons of gasoline represents 1.2 billion barrels of oil (21 gallons of gasoline per barrel of oil), so that at $100 (EBWR projection) a barrel in 2017, this represents $120 billion that stays in the US economy and away from mideast countries that fund madras schools that train Islamo terrorists. This is surely a win-win for America. Wall Street pundits, who are negative on ethanol, might want to study this EBWR analysis.

Part of the negative argument for ethanol is based on the 51 cent per gallon federal subsidy that goes to blenders (big oil companies mostly) who mix ethanol with gasoline to stimulate use in gasoline. Brazil, that has around 80 percent of vehicles using ethanol, used extensive government subsidies back in the 1970s during the mideast oil embargo to stimulate the start of an ethanol automotive fleet and has been very successful. So Brazil today is not dependent on foreign oil and Brazilian government subsidized the sugar industry, which has the advantage of lower production cost to corn, to provide the ethanol fuel. The big benefit not appreciated, or mentioned, is that gasoline fuel economy changes dramatically with E85 (85% ethanol, 15% gasoline). A vehicle that achieves 20mpg with E85 has equivalent miles per gallon gasoline of 133mpgg (20 divided by 0.15) better than any hybrid.

GM, Ford and Chrysler already have 6 million Flex-Fuel (E85 capable) vehicles on the road today that can run on E85 and any combination of ethanol/gasoline, from 15% up to 100% gasoline. They announced to President Bush in meetings in late 2006, and also early 2007, that they will make 50% of production vehicles E85 capable by 2012. A Flex-Fuel car simply has some special hose materials and a few special engine parts with an ethanol sensor that allows the vehicle to run on any combination of gasoline and ethanol up to 85% for a cost of much less than $100. The Flex-Fuel E85 vehicle

is the same price as an identical 100% gasoline vehicle, a better deal than a hybrid. EBWR has personally suggested to Rick Wagoner, CEO of General Motors, to build all 9.2 million GM vehicles worldwide with E85 capability to make a significant green statement. GM launched a **LiveGreenGoYellow.com** campaign in 2006 to promote E85 and both GM and Ford have done deals with VeraSun Energy that provides VE85, branded E85, to gas stations in the midwest. E85 stations have grown from 500 to 1,100 in just two years but more needs to be done with the other 169,000 gasoline stations out there.

There are 113 corn ethanol plants with 5.6 billion gallon per year capacity running with 84 under construction adding 6.1 million gallons in the next few years. By early 2007, demand for ethanol reached 400,000 barrels a day or about 4% of the total gasoline market. This ethanol is blended at the 10% level in most states that replaces the banned additive MTBE with ethanol. This demand for E10 gasoline still grows and proponents for E20 (20% ethanol) in Minnesota and other states will push demand for more ethanol. Ethanol companies can grow quickly, an example is VeraSun Energy of Brookings, SD (www.verasun.com) that has three plants running in only three years, has two more under construction, and will produce 560 million gallons of corn ethanol by 2008. VeraSun announced a new process to extract biodiesel fuel from distillers grain byproduct from the ethanol process. This will produce a higher fuel yield from the same corn base. Farmers are planting more corn to meet ethanol demand so are rising to the ethanol production challenge recommended by President Bush.

Secretary Bodman also emphasized that time is critical to start putting more nuclear electricity plants on line to meet growing demand in order to keep the USA economy moving forward. In fact there is a worldwide need for nuclear power, as in China and India, who are striving to become more "green" to reduce CO_2 emission. The USA is participating in the GNEP, Global Nuclear Energy Partnership, whose goal is to develop safe nuclear reactors and a system of recycling spent nuclear fuel so that the amount of radioactive waste and radiation levels are reduced by a factor of 1,000 from present technology. The idea is to have recycled fuel burned in new reactors where the possibility of extraction of material for nuclear weapons is eliminated. Nations would be identified as fuel suppliers and processors of spent fuel with careful accounting of handling and use between participating nations.

Nuclear power was denigrated by the "green movement" after the 1986 Chernobyl reactor accident in Ukraine and now is looked on favorably since nuclear fission does not produce CO_2. There are 435 nuclear reactors in operation worldwide with most built in the 1960s and 1970s. The USA has 103 reactors producing 20% of the nation's electricity while France has 58 reactors producing 70%. There are 30 reactors under construction now in 14 countries with India 7, China 5, Russia 5 the leading builders but none have been built in the USA for 30 years. Sweden and Germany are dismantling reactors from past referendums that turned against nuclear power. China wants to build 30 more by 2020 and their need is critical since China has many dirty coal burning plants. USA companies cancelled 104 nuclear plants 30 years ago as government regulations, green opposition and cheap natural gas made nuclear uneconomic. Higher energy prices, hysteria about global warming and CO_2 have changed the economics of nuclear power. USA CO_2 footprint would be a lot smaller if those 104 nuclear plants were built as Senator Domenici(R) of New Mexico opined at a hearing on energy in 2006. He mused that the Congress might have made the wrong decision 30 years ago, a refreshing revelation, but hindsight is always right. We will see more interest by utilities in the USA and some are organizing to pursue new nuclear plants, around 30 could be built, today. Westinghouse was the dominant manufacturer of the Pressurized Water Reactor, pioneered in the first nuclear submarine Nautilus, (those were the days that EBWR publisher was involved) and built the majority of the nuclear plants in the USA. Westinghouse, with only repair and maintenance business, was ultimately bought by Toshiba, a Japanese company, and is bidding on new plants worldwide. But nuclear power will not be denied now. Watch the news.

There are other parts of the energy plan that Secretary Bodman mentioned, research on clean coal, hybrid and hydrogen fuel cell vehicles and fusion power. The unknown in all these great intentions is whether the "will of Congress" can focus on the good of the nation by legislating energy independence programs or to maintain a "business as usual self interest ("pork") attitude".

Thus, though this may be a stretch, the EBWR04 "Scenario for Success" has become USA national policy. We owe this positive energy policy movement to the oil producing countries, many of them our enemies, who control the price of oil and will keep it high. In the long run, it will be a good thing since the USA does need to be heading toward energy independence with domestic energy sources replacing oil. The ultimate solution is hydrogen generated from nuclear power as indicated in EBWR04 with vehicles powered by hydrogen fuel cells.

All of this preceding discussion applies to all the other nations of the world who buy oil at high prices and want to move to green energy sources like wind, solar photovoltaic and nuclear power. Wind farms are growing tremendously in the USA midwest, Texas and California and other regions are moving as well in Europe. Spain is the leading producer of wind farm equipment and ships products worldwide. Solar photovoltaic is in a renaissance with solar panel prices coming down as production and sales increase.

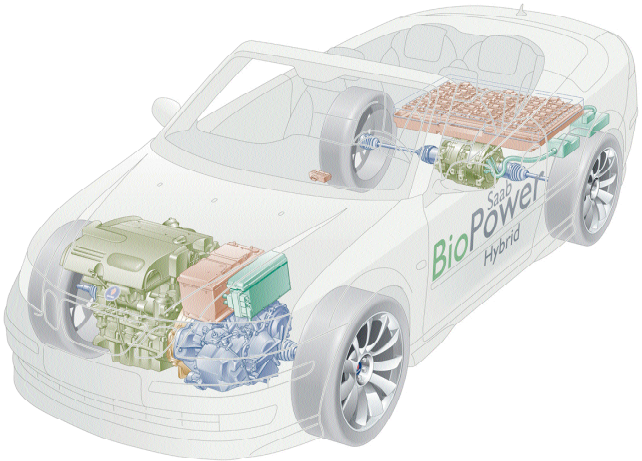
Rand Positive on Renewable Energy

A RAND Corp. report, issued in November 2006, estimated that if the cost to produce renewable energy continued to fall at its current rate, renewable energy could provide 25 percent of USA power by 2025 at no additional cost to the economy and perhaps even save money. Renewable energy will be 20 percent less expensive to produce in 20 years. If renewable costs fall at a faster rate, the nation could save $30 billion in energy costs by 2025. Beyond the economics, such a shift would have a big impact on US emissions of greenhouse gases, eliminating 1 billion tons of carbon emissions by 2025, about one-seventh of total US emissions. The USA "can achieve significant reductions in greenhouse-gas emissions without significant effects on energy expenditures," the study found. The Supreme Court, April 2006, issued a ruling that CO_2 is a pollutant subject to regulation. This will incentivize renewable energy, nuclear power and CO_2 sequestration. Since people, and animals, exhale CO_2 there may be a tax on our CO_2 exhalation someday. Studies on minimizing people/animal exhaling CO_2 should begin.
www.rand.org

Saab Bio Plug-in-Hybrid

In 2006, Saab showed a Bioethanol Hybrid with Plug-in-Hybrid capability at the Stockholm Motor Show. It uses a 300V Lithium Ion batery and goes 10-20km on battery power alone. The system is installed in a Saab 9-3 convertible that uses a 260hp 2.0L turbo BioPower engine that runs on 100% ethanol. Saab's modular hybrid system features a maintenance-free, 300V battery bank, a 38kW rear-mounted electric motor, a 15kW integrated starter generator and all-wheel-drive with electric power transmission to the rear wheels. It is a sporty combination that makes for improved performance as well as greater fuel economy with extended driving range. EBWR estimates the fuel economy of this Bio Saab at 100 mpg ethanol with an all electric usage of 80% of the time for short trips.
www.saab.com

Saab BioPower Hybrid



Cutaway Saab Biopower Hybrid

China Automotive Market Also Expanding

The China automotive market has grown tremendously in the past ten years from a few hundred thousand units to many millions. The total production in 2001 was over 2 million cars and trucks of all types. In 2004 that number was 4.5 million, in 2005 grew to 5.8 million vehicles and a big 25% increase in 2006 to 7.2 million. Not quite as big as China electric bike sales of 17 million in 2006, but nevertheless a remarkable achievement considering that twenty years ago there were virtually no vehicles owned by the public, only government officials had cars. As the market economy has taken hold in China, the transformation of the society to a more mobile one using four wheel vehicles is underway. Companies such as General Motors, Ford, Volkswagen, Toyota and Honda have plants and products in China. Production is projected to grow to 10 million vehicles in a few years. China companies are also exploring the USA market and are starting to show their vehicles at US auto shows. General Motors plans to build hybrid cars and busses there so China will embrace greener vehicles in order to clean the heavy pollution from their cities. China plans to build 30 nuclear power plants by 2020 to cut back on coal plants that are very dirty. Will this rapid movement to automobiles affect the electric bike and scooter market in China? Probably not, but surely there will be a leveling of the electric bike sales as there ultimately will be with automobiles in China, but when that will occur is still not predictable. All vehicles are growing in numbers fast as consumers are becoming more vehicle conscious.

India Increasing Auto Fleet and Highways

Following in the footsteps of China, India is also now on the way to being a motorized economy. As part of the reform process in that country there is a huge thrust on modernizing the road infrastructure. A four and six lane national highway system has been completed that connects the four biggest cities, New Delhi, Kolkata, Chennai (Madras) and Mumbai. This "Golden Quadrilateral" is 4,000 miles long built at a cost of $7 billion. Another national road project of 4,500 miles will provide four-lane highways connecting in other directions to the Golden Quadrilateral. Additionally there are 200,000 miles of state highways and rural roads being built to connect the thousands of villages to these new highways for access to the big cities.

These new highways and the increasing consumerism, fuelled in part by a sharp improvement in the availability of consumer financing, has seen the number of vehicles on the road in India triple to 67 million since 1981, when the first reforms were introduced to open the country's closed economy. Of late this has gathered even more momentum. Annual vehicle sales have surged from 707,000 in 2002-03 to 1.14 million in 2005-06. Two-wheeler sales have gone from 4.8 million to 7.1 million during the same period. Electric bikes and scooters have just been introduced in this economy and will play an increasing role in the future. Despite the improvement of the highways, the intra city roads are still a problem. Also, the smaller towns lack efficient public transport. This niche is now to be filled by electric bikes and scooters and a whole host of new players have set up shop to cater to the demand. Existing bicycle and ICE moped makers are also looking to offer electric bikes and scooters in the near future.

Automotive Hybrid Update

Not a day now passes without some press mention of automotive hybrid activity, compared to five years ago when fuel cells were the only hot automotive topic.

Every OEM has now announced plans to field a production hybrid within the next one to two years.

Toyota, with a commanding lead of three current models, the Prius II, the Highlander and the Lexus R400H, forecasts 600,000 units in 2007 while also announcing the advent of the their most popular model, the Camry Hybrid fall 2006. It should be noted that these hybrid volumes are constrained by component supply, and higher volumes would be realized if the critical hybrid parts, such as NiMH batteries, were available. Toyota has said all their vehicle lines will offer hybrids by 2010.

This market popularity however is concentrated on the so-called heavy-hybrids that give spectacular gains in fuel economy as well as good acceleration. The only other hybrid OEM in the market today, Honda, offers a “lighter” hybrid, which while giving good fuel economy gains by any normal standard, is not doing near as well in the market place.

The differences among hybrid types can be catalogued as follows:

• System operating voltage.
The best-selling hybrids use 500V or higher. Toyota’s first

Prius, a Power-split hybrid (see diagram), in 2000, operated at 288V and was not a strong market success. When the system voltage was upped to 500V in the 2003 Prius II, sales took off. Some yet-to-be introduced hybrids will operate at only 42V and cannot offer as much efficiency or performance as the heavy hybrids. It is easy to predict that all hybrids OEM's will move to increase their operating system voltages in the future.

• Engine operating cycle.
Heavy hybrids never let the engine idle, instead they use stored electricity for operating the air-conditioning system. (The power to drive the air conditioner is more than that required to drive the vehicle in the city). Using a constant speed electric drive air conditioner cuts its fuel usage by 50%, adding to the vehicle fuel economy gain. Not all hybrids yet do this, but it is again easy to foresee this becoming a trend.

• Elimination of automatic transmission.
The fundamental principle of all hybrids is that you have to combine two or more variable power sources in a manner transparent to the driver. Heavy hybrids use a planetary gear set, or other torque transfer device, but delete the expense of the automatic transmission. Others are still retaining the automatic transmission but add electric motor generators, thus adding the cost of the hybrid components on top of the existing powertrain.

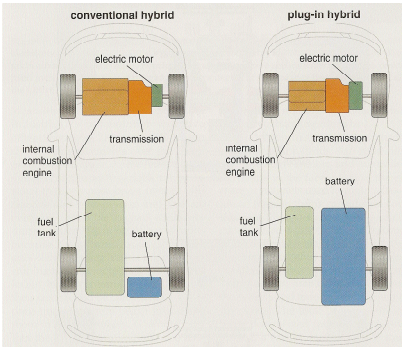
• Ratio of engine power to electric drive power.
Heavy hybrids have large electric traction power, on the order of that of the IC engine, or more. Lighter hybrids, such as the Honda, still use large IC engines but small electric traction motors, (limited by the lower available system voltage).

• Parallel hybrid (see diagram) operation.
Any successful hybrid must allow at least three drive modes, electric only drive, IC engine only drive and combined IC engine/electric motor drive in a manner transparent to the driver. This is called a parallel hybrid. By contrast, the less efficient series hybrid, now used in the plug-in-hybrid (see diagram) uses the IC engine to drive the generator and charge the battery, which then drives the electric traction motor, but the IC engine never drives the wheels directly.

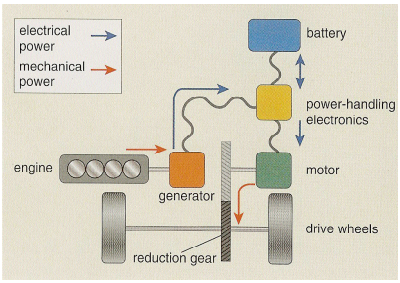
The onslaught of hybrid publicity has pushed the fuel cell to the back pages. Added to this is the now documented 60mpg city fuel economy of the Prius II versus the 60mpg city fuel economy of the latest Honda fuel cell vehicle, showing that the hoped-for two-fold advantage in efficiency of the fuel cell over the IC engine has been eliminated by hybridizing the IC engine. Accordingly, the obstacles to commercializing the automotive fuel cell have worsened.

Few people are aware that two of the major advantages enjoyed by Diesels are: 1. higher energy content of a gallon of Diesel fuel versus gasoline, which inflates the mpg figure for all Diesels over comparable gasoline vehicles, and 2. lower tax per BTU caused by the present method of taxing the volume rather than the energy content of the fuel. On a comparable fuel energy basis, Diesels do enjoy an advantage over the gasoline engine, but when both are hybridized, the difference is substantially lessened significantly. Nevertheless, you can expect to see Diesel hybrids appear in the market place, especially in Europe, where the Diesel has become most popular.

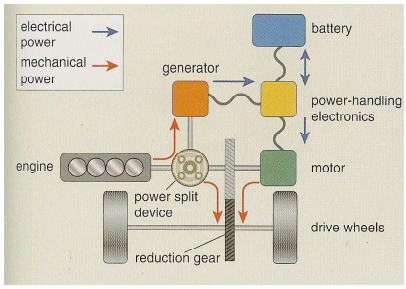
Robert Templin
Chief Engineer (Retired)
Cadillac - General Motors



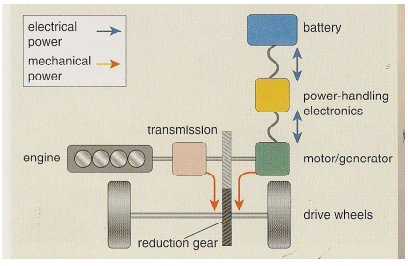
Hybrid Component Sizes



Series (Plug-in-) Hybrid



Power Split Hybrid

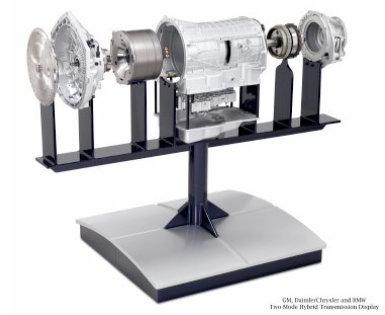


Parallel Hybrid

General Motors Two-Mode Hybrid / Vue Plug-in-Hybrid

GM started the Two-Mode-Hybrid (TMH) program in 2004 with the introduction of diesel TMH busses and has delivered over 600 to fifty USA communities that save one million gallons of fuel annually. GM has a program with Shanghai Automotive to introduce these TMH busses in China and around the world by 2010. A partnership of GM, DaimlerChrysler, and BMW called "Global Hybrid Cooperation" has developed the TMH suitable for cars and trucks. GM is now rolling out those TMH products and DMC and BMW will follow. 2007 Chevrolet Tahoe and GMC Yukon full-size SUVs. 2008 Cadillac Escalade full-size SUV. Chevrolet Silverado, and GMC Sierra crew cab full-size pickups. 2008 Saturn Vue Green Line and an all-wheel-drive Vue in 2009. GM also announced that the Vue will have a Plug-in-Hybrid modification of the TMH that will double the fuel efficiency of any current SUV. This PIH Vue will have over 10mile electric only range and include a Lithium Ion battery, two interior permanent magnet motors and GM's 3.6L V-6 gasoline engine with direct injection. It can be recharged from 110V AC outlet and awaits the lithium battery pack development/production as does the Chevy Volt PIH. The basic TMH transmission is an unprecedented fully integrated combination of electric motors with a fixed-gear transmission. It has low- and high-speed electric continuously variable transmission (ECVT) modes, thus the name Two-Mode-Hybrid. There are four fixed gear ratios for high efficiency and power-handling of a broad variety of vehicle applications. The system uses more compact electric motors that are built into the TMH transmission since the higher efficiency of power transfer allows for smaller motors and is less dependent on engine size. The electric motors can boost power and provide regenerative braking on all combinations of ECVT and gear ratios. The numbers are not out yet on fuel economy, so check them out when they arrive. You might be pleasantly surprised.

www.gm.com/hybrid



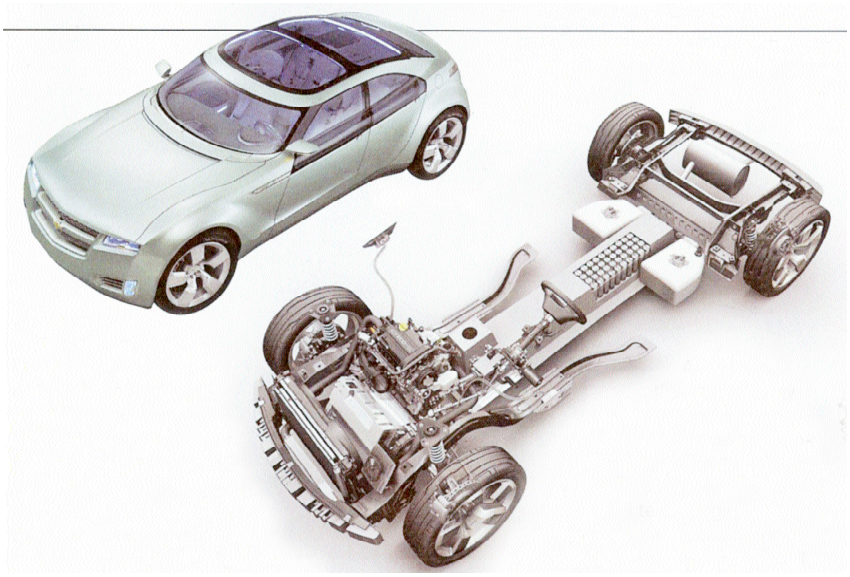
GM Two-Mode Hybrid Transmission

2008 GM Saturn Vue TM Hybrid

GM EV1

General Motors Chevrolet Volt Plug-in-Hybrid

GM announced and showed a prototype of a practical PIH at the Detroit International Auto Show in January, 2007, a first in the industry. Ford showed the Edge Hy Series PIH that uses a battery and fuel cell instead of the ICE that will be possible when fuel cells enter the vehicle market. The eco-world has been clamoring for a PIH so GM is giving it to them. This will probably lead to an eco-movie called "Who gave Birth to the Plug-in-Hybrid?" that will humble the film "Who Killed the Electric Car?" about GMs EV1, it was lack of customers that killed it in fact. The Chevrolet Volt is a Series Hybrid that has a small 1 liter 3 cylinder engine that runs a 53kW generator that starts to run when the battery reaches 30% of charge to recharge it. When the battery reaches 80% of



GM Volt

GM-DOW StationaryFC

GM Volt

GM Volt

GM-DOW FC Plant

charge, the engine shuts off. The battery powers a 120kW PM motor that will move the Volt 40miles before the engine turns on to recharge the battery. The battery is Lithium Ion and located as shown in the schematic with two six gallon gas tanks on either side of the battery. For a 60mile round trip, most work commutes are less mileage, the overall fuel economy will be about 150mpg. Total range could be up to 640miles. GM calls the Volt an E-Flex vehicle since it also will run on E85 where the gasoline fuel economy will become an astounding 640mpgg (miles per gallon gasoline). The Volt awaits a Lithium Ion battery that will match its requirements so GM says this will take some time and did not announce a production date. It should not be long, as GM has contracts with two Lithium Ion teams, Johnson Control/Saft and Cobasys/A123 Systems, to develop a production battery pack for the Volt. The 3,200pound Volt will require about a 400pound Lithium Ion pack (EV1 had a 1,000pound second generation NiMH pack). BTW, the GM website was taking a vote on the Volt and in mid April the viewer count was 447,000 with 99.5% indicating an interest in buying a Volt. The future of Volt is guaranteed. So watch out Toyota, GM is coming back to score! EBWR expects to be an "early adopter" of the Chevy Volt. In early March, 2006 General Motors announced that it will have the Volt in production by 2010. So be ready to buy one.

www.GM.com/Volt

Hydrogen Economy Implementation

There was a very significant study on implementation of the Hydrogen Economy that resulted in a 257 page report issued February 4, 2004 by the National Research Council and the National Academy of Engineering, a prestigious scientific organization originally established by President Abraham Lincoln to provide an independent intellectual body to advise the government.

The objective of the report was to analyze the technical methods that could be implemented for the generation of hydrogen and distribution as a fuel in vehicle systems. If fuel cell vehicles are to be a reality and used nationwide to replace the internal combustion engine, serious attention

needs to be given to the origin and cost of the hydrogen fuel.
Topics studied: hydrogen production alternatives with consideration of costs, CO_2 emissions, energy efficiency, barriers to implementation, distribution, storage and dispensing. Also discussed was hydrogen end use, market penetration scenarios with recommendations to the U.S. Department of Energy. The goals of the hydrogen economy are: 1. reduce imports of oil and natural gas to improve energy security, 2. reduce CO_2 emissions to the atmosphere and ameliorate global warming, and increase energy efficiency as it affects oil imports and CO_2 emission. There are five main unsolved issues: 1. fuel cell/vehicle cost, 2. hydrogen production method selection for major implementation, 3. storage of hydrogen, 4. sequestration of CO_2, 5. transition of infrastructure from gasoline to hydrogen.

The target is fuel cell cost of $50/kW that may not be achieved until 2030.

Auto companies continue to test vehicles that run on pure hydrogen as an alternative to the fuel cell approach. The Ford 2003 F-150 runs on gaseous hydrogen fuel in a modified 5.4 L V-8 engine. It has 3 fuel tanks of 150L each with 2,900psi hydrogen at 6.5gallon gasoline equivalent. Range is 117miles with economy of 18mpg gasoline equivalent. BMW set a land speed record for hydrogen fueled cars using a 6 L 12 cylinder 285hp engine that went to 188mph. It used a modified GM 572 crate engine tuned to 745hp with turbo cam drive and 3 injectors per cylinder. General Motors and Dow Chemical have established a large stationary fuel cell at the Dow Freeport, Texas plant that uses excess hydrogen from the plant to generate 35 megawatts of electricity from 400 stationary fuel cell modules. This is a major step in testing the fuel cell as a CO_2 - free electricity source for industrial application.

ENGINES / FUELS
Vehicle Current

	Efficiency	Cost Premium
Conventional Gasoline	1.00	----
Gasoline Hybrid	1.45	$3000-4000
Hydrogen Fuel Cell	2.40	10X – 20X
Diesel Fuel	1.45	~$3000

This table shows that fuel cell vehicles will be the most efficient but the cost premium today is prohibitive. On-board hydrogen storage is now being tested using compressed gas, cryogenic liquid and metal hydrides. A 300mile range is the goal with safety, cost, and recycling needed to be achieved. High pressure hydrogen storage has achieved range close to 300miles in a GM test FCV. The fuel cell of choice for vehicles today is the Proton Exchange Membrane (PEM) that works at 80C but is 10 times too costly still.

The NAE report spent considerable effort on methods to generate hydrogen that have to use another energy source to make it.

1. Coal can be gasified and reformed to hydrogen at centralized plants. Coal is low-cost, has useful byproducts and low cost domestic supply is plentiful. Air pollutants, sequestering CO_2 and large capital costs are problems.
2. Natural gas can be steam reformed and partially oxidized in central or distributed plants using a commercial process. Air pollutants, and sequestering CO_2 are problems. Natural gas would still need to be imported to meet demand.
3. Nuclear electricity could electrolyze or thermo chemically decompose water to hydrogen and oxygen. This approach produces no CO_2 or other pollutants and truly replaces oil imports. Nuclear waste and overall lower efficiency are problems.
4. A distributed system using electricity from the grid to electrolyze water locally could avoid distribution issues but requires a local hydrogen storage solution.
5. Another distributed system would use renewable energy, wind or solar power, to generate electricity from the electrolysis of water. But wind and solar power are intermittent sources so battery storage and grid backup need to be considered.
6. Biomass that could be gasified, pyrolyzed and reformed in centralized plants could generate hydrogen with no net increase in CO_2. Feedstock transport and competition for land area are issues.

The report concludes that sequestering carbon dioxide from the use of coal to make hydrogen will, in 2050, require the movement of 1.4 billion tons of CO_2 /year (two times the natural gas moved in 2020) and require storing 20 billion tons of CO_2. The problems that will need to be addressed are CO_2 separation, transfer, and injection into saline aquifers, depleted oil wells or into the deep ocean with much technology yet to be developed.

The NAE report discusses a mul-

tiplicity of scenarios to evaluate the current and future cost of the production of hydrogen from these sources, coal, natural gas, electrolysis of water and biomass gasification and with these electricity sources: nuclear, coal, natural gas, photovoltaic and wind. Surprisingly the cost of hydrogen production in $/kg of hydrogen ranges from $2 to $10 with the price of gasoline equivalent at $2. This is good news for the future success of the hydrogen economy, but much has to be done with strong commitment by all stakeholders. The conclusions of these extensive cost analyses follows.

1. Hydrogen from central station plant natural gas or coal is roughly cost-equivalent to gasoline in a Hybrid EV on a "Gasoline-Efficiency-Adjusted" (GEA) basis.
2. Hydrogen generated by nuclear power, distributed natural gas steam reforming, and distributed electrolysis using wind-turbine electricity could have costs within $1/kg of gasoline on GEA basis.
3. Hydrogen from distributed electrolysis using photovoltaic or grid electricity or hydrogen using gasification of biomass would have GEA costs higher than gasoline.
4. Distribution and dispensing costs of hydrogen will be a significant component.
5. Carbon dioxide disposal costs of $10 a ton and carbon imputed cost of $50 a ton of carbon released to the atmosphere would have only a small impact on costs.
6. Whether distributed electrolysis will become finally economically viable will depend on the cost of electricity. Hydrogen can be produced by wind electricity but will depend on the cost of electrolyzers being reduced by 90%.

Other major issues need resolution such as transportation, distribution and storage of hydrogen. Hydrogen storage as compressed gas, as liquid or metallic alloy matrix, is all being developed. Solutions to all these technological issues are concluded to be possible and that implementation can move forward on the hydrogen economy over the next few decades. The report plots the transition from the ICE to the fuel cell vehicle over the next forty years and shows that 100% hydrogen fueled vehicle production could arrive in 2038 if all the economically viable solutions to the technology challenges are discovered.

William Agnew, NAE (Retired)
Director, General Motors Research Labs
Responsible for Independent Overview
NAE Hydrogen Economy Report

NAE Hydrogen Economy Report Formal Conclusions

The National Academy of Engineering report on the Hydrogen Economy arrived at conclusions for four topics addressed. 1. implication for national goals, 2. priority for R&D, 3. challenge of transition, 4. impact of hydrogen-fueled light-duty vehicles on energy security and CO_2 emissions.

1. Transition to hydrogen as a major fuel in the next 50 years could fundamentally transform the US energy system, creating opportunities to increase energy security while reducing environmental impacts. Conducting hydrogen RD&E activities to determine whether a hydrogen economy might be realized are important to the nation.
2. Four most fundamental technological challenges that should be addressed. Develop and introduce economical, safe and environmentally clean fuel cell and hydrogen storage systems. Provide hydrogen infrastructure for hydrogen-fueled vehicle users. Sharply reduce the cost of hydrogen production from renewable energy sources, over a period of decades. Capture and store ("sequester") the carbon dioxide by-product of hydrogen production from coal.
3. The transition to a hydrogen economy will begin with distributed production of hydrogen. Small hydrogen generation stations can locally distribute hydrogen made from the reforming of natural gas or electrolysis of water. A transition emphasizing distributed production allows time for new generation/distribution technology development and for the market to develop before too much fixed investment is in place.
4. The demand for hydrogen for vehicles in 2027 will be 9 million tons, a small fraction of the 110 million tons that will be needed for light-duty vehicles by 2050. CO_2 emission from vehicles will be reduced significantly if hydrogen is obtained from renewable energy sources or nuclear power. Fossil fuel sources, coal, would require CO_2 sequestration. Overall, if the RD&E succeeds, the hydrogen economy will transform the USA economy with great benefits from the reduction of oil use and CO_2 emissions.

The Hydrogen Economy: Opportunities, Cost Barriers, and R&D Needs
National Research Council & National Academy of Engineering
ISBN 0-309-53068-7 (PDF) (2004)

California Fuel Cell Partnership

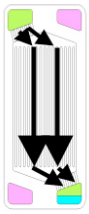
The California Fuel Cell Partnership is a collaboration of 31 member companies who are working together to promote fuel cell vehicle commercialization as a means of moving towards a sustainable energy future, increasing energy efficiency and reducing or eliminating air pollution and greenhouse gas emissions. The 20 full members include major auto companies Daimler-Chrysler, Ford, General Motors, Honda, Hyundai, Nissan, Toyota, Volkswagen, three oil companies BP, Chevron, Shell Hydrogen, two fuel cell companies Ballard, UTC Power and state and federal government agencies. The 11 associate members include utilities, transit agencies and supplier companies. Automobile companies and fuel suppliers have joined together to demonstrate fuel cell vehicles under real day-to-day driving conditions. In addition to testing the fuel cell vehicles, the CaFCP is examining fuel infrastructure issues and beginning to prepare the California market for this new technology. Governor Arnold Schwarzenegger has initiated the installation of a hydrogen highway in California to be the first in the country.

www.fuelcellpartnership.org

Opel FC Zafira

Honda FCX

Honda FCX Concept



Honda Fuel Cell H_2/Water Flow Vertical

Honda FCX Concept Fueling

Honda has a major program on PEM fuel cells for vehicles and for home energy stations. There are 23 FCX fuel cell prototype cars in demonstration fleets in the USA. One FCX is leased to a private family and after one year, ending June 2006, of use in everyday activities, has successfully logged several thousand miles. The FCX carries an EPA city/highway rating of 62/51 miles per gallon and a range of 210 miles. The FCX Concept will move the technology closer to limited production in 2008 with full production of FC vehicles in 2020. The FCX Concept is equipped with a new vertical-flow design PEM fuel cell platform consisting of a compact, high-efficiency fuel cell stack arranged in a center-tunnel layout. This new fuel cell stack is 20% smaller and 30% lighter than the current FCX FC stack, yet its power output is 14kW greater. The drive motor has been positioned coaxially with the gearbox for a more compact design, with output increased by 15kW. Overall, the power plant is about 180kg lighter than that of the current FCX and about 40% smaller in volume. The new vertical-flow FC design allows gravity to assist in discharging the water that is produced, resulting in a major improvement in water drainage and performance. A compact, high-efficiency Lithium Ion battery provides auxiliary power. The overall energy efficiency of the system is 60%, three times that of the ICE, and provides range of 280 miles, a 30% improvement over the FCX. Honda also has a new hydrogen absorption material that doubles capacity to 5kg of hydrogen at 5,000psi, extending cruising range to 350 miles. Electric motor power is 95kW with torque at 256N.m and the fuel cell stack is rated at 100kW. The FCX Concept has a top speed of 96mph and carries 4 passengers. Will the FCX be first FC vehicle to market? Stay tuned.

www.Honda.com

H2 Logic FC Utility Truck

H2 Filing Station

H2 Logic FC Truck

FC Power Unit

H2 Logic SpA, Herning, Denmark, is selling a utility truck powered by a fuel cell. The 2kW Power Unit provides 1.2kW of 24V DC or 1.0kW of 230W AC that can run the truck for 4 continuous hours or 12-16 normal operating hours in a factory. Truck weight is 450kg and load limit is 2,000kg. The Power Unit uses Ballard fuel cell modules and has two hydrogen gas canisters that are refilled at a H2 Filing Station also sold by H2 Logic. The Filing Station is supplied by a bulk supplier and fills at 65L per minute so the 3,800L canisters can be filed in 30-60 minutes. Fill pressure is 218 to 2,900psig. H2 Logic has sold 6 units in 2006 and expects to deliver around 50-100 units in 2008 of a new truck the V3. Price of the H2 2006 truck was 46,000 euros or $60,000. The Danish government has eliminated all taxes on fuel cell vehicles. It seems that industrial use of fuel cell vehicles has started in Denmark and the government is helping to stimulate it. H2 Logic and Th!nk Technology of Norway in January, 2007 announced a Th!nk fuel cell car project where H2 Logic will supply the fuel cell power unit. Norway has a program for a hydrogen infrastructure system by 2012. Fuel cell cars and trukks are on the way in Scandinavia. Hooray for the Scandinavians.

www.h2logic.com
www.h2truck.dk

Honda Home Hydrogen Station

Honda Home H_2 Fueling

Honda R&D Americas, Inc., in conjunction with partner Plug Power Inc., has introduced a third generation Home Energy Station in Torrance, CA, which provides heat and electricity for the home as well as fuel for a hydrogen-powered fuel cell vehicle. Hydrogen storage and production capacity are both improved by 50% with the use of a new, high-performance, natural gas reformer. The Home Energy Station is also a backup power generation system during power outages by using the hydrogen in the storage tank to power the internal fuel cell, providing 5kW of electricity to the home. This is in fact a distributed hydrogen generator that was identified by the National Academy of Engineering as the way to introduce the hydrogen economy. So home FC power may really be beginning. Stay tuned.

www.Honda.com

General Motors Fuel Cell Sequel and Equinox

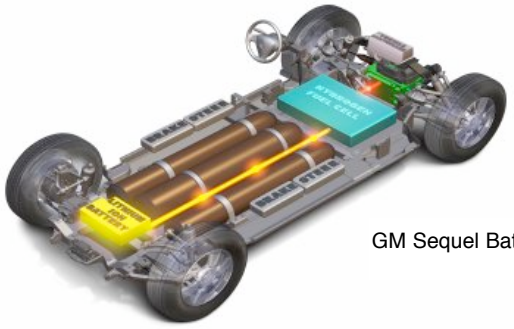
General Motors continues to improve its fuel cell technology. In 2004, a FC Opel Zafira traveled 6,000miles through 14 European countries, the first long distance trip by a FC car. The Sequel was announced at the 2005 Detroit Auto Show and GM continues to improve all aspects of the technologies used in the Sequel as well as manufacturability and cost. The Sequel uses the eleven inch "skateboard" aluminum chassis introduced in the GM Autonomy (featured in EBWR02) that houses the fuel cells, battery pack, motors and three hydrogen storage tanks. The exterior skin is aluminum with vehicle weight at 4,770pounds. The fuel cell stack delivers 73kW and a 143pound Lithium Ion pack delivers 65kW. All wheel drive includes a single 60kW 3 phase synchronous motor with planetary gear in the front and two 25kW 3 phase PM hub motors in the rear. Total traction power is 110kW with 3,398Nm torque that provides 0-60mph in less than ten seconds and top speed of 90mph with 300mile range. The three carbon fiber hydrogen storage tanks hold 17.6pounds of hydrogen at 10,000psi. The Sequel has a 42V by-wire system for control and braking, a high voltage drive system, and a 12V system for interior functions like lighting an audio. There are extra openings in the skin to provide extra cooling of the fuel cells as seen in openings near headlamps and in the rear. For 2007, GM will provide 100 Fuel Cell powered Chevrolet SUV Equinox's to families who will use them for everyday trips to gain insights from the experiences of typical drivers. These will be distributed in three market areas, California, metropolitan New York and Washington, DC. The FC Equinox is capable of 50,000mile life. The Sequel and the Equinox FCVs are the beginning of things to come from General Motors, that plans to be first in the market place with Fuel Cell vehicles. Stay tuned.

www.GM.com/Sequel

2007 Chevy FC Equinox

GM Sequel "Skateboard"

GM Fuel Cell Sequel



GM Sequel Battery/H2 Tanks/Fuel Cell

Section 4

Worldwide Electric Bike Activities

Overview

This section includes a worldwide activities review that embraces the notion that the world is finally accepting green and sustainable transportation and that national governments and the public are finally addressing this momentous issue. Events in China are leading the way in Ed Benjamin's review of worldwide EB activities. Jonathan Weinert and two graduate student colleagues spent time in China interviewing and surveying the public and discuss the important factors for E-Bike growth in China and impact on travel behavior. Simply stated, the electric bike is a perfect match to the needs of the Chinese commuting public. European organizations like the International Energy Agency (IEA) and CITELEC are organizing to promote electric bikes in EU countries. ExtraEnergy and ITRI hosted the 2007 Light Electric Vehicle Conference that included four days of talks and discussions. Sessions on Energy Bus and Battery Safety show the LEV industry moving to standard systems and tests that will promote more reliability and higher quality products. Segway Human Transporter sales are growing with acceptance in tourist travel and law enforcement market niches, and new HTs, like Blue-Ride™ in California, are entering the market. To highlight the variety of electric bike and related products that now are in the market, the following companies and projects are reviewed: TresTerra, Currie Technologies, Pacific Cycles, Optibike, RunAboutCycles, Neodymics, Go-Kid E-Quad Coaster, Bike eZe Australia, Series Hybrid Electric Bike (SHEB), and Fallbrook NuVinci Continuously Variable Planetary Transmission. There is lots of electric bike activity worldwide and the 2007 LEV conference suggests that companies are now starting to talk like the auto industry about standards and commonization for the good of the industry. This is a good sign indeed.

WORLDWIDE EB ACTIVITIVES

Electric Powered two wheelers and three wheelers are experiencing major growth and will continue to do so, at an ever increasing pace. The energy and vigor of the market can be seen and physically felt in the booming (literally – every booth has a massive sound system) sales halls of the China Cycle Show. Factories in Asia work around the clock, and numbers produced by a single factory are now in the millions. And all over the USA, EU, China, and India, electric bikes are appearing more and more often on the street. One in five new bikes sold in China is now electric. Electric bikes are coming of age, at a time when the world badly needs them.

This is spurred by a combination of rising price of oil – which puts tremendous financial pressure on many people in the world that use cars or motorcycle / motor-scooters – and the increasing viability and reliability of the electric bicycle and vehicles that use similar power systems derived from electric bicycles. Additional growth encouragement comes from ecological issues, often in the form of government bans or constraints on gasoline powered (especially two stroke) two wheelers and tax / subsidy / licensing privileges for electric. Powered two wheelers (most powered by gasoline) are the second largest selling type of vehicle in the world, just after human powered bicycles. In the category of PTW, small displacement motorcycles,

usually with two stroke (cheaper to build) engines are the dominant type.

Note for USA readers: Large displacement motorcycles are nearly exclusive to the USA. In most countries, a 150cc motorcycle is regarded as plenty of power. An odd fact about USA motorcycles is that many of the most popular ones cost more than a car and have far less energy efficiency per passenger mile. So most “American” ideas about powered two wheelers are far from the normal worldwide experience. For purposes of this article, think about electric scooters equivalent to the 50cc to 150cc gasoline scooter size. Most popular are the “Vespa” style scooter designs made by mostly Asian makers. They are transportation tools, not toys, not recreation.

An electric bicycle used in a mild climate, in a flat urban terrain, is a viable alternative to mopeds, power assisted bicycles, Solex, a French gasoline assisted bicycle identified as a moped, motor scooters, and small displacement motorcycles. Even the simplest electric bikes succeed in this role. This makes electric bikes and mini scooters the fourth best selling vehicle, world wide in 2006, already behind 1. bicycles-130 million , 2. motor scooters / mopeds 70 million, 3. cars and trucks- 67 million and 4. electric bikes - 17 million.

When the electric bicycle is styled like a motor scooter and can carry two people, plus cargo, with the convenience of a “Vespa” like configuration – the vehicle becomes very attractive to a wide range of humans in many cultures and climates. Since an electric powered two wheeler of any power range is simpler (far fewer parts) and less expensive to make than a gasoline powered equivalent, they sell for low prices. This, combined with very low cost to “refuel” makes the electric bicycle a very attractive cost based alternative. Before any government subsidy, favorable taxes, or licensing breaks.

CycleElectric Chief Engineer Mike Fritz calculated the cost of recharging a 10.5Ah 36V battery E-Bike, with 20 mile range in Los Angeles, at 0.04 cents USA. Traveling 20 miles on a KYMCO gasoline motor scooter is estimated at 0.56 cents USA or 14 times more cost.

The limitations of electric bikes still exist. Batteries are sometimes unreliable and vary widely in quality and performance. Motor controllers have subtleties that many makers do not understand and these results in many troubles that mystify users and service technicians. Motors made to be as cheap as possible and in millions of pieces are often troublesome. A major lesson learned from the electric bike industry is that when millions of vehicles are made on a “cheapest possible” basis – using technology that is relatively young and not well understood – there are going to be millions of disappointed and frustrated customers. And frustrated and financially stung manufacturers.

The electric bike industry has been heavily influenced by the bicycle industry. In the worldwide bicycle industry, there is tremendous pressure to have the cheapest possible product – and the “margin” between “too expensive” and “good enough” has been razor thin. This works in a very mature industry like bicycles. But has been disastrous in the less well understood technologies of electric bikes. This results in electric bikes being less functional than gasoline powered bikes. Shorter range, many service problems, hard to find parts.

Shanghai EB Rider

Scooter for Two

Giant Twist 2.0

New Sun Folder

Warranties are short or nonexistent and manufacturers and distributors have disappeared frequently. However, this is getting better. Sealed Valve Regulated Lead Acid (SVRLA) batteries have improved in quality at the low price points, Nickel Metal Hydride (Ni-MH) Batteries are frequently used, and Lithium Ion (Li-Ion) Batteries are becoming popular fast.

Every component of the vehicles is getting better in quality and functionality, while prices have stayed relatively constant – and low. Electric bikes in China can be purchased for as little as $115 US. Even the high end electric bikes of EU (2,000 Euros) and USA ($1600) are less expensive than “equivalent” gasoline motor powered two wheelers. (Example: TresTerra E-Bike at 1600 USD, compared to KYMCO People model at 3200 USD in Tampa, Florida.) Sales and use confirm this trend. Electric powered two wheelers are a major part of the human transportation mix today.

The largest market today is China. A wide range of predictions come from various sources, but there is little doubt that perhaps as many as 17 million electric bicycles will be sold inside China in 2007. China is strong in this for two basic reasons – the 240 watt electric bike works “well enough” for Chinese people in many (but not all) cities – plus the strong government encouragement in the form of restrictions of gasoline powered two wheelers and favorable tax / licenses fees for electric.

There have been confusing reports of electric bikes banned, not banned, restricted, not restricted coming from China – but these are local, not country wide, and are phenomena of complex local politics in the affected cities. Generally, the Chinese people are very accepting of electric bikes. The typical user of an E-Bike in China is a commuter, for whom the E-Bike can extend their choices of housing or employment, and make the commute easier. An example is the educated lady manager who can buy a nicer home for less money that is farther from the subway or train station and still get to work in the same commuting time. Latest National Electric Bike standards for China establish that Maximum speed should be 20kph, Maximum weight at 40kg, a minimum range of 25km, maximum noise of 62 decibels, power consumption of 1200 Watt-hours per 100km of travel, and a maximum motor power of 240 watts. The bike should also be capable of being pedaled 7km in a 30 minute period. This is the world’s most sophisticated set of standards for E-Bikes, but is not uniformly complied with – yet.

In Japan, the current second largest market, electric bikes have had a boring couple of years. Around two hundred thousand Pedelecs have been sold in Japan every year since 1994, and they fill an important function in a land where parking spaces, roadways, and living space are very limited. Japanese are not motivated by price as much as by convenience and functionality in their use of Pedelecs. The product has not had a major evolution aside from battery and charger improvements for some time. There may be changes in Japanese law to allow more powerful Pedelecs, for the present this is a mature market with no significant growth. The vehicles have found their place, and are filling it well. The typical user of a Japanese Pedelec is a middle aged woman who uses it as a “second car” to get to train station or shopping. The family could afford another car, but has no place to park it either at home or at the train stations.

Targets Sells SSEBs

T3 Motion Police HT

The EU takes third place, with rapid growth, especially in Netherlands, Germany, and Switzerland. EU users are often older people who have ridden bicycles their entire life for transport and recreation – and appreciate electric power assistance today. But they did not accept electric bikes that did not work well and that were visually different from normal bicycles.

Pedelecs in EU have been the best example of manufacturers listening carefully to their customer and delivering what is asked for. The best selling Pedelecs in the EU look like normal bicycles and are very easy to use, and very reliable. They are not inexpensive. The markets that have accepted the product have been willing to pay substantial prices. An exception is the UK, where low price has been a major issue. In the UK, E-Bikes made originally for China have been selling well, as a function of price. Strong ongoing efforts by French companies will result in growth of E-Bikes and Pedelecs in France this coming year. And it is believed that Eastern Europe is a natural market for electric bikes – but that cultural perceptions ("only poor people ride bicycles, and we have been poor long enough – we want cars") are holding this back.

Next is the USA. Millions of electric mini scooters and many thousands of inexpensive Chinese electric bikes have been sold as throw away toys at very low prices over the last 4 years. However, the use of electric bikes as transportation, or the purchase of quality bikes, has been slow to develop. However, interest is rising fast, fueled by Americans reacting to high oil prices and discovering that the lack of public transportation in the USA means a car, motorcycle, or a bicycle are nearly the only transport choices. And since most Americans are not inclined to the physical activity of cycling, gas powered two wheelers and electric bikes are enjoying growing sales.

Emerging markets with little past history are about to explode onto the scene. And the word "explode" is appropriate. Indian companies importing Chinese electric bikes and components report sales of 2,000 pieces per month – in an industry that has just barely a year of real history. Most major Indian bicycle companies are or will be selling electric bikes within months. Due to the traffic congestion, parking limitations, cost constraints and air pollution of Indian cities, it is easy to see that electric bikes and motorcycles will be major parts of the Indian transport mix. It is nearly certain that India will be an electric bicycle market similar in size to China, within a few years.

Thailand is a country whose transport situation and economy makes electric motor scooters an obvious necessity. The largest bicycle company in Thailand is a long time maker of electric mini scooters and is selling E-Bikes and a mid size scooter throughout Thailand. Sales numbers are unavailable, but the factory is busy all the time. Taiwan has changed several sets of laws to encourage electric powered two wheelers in the SLES (Small Light Electric Scooter – actually in between the mini scooter and the motor scooter in size) and electric bicycle categories. Indonesia and Malaysia both have emerging electric bicycle markets, as does Vietnam. Obvious future markets include Africa, South America and Central America. But so far, there have only been tiny experiments in serving these markets.

Ed Benjamin

IMPORTANT FACTORS FOR E-BIKE GROWTH IN CHINA AND IMPACT ON TRAVEL BEHAVIOR

E-Bikes, though they floundered twice in the 80s and early 90s, experienced extraordinary growth in the late 90s to the present due to a combination of economic, technical, and political factors (Weinert, Ma and Cherry, 2006). Firstly, E-Bike technology, specifically motors and batteries, improved significantly during the late 1990's. Simple technology, a vast supplier base, and weak intellectual property protection made it easier for E-Bike makers to enter the industry, increasing competition and driving prices down.

Secondly, Incomes of urban households and the share spent on transportation both rose considerably due to improving economic conditions nationally. E-Bike prices decreased, gasoline prices rose and electricity prices in rural areas dropped, making E-Bikes more competitive economically with alternatives like gasoline-powered scooters and the bus.

Thirdly, national and local government policy motivated by energy and air quality issues created favorable conditions for E-Bike growth. Banning gasoline powered motorcycles in large city centers removed the most competitive mode from the choice set. National E-Bike standards with loop-holes and flexible guidelines created a rich opportunity for manufacturers to create E-Bikes that appealed to more users, namely, scooter-style electric bikes. Furthermore, due to changes in urban form, performance of alternative transportation modes decreased as trips lengths and congestion increased. This made trips difficult to traverse by bicycle and slow by motorized modes, particularly buses and taxis.

The history of E-Bikes in China provides an important lesson on the powerful impact of regulatory policy, given the evolution of technology to a market acceptable product. While technological progress was required to meet the customer demands for economics and performance, the regulatory environment provided strong impetus for the market to grow and for further investment in technology evolution. Without this the E-Bike market would not have emerged. Support for this conclusion can be found by looking at the lack of growth in “anti E-Bike” cities. There is further evidence of the sensitivity to local policy in Shanghai, where an alternative (LPG scooters) emerged in a regulatory environment that was otherwise favorable to E-Bikes. Where regulatory policy is favorable / neutral, economics and customer expectations will determine market success.

While electric bikes have some positive impacts on transportation and urban air quality, policy makers are not unanimously in favor of this mode resulting in E-Bike bans in three cities: Guangzhou, Fuzhou and Zhuhai. Safety is the most commonly cited concern due to their silent nature and increasing speed and weight. City planners and policy makers are undecided on how to plan for and regulate E-Bikes because it is not yet clear what effect they will have on travel behavior, public transportation use, and safety. To begin to understand these effects, we have surveyed 750 bicycle and 450 E-Bike users in Shijiazhuang, a medium-sized city with particularly high two-wheeled vehicle (2WV) use, to identify differences in travel characteristics and attitudes (Weinert et al, 2006).

From the survey results, we found that E-Bikes are enabling people to commute longer distances. This has important implications on energy use, accessibility and urban expansion of cities. People under-served by public transportation are shifting to E-bikes though they depend on public transit as a back-up option (i.e. during inclement weather). There are concerns by both bicycle and E-Bike users about the E-Bikes being too fast, however E-Bikers find crossing intersection easier than bicycles. Women feel safer crossing intersections on an E-Bike compared to regular bike, however they have strong reservations about increasing E-Bike speed capability.

While E-Bikes provide zero tailpipe emissions, they do emit pollution from power plants, which are mostly coal fired in China. Lead emissions from batteries production and recycling also have serious health implications due to high lead loss rates in the Chinese lead and battery industries (Cherry, 2006). Overall, the Chinese city traveler is inclined to not be concerned about the lead issue and this has led to E-Bike sales in the 15 million unit range, and still climbing, to make the Chinese E-Bike market the largest in the world.

Jonathan Weinert, PhD Candidate, University of California Davis, Institute of Transportation Studies

Chaktan Ma, Masters Student, Tsinghua University, Transportation Engineering

Chris Cherry, PhD Candidate, University of California Berkeley, Institute of Transportation Studies

Flying Pigeon Cab/Utility

Geoby

Papa Johns Pizza Delivery

Nova Bikes Inspire

Tianjin Cycle Txed Happy Time

INTERNATIONAL ENERGY AGENCY LEV TASK FORCE

International Energy Agency (IEA) is the energy forum of 26 OECD countries. IEA member governments are taking joint measures to meet oil supply emergencies, share energy information, coordinate energy policies and develop energy saving programs. IEA has an Implementing Agreement for Electric and Hybrid Vehicles (HEV) that establishes data on EVs and HEVs to assist government policy makers. Several expert groups work in “Annexes” on environmental impacts, battery technology or information exchange.

A new Annex was established in January, 2006 on Electric Cycles, Electric Bikes and Scooters. Participating members include AVERE, the European Association for Electric Vehicles, CycleElectric USA, the Industrial Technology Research Institute (ITRI) of Taiwan, Tokyo R&D, New Ride from Switzerland and Arsenal Research Institute from Austria. The kick-off meeting of this Annex was held on March 10 / 11 2006 in conjunction with the Taipei Cycle Show and the LEV conference. There it was decided to compile a list of selected electric cycles as a general data base. A set of recommendations both for governments and manufacturers should create favorable conditions for the market introduction of electric cycles. ITRI announced a plan to develop a mathematical model for the calculation of the performance of electric scooters.

So far, potential customers, outside of China, seem to misjudge the benefits of these vehicles since not many are purchased. Authorities at the national and local level may recognize the benefits but can obviously not take the leadership in market introduction. Last but not least, not all the manufacturers, the supposed leaders in market introduction, seem to not have enough insight in the market systems, because these vary strongly from country to country. The aim Annex XI is to stimulate governments to issue regulations and incentives to promote the use of Electric Bikes and Scooters in cities and towns to reduce congestion and pollution.

Urs Schwegler
urs.schwegler@bluewin.ch
www.ieahev.org

Elektro Rad CD22

Heinzmann Sport

Helkama E-Trike

CITELEC

CITELEC, an international association of twenty European cities interested in the use of electric and hybrid vehicles, was founded February 2, 1990 under the aegis of the European Community. CITELEC and its members consider the electrically propelled vehicles as a potential solution to traffic and transport congestion and to pollution problems in their cities. CITELEC is established in Brussels as an international non-profit association under Belgian law, and has access to the research and laboratory facilities of the Vrije Universiteit Brussel allowing to develop its test and evaluation programs.

Major activities include:

* Inform cities about performances and characteristics of electric vehicles.
* Help cities with the deployment of electric vehicles and to organize user-training.
* Help cities and boroughs build up the required infrastructures.
* Organize realistic test demonstrations for electric vehicles in urban traffic.
* Study the impact of electric vehicles on traffic, environment and urban planning.
* Establish standards related to electrically propelled vehicles.

CITELEC has evaluated the infrastructure, charging stations in urban site; hybrid buses to lower outlet emissions; demonstration of electric vehicles for goods and mail delivery; and demonstration of electric two-wheelers (E-Tour), that is electric bikes. CITELEC supports the ongoing European petition action for "green" vehicles. AVERE, CITELEC and EPE request the European Parliament, the Commission of the European Communities and the European Council of Ministers to set up a large program for development and demonstration of battery-electric and hybrid electric vehicles, so as to highlight their respective and immediate benefits for energy economy and emission reduction, while eliminating the burdens restricting these technologies from real market access. This petition started late 2006 and will be open until the forthcoming EET-2007 conference **(http://www.ele-drive.com).**

Dr. Peter Van den Bossche
CITELEC
pvdbos@vub.ac.be
www.cleanvehicle.com

LIGHT ELECTRIC VEHICLE CONFERENCE 2007 IN TAIWAN

HSINCHU, Taiwan: This year's LEV Conference was held in Hsinchu, Taiwan, on March 20-23, just before Taipei Cycle Show. Speakers from around the globe presented new developments in light electric vehicle technology as well as the latest trends in various markets.

Organizers: ITRI and ExtraEnergy

The LEV Conference offered four days of concentrated information on light electric vehicles including hands-on riding experience. Around 150 visitors from Europe, USA and Asia attended the conference and were provided with a high-profile update of the latest technological developments, standardization, market trends and international legislation. The organizers, ExtraEnergy from Germany and Industrial Technology Research Institute (ITRI) from Taiwan, were pleased with the outcome of the conference, which was met with great positive response despite its late announcement. The headquarters of ITRI in Hsinchu offered an excellent facility for lectures, discussions, display of exhibits and test riding.

ExtraEnergy and ITRI had agreed with show manager TAITRA to hold the conference on separate days from the show and not at the same time as in previous years. This allowed key representatives from the bicycle industry to attend the LEV Conference without missing important business during the show. For LEV Conference 2008, the dates just after Taipei Cycle Show are currently being discussed. This year's experience has shown that just before the show many companies are still too busy with last-minute preparations to attend the conference.

20 March 2007: EnergyBus

On the evening prior to the conference, the EnergyBus Organization was founded as an initiative of ExtraEnergy and ITRI. Ten founding members signed the charter of the non-profit association with the goal to further develop the EnergyBus standard and introduce it to market. This communication protocol for electric vehicle components is designed to improve the functionality and serviceability of electric vehicles. In her presentation, Janine Mueller from ExtraEnergy compared EnergyBus with the USB standard for computers. Yet, EnergyBus will not standardize just one type of plug. Significantly higher current in some LEV applications will demand a set of plugs. The requirements for the EnergyBus plug system were presented by Sven Schlicker of German plug development company Schlicker GmbH. Norbert Haller of Craftsmen Design, Germany, who designed the EnergyBus Corporate Identity presented a first design of such a plug system set.

As a futuristic example of application, Hendrik Markowski from Germany presented his diploma project: the re-creation of a motorized bicycle. In other words: the re-definition of the word MoFa (English: Motor Bicycle) by designing a fun vehicle for young cyclists. Hendrik's result is a Freestyle bicycle with electric drive and hybrid energy storage system (lithium battery and fuel cell). EnergyBus can save a lot of time and money in the development and production of this and other LEVs,.

Other speakers of the day provided an insight into possible appli-

EnergyBus founding members: Johannes Dörndorfer, Frieder Herb, Janine Mueller, Norbert Haller, Hannes Neupert, Daniel Hoppe, Mo-Hua Yang, Anton Kip, Bing-Ming Lin, Sven Schlicker, Susanne Bruesch

cations, advantages, challenges, and marketing strategies. In a panel discussion at the end of the day the key question was: Where is China? China was unfortunately not represented in this discussion. In order to promote a worldwide standard China needs to be on the EnergyBus team. For Hannes Neupert, President of ExtraEnergy, there is no other way but the EnergyBus to use the full potential of LEVs in all worldwide markets.

The next goal of the EnergyBus organization is to have companies from the industry join to further develop EnergyBus for their own purpose and application. The first focus will be a communication standard between batteries and chargers to prevent accidents which today's technology, unfortunately, does not prevent (batteries have caught fire when charged with the wrong charger). First companies to publicly announce they will use EnergyBus: ITRI and Telerob.

21 March 2007: Battery Safety

BATSO A+2007 BATSO B 2007 BATSO A‡2007 BATSO C 2007

BatteryTest Seal

Battery experts presented the latest battery technologies with reference to their safety, among them manufacturers as ENAX, Degussa, Amita, and PHET. Tim Schaefer, an expert on dangerous goods handling, explained the UN regulations for lithium battery shipment and legal responsibility of LEV manufacturers—a significant issue in the context of recent battery fires. ExtraEnergy, ITRI, and Taiwan UL are working on safety standards for battery pack testing. For this purpose a special test laboratory was built in Germany and shipped to Taiwan. It has just been started operation at the ITRI facility. ExtraEnergy has created a battery safety logo to indicate the battery meets the BatteryTest.org safety standards applied by ExtraEnergy and ITRI.

Hannes Neupert presented the lecture of Kaz Suzuki of Panasonic from a Panasonic-external point of view. This was an interesting experiment and an even stronger message when since Panasonic is a leading example on how to handle lithium battery shipment correctly. Tenor of the day: There are very safe lithium batteries. Some of them have passed the ExtraEnergy safety tests even better than certain NiMH batteries. But there are also very dangerous batteries on the market as numerous videos of tests and pictures of severe accidents demonstrated. With a fake newspaper article of a burning retirement home titled "Electric bicycles exploded, residents burned while sleeping" Mr. Neupert tried to emphasize the urgency of appropriate testing: "I hope we will never see such an article this in the newspapers. This will cause big damage to the market."

Hannes Neupert: "I hope, we will never see something like this in the newspapers" (Electric bicycle exploded. Seniors got burned while sleeping). This was a fake article to demonstrate the urgency of appropriate battery testing.

22 March 2007: Technology

Opening Speech by ITRI President

After the opening speech of ITRI President Johnsee Lee, ExtraEnergy presented the results of last year's Pedelec and E-Bike Test. Evaluating the results of 36 Pedelecs and e-bikes, Test Manager Frieder Herb, found that the power assistance factor (PAF) varies extremely from product to product. Surprisingly, he concludes that the assistance factor uphill is not closely correlated to the uphill range.

The following presentations included innovative LEV components such as the gearless hub NuVinci by Fallbrook Technologies from the US, which also works in combination with an electric drive unit. Motor controller design was takkled by Yen-Shi Lai from the Technical University of Taiwan. ID is renowned for its power sensors, which were presented by Gijs Roovers from the Netherlands. Bill Liou of GWA, Taiwan, reported on the latest developments in Battery management. Tai Lee of Taiwanese fuel cell manufacturer APFCT showed scooter and wheelchair projects involving fuel cells. Equipped with two canisters of hydrogen (100g), scooter range is a long 86km. Ed Benjamin and Mike Fritz from CycleElectric in the U.S. presented a data logger, which can be attached to various places on a vehicle for development and testing purposes. It helps to find and solve problems much faster than it would take without such a recording unit. For manufacturers and dealers it is a valuable tool to provide better products and better service. CycleElectric offers hardware including training company staff to use it. Last but not least Mo-Hua Yang from ITRI talked about applications and challenges of lithium batteries: smaller size, more options in vehicles design, thanks to smaller batteries, more vehicle performance requiring higher standards for batteries, materials and manufacturing process.

23 March 2007: Global Market and Legislation

Indonesia: New Market. Presented by Mario Rivaldi, owner of Betrix brand Ind.

The last seminar day began with a factory tour to Pihsiang near Hsinchu. Pedelecs, e-bikes, wheelchairs and small electric cars of Pihsiang are known under "Shoprider" brand name. The factory at which 200 employees assemble Shoprider electric vehicles was impressive with its well-organized production lines and fully automatic storage. Shoprider factory in China is said to be "only" 20 times as big …

Back to the seminar venue, markets and regulations in China, Europe, Japan, Korea, Taiwan, and Canada were on the agenda. Attention caught the plan of Panasonic to built underground parking lots for Pedelecs including charging stations. Above-ground parking lots are getting scarce in Tokyo, even for bicycles. For the same reason, Panasonic has established rental stations for the inhabitants of apartment buildings in Tokyo—there is not enough room for a bicycle for everyone.

In contrast to such progressive market activity, a number of provinces in China (Guangzhou, Fuzhou, and others) have prohibited the use of e-bikes because they are said to be too dangerous. E-bikes are faster than pedestrians and slower than motorbikes or cars, there are too many different speed modes on one road, which causes accidents. In most Chinese cities e-bikes are neither permitted nor forbidden by law. In these places and the provinces where e-bikes are expressively permitted, the market continues to boom. The rapid urbanization and motorization creates a large demand among the middle and low class. As Mr. Feng Liguang from the China Urban Sustainable Transport Research Centre reported, an e-bike is the most suitable means of transportation to fill the vehicle space between bicycle and car. In 2005, new e-bike ownership in China almost reached 15 million. With growing car ownership China is facing a serious problem: Traffic emissions already cause 60% of the country's air pollution. The government is taking measures to promote low emission energy saving vehicles—to the benefit of e-bikes.

Mario Rivaldi, owner of Betrix electric bicycle and scooter brand reported about a market that was almost unheard of before: Indonesia. With consumer finan-

ce offers, good products of different price levels, 24-hour hotline, home service, lobbying, a monthly Betrix magazine and the establishment of a Betrix community, Mr. Rivaldi has reached remarkable success in a potentially big but demanding market.

Further information: The three volume Conference Proceedings are available from ITRI in Taiwan or ExtraEnergy in Germany. The volumes on EnergyBus (March 20, 2007) and Battery Safety (March 21, 2007) cost 60 Euros. The volume on Technology and International Markets (March 22 and 23, 2007) costs 120 Euros.

ExtraEnergy.org
LEVConference.org
Susanne Brüsch

Conference Proceeding

HUMAN TRANSPORTERS

The most famous Human Transporter is the Segway and it has now found success in two niche markets. One market is law enforcement, where security staffs at airports and industrial plants are on the lookout for suspicious activity. Security personnel like the advantage to ride and observe crowds over their heads. A second market is the local tour business where tourists rent Segway's to travel around the White House for example. Segway has a new X2 model that carries a golf bag and thus is a one-golfer golf cart. Segway seems to be a real product with real customers and users that take advantage of the ability to travel quickly in tight places. The Segway, since 2005, uses Valence Technology Saphion® Lithium Ion batteries that doubles the range to 24miles (flat) or 15mile (hilly) compared to the NiMH batteries used in earlier models. Energy storage with Lithium Ion is doubled to 400Watt-hours and operating temperature improved to 14-120°F. This appears to be the first major product commitment to Lithium Ion technology in the LEV arena.

News reports state Segway has sold over 10,000 units worldwide, since 2001, with 50% per year growth the past two years. International sales are now 40% of the business in 2006. In London, police on Segway's responded to the Islamist terrorist bombings in the summer of 2006, and bomb squads with heavy gear used them to advantage. The latest 2X golf Segway has Valence Technology Saphion® Lithium Ion batteries with range of 14 miles, good for 36 holes, and top speed at 12mph. Individual golfers have their own Segway, so theoretically they can speed up their play. The 2X also can turn by the rider leaning left or right rather than rotating the Lean Steer frame as on the original Segway. Forward and backward leaning by the rider moves the Segway forward and backward. The system

JAPB Human Transporter
150W/24V/17Ah 20kph

JAPB Traveler Transporter

uses five gyroscopes and several tilt sensors with sophisticated electronics to make this work. Tourists must learn to use the Segway successfully pretty quikkly which suggests that mass appeal must be just around the corner, provided the price point comes down from the current $4,000 to $5,000 range. There are examples of "copy cat" Segways in the Asian market that are lower cost but with much less sophisticated technology. Most of those Human Transporters are three or four wheel stand-up electric scooters with no gyroscopes or sophisticated electronics. The next 3-5 years should determine if the Segway can jump from 10,000 units to 100,000 units of yearly sales. Stay tuned.
www.segway.com

Golf Segway

Hirun Tri-Board

Tourists on Segways

Zhejiang Yiyang H. T.

Angell Transporter

Blue-Ride™ Human Transporter Enters the Market

It is recognized that Segway has created a new market for stand up electric human transporters and sold many thousands of units. Police departments, security companies, rental outlets, and large campuses have purchased some units and have budgeted for more. Thus this newly created marketplace is wide open for newcomers. RideVehicles LLC is launching a new Human Transporter called the Blue-Ride™ that will compete with the Segway. The Blue-Ride is easier to operate, requires no instruction, is faster, has a longer range, carries double the payload, has more features, and is simply more fun to ride. The Company's proprietary eRide platform is very stable with three wheels. Just rotate the handlebar to turn. A throttle and hand brake provide control and all the electronics are weather resistant. With the lead-acid battery pack, the Blue-Ride will travel at 18mph for 20 miles. With the optional Lithium Ion pack, it goes 25mph for 50 miles. It has a 1.5kW 48V brushless PM motor and weighs 220 pounds with a maximum payload, including rider, of 450 pounds. The Blue-Ride expects to be well received in the marketplace. The Blue-Ride sells for $4,495 through a limited number of premium distributors of industrial and municipal equipment. RideVehic-les is initially targeting law enforcement and private security companies with the Blue-Ride. The company has also designed versions that it plans to market to the Industrial, Military and Postal sectors. Blue-Ride and Segway will be an interesting competition to observe. Stay tuned to see if HTs can enter the domain of EB sales in the millions.
www.RideVehicles.com

Blue Ride Police Version

Blue Ride Human Transporter

Blue Ride Logo

TRES TERRA

The TresTerra brand of E-Bikes is the result of veteran E-Bike guys, Ed Benjamin and Mike Fritz, believing that they have learned enough about E-Bikes to build good ones and to import and sell them successfully in the USA. The TresTerra line includes 3 models (Jan 2007) that use Heinzmann hub motors, Lithium Ion batteries, and production is located in a Taiwanese owned factory in Longkau, China. The bikes have a two-year warranty, are sold only through dealers, and are designed for practical commuter use on a daily basis. Basic performance is 20mph for about 20 mile range with a 200 pound rider, and the bikes do climb substantial hills. Based in Newbury Park, California, the company has completed its first year of operations and is primarily selling in Southern California and Florida with very positive customer satisfaction.

TresTerra Europa

TresTerra Callisto

Ed Benjamin
American Electric Cycles and Fitness
TresTerra Brand Human Electric Hybrids
www.tresterra.com

CURRIE TECHNOLOGIES

Currie Technologies, one of the original pioneering EB companies in the USA founded in 1997, continues to have success with sales of electric bikes and electric scooters distributing them under the IZIP™ and Mongoose® brands on EBs, and IZIP™, Meerkat™ Schwinn®, Mongoose® Dyno® and Powerlite® brands on scooters.. In late 2005, Currie began to expand their offering of IZIP™ brand, Electro-Drive™ hybrid electric bicycles and now include some models of bikes and scooters with the newly introduced Fallbrook Technologies NuVinci brand CVP transmission and has expanded their electric bike line to include over 15 models of hybrid electric bikes and over 12 models of electric scooters. The Currie electric scooters are sold in the Mass, Sports Specialty and Dealer channels and are priced in the most popular $199-$499 price range. After an explosive market growth in 2003-2004, sales declined in 2005 but have rebounded nicely in 2006 and are expected to grow in 2007.

Currie iZip Intercontinental

Currie HG1000

Electric bikes at Currie are focused on all sales channels, the Independent Bicycle Dealer, the Big Box Sporting Goods Retailers and the Mass Market Retailers. Some models use Safion® Lithium Ion batteries by Valence Technology, NiMH batteries and lightweight hub motors, with total bike weight in under 44 pounds. The Lithium batteries are neatly stowed in the down tube with built-in charger plug. In the past, Currie EBs were throttle controlled, "Twist and Go". The 2007 models have two new control systems: 1. cadence sensor and a throttle or 2. new pedal torque sensor that reads cadence and torque, without a throttle. So the motor is pedal actuated in both systems like the classic Pedelec.

Typical specs for Currie EBs vary by model but are: 450 watt motor, 24V Lithium Ion or NiMH battery or lead-acid with 10 Ah capacity, range of 20 to 40 miles and top speed of under 20 mph. The Fallbrook NuVinci™ CVP transmission provides a seamless variable gear ratio change (400%) that makes for a smooth effortless

ride on the Curie EB and some scooter models as well. Currie Technologies has made two significant moves that bodes well for their future success. One was to move into the sporting goods and mass retailer outlets that greatly expanded their customer base and the move to use Lithium Ion batteries and the NuVinci™ continuously variable transmission by Fallbrook puts them at the forefront of technology that should bring customer satisfaction.

Larry Pizzi, CEO
www.currietechnologies.com

Currie Mongoose MTNAL

PACIFIC CYCLE ENTERS EB BUSINESS

Pacific Cycle Inc., a division of Dorel Industries Inc., is a global leader in branded consumer products, is entering the EB business in the spring of 2007. Pacific Cycle designs, markets and distributes high quality bicycles and other recreational products around the world and includes the following brands: Schwinn, Mongoose, GT, Kustom Kruiser, Roadmaster, Pacific, Dyno, Powerlite, InSTEP and Pacific Outdoors. Pacific Cycle sells more bicycles than any other company in North America and sells products in more than 60 countries. U.S. distribution channels include leading mass-market retailers such as Wal-Mart, Target, Kmart and Toys "R" Us; sporting goods chains such as Dick's; and independent bicycle dealers that serve local markets.

This is a significant step since Pacific Cycle is a big player in the US market as well as Europe and could foretell a major increase in EB sales in the USA.

The Schwinn brand offered electric bikes provided by Currie Technologies in 1998-2000 but now only offer electric scooters provided by Currie. The new line of EBs were developed with the worlds market leader in high end electric bikes, Protanium LTD of the Netherlands. Three Schwinn-Protanium models are to be launched in the spring of 2007 in the USA. Eleven Schwinn-Protanium models will be launched in Europe. The Pedelec type will be marketed in Europe and the E-Bike type will be marketed in the USA and Canada. These will all be made in Asian plants with Schwinn-Protanium high end Technology. Motor power for USA models is 400 watts and for EU is 250 watts.

The hallmark of the Schwinn EBs is the use if compact Lithium-Polymer batteries (24V 10Ah) that sit in a box mounted on the rear rack with a plug-in connector making it convenient to remove to charge. The advertised nominal range is 40 miles. The front-mounted hub motor rated at 400 watts for the USA bikes and 250 watts for the Europe bikes reflects the power desires of the customer. Top speed is stated to be 20 mph and overall electric drive system weight is a low 8 pounds. Battery life is more than 1000 cycles that is the new benchmark for electric bike batteries. The Schwinn-Protanium Ltd battery is a state of the art Lithium-Polymer battery, the most stabile on the market because of a unique cell design.

Chris Holmes-Schwinn USA / Brian Hoehl Protanium Ltd.
www.pacific-cycle.com


Schwinn Campus


Schwinn CONTINENTAL


Schwinn SPEEDSTER

OPTIBIKE

Optibike LLC designs and builds High-Performance Electric Bikes in Boulder, Colorado. The Optibike 400 features Fox Front Suspension Forx and Fox Rear Airshox with Avid Disk Brakes front and rear. The aluminum monocoque frame houses a 13Ah 36V NiMH battery pack. The 400 watt motor in the patented motorized bottom bracket drives the front chain ring and runs for 75 minutes at full power with a top speed of 34 mph. Standard operating range is 30 miles and with a 13 Ah NiMH (standard) and is available with various upgrades with a max range of 100+ miles at full speed. Craig Weakley won the NESEA Tour De Sol with twice the mileage (60 miles) than the second place finisher in the 3 hour range event. The new 2006 Optibike offers a quieter motor, and more efficient controller designed to increase the already industry leading riding time. Optibike became the first E-bike to climb Pikes Peak in Colorado. The highest road in North America has a 7,200 ft climb, over 19 miles, and the Optibike raced to the top in one hour thirty minutes at an average speed of 12 mph with an average grade of 17% (maximum 55%). Optibikes are now available direct and in dealers with hand built production started in 2006.

Craig Weakley
www.optibike.com

Optibike

RUN ABOUT CYCLES

RunAbout Cycles is a relatively new company, now located in a factory space in Florence, MA, that builds the rugged RunAbout electric recumbent tricycle. Speed is 20mph with range of 40 miles on flat terrain from carrying extra large batteries. Batteries are either round Hawker Cyclone deep discharge 36V lead-acid, or a Valence Lithium Ion option, that allows the 300 pound RunAbout to accelerate smartly and run to 20mph. The RunAbout can run in reverse and has full suspension along with regenerative braking. The new 2007 Spincycle uses a Cyclone 500 watt Brushless motor, with power being transmitted through the bicycle drive train. Utilizing the derailleur, the rider can change the motor toque at will. Each bike comes equipped with the Brain Drain fuel meter, which also has a speedometer to help calculate amp hours per mile. Valence Lithium Ion batteries are recommended for best long term value, providing the rider with a 30-40 mile range per charge. Projected ramp up for production could produce 2-5 thousand units in 2007. The rugged Spincycle could fit many commercial and law enforcement applications. RunAbout Cycles enhances the cycling experience with appropriate assistive technologies.

Joshua Kerson
josh@runaboutcycles.com
www.electric-cycle.com

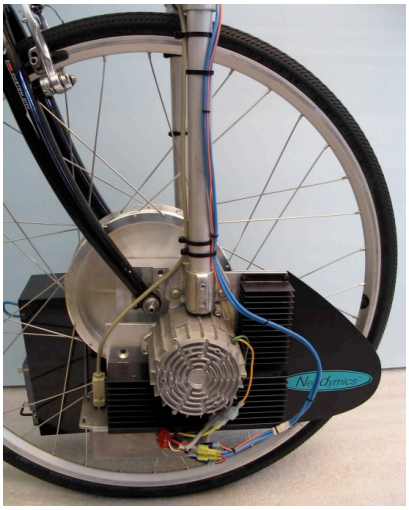
RunAbout Cycles Trike

NEODYMICS™

The Neodymics™ system for converting most bicycles into an electric bike includes an integrated propulsion system that replaces the front wheel on any standard bicycle. It integrates the batteries, motor, transmission, drive electronics, and control mechanism into a design that allows simple installation. The “power on demand” control mechanism is fitted to the bicycle steering column on an arm extending down to the drive electronics. Attachment or removal of the self-contained and self-propelled wheel is then instantly accomplished without tools using a standard quick release assembly.

Neodymics patent pending design provides several advantages. The bicycle center of gravity is moved closer to the pavement for better handling than other motorized drives. The powertrain is dust shielded and water resistant. This design does not change the original aesthetics of the bicycle, and allows for quick removal of wheel for charging, security, or protection from the elements. The original drive train is not altered, so that pedal propulsion is always available. The battery pack may be independently removed, with-out use of tools. This enables range extension by multiples of battery packs that may be stored on the bicycle rear during long rides, or at a commuting destination.

Neodymics Battery



Motor in Neodymics Motor Controller

The Neodymics electric bike conversion kit is moving from prototype to production with these specifications. The battery pack uses Saft NiMH 8A-h cells which provides range of about 30 miles. Powered speed range is 10 to 27 mph, although the maximum will be limited to 20 mph to comply with electric bike regulations. The 750W 36V brushless motor is manufactured by Trans-magnetics. Total system weight is 45 pounds but the production unit will be significantly lighter, and may use a different motor and battery. The latest system incorporates a suspension to isolate the rider from vibration due to road imperfections. This is especially important at high speeds

Jeff Radke
www.neodymics.com

GO-KID E-QUAD COASTER

Go-Kid, Houston, Texas, continues to innovate with four- wheel electric push carts that are sit-down or stand-up models. The original coasters were sold to professional football stadiums and used by team mascots during the game. A new high performance E-QUAD is under development that uses a twin 500W heavy duty chain drive with four wheel disc brakes. It will be more powerful than a golf cart with better visibility in the standing position. An improved steering system is incorporated and it has tough NiCd batteries to take the southern heat. As the photos show, Go-Kid has built a variety of custom four-wheelers. Go-Kid will have a Push/Kick version produced in Shanghai emphasizing high quality and marketed through mass retailers. Speed range is 10-20 mph with travel range 10 to 20 miles depending on battery pack size. The Go-Kid seems to be developing a new niche vehicle between the NEV and EB.


Go-Kid Quad


Go-Kid Quads

www.gokidusa.com

NEW SECRET AUSTRALIAN EB FOLDER

Bike-eZe Pty. Ltd., of Gold Coast Queensland, Australia, is developing a new EB design that will fast track the evolution of the electric bicycle with a design based on similar architecture principals to the automotive field. This design will allow several models or frame styles to be made from the same architecture, therefore being the first bicycle frame to be adaptive in style choice with a huge benefit being ultimate eze of manufacture. Bike-eZe has redesigned the EB with commuting and public transport users in mind, with a steel alloy, folding frame. This EB is the first serious option as an ultimate transport connector vehicle that can be taken on plane, bus, train, ferry, or the boot of your car. Its strong unique design is suitable for military applications, such as being air dropped from a plane with parachute attached. The key to the design is the unique mechanical design details that are being kept very secretive to date, but this frame utilizes mostly existing components. The eZe uses an in hub motor and is variable to suit different country regulations as simple as changing the rear wheel, regulator and controller which is done with eze with this design. The design will allow use of other motor/battery combinations to achieve a wide range of performance and price points. Bike-eZe is in development stages and is working to develop a partnership, or to license the design to a leading brand name manufacturer of quality electric bicycles. Bike eZe believe this breakthrough in frame design alone will lead bicycles into the next generation of stylish individual transport option for the discerning public. EBWR awaits the secret to be disclosed and plans to report it.

diane.george@bigpond.com.au

Series Hybrid E-Bike (SHEB)

In a series hybrid (SH) cycle human power is converted into electric power using a pedalled generator. In “chainless” SH cycles, the chain or shaft drives are substituted by pedalled generators. For maximum efficiency, during the ride, pedalling power is fed directly into the electric motor, not into the battery. The battery however delivers current while the pedalled generator accelerates from stand still to nominal cadence. The motor of a SH cycle delivers about twice the torque of a parallel hybrid cycle motor because the SH cycle has to start (on hills) without the help of a chain or a shaft drive. The SH cycle is very well suited for elderly or handicapped users because every mode of operation is possible between 0 and 100% pedalling effort. The photo shows a Series Hybrid EB drive system (no chain drive) on an AnthroTech trike. It was built by Fuchs and colleagues in collaboration with Brueggli.ch; supported by Swiss Federal Agency of Energy.

The SHEB was tested to over 35 kph in the flat and up to 10 percent slope. On the slope, the motor control and motor stayed so cool that it was hardly possible to feel any heat with the hand. So the SHEB could even go much steeper. In about one hour of stop and go riding the battery was not yet drained. One hour stop and go is sufficient for most practical riding purposes. Thus the utility and practicality of the SHEB concept has been demonstrated. Technical specifications are: Motor peak power: 1.2 kW (DiscPower motor by www.permmotor.de), effectively use about 800W, Pedal generator nominal power: 150W (Concept A. Fuchs), Battery: NiMH, 36V, 15Ah (Saft). Originally the SHEB project was funded by autork but activities on SHEB stopped in February, 2005. Andreas Fuchs continues to develop SHEB technology and, with partners from www.swissmove.ch, to develop Intellectual Property. They are looking for business partners interested to license patent US7,156,780 and the corresponding EP patents.

Andreas Fuchs, PhD
andreas.fuchs@bluewin.ch
History -
http://en.wikipedia.org/wiki/Series_Hybrid_Cycles
Project Details -
http://mypage.bluewin.ch/fuchsbau/sheb.htm

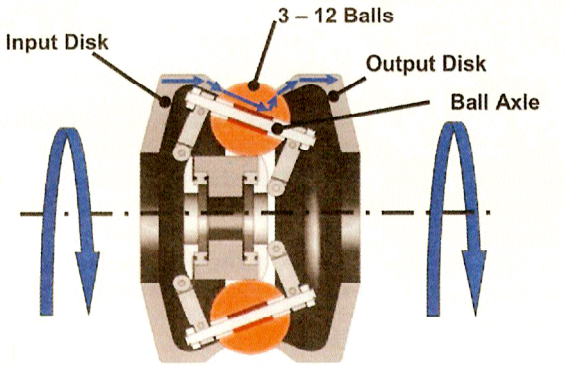
SHEB Series Hybrid EB

NU VINCI™ CONTINUOUSLY VARIABLE PLANETARY TRANSMISSION

Fallbrook Technologies Inc., San Diego, CA, has developed the first commercially viable CVT (continuously variable transmission) for the LEV industry. Fallbrook's patented NuVinci™ Continuously Variable Planetary (CVP) can give LEVs extended range, improved acceleration, enhanced battery life, greater hill climbing capabilities, and better performance under load. It provides a superior riding experience with smooth, continuous and thus seamless shifting.

The NuVinci transmission uses a set of rotating balls positioned between the input and output components of the transmission. The balls tilt to vary the speed of the transmission. This changes their contact diameters and varies the speed ratio. As a result, the NuVinci CVP offers seamless and continuous transition to any ratio within its range. The NuVinci CVP is particularly suitable for LEVs because it is less complex than conventional CVTs (Continuously Variable Transmissions), offers more stable control, is easily packaged either in the rear wheel or at the motor, and is less expensive to manufacture and assemble.

For LEV designers and manufacturers, NuVinci technology enables a whole new generation of LEV designs. NuVinci technology will be a key product differentiator that delivers a significant competitive advantage. With existing fixed ratio drivetrain technology, LEV designers now must make a tradeoff between top speed (a major selling point), acceleration/hill climb capability, and range/battery life. Reducing costs while increasing top speed usually means giving up hill climb and acceleration capability, or range and battery life, or some combination of all of these characteristics. The NuVinci CVP eliminates this compromise. For the rider, NuVinci technology creates a new and exciting LEV experience, complete with a smoother ride, superior hill-climbing ability, extended range and battery life under most driving conditions, and true shifting under load or at a complete standstill. With these enhancements now made possible, LEVs can become an enjoyable commuting alternative to the automobile. Fallbrook has signed a license with Aftermarket Technology Corp. (NASDAQ:ATAC) to manufacture the NuVinci CVP. It is being used by Currie Technologies in their electric bikes and scooters. Other applications are being discussed.



NuVinci CVP Schematic

Emile Barrios
www.fallbrooktech.com

Historical Picture

Indianapolis Solar Bike Race 1995
Hannes Neupert ExtraEnergy, Frank Jamerson

Indianapolis Solar Car Sunrayce 1995
Howard Wilson VP Hughes Retired, headed 1987 GM Sunraycer solar car team,
Bob Stemple CEO General Motors, Retired
Ken Baker Program Manager GM EV1 (Frank's last GM boss)
Frank Jamerson Electric Battery Bicycle Company

Section 5

Marketing and Servicing Electric Bikes

Overview

Schwinn SPEEDSTER

Currie HG1000

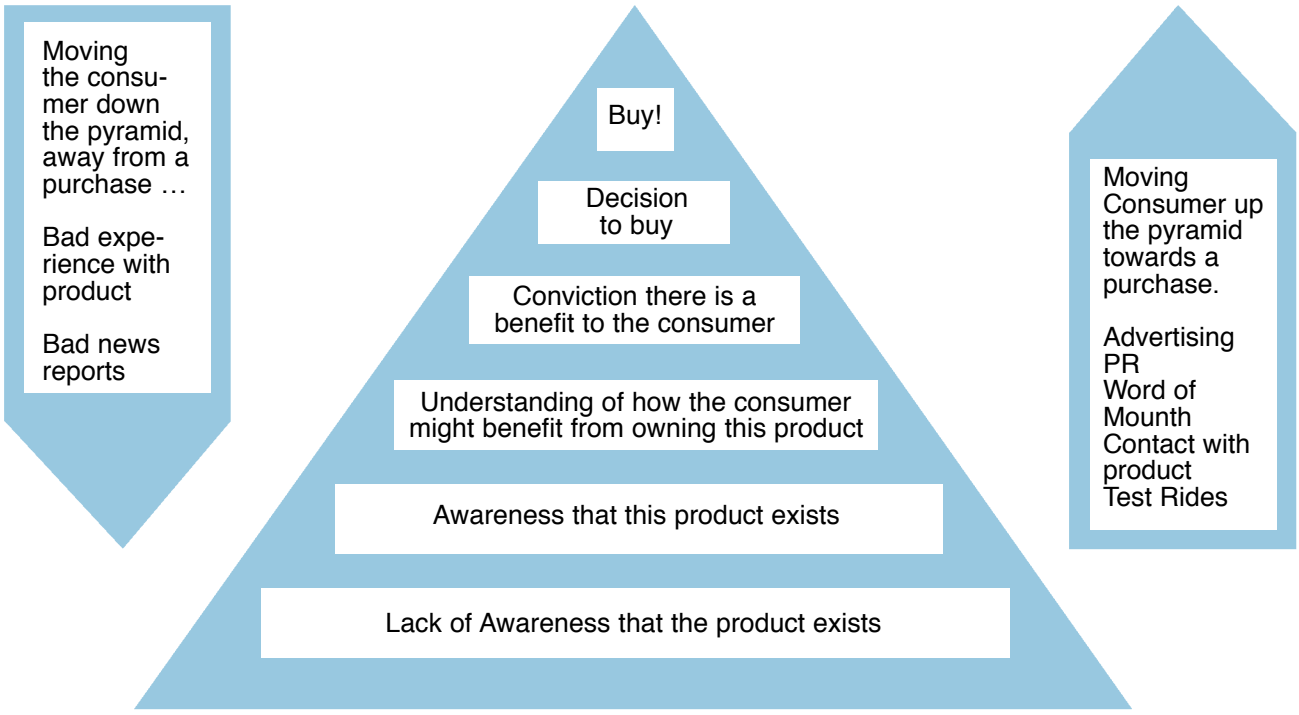
Sales of any product will grow if it provides good value for the purchase price and if the marketing and servicing experience is pleasant and hassle free. This occurs with mature products, in general, that have honed their skill to make all these attributes work to entice the customer to purchase. In the Light Electric Vehicle business, particularly the electric bike and scooter, the industry is just turning 10 years old with growing pains and "learning how to do business" is still the norm. In EBWR04 Ed Benjamin wrote a classic piece on the "Marketing of LEVs in the USA" that has many universal truths about the electric bike and scooter. A segment of that article follows. Eric Sundin, EV Northwest store owner, reports on his growing success in marketing EBs in Seattle, Washington and identifies the customer as wide ranging in background and age level suggesting that EBs can find a broad customer base. NYCE Wheels in New York City continues to offer electric bikes to a growing Manhattan clientele. Chen Ding Wu, owner of EV Sales Service Co. Ltd., Shanghai, China, provides some figures on what the Chinese customer spends on service for an EB. One third of the Chinese EB owner's expense for a year is spent on service. That confirms that many Chinese made EBs are not up to reliability expectations as in the USA market. The final article by Mike Fritz, TresTerra Chief Engineer, explains the importance of Owners Manuals that are clearly and simply written so that the customer and repair shop can properly maintain the electric bike according to the manufacturer's instructions. This is essential to provide customer satisfaction and to continue sales growth.

TresTerra Europa

Marketing of LEVs in the USA

Most consumers do not know of any reasons why they would want to buy an electric bicycle or scooter. There may be reasons, but they have not thought of them, and no one has suggested these reasons to them. The technical features are not known to them, and certainly do not cause them to make a buying decision or not.

In its simplest concept, marketing involves the movement of a consumer from a "lack of awareness" to a "buy decision". There is a continuum of awareness and product interest that the consumer experiences and can be visualized by the pyramid diagram labeled "Marketing Continuum". All consumers start at the bottom of the pyramid. Advertising and other events move them up, closer to a buying decision. Bad press and other events can move them back down the pyramid. All consumers must pass all of these stages to become buyers. Usually, an advertisement or test ride, or other experience will only move them up one or two levels.



The normal way that most of the world learns about a new product, and the reasons that they would want to buy that product, is through marketing. The major tool of a marketing campaign is advertising. Most new products that succeed today are supported by advertising campaigns that educate the target consumers about the benefits to them that they will enjoy if they buy the new product. Western cultures, in particular, rely upon advertising to notify them of such opportunities to improve a consumer's life. And if there is no advertising, the new product is largely invisible to most consumers. In the case of electric bikes and scooters the numbers of units that exist in the world are so small compared to the world population that consumers rarely have a chance to see, test ride, or talk to a person who has seen or test ridden an electric bike or scooter. This is improving – most Americans now know what an electric bike is, and most have seen a mini electric scooter on the street. But learning about these products has been slow and disorganized.

Retailers are the primary source of the advertising that does exist. The most effective is probably that done by catalog merchant Sharper Image in the USA. Most editions of the Sharper Image catalog have carried an electric bike or scooter product since the mid 1990s. This is the longest running and most successful advertising campaign that the author is aware of. But this is not enough to create an industry – and most of Sharper Image's effort has been on stand up scooters aimed at youth.

Examples of focused marketing campaigns would be:

1. Select a city that is particularly well suited for light electric vehicles – flat roads, bike paths, warm weather, and affluent population. Create excellent relationships with a few local retailers – or open company owned retail stores – and advertise with a mixture of TV, print, and outdoor media to a level that reaches all possible customers. Keep on this campaign and adapt as lessons are learned until sales are satisfactory. Then expand out of this market slowly.

2. Select a niche – such as Pedelecs as an exercise machine. Use a product especially well suited to this (such as the Canada BionX bike), create studies in cooperation with credible medical authorities to back up claims, and advertise via TV Infomercial. Sell direct to the consumer.

3. Select a demographic – such as RV Owners. Attend applicable events, advertise in magazines and TV focused on this demographic. Distribute via RV dealers and direct to the consumer.

Marketing of electric bikes and scooters is still evolving and the newest twist to increase demand is the high price of oil and thus gasoline in the USA and most countries worldwide. This is projected to continue to increase and that should move more customers to look at the EB and ES as a low cost transportation alternative and the best marketing and servicing companies will be the winners.
Ed Benjamin

Retailing Electric Bikes in the U.S. in 2006 - Electric Bikes Northwest, Seattle

2006 marked our company's 10th year in the quaint pursuit of hawking electric bikes. Ideally this should be the occasion on which to report fame and fortune. No fame has been attained but electric bikes do encounter less ridicule as the years go by. In a few places, such as in Seattle, the electric bike has actually attained an enthusiastic following. In 2006 I had the privilege of participating in the LEV Conference that ran concurrently with the fabulous Taipei Bicycle Show. In attendance were of course, EV, transportation, marketing, and other folks from around the world. No doubt we shall at some point see a proliferation of LEVs, while our own company looks at the electric bike as primarily and uniquely 'human power augmented' first, and electric second. Thus I did not come away with much more than the distinct impression that what the U.S. electric bike market endures is a mere and minor reflection of the industry at large. A mixed U.S. market picture emerged in 2006. Sales were up and only to a limited extend due to higher gas prices as more commendable reasons for acquiring an electric bike abound. On the other hand sub-optimal brands with correspondingly deplorable product support again came and went. Meanwhile, here such offerings rarely improve the public's perception of the electric bike.

Our internet sales were down in 2006. We suspect that some customers shall unavoidably gravitate toward a $400 web offering even though $400 barely buys a quality pedal-only bicycle. However, in today's consumer society it is perhaps not what actually is that is, but rather what we want it to be? So why should not a drive system be 'included free' so to speak? Or perhaps our longstanding high web visibility is no match for those merchants paying for per click ads? Be that as it may, our in-store sales increased to handily offset the downturn in internet sales. In the last few years we sold only pedal-activated models, a design we admit partiality toward. But in 2006 we finally brought in a new throttle controlled make with consumer response and sales way beyond our expectations. While the trusty sealed lead acid battery absolutely has its uses we sold only bikes with NiMH and Lithium batteries. Our experience with NiMH has been highly satisfactory over the last few years as was our first year with Li-Ion.

Our days of offering kits ('adaptable power systems' would perhaps be a more descriptive term?) are behind us because we have found better quality and value offerings in, and demand for, fully integrated electric bikes. And far from all kit installations turn out well. That said, the adaptable system clearly has its applications. Hapless owners continued in 2006 to attempt to drag their rather dismal odd brand electric bikes and kits in to our service department. We service only brands we currently sell (while of course supporting our own early customers of brands we have discontinued). Frankly, it cannot be our job to encourage sub-optimal and cavalierly 'supported' brands. Thus the U.S. market still leaves much to be desired. Reliability and service

issues abound. Bikes are amazingly and routinely shipped with safety issues. Some web claims about quality, performance and support continue to be wildly overenthusiastic at best. As far as what constitutes 'consumer readiness,' criteria vary of course. Personally I came to electric bikes from earlier careers flying planes and later operating cargo ships around the world. While I appreciate that malfunctioning electric bikes rarely fall out of the sky or sink to the bottom of the sea I remain, ten years later, thoroughly puzzled over how few 'consumer ready' electric bikes the U.S. market offers.

For consumer-ready electric bikes there are however good prospects. 2006 proved again that it is not a niche market item. We continue to see an amazingly broad customer base: Athletic riders and those far less so; those with and without ailments; young, middle aged and nominally old; women and men (close to 50-50); serious cyclists and those who rarely ride a bike; commuters and recreational riders; those having sworn off the car and those experiencing gridlock in their own driveway; PhDs and high school dropouts; technical wizards and those perhaps challenged changing out a light bulb; those for whom the electric bike is a cheap toy and those for whom it is a barely affordable car substitute etc. Are they all Environmentalists? The answer is either 'yes', as just about all of us claim to be for a clean environment regardless of how recklessly we hasten global warming and deplete resources. Or 'no', because many of the pronounced greens seem too busy driving to meetings to learn how to not drive so much. In any case we are usually spared the impulse buyers and those who overly need to live vicariously in a product. Instead we are privileged to have largely self-motivated, independent-thinking, positive and gracious folks as our customers. This aspect of the business has been most enjoyable.

What is needed for greater U.S. consumer acceptance and sales in 2007? Apart obviously from advertising (and we do not see anyone with the resources to make a national impact) above all for now: reliability and serviceability.

Electric Bikes
Northwest - Seattle, WA
www.ebikesnw.com

eric@ebikesnw.com
NYCE Wheels - New York

NYCE Wheels, located in Manhattan, is the premier electric bike and scooter store in New York City and has a growing clientele of business commuters who can usually get to work faster than with any other mode of transportation. The store carries a nice mix of products. EB brands include the Giant Lite and Suede, six eZee models including an EB folder, and the ElecTrec. Mini Scooter brands include Go, Pacelite, GoPed and LashOut. Their most recent addition is the Giant Suede-E. It features three different modes of riding. Pedal assist mode allows you to either do all of the work or have the motor provide 30% of the effort, or provide 50% of the effort. While riding, the throttle allows for a power boost. If you don't want to pedal, simply hold the throttle down for about 3 to 5 seconds, at which point the motor will take over and you can cruise. Simply hitting the brakes will put you back in pedal assist mode. The Suede is a lighter electric bikes and it has lots of torque. New Yorkers really love electric bikes.

www.nycewheels.com

Ezee Quando

GoPed ERS750 Sport

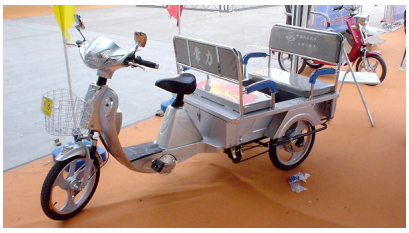
Pacelite Mini Scooter

Electric Bike After Sales Service Market in Shanghai

The after sales service business is a big share of the LEV business in China. Chinese consumers have different expectations from those in the USA, EU and Japan. One third of the expense of an EB is spent on service every year. This includes the following RMB estimates for each component: Batteries 350, Tires & Inner tube 90, Controller or Charger 100 each, Throttle 35, Brushless Motor 380 every 2-3 years, Brushless Motor and Controller 200 each every 1.5 years.

The sale of 12 million EBs generates 24 billion RMB in sales. EB repair sales are around 6 billion RMB. The consumer expects to use the EB for 5 years and will pay a total of around 5,000 RMB for it that includes 2,000 RMB initial price and 3,000 RMB for service during those 5 years. For each EB unit the profit margins are greatest for the service operator. Margins in RMB are estimated to be: manufacturer 100-150 RMB, retailer 100-150 and repair service at least 200.

Competition for the small EB repair shop is tough and includes the EB retail shops that also are authorized by a bike association. The retailers are beginning to understand that the repair business can be very profitable. Manufacturers are also trying to improve product quality to reduce repair service. Factory authorized repair shops were started in 1999, and are displacing small shops. These authorized repair shops also provide service for large retailers. Selling components for the EB is also a good business for the repair shop and retailer. The price of these components increases as they move from the original equipment manufacturer (OEM) to the end user. Listed are prices for motors in recent years. Brush motors are warranted for 2 years and brushless motors for 5 years.



EB Cab

Motors

Year	1999	2000	2001	2005
Price in RMB	Brush-Gear		Brushless	Brush-Direct Drive
OEM	430	300	300-220	250
EB Distributor	700	500	650-600	500
Component distributor	450	320	370-240	270
Repair Shop	580	450	500-380	350

Mixing components from different manufacturers can cause problems, for example the controller will work best with the throttle and brake system for which it is designed. Prices for components have been coming down. Controller for a brush motor was 180 RMB in 1999 and 22 RMB in 2005. Throttle was 19 RMB in 1999 and 2.5 RMB in 2005. Brushless motor controller was 180 RMB for a 180W motor and in 2005 was only 90RMB for a bigger 350W motor. The throttle and brake warranty is 6 months and the controller warranty is 1 year. But these different warranty times make it difficult and confusing for the customer and repair shop both. Lead-acid batteries are the most common on EBs in China. The Amp-hour rating is from 10 to 16Ah. Prices also have become lower in recent years.

Epanther

Batteries Lead-Acid 10-16Ah (Price in RMB)

Year	1998	1999	2002	2004
OEM(price)	95-90(14-10Ah)	120	115-90(16-10Ah)	85-68
EB manufacturer	160-150(14-10Ah)	200	120	150
Repair Shop-Bike Shop	135-125	160	115-110	140-90

Batteries come with a 1 year warranty to achieve 60% of capacity at the end of that first year. The top 3 battery makers should not have more than a 10% warranty cost. Most problems with batteries result from problems with the controller, motor, bike weight and charger. The battery charger is very prone to problems with high failure rate though it has a 1 year electronic warranty.

Plastic Body for SSEB Price in RMB	1999	2000	2002	2003
OEM	180	280	300	400
EB Manufacturer	400	500	600	900
Retail Shop	420	550	650	950

The bicycle frame carries a two year warranty and there are complaints about crank and other parts of the bicycle also. Many EB manufacturers do not have experience with bicycle parts that leads to the customer experiencing problems. The most popular style of EB is the Scooter Style that has lots of plastic in it to accommodate that design. Many different EB manufacturers buy the plastic bodies from a single OEM. The SSEB has a higher price and the plastic components to these models have been increasing in price in recent years.

The EB industry in China is very young and currently lacks skilled technicians, and does not have standard components. Though EB sales have grown dramatically, the support and service infrastructure has been growing much slower with the consequence that the customer does not have a good service experience. There has to be a significant improvement and Shanghai must lead that improvement. Better education of the work force is needed to make good quality electric bikes at the OEM level and the service and repair industry has to improve to provide high quality repair service as well.

Whirlwind

Chen Ding Wu
EV Sales Service Co. Ltd.
Shanghai, China

OWNER'S MANUALS:

A component critical to customer satisfaction.

Electric bicycles are relatively new products in the marketplace. While enjoying explosive growth in China, sales are growing in the North America and Europe. Manufacturers who sell to regions outside China should understand that effective communication with the customer is essential if the customer is to have an enjoyable product experience. The Owner's Manual is the communication medium. The basic and important elements of the Owner's Manual are described here.

The objective of an Owner's manual is to inform the customer of the essential features of the electric bike to operate it comfortably and in safety. Another objective is to provide instructions on how to repair minor problems and how to handle major problems. It is incumbent on the manufacturer and/or distributor to make sure that the instructional and reference materials given to the consumer are accurate and comprehensive. Thus the content and quality of the Owner's Manual is critical to the long term satisfaction of the customer for the product purchased.
A good Owner's Manual addresses several important topics:

1. Cautions and warnings intended to emphasize the importance of safe operation and preventative maintenance
2. Specifications and performance characteristics
3. Guidelines for safe operation
4. Care and maintenance
5. Troubleshooting
6. How to reach Customer Service
7. Warranty

1. Cautions and Warnings
Cycling (electric or otherwise) can be a hazardous activity, no matter what type of bicycle is ridden. Mistakes and accidents can lead

TresTerra Europa

TresTerra Callisto

to severe injury or death. We have a moral obligation to do whatever we can to protect our customers form injury. Further, we live in a very litigious society. Manufacturers and distributors of bicycles are exposed to liability claims when their customers are injured. A common element in a legal cause of action is an allegation of failure to warn. A general principal of safety and liability prevention is "If you cannot re-design your product to eliminate a potential hazard, then you must effectively warn the user against that hazard". We must warn the user about these potential dangers.

Every warning has three key elements:

1. A warning in an Owner's Manual must be clearly identified as a warning. Symbolism, colors, text font, etc., are all common ways of calling the user's attention to the fact that this is important information that can save his life.
2. The warning must give specific information about the hazard, and specific guidance as to how to avoid or mitigate it.
3. Finally, the warning must describe the potential consequences of failure to heed the warning.

Points 1 and 2 are straightforward. Point 3 forces the Owner's Manual author to include those terrible words, "Failure to heed this warning may result in an accident resulting in property damage, serious injury and death." Product managers hate to imply that their products can lead to serious injury or death. However, we must emphasize and reemphasize the serious nature of these instructions.

2. Specifications and performance characteristics

Specifications are important. An electric bike is different than a conventional bike. It utilizes components and technologies unfamiliar to the typical bike-oriented consumer. Despite the fact that we are all surrounded by electric motors doing everything from brushing our teeth to rolling up our windows to keeping our beer cold, few of us appreciate how ubiquitous and important motors really are. Motors introduce new terminology to the user: "power", "torque", "brushed" or "brushless", etc. The same holds true for batteries. "Lead-acid", "Nickel-Metal-Hydride", "Lithium-Ion" and "amp-hour capacity" are all new terms very relevant to the value inherent in the bike, yet completely foreign to the non-technical user. A brief explanation of each concept, in layman's terms, is very helpful in enabling the buyer to understand the capabilities and limitations of his bike.

Up until now, a lot of e-bike purchasers (early adopters) were technically astute, and understood the implications of these parameters. We are now beginning to appeal to a broader range of customer, most of which haven't a clue as to what these mean. A clear explanation of what the electric bike can (and cannot) do in term of performance is important. Top speed, maximum range, acceleration and hill climbing capability are all performance characteristics that, whether or not the customer appreciates it, will be critical to his level of satisfaction regarding this purchase.

This **IS NOT** the time for 'puffery', or making exaggerated claims. I once worked for an e-bike company whose marketing personnel thought that "15 miles per hour for 15 miles" was a 'catchy' advertising claim. The problem was that the bike could do neither 15 mph nor travel 15 miles per charge on the best day. Larger-than-normal riders and hilly terrain further degraded performance. The volume of calls received by our Customer Service Department

was staggering. Remember, for less than $30, a customer can buy an accurate and easy to install cycle computer. Exaggerated claims are easily refuted and WILL result in unhappy customers. The moral of the story is: Know your product's operating characteristics, and convey them to your buyers accurately. Further, qualify your performance claims. If claiming 20 miles range, state it as follows:

Range: up to 20 miles (32 km)*
***NOTE: Range is affected by many factors including speed, rider weight, riding conditions (temperature, winds, riding surface and hills), tire pressure, number of starts and stops, etc. Your actual range may differ. To maximize range capabilities, ride more slowly, and pedal to share the load with the battery.**

Establish a reasonable set of 'benchmark criteria', and communicate those as the basis for your claims. For example: "These mileage claims are based on actual road testing performed on flat, level terrain with tires inflated to recommended pressure, holding speed constant, with no starts and stops, and no pedaling." This gives your customer insight into the riding conditions under which you established your claims.

3. Guidelines for safe operation
This is where experience in the bike industry, coupled with common sense, really pays off. Guidelines for operation are similar to those for a conventional bicycle. Language relative to the following topics should be included:

- Please read this important Owner's Manual.
- ALWAYS WEAR A HELMET! (Perhaps the single most important point to make.)
- Check your bike (especially the safety equipment, i.e., quick release levers, brakes, reflectors, etc.), before each ride.
- Obey the Rules of the Road, especially when mingling withauto traffic.
- Watch out for drivers opening car doors in your path.
- Don't ride with more than one-person on the bike.
- Don't ride at night. If it's absolutely necessary to ride at night, wear light and reflective clothing, use a head light, tail light and strobes, ride defensively (assume that the cars don't see you) and be extra alert.
- Be extra careful in wet conditions. Bike brakes, especially caliper brakes, don't work well when wet. Ride more slowly and increase stopping distance to accommodate reduced braking effectiveness.

In addition to the standard bike guidelines, a few additional are required given the nature of an electric bike:

- Obviously, an electric bicycle can propel itself at speeds up to 20 miles per hour without rider contribution. All the safe riding guidelines mentioned above take on additional importance when traveling at these speeds.
- Your electric bike features additional equipment (motor, battery, controller, etc.) that add weight. Therefore, your electric bike is
- heavier than a normal bike. Consider this additional weight when braking, especially under wet conditions. Take care when moving or lifting your bike to accommodate this additional weight without injury.
- Your electric bicycle comes with a battery charger. Pay particular attention to the instructions supplied with the battery charger to insure safe recharging of the bike's storage battery. There are special precautions associated with the storage of the bike's battery to insure that it is not damaged by months of disuse.

4. Care and maintenance
An electric bike is still a bike. Most components are common to those found on conventional bikes. Caliper brakes, derailleur, head sets, bottom brackets, etc., are all standard and are all maintained in a like fashion. Language similar to that found in a conventional bike's Owner's Manual must be included. However, the motor, battery, controller, controls and wiring harnesses present a new set of care and maintenance requirements to the user. In most cases, the elements that differentiate electrics bikes from conventional bikes are designed to be modular. Generally speaking, aside from protecting these components from damage and contaminants (dirt and water), there is relatively little maintenance required. Motors and controllers are not user serviceable. If they fail, they are replaced as a module. There are no settings and/or adjustments necessary.

The battery, however, is the major exception. Batteries do require care and attention. There are currently four different battery chemistries in use. Each battery presents different advantages and disadvantages, plus a unique set of care and maintenance requirements.

Lead-acid:

- Least expensive, but heavy (low energy density)
- OK service life (~800 charge/discharge cycles)
- Able to provide high amperage
- High internal resistance, there-

fore, will self-discharge quickly
- Will sulfate in not maintained in a fully charged condition

NiCd:
- More expensive, lighter but still low energy density
- Excellent service life (~1000 charge/discharge cycles)
- Able to provide relatively high amperage
- Low internal resistance; able to be recharged quickly
- Recycling required due to cadmium content

NiMH
- Very expensive but lighter still (high energy density)
- Modest service life (~500 charge/discharge cycles)

Lithium Ion
- Very expensive, but lightest with highest energy density
- Excellent service life (~1000+ charge/discharge cycles)
- REQUIRES close control of operating parameters (charge /discharge rate, cell balancing, etc.) or potentially dangerous

Obviously, the Owner's Manual must address the requirements for the battery chemistry utilized. Further, all batteries must be FULLY charged before first use. Most batteries must be cycled several times before they reach full capacity. If a user is unaware that claimed by the manufacturer, resulting in early dissatisfaction with the product. Given that most of our country has seasons unfavorable to bicycle riding, care must be taken when storing batteries during the off season. Batteries must not be allowed to freeze. Instructions for periodic 'topping-off' to counter self-discharge must be given and followed if the battery is to be serviceable once the weather improves.

All batteries must be disposed of in an appropriate manner at the end of their service life. Fortunately, an organization to facilitate the proper recycling and/or disposal of depleted batteries has been established. Rechargeable Battery Recycling Corporation (RBRC) maintains a database of companies, retail outlets and community services that accept used batteries for disposal. The RBRC database can be found at **www.rbrc.org**. ALL Owner's Manuals for electric bikes should include this important information. On balance, the manufacturer/distributor of electric bicycles MUST give comprehensive and accurate information regarding the battery, a critical component of an electric bike. Failure to do so will result in unhappy customers.

Most importantly, customers must be urged to seek additional help from qualified personnel in the event that they feel unqualified to maintain or service any component of their bicycle. Most bike shops can service and repair the bike elements of the product. The dealer that sold the electric bike will be able to trouble shoot and repair the electrical elements. The distributor's Customer Service Department should be a source of assistance under any of these circumstances. The company that makes a commitment to stand behind the consumer with respect to his use and enjoyment of their product is the company that has a chance at succeeding in this new industry.

5. Troubleshooting

Again, electric bikes are relatively new in the marketplace. At this time, most bikes represent the consumer's first exposure to these products. As noted above, there are elements of electric bikes that are unfamiliar to the first-time user. If the bike does not function, or functions in a manner that the user does not expect, the distributor must offer the customer a reference that allows them to understand why.

Experience shows that many apparent 'product failures', when diagnosed, are due to some very simple, easily rectified conditions. For example:
- One manufacturer shipped its bikes with insulating caps over the battery terminals to isolate the battery from the electrical system during transit. Failure to remove the caps renders the bike non-functional.
- Many bikes come equipped with brake lever sensors designed to cut power to the motor when the brakes are applied. A misadjusted switch will signal the controller that a brake is applied, and the controller will not power the motor for operation.
- A controller or battery management system that senses a discharged battery, whose voltage is lower than the predetermined cut-off voltage, will not power the motor.
- Poor range is often caused by under inflated tires.
- A blown fuse will prevent the battery charger from charging the battery.

Each 'product failure' described above can be easily remedied by the customer if the Owner's Manual includes a description of such common problems and their solutions. The best means for conveying this information is a simple chart that describes generic symptoms, and the appropriate steps to correct these problems.

6. How to reach Customer Service

A customer must always have a last resort. A short paragraph that reads as follows will help:

"We have tried to provide all of the information necessary for you to have an ongoing enjoyable and fulfilling experience with our electric bicycles. However, if we have overlooked some aspect of the product, or if the information presented is not clear, PLEASE do not hesitate to contact the dealer where you purchased the bike, or our Customer Service Department. It is easy and convenient to do so. You may call Customer Service toll-free at +1-888-987-6543 from 8:00 AM until 5:00 PM Pacific Standard Time or you may send an e-mail to www.service@acmeebike.com 24/7. We are committed to your satisfaction, and will do everything that we can to help."

7. Warranty

No doubt, your attorneys will dictate the language in your product warranty. Please work with them to insure that the warranty is written in clear and understandable terms. It's important that the customer be advised and comprehends what's covered and what's not covered in the product warranty. Batteries can be a big issue. Use guidance from your suppliers in this regard as well.

In conclusion, an Owner's Manual is a critically important component of our product offerings. It deserves as much attention as the engineering efforts necessary to develop these fine products. A knowledgeable customer has the best chance to be a happy customer. Happy customers are the best promotional tool that this nascent industry can hope for.

Mike Fritz - Chief Engineer - TresTerra
American Electric Cycles And Fitness
www.tresterra.com
michaelfritz@tresterra.com

Historical Picture

CABDA Show Chicago 1999
Executive Comm. Electric Cycle Association
Fred Teeman Giant, Ed Benjamin Cycle Electric, Richard Mayer Currie Tech.,
Bob Ligman ETC, Doron Amiran ZAPWorld

Section 6

Worldwide Electric Bikes and Mini Scooters

Overview

China continues to dominate as the largest manufacturer and user of electric bikes in the world. It also manufactures most of the mini electric scooters that are exported around the world. These facts result from China being the lowest cost producer and the continuing economic improvement of the working class Chinese who move from pedal bicycles to electric assist bikes. Growth in the number of units China will produce and sell is expected to continue in the near future. The number of EB manufacturers in China is large but small companies, mainly assemblers, are unable to provide the quality of products demanded worldwide and as well in China as the buyer becomes more selective of better products. The USA continues to dominate as a user of electric mini scooters (platform and seat type) that are popular with teenagers. Electric bikes will be entering a period or renaissance and larger sales as the price of gasoline continues to influence the behavior of people who need transportation. Canada is opening regulations to allow electric bikes on pathways that regular bicycles use so EB sales should start to increase there. Europe is seeing a jump in EB sales growth as highlighted by a 60% increase of 2006 over 2005 in The Netherlands. That leads to a prediction that Europe EB sales will reach over 1 million units by 2010. Japan continues to have sales at a plateau of 200,000 units or so. Taiwan is a big exporter of EBs and a small user as commuters still favor gasoline scooters there. The economy is growing in Taiwan as in China and the hope in Taiwan is that scooter users change to electric scooters to help reduce air pollution. India is highlighted as the next major market that may take off in EB sales, it could become as a multi million EB market as China in the near future. Movement to lithium batteries will favor those EB manufacturers who can manage to design the EB system to use lithium batteries in a safe and effective manner while managing to provide a competitive EB price that will include the higher initial price of the lithium battery. Overall, EB sales will continue to expand to meet the transportation needs in many countries worldwide and mini electric scooter sales will continue to be dominated by USA fun-loving teenagers.

USA

The USA market is a combination of very cheap vehicles sold by mass merchants and low price importers, and high quality bikes in small quantities. Many companies have tried and failed in the USA market. At this time the number of players is as low as it has been since 1995. The “last man standing” effect is coming into play at the same time the consumers are starting to buy due to oil pricing. The total numbers of sales are difficult to determine, as most import numbers are unavailable or confusing (more than one import classification is used by importers – sometimes deliberately to mislead, or due to ambiguous USA regulations.)

Probably, electric bicycles sold by the Independent Bicycle Retailers and other specialty retailers are less than 5,000 pieces in 2006. Probably, nearly 100,000 additional low priced electric bikes from China were sold by mass merchants, auto parts stores, sporting good stores, flea markets, internet retailers, and others. This does not include the electric mini scooter

that the USA has purchased in the millions of units for the last few years.

Trends: Electric bicycle sales are growing. Most bicycle retailers are receiving inquiries about electric bikes from consumers, and product is selling well. This is primarily due to consumer concern about high oil prices.

Electric Mini Scooter sales are declining. The legal ambiguity of mini scooters (often adversely affected by gasoline mini scooters) and the bad reputation that minimum quality, minimum price scooters have for reliability have created a strong decline in mini scooters. However, the surviving companies (Primarily Razor) are doing well as most of the decrease is the demise of importing efforts of various companies.

Sealed lead-acid is still the dominant battery, but NiMH batteries are found in many products now. And Li Ion is increasingly found in USA product. (Although much of the Li Ion is in cheaply made imports and may be a safety hazard.) Motors are mostly Chinese made hub motors in the 180 – 240watt range. Often the motors are labeled as being much more powerful than they actually are. Heinzmann motors are in the 400watt range and are found on many better EB products.

Companies of note: Lee Iacocca's EV Global Motors stopped answering their phone, and their website disappeared in mid 2006. The remarkable vision and pioneering efforts of this company deserve a chapter in themselves. Parts are now in demand, and very limited supply. EV Rider was sold to a mobility scooter importer that now goes by that name. WaveCrest stopped Tidal Force electric bicycle operations in 2005, and the last bikes in dealer inventories were sold in 2006. Warranties that are still valid continue to be serviced by Light Electric Vehicle Technologies (LEVT) of Pocatello, Idaho. The WaveCrest bikes have attained a nearly cult status for their high performance and speed, though it is getting hard to get parts and information. Giant Bicycle Company continues to do a good job with their Suede E, and the primary comment heard from dealers is that they cannot get enough bikes.

TresTerra Human Electric Hybrids (a new company owned by Ed Benjamin and Mike Fritz) started sales of 400Watt Heinzmann motor, Lithium battery equipped bikes in 2006 and continues to introduce new models. Remnants of inventory from Total EV, including Prima, ETC and others are being sold on eBay and over the internet by ZAP, who seems to have little other E-Bike business. Remnants of EB inventory from Charger and Merida are still being sold by ElectroPortal. Currie Technologies has experienced management and ownership changes, and has created a new label (Izip) and marketing strategy. It seems that quality has improved, as has management. The range of product is wider and more attractive.

eGO scooters have had a change of ownership, and the product sells well, although it is not legal in many jurisdictions (non conforming motor vehicle). Optibike has re-appeared on the market with a very nice and very expensive bike made in limited quantity. Electric Bike Factory may be the oldest surviving USA E-Bike maker – producing kits in the USA. Wilderness Energy sells DIY kits through a wide variety of channels. BionX has established a niche as a high quality DIY kit in both USA and Canada.

Ed Benjamin

Trike

Currie IZIP Urban Cruiser

Schwinn CONTINENTAL

CANADA

Canada recently adopted a new law that legalizes more powerful E-Bikes in addition to the already legal low powered Pedelecs. Ontario approved a recent ruling to allow EBs on bike pathways. This has created a surge of interest in Chinese imports and higher power bikes from USA. BionX has enjoyed strong sales in kits, both in Canada and for their export market. Airstream has distributed E-Bikes and Pedelecs from several Japanese, Taiwanese and Chinese sources. There is a strong environmental movement in British Columbia that may stimulate the EB market there. Palcan Fuel Cell Ltd. in B.C. has been developing their hydrogen fuel cell for EBs for several years with a Chinese partner. But that connection has changed and the future of Palcan ever seeing its fuel cells in EBs may be in jeopardy but the company is still optimistic.

Ed Benjamin

EPS Bionx

CHINA

Various estimates of the Chinese E-Bike market range from 12 million to 18 million pieces to be sold in 2007. The product has not changed in performance or basic specification in the last two years. Changes have been in the form of styling, increased reliability and better distribution.

Best selling electric bikes are two basic types:

1. Basic or “traditional” E-Bikes that look like a bicycle with a battery box below the top tube or behind the seat tube and a hub motor. These sell because they are the cheapest version, and some come from makers that have established a reliable product and reputation.
2. Scooter Style Electric Bikes (SSEB)– these look like a motor scooter, but have pedals (or a place to mount pedals) and a 240 watt hub motor, so that they legally meet the definition of a bicycle. These have been under assault by authorities on the basis of they are too big and too heavy to be considered bicycles, so there is a variant of these that is narrower and lighter.

The wide variety of models and styling ideas of years past has calmed down, and most Chinese E-Bikes look much like the others, with most variation being in decals, chrome, and color. A notable exception is the Wettsen bike that has unique (German) styling and sells well. Some Chinese cities have had periods of banning or not permitting E-Bikes. This seems to have settled out in a nearly universal acceptance of E-Bikes in all cities (at this moment that the author is aware of). There have been a variety of restrictions, such as the one in Shanghai that limits licenses issued until a battery recycling infrastructure is created.

There are reported to be nearly 1,000 companies in China that call themselves “electric bike manufacturers.” Most are actually assemblers of kits purchased from more comprehensive electric bike makers or component suppliers. About 60 companies actually make most of the Chinese E-Bikes, with only 30 or so above 50,000 pieces in volume. At least one company is in the more than a million units per year range. Most

Shanghai Show Carol Ma / Jane Yao
Selling EBWR04 Chinese version

Oasis Sunbird

Modern Bug YT904 250W/24V/12Ah
24kph/20km Zhejiang Yeying EPowerV Co

Chinese E-Bike companies are so focused on their domestic market sales that they have little interest in export sales. The Chinese companies that are interested in OEM production for export tend to be either owned by Taiwanese, or are very small in the domestic market.

Companies of note: Giant Bicycle Company – sells a Giant electric bike in China. Reputation for top quality and high price. Merida Bicycle Company – similar to Giant in activities, on smaller scale. Fairly / Wettsen – establishing reputation as best, most unique and most expensive E-Bike in China. Done's Yadi – one of the largest E-Bike makers in China. Shanghai Cranes – one of the oldest and best for quality. Shanghai Elite – strong export business to UK. Hongdu – exports to UK, strong domestic business. Adda – computer parts maker moving into E-Bikes, sells in various markets.

Shanghai Forever – one of largest bicycle companies in world, with strong E-Bike business. Shanghai Phoenix – Forever's long time competitor. Peerless Good Baby is one of the world's largest toy and children's goods makers, with an electric bicycle development project. Wuxi Angell has a large factory, strong marketing to export customers. LuYuan E-Bike Company president Ni Jie is a veteran E-Bike man and active in Chinese regulatory issues. Small Antelope has established perhaps the best track record of all over time. Tiandi is one of the oldest and stronger companies. Ace Trikes is the supplier and owner of Currie. Peace Bay – Tianjin area has become one of the most important for domestic E-Bike production.

Ed Benjamin

A&B Modern Bug CD17 250W/24V/7Ah 18kph

Lvneng Electribicycle Changzhou

Powersine Folder 180W 20kph/35km GuangZhou Jun Ji

Merengo

Tianjin Cycle Txed Happy Time

Nova Bikes Inspire

AVE Town

Tourist with EB in Suzhou

Electic Bike Suzhou

Observations on Chinese EB Manufacture

The company that makes the most brush hub motors is Zhong Yi Machinery-Electronic Company, and the company that makes the most brushless hub motors is Xin Da Yang Group. The company that makes the most Sealed Lead Acid batteries is Tian Neng Battery Company that is located in ZeJiang Province.

There is no single company that makes the most electric bicycle frames. The market in China is very strange and chaotic. Most companies purchase "set models" from certain "model companies" which supplies the plastics, forks, and frames to the buyers. Even though they do not make these themselves, they usually subcontract to many different smaller companies for the jobs.

None of the companies in the Chinese electric bike business is listed on China's stock exchange market. However, two companies that are also battling in this field from the bicycle industry are listed on Taiwan's stock exchange, namely Giant Manufacturing Company, and Merida Manufacturing Company. (Both of them are listed as bicycle manufacturers).

Shanghai Show Booth

American businessmen should pay attention to the rapid growth in lithium battery applications. It is interesting that most lithium battery companies make cell phone batteries. However, a few companies realize that making such a commodity isn't going to make them rich. They turn to investing in high power, high capacity lithium batteries. Although the technologies involved are more complex, they seem to enjoy more profitability than those of making cell phone batteries. A few universities establish the different chemistries of lithium batteries. While most of these companies chose to work on lithium polymer, others are taking conservative approaches toward using Lithium Ion in order to manufacture safe lithium batteries for the LEV industry.

Press reports provided by
Percy Chien
Fairly Bike Manufacturing Co., Ltd., Taipei, Taiwan
Wettsen Corporation, Longkou, Shandong, China

EUROPE MARKET AND PRODUCT DEVELOPMENTS

The European LEV market keeps growing steadily. This is especially true for Pedelecs (pedal electric cycles). Quality e-bikes are in a minority and light electric scooters of good quality with street approval have almost disappeared. One explanation for this is: European law favors Pedelecs by regarding them as bicycles (up to 25 km/h). Thanks to eased regulations on acceleration, many Pedelecs now use an electric-only kick-off function. This way the rider can start from zero by just turning a throttle, which was once the privilege for e-bike riders compared to a Pedelec. The main difference between Pedelecs and e-bikes now remains complicated homologation, insurance plate and helmet obligation (depending on national regulations) that is required for e-bikes. This is why e-bike sales are expected to stay very low. Maybe they will gain back some popularity with higher speeds - but there are hardly any products ready for the market at the moment. The scooter market has suffered significantly from poor quality products, which failed operation after a short time and kept customers from spending over a thousand additional Euros for a new one of better quality and with homologation.

The splitting of the electric bicycle market into a low and a high price segment is continuing. Low priced products, which often don't live up to European safety standards,

usually originate from Asia. Some of these import products are of very poor quality. Others come with good components and performance. Some products bought in China at around 200 US Dollars are sold in Europe far above their value at 1,000 to 1,700 Euros. Price is not an indicator for quality, which makes the decision for buyers difficult. In 2005 estimated 180,000 Pedelecs and e-bikes were sold; about 80,000 in the high-price-high-quality segment and 100,000 in the low-price-low-quality segment. In 2006 sales in Europe slightly increased to approximately 190,000 units. Fortunately, the bicycle industry managed to grow their sales in the quality segment to about 50% of the total number. This leaves the European market pretty much with a 50/50 share of high and low quality segments.

Most Pedelecs of the upper price and quality range have been sold in the Netherlands and Northern Germany. The Dutch Dealer Association BOVAG states that in the first 9 months of 2006, 32,000 electric bikes (almost all of them Pedelecs) were sold in the Netherlands. If the 60% sales gain compared to the January-September period in 2005 also continued during the rest of the year, then 2006 total sales of electric bikes in the Netherlands ran up to about 55,000 units. Russia, Spain France and England have taken the lead in the low price and low quality segment. Precise market numbers do not exist. One reason for this is that imported products are not always declared as electric bikes. Some are imported as bicycles with motor assistance, some as toys others as sports equipment. Plus there are no constant players or sales channels.

What will happen in the next couple of years? LEV expert Hannes Neupert, President of Extra-Energy, predicts that sales in the quality segment will increase by as much as 30,000 units this year. A justification for this estimate is that some bikes will be offered in mass distribution channels and more vehicles will be available. In 2006, the market leaders Accell Group and Gazelle were sold out, numbers could have been higher if they had been able to supply more bikes to the customers who asked for them. Several newcomers have announced their sales start for 2007. In the long run, ExtraEnergy sees a continuing growth if the industry works hard to improve technology and quality standard and establishes a more sophisticated after sales infrastructure. Under such condition Mr. Neupert expects that annuals sales may reach 1.2 - 1.6 million units in 2010. The environmental conditions only encourage such growth rate. There are however, threats on the way – poor product quality at too high cost, dangerous batteries, bad after sales service.

Players and Products

In times when technological progress is taken for granted customers want more comfort, nice design, good service and convincing details. Many products displayed at Eurobike and IFMA Cologne in September 2006 came up with clever features, special parts and functions for specific customer groups and new design elements. The general trend is—more comfort. Some companies focus on more range, others on less weight, diversity in the product range or lower price. Sporty, fast and individual seem to be the predicates for the 2007 season.

Show report: With professional marketing **AVE** (Adda Vehicles Europe) presented a stylish looking product with battery and luggage bag attached to the front of the handlebar. Some work still needs to be done on the software. **Biketec** showed their new S-series with stronger Panasonic drive unit and a Tandem. Canadian motor manufacturer **BionX** won the hearts of all riders who like it fast and strong with their new 36V Lithium add-on kit with 360Watt motor on a mountain bike and a racing bike. Other applications of the BionX system (NiMH, 24V, 250W) included a **USED** recumbent, a recumbent tricycle, and the **Matra** istep. **Gazelle**'s Easy Glider Pedelec with Panasonic drive, lithium battery and many comfort features

Sparta ION Intro

Gazelle Easy Glider

Biketec S-Serie

offers a great price for value relationship at 1999 Euros. The new **Giant** Twist 1.0 with Sanyo hub motor and two lithium batteries on the rear rack is the winner in range, even if it reaches the stated 130km only on the flat in eco mode. **Heinzmann** has worked on many details to improve their estelle models including a new grip shift, two new battery bags to be attached to the rear rack, new colors and a men's frame Pedelec. Heinzmann's new top model is the estelle elegance, a 26inch bike with full suspension, low entry and NiMH battery, which is now also available as 34kph version. The Finish company **Helkama** presented a trike with Panasonic drive and lithium battery in addition to their two-wheeler with automatic gear shift. **Hercules**, the German distributor of the Sparta ION Pedelecs showed a racing bike with hub motor and the battery in the main frame. At their main booth they showed a prototype of a postal delivery Pedelec with Kasbauer DC drive unit. It was originally a project of the German company Sun+Cycle that was recently bought by Hercules. The Pedelec by the Taiwanese bicycle and toy maker **JD Components** looks almost exactly like the Sparta ION, has less comfort features, less attention has been paid on details, but the motor is surprisingly strong even uphill. JD's TranzX pedelec drive unit including 250 Watts brushless DC hub motor, NiMH 24V 9Ah battery, ID Bike torque sensor and a display with trouble shooting function was officially introduced at Taipei Cycle Show 2007. The drive kit weighs 7-8kg, kosts 999-1599 Euros and is supposed to provide 50km range. JD aims to make major sales in the Europen market. **Sachs** showed their long-year models with Sanyo drive, and two eye-catching cruisers with the same motor. **Schachner** from Austria presented a variety of models with their strong and silent motor. They are working on a new smaller motor system with the battery in a drinking-bottle-like container. **Sparta** showed their new low entry model, the ION Intro. At IFMA They also showed a model with the battery in the side bag that can be taken off. Currently Sparta is developing new software that will allow to better adapt the riding performance to the customers' demands. They also work on a stronger motor. EV Showroom from Lyon presented a Pedelec using the original Swizzbee 50C frame in combination with the very small and lightweight **SunStar** system from Japan. It is a bottom bracket system with a small lithium battery.

Newcomers in the LEV business such as Smike and Gruber showed products for very specific applications and big names such as Panther, Schwinn, Storck, Biria, KTM displayed quite a number of new models at their booths.
Biria The German bicycle manufacturer presented three Pedelecs at their booth. One with Panasonic drive retails for approximately 1,600 Euros. One called Conway with 160W Biria motor and two Lithium batteries, one behind the seat post, one attached to the rear rack in a small bag. The range on both batteries is 40-50km. The Conway retails for 999 Euros. From a dealer's experience it is a good value for price product for those who can't afford to spend 2,000 Euros or more for a Heinzmann bike. Both bikes retail under the Hartje brand name. The third Pedelec with the same Biria motor hides the lithium battery in the down-tube of the main frame.
Gruber At IFMA, Gruber from

AVE Pedelecs

TranzX electric drive system by JD Comp.

BionX Mountainbike

Matra with BionX unit

Heinzmann Estelle Elegance

Austria presented a 200W motor to fit into the down part of a mountain bike saddle tube. It helps turning the treadle via a gear wheel. A NiMH battery is located in a small bag behind the saddle. The system weighs approximately 2.25kg and is activated by a small button on the handlebar. It assists on demand, not permanently. The Gruber Assist is designed for mountain bike riders who want to keep up with their young days or faster team colleagues. From the outside you can't tell there is a motor. The system is supposed to retail for 1,680 Euros.

KTM The Austrian motorcycle and bicycle maker KTM is back in the LEV business. At IFMA they presented a Pedelec with Heinzmann system, 36V, NiMH battery, and motor-only kick off until 4kph. Delivery is scheduled for May 2007.

Panther bicycle company showed two solid-looking Pedelecs: one, PanTerra Premio, with Sanyo hub motor and 24V, 9Ah NiMH battery behind the seat post. In Eco mode it automatically regenerates energy when riding 15kph or faster. The PanTerra will retail for around 2000 Euros. The PanTerra Eco model uses a Chinese pretty heavy but strong motor, 24V 12Ah NiMH battery on the rear rack and retails for 1200 Euros. The same models are also sold under Goericke brand name as Capri Premium and Napoli Eco models.

Schwinn first introduced a whole range of Pedelecs at Eurobike with the same drive system in different frame styles including classical bicycle design, a folding bike and cruiser models. The hub motor comes in two versions: medium torque for markets with Pedelec regulations and high torque for other markets. The lithium polymer 24V, 10Ah battery is located on the rear rack of most models.

Gruber - motor in down tube

Hercules Postal Delivery Pedelec

Smike A G, a Swiss company first introduced a new vehicle concept: a touring bike with attachable sidecar. The modern-looking bicycle is available with or without Heinzmann drive unit. The sidecar is easy to attach and serves for many purposes. Smike is small enough to use bike lanes, flexible enough to ride on off road trails and rigid enough to carry loads up to 75kg. What is special of the "two in one bike" concept is that both sit side by side and can talk to each other.

Storck is another newcomer in the electric bike business this year with a high quality touring bike, Heinzmann hub in the front and an own solution for the bat-

Storck Pedelec

SunStar Pedelec

Schwinn Pedelec

Panther/Goericke Pedelec

Smike with detachable side-car

tery above the rear wheel.
Hongbu showed a range of Chinese-made e-bikes, among them also a tandem. They sold e-bikes with lead-acid battery for 550 Euros at the end of the show. Importers of various Asian products had a booth at IFMA such as **Easybike** from the Netherlands or **Radac** from Germany. **Kranich**, Swiss importer of **Cranes**, took part in the Test Track event at IFMA. **NewSun** from Hong Kong presented quite a range of e-bikes, including folding bikes at IFMA in classical China export style. **Elebike** displayed a cart for kids to slide around the corners. **Suzhou Jiangcheng Electric Vehicles** (JCE) presented their IZIP Pedelec and e-bike models in different variations. Batteries are in the down tube of the main frame. They use a Chinese hub motor and components.

ExtraEnergy 2006 Test Results
Twelve Pedelecs and one e-bike were tested in the ExtraEnergy 2006 comparison test. The Pedelecs of the companies Biketec (Flyer T8 Premium), Gazelle (Easy Glider), Giant (Twist Comfort) and Heinzmann (estelle elegance) were rated "very good". A "good" was rewarded to eGo Vehicles (Helio), Helkama (Jubilee), Hercules (Emove Tourer) and Sparta (ION m-gear). The products of the companies Shanghai eZee Kinetic (eZee Sprint), Euromoto (Binbike), Lohmeyer-Leichtfahrzeuge (Mistral-E) and Sachs (ALU-Touring) received recommendations for outstanding characteristics. All bikes evaluated "very good" or "good" in the big comparison test were rewarded with the ExtraEnergy 2006 Test Seal. This seal is supposed to help separating high quality products from the mediocre products on the market.
Eight test riders between ages 26 and 52 years rode each test bike on three different test routes in Germany until the battery was empty. The 7.8km long track around the city and surrounding countryside of Tanna, where ExtraEnergy is headquartered, was to simulate an everyday ride. The assistance factor was measured on a mountain route and on a mostly flat track in the Kirchheim/Teck mountain range. Assistance factor means the difference between pedaling power and average speed of a regular bicycle compared to the pedaling power and average speed of a Pedelec on the same test route. Assistance factor 1 means that the motor doubles rider's power. If the assistance factor is 0 the motor only compensates the additional weight of the drive unit. If the assistance were negative it would be easier to ride without any electric drive unit.

ExtraEnergy compared the 2006 test results to previous test results since 1992 and concluded the following. The dominating battery technologies have become NiMH and Lithium. Lead-acid and NiCd have completely disappeared on the Pedelecs tested in 2006. The average vehicle weight has stayed about the same over the years. This shows that the new battery technologies are not primarily used to save total weight but to increase the performance. Today's Pedelecs reach higher mountain range and provide better assistance uphill. On the flat power assistance has rather decreased. Due to improving battery technology, range is not an issue to worry about any more. Now, useful features, comfortable extras, and fancy details are important. Component quality has improved constantly. This

ExtraEnergy Test Seal

is also true for servicing. In the 2006 Test ExtraEnergy has paid special attention on after sales service, the availability and quality of user manuals, features to find errors easily. The test team honored the bikes that were especially easy to operate. Prices in the upper quality segment have strongly increased. In most cases this means extra profit for the manufacturers, which they invest into better marketing and further product development. The test of the following products is still running: Schachner (Citybike), Adda Vehicles Europe (AVE streetE), BionX (Add-on Kit), Euromoto (BinBike Europa), Giant (Twist 1.0), Matra (istep), Smike (Turbo), SunStar (ibike), USED (Scooterpedelec). All published results can be found at www.ExtraEnergy.org.

Velo-city 2007 Conference
The goal of the international Velo-city 2007 Conference in Munich is to create an international communication platform for decision makers in the economic, political and administrative fields to successfully promote cycling as daily transport and leisure exercise.

With its slogan “From Vision to Reality”, the Conference will comprise plenary sessions, workshops, poster sessions and an exhibition. Active cycling will also be part of the agenda. Munich as the host city aims to encourage bicycles more and more, also as a reaction to its traffic problems, shortly outlined in the Mayor's speech at the ExtraEnergy Test Award ceremony at Deutsche Museum: “At a time when traffic jams and particulate matter are in the news every day, there is a growing need for unconventional solutions.” In this regard, according to Mayor Monatzeder, the Pedelec as a new category is mostly welcome. The local government pursues the goal to increase bicycle traffic from 10% at present to 15% in the year 2015. In addition, with the European bicycle conference Velo-city 2007 taking place in Munich, the state capital wants to send out a pro-bicycle message on international level and position itself as a capital of bicycles. Co-organizer of the Velo-city 2007 Conference is the German Federal Ministry of Transport, Building and Urban Affairs. The Conference is also supported by the State of Bavaria, bicycle unions and the bicycle industry, public transport companies such as the German Train Corporation (DB), as well as BMW and other local business corporations.

Susanne Brüsch

EMERGENCE OF AN ELECTRIC BIKE INDUSTRY IN INDIA

The two to two and a half years period ending in March 2007 has seen emergence of a new electric bike industry in India. The Indian electric bike industry is largely a story of entrepreneurs trying to replicate the success of the Chinese electric bike industry in India. This attempt at replication had two dimensions. The first is an attempt by Indian entrepreneurs to try and create an electric bike business based on direct imports of Completely Knocked Down (CKD) kits from China/Taiwan. The second is the attempts by various motor and controller vendors to show leading Indian bicycle manufacturers what had been happening in China and to entice them into developing electric bikes based on their equipment.

Work by the newer entrants and also by the various technology vendors etc. has ensured that Indian bicycle manufactures now realize that they need to have an electric bike range of products as part of their market offerings. It has also seen the January 2007 bicycle industry trade show having a space for the electric bike segment for the first time. All the major bicycle makers (and some of the smaller ones too) have used this occasion to announce plans for introducing their electric bike offerings.

While the thrust to entice the large bicycle manufacturers into entering the electric bike space will result in a product only in the coming twelve months, a number of new players have already entered the market with their own brands of products based largely on imported CKD kits.

The Evolution of the Indian Electric Bike Industry

When the first lot of players began, there was no regulation at all covering e-bikes under the Indian Motor Vehicles Act and Rules. With players approaching individual state governments for approval of their vehicles as an eco friendly non polluting transport option, the central government finally stepped in and issued

Ultra Motor India

EYEKON 2-Wheel India

a notification in September 2005. This notification exempts E-Bikes having a motor below 250W and a peak speed of below 25 km/hr from being classified as a motor vehicle. Such e-bikes therefore only need a one-time type certification and then can be sold freely. Users need not apply for a license. E-scooters that are above these limits need to obtain motor vehicle registration and number plates, while riders need to get a license.

The product offerings of the players have evolved based on the above classification. Most players claim to offer at least two products that do not need registration and at least one in the motor vehicle category. While most claim to have product offerings in the e-scooter range, these do not appear to have made a dent in the market place yet. In the e-bike category, the two broad categories of offerings are really the single seater (with a 180W motor) and the somewhat more powerful two seater (with a 240W motor). Both these products are designed to look like scooters, rather than bicycles.

Eco Rick 3-Wheel India

Price points for these products are still emerging. Most players operate in largely one state or a small group of neighboring states and do not yet compete head on head. Also, volumes are fairly low. It appears that the single seater model is priced in the vicinity of Rs.15,000 ($340) while the two seater is priced around Rs.24,000 ($545). The indicative price for the 500W e-scooter offering is indicated to be in the range of Rs.32,000 ($725). As volumes and competition ramp up, these prices will obviously head sharply southwards.

In terms of volumes, there is really no way to check what is happening on the ground. There are claims and counter claims with accusations flying back and forth that one or other manufacturer is not supplying bikes against advances taken. While all claim to be manufacturing and sourcing components locally, they are all reliant on the import of CKD kits from China/Taiwan. While two of the six players currently operating have begun their operations in Jan-March 2006, and another in June 2006, the other three have been operating throughout 2006-7. The mainstream bicycle industry has only announced launches to coincide with the industry trade show in early January 2007.

Conversations with dealers etc. suggest that for the twelve month period ending March 2007, about 50,000 e-bikes would have been sold in India.

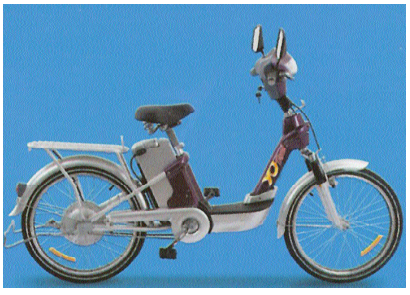
Component Sourcing and Manufacturing

One of the reasons that all the entrepreneurs entering the e-bike space in India make grand claims is that everybody claims to have put up a factory that can process up to 100,000 vehicles a year. This is necessary since the duties on imported CKD packs are sharply lower than on the import of complete bikes. Hence, the need is to create a low cost, but large manufacturing set up on paper to be declared a manufacturer. Despite the import of CKD kits, there are some attempts to begin sourcing components like tires, batteries, lights etc. and in some cases the body assembly from the Indian automobile industry. These attempts are still in the early stages.

Given the extreme price sensitivity of the Indian market, all the current e-bikes and scooters use Lead Acid batteries. There is a lot of talk about offering products with NiMH or Lithium batteries, but it seems to be just talk at this point. As mentioned earlier, some motor and controller manufacturers are targeting the esta-

Eco Rick India 3-Wheel

Indus Yo Smart India



EYEON 2-Wheel India

blished bicycle manufacturers with an offering to suit their needs. Also as more reliable players get into the game and the volumes ramp up, the Indian electrical industry will engage more closely with the e-bike industry. Some preliminary moves appear to have begun, but it is early days yet.

The Future of the Indian Electric Bike Industry

The Indian electric bike industry has clearly started. All the current players are working on increasing the dealer networks, going into newer geographies, getting approvals for higher wattage models and ramping up volumes. This will help them ramp up volumes going forward. In terms of the potential size of the market, an A C Neilson study released in July 2006 suggested that the market could grow to 200,000 e-bikes in the year to March 2008 and then grow further to 500,000 e-bikes in the year after that. While the percentage growth does look explosive, keep in mind that this is off a small, almost undeveloped base. Again, A C Neilson has surveyed 10 cities and tried to extrapolate data for the top 70 cities from that while the real potential would be in smaller towns and hamlets. A China like explosion in the market for e-bikes is a distinct possibility.

Electric three wheelers

Another facet of the future of e-bikes in India is going to be unique to India. That is going to be the electric three wheeler vehicle in all its variants. This segment can be broken into three distinct parts. The lowest end would be the motorized trikes or cycle rickshaws. In the middle would be the four seater (driver plus three passengers) auto rickshaw that is ubiquitous in India. At the top end would be the cargo three wheelers and the six-seater tempos that are used as public transport in semi urban India. Work is being done to create electric vehicles in each of these segments. Electric cycle rickshaws have been developed some years ago, but the current regulations would force the driver to seek a driving license, even if the maximum speed is below 25kph since the motor would be above 250W. This is likely to change.

On the auto rickshaw, the largest manufacturer, Bajaj Auto has been working on an electric "EcoRick" for some time now. Launch of this product seems to be constantly pushed onto the back burner by Bajaj Auto since Bajaj Auto seems to be focusing entirely on its various ICE offerings. Other ICE vehicle manufacturers and even some of the newer e-bike players are also targeting this market and claim to be working on their offerings in this space. Any product release by these players will galvanize Bajaj Auto also. For the larger three wheelers, Scooters India Ltd., has already been trying out an Electric Vehicle for some years now. Also, Mahindra & Mahindra have announced plans to relaunch their offering in this space. Given all these developments, it is likely that India will end up creating a niche for electric three wheelers and quadricycles that would most likely be unique.

Current and Announced E-Bike Players in India

A) Pure E-Bike Makers

Ace Motors Based in Pune in Maharashtra.(a state in Western India). Launched two models in June and one in December 2006. Is focusing on building a dealer network in Maharashtra and neighboring states including the central Indian state of Chattisgarh.

Cynosure Enterprises Has started deliveries from February 2006. Based in Hyderabad (state capital of Andhra Pradesh) and has a dealer network in the smaller towns of that state. Also in eastern Indian states of Orrisa, West Bengal and Assam and in the central Indian state of Chattisgarh

Eko Vehicles Launched December 2004. Claims to launch first India e-bikes in the eighties, before withdrawing, and now sells one model. Claims to have a high powered vehicle (needing a driving license), which is under test with the regulator agency. Based in Bangalore (state capital of Karnataka) and has dealers in the smaller towns of the state of Karnataka

Electrotherm An electric arc furnace maker based in the western Indian state of Gujarat who is now into electric vehicles. Launched an e-bike early February 2006 building a network in Gujarat. Now expanding aggressively into other states. Seems to be most aggressive in terms of dealer roll out and volume growth. While their e-bikes are based largely on imported components, they have an R&D effort on electric three wheelers and electric hybrid buses.

Maharashtra Engineering/R K Rim Originally operating under the name, Maharashtra Engineering, moved to separate company called R K Rim since late 2004. Based in Mumbai (capital of Maharashtra state) and focusing on e-bike distribution in Maharastra.

Planet 7 Started in mid 2004, the

first of latest players, located in Gujarat. Now in southern Indian state of Pondicherry having lost dealers to later entrants. Began trend of importing Chinese CKD packs. Now claims to buy locally but buys motor and controller from Korea. Has dealers all over South India, especially the states of Tamil Nadu and Kerala and started in central state of Chattisgarh.

B) Bicycle Manufacturers

Atlas Cycles Announced the launch of e-bikes in the first week of February 2007. Has begun with a low end model and plans to introduce variants and other models "soon".

Avon Cycles Announced the launch of e-bikes more than once over the last year. Does not appear to have made much headway yet.

LA Sovereign Sovereign Cycles, a small scale sector maker of bicycles, has announced, January 2007, a JV with LA (Thai), from Thailand to introduce e-bikes in India.

Hero Cycles Has inked a tie up with Ultra Motor Ltd., a UK based company, for the technology in January 2007. Plans to roll out the e-bikes and e-scooters in North India in the first phase and then roll out the same nationally.

TI Cycles Has stayed out of the frenzy of announcements by all the organized players in the cycle market, but has been working on its own product for the last two years. Should be a fierce competitor when it finally launches.

C) Smaller Players

Sensing the potential, some businesses from smaller towns have also announced plans to launch imported e-bikes under their own brand around the time of the Bike Industry Exhibition in January 2007. These include Standard Group in the North state of Punjab, Kailash Electric Vehicles in the North state of Uttar Pradesh and Kaiser Auto Moto.

Sachin Joneja
sachin.joneja@gmail.com

Hero-Ultra Motor LEVs - Indian Two-Wheeler Industry – On a Fast-Track

Hero and Ultra Motor executives introduce Electric Two-Wheelers

Every month in India 750,000 new bicycles; 100,000 new scooters; 500,000 new motorbikes are sold. This puts the overall two-wheeler market in India to a staggering 16 Million per annum. The Two-wheeler industry in India has seen an exponential growth in the past few years, with seven motorized two-wheelers sold against every car produced and sold in the domestic Indian market. Various factors have contributed to this momentous growth in the Two-wheeler industry like increasing disposable income, availability of sophisticated and competitive consumer financing schemes, introduction of fuel-efficient motorcycles with lower running costs and new consumers entering the market. However, with rising fuel prices the relative advantages of higher fuel efficiency have been diluted in recent years and consumers are now eagerly looking at alternative modes of transport.

Light Electric Vehicles – The Future of Two-Wheelers in India

A detailed market study by AC Nielsen ORG-MARG to understand the potential of Light Electric Vehicles in India brought to the forefront the magnitude of the potential for Electric Two-wheelers in India. Over 2000 interviews were conducted across 10 cities. These 10 cities were selected from over top 70 towns with high Two-wheeler population. The study confirmed the high level of interest amongst Indian consumers in the benefits and uniqueness of Electric Two-Wheelers with over 70% of the respondents showing positive acceptance for these vehicles. The study also brought forward a significant potential of almost 1 million units for Electric Two-Wheelers across the biggest 70 towns in India.

Around the same time, the Electric Two-wheeler market has seen a lot of activity, with a series of new players having entered the market with Imported Kits on a regional scale and catering to limited local markets. From 'zero' presence at the beginning of the year 2006, the Electric Two-wheeler category already has around 15 players in various regional markets of North, South and West India. Some of these players have gone national with a wide presence across 10 states and claim over 25,000 units sold of Light Electric Vehicles in a period of 1 year. While majority of the players are directly importing the mechanical and electrical components that form the backbone of these Two-wheelers in the form of Semi

Knocked Down kits, to date very few players have focused on the technology that would suit the Indian conditions.

"Hero Electric – Ultra Powered LEVs"

In the context of being the leading EV Technology brand, poised to lead the EV revolution in India, UK based Ultra Motor Company has recently launched its new range of Electric Two Wheelers in India. These products are being offered in the market in technical collaboration with Hero Cycles, part of the Hero Group, the world's largest two wheeler manufacturer. With the combination of Hero's manufacturing strength and Ultra's Technology expertise, the new venture has launched a range of 7 Light Electric Vehicles specially designed to suit the tough Indian conditions. These vehicles are available under the "Hero Electric" brand with the "Ultra Powered" technology tag supporting it. With the entry of Hero & Ultra in this category, the Two Wheeler industry feels that the growth of the LEV category in India will be exponential. In order to additionally provide the necessary fillip to the category, the two companies have also co-invested in Marketing and Retail Infrastructure to provide the consumers with a 360º Sales and Service experience. Both companies are targeting to open around 70 co-branded exclusive LEV showrooms across in 16 major cities of India over a period of 12 months. Five of these are already operational in the Delhi and the National Capital Region (NCR), with another 12 coming up in the other important markets of North India by April 2007.

Deba Ghosal
Director Marketing India
Ultra Motor India Pvt. Ltd.
ww.ultramotors.co.uk

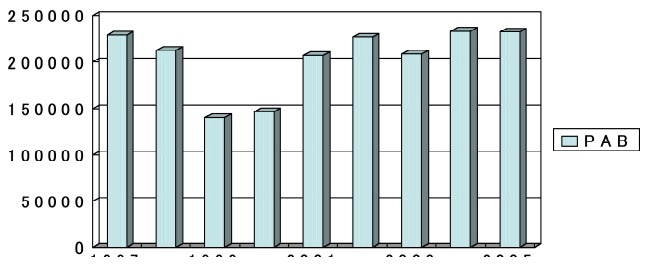
EB & ES MARKET TREND JAPAN

In Japan, the EB is marketed and known as the "Power Assist Bicycle (PAB)". Sales of PAB decreased around the year 1999, but introduction of new products with a Li Ion battery brought sales back to over 200,000 units per year. What may be typical to the Japanese consumer market, and is quite obvious in the PAB market as well, is that users of PABs tend to buy new models again once his or her PAB becomes too old or breaks down. Most popular PABs seen in the Japanese market are from National (Panasonic) and Yamaha.

Why is the PAB so successful in the Japanese market? The manufacturers succeeded in lobbying the government to allow the PAB to be treated as an ordinary bicycle that requires no driving license, no registration number and can be ridden on a pedestrian path. Further, the new small and lightweight Li Ion battery pack is friendlier to the owner, including housewives, to remove and reload on the PAB, thus making battery recharge easier.

Contrary to the success of the EB (PAB), the Electric Scooter (ES)

Sales statistics of PAB, 1997 to 2005 (Data: Japan Bicycle Promotion Institute)



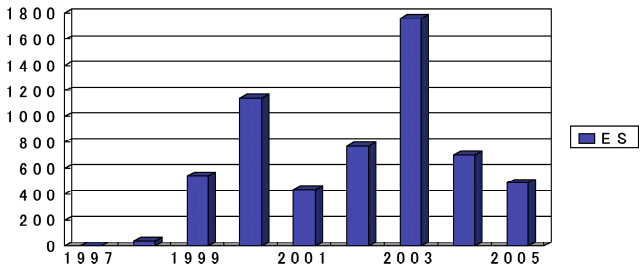
	1997	1998	1999	2000	2001	2002	2003	2004	2005
PAB	229577	212666	140609	147072	207356	227005	208913	233332	232402

National Vivi ¥115,800

Yamaha PAS Lithium L ¥117,800

Yamaha Passol-L ¥209,790

Sales statistics of ES, 1997 to 2005 (Data: Japan Automobile Research Institute)



	1997	1998	1999	2000	2001	2002	2003	2004	2005
ES	1	37	542	1144	435	773	1764	699	489

market has been flat, no change, in Japan. Over the past few years, ESs imported from Taiwan sold in some numbers. “Passol” from Yamaha has increased its sales significantly in 2003, but after the first year, the sales decreased. Introduction of higher performance “Passol-L” in 2005 could have increased sales. Reasons why ES sales in Japan are stagnated: performance generally is considered to be insufficient, too-high initial cost, equally too-high life cycle cost (cost of replacing battery) and the lack of infrastructure (charging stations). Running performance such as acceleration and maximum speed of some models was the same as gasoline engine scooters. Scooters are used for short distance and the cruising range during spring, summer and autumn was acceptable but because lead-acid batteries were used in most models, the range was reduced significantly in winter and the battery weight was too heavy. Excessive retail price due to limited production volume also hampered sales. With more development using the Ni-MH battery, like the ES from Tokyo R&D (a conversion based on the Honda Zoomer 50cc gasoline scooter), the real world cruising range of 25km was available with only 10kg additional weight to the original gasoline engine version. Recent Li Ion battery development is showing promise for ES application. Once such batteries becomes available at realistic cost, the real world cruising range may exceed 50km and this performance will satisfy significant number of users and ES sales should grow significantly in Japan.

Eric Marcel Misoe
Manager, Business Development & Planning
Tokyo R&D Co., Ltd.

Panasonic OffTime 240W 3.6Ah Li 24kph 38km 105,300yen 18kg Batt10,500

Panasonic ViVi Mammy Pocket 2.8Ah NiMH 78,450yen Batt7,350

Panasonic Lithium ViVi EX 240W 8Ah Li

Giant ReviveE NiMH 230,000yen 6Ah 240W

TAIWAN

Taiwan has had strong encouragement from Government and from common sense to develop acceptable electric two wheelers. So far, the Taiwanese have not adopted any LEVs for daily use in significant numbers. Several factors contribute to this: Steep parking ramps in underground parking lots, mountainous terrain in much of Taiwan, rain, heavy traffic on narrow roads with little room for bicycles, and the relative affluence of Taiwanese that allows many to use a car, and nearly all to afford good quality motorcycles / motor scooters. The Taiwanese prefer functional powered two wheelers for parking and traffic congestion issues, and there are virtually no bike paths / lanes – riding at below the speed of traffic is not viable. Cars may be more visible on the elevated

highways, but for daily transport gasoline motor scooters are the overwhelming choice of Taiwanese. This is not likely to change, except when public mass transport can be built – Taiwan does not have the room for roads, and parking places for cars. There have been and are ongoing attempts by the government to promote electric scooters to replace the gasoline powered polluting scooters but that effort has not succeeded. But the push for LEVs by ITRI (Industrial Technology Research Institute), and other government bodies has resulted in some of the most important work done on electric motor scooters over the last 10 years. And now Taiwan has changed its laws to encourage both electric bicycles and a new category of light electric scooter.

Taiwanese companies are major players in the Chinese Electric Bike business. There are Taiwanese owned plants in China, and Chinese plants with Taiwanese investment, and Chinese plants owned by Chinese but managed by Taiwanese, and many of the engineers / manufacturing process people in China are from Taiwan. Giant Bicycle Company builds and sells more than 250,000 E-Bikes in China / EU and USA. Merida Bicycle Company builds and sells E-Bikes in China and as OEM for other western companies. Fairly Bicycle builds and sells E-Bikes in China, USA, EU and SE Asia. The eGO is built in Taiwan. Razor is a brand of JD Components of Taiwan, but built in China.

Ed Benjamin

Taiwan Bicycle and Electric Bicycle Industries

In 2004 the Taiwan bicycle industry exported 4.4 million bikes (85% of output) in 2004 and China exported 51 million with 45% coming from Taiwanese-owned plants. Around 325 bike firms moved to China and Vietnam from Taiwan and of these, 295 moved to China. Taiwan is an important global supply center for middle and high end bikes and bike parts and contributes to and cooperates with buyers all over the world. China manufactures low and medium-end bikes for the mass-market. This means that Taiwan faces pressure from China's low-price competition. The American mass-market bike industry has had 80% of the market share for quite some time and virtually all the bikes sold in the USA are imported from China and Taiwan makers mainly with some from other countries like Japan, Thailand and Viet Nam.

Mainland China's production is more than 78 million in 2004 and accounts for two-thirds of world's bike production. The European Union has levied a 31% import tax as an anti-dumping duty on China's bike imports to Europe. Nevertheless the number of Chinese exhibitors is still increasing at European cycle shows. Six Taiwanese whole bike manufacturers moved to Vietnam and all makers produce 2.7 million bikes a year there. Some Taiwanese companies in Vietnam are already looking for another home.

The Taiwan bicycle industry is broad-based and mature, and Taiwan is one of the world's most important supply centers for bicycles and parts. Taiwan's electronics and electrical machinery industries are also strong and well developed. Taiwan is the world's leading exporter of electric motors. Mass production technology for control systems and large nickel metal hydride batteries is becoming increasingly mature. Lead-acid battery technology has reached a state of great maturity. Taiwan produces less than 30,000 E-Bikes (including export models) annually, and this total includes motors. Taiwan exported less than 5,000 E-Bikes in 2004 at an average unit price of US$415. Taiwan's produces PAS (power assisted system or Pedelecs) electric bikes.

JABP Spindle X5 250W/24V/12AhLA 20kph 25km Nanjing www.jabp.com

JABP Mini DirtBike 450W/24V/12AhLA 30kph 30km 36kg

Lvneng Electribicycle Changzhou

According to Taiwan's National Bureau of Standards, E-Bikes must be electric-auxiliary bicycles with a maximum speed limited to 30kph. E-Bikes in Taiwan are priced from NT$8,000 to NT$30,000. Numerous companies are illegally importing much cheaper Chinese E-Bikes for sale in Taiwan. Taiwan's E-Bike manufacturers stress quality and safety. Controllers, motors, and batteries must all have safety certificates.

Chinese E-Bike manufacturers use much cruder and less expensive products. E-Bikes have become very popular in China. Chinese companies have acquired considerable E-Bike manufacturing experience. They are also steadily improving nickel metal hydride and lithium batteries. We have to give the Chinese credit for their hard work in this regard. In Taiwan battery price still remains a big problem. Nickel metal hydride batteries are only used in a few high-end Taiwanese models.

E-Bike makers in Taiwan include Giant, Merida, Elebike, Fairly, Ideation, Navajo, and Pretty Wheel with over 70 electric bicycle suppliers in Taiwan. Most of these companies are manufacturing E-Bikes in China. It is still not legal to import E-Bikes from China. Taiwan's E-Bike makers are paying close attention to the cooperation between Bi Xiang and China Fujida. If we make the best use of resources and our advantages in both Taiwan and China, E-Bikes will become a successful business.

Grace S. Ruan
Wheel Giant Inc.
www.biketaiwan.com

CHINESE E-BIKES GETTING CLOSER TO WESTERN DEMANDS

Shanghai, China:
China International Bicycle & Motor Fair 2006 in Shanghai showed a large number of e-bikes. Compared to previous years overall product quality has improved immensely. Some products and details still don't live up to European expectations. But the Chinese are learning faster than we might expect.

At the 16th China International Bicycle & Motor Fair that was held at the Shanghai International Expo Center from April 17 - 20, 2006, one and half of eight halls were packed with light electric vehicles. Most of them were e-bikes, some pedelecs and utility electric vehicles as well as electrical components. Big electric scooters and smaller ones with the seat integrated into the main body design could be found all over the show, but the small stand-up and sit-down scooters are almost completely gone. Other designs included an electric freestyle motor-cross machine, a 'Segway'-sort-of vehicle for police officers and a platform on 4 wheels with handlebar and seat by Angell Autocycle Company. An e-bike with a round shaped body on top of which the rider is sitting was presented as new model at quite a number of booths.

E-bike development showed two directions: The typical China-style e-bikes in bright colors (orange, pink, yellow etc.) with bulky Lead-acid batteries, usually a luggage box on the rear rack, hardly functional pedals, step-though frames, and small wheels. The wheels on many of these bikes had tree wide spokes instead of the thin classical bicycle spokes. The other direction of e-bike development shows an adoption to Western style: less fancy designs, less plastic covers, step-though or men's frames, more decent colors (white, gray, light green, blue etc.), and some models with 28 inch wheels. Many of these bikes can be folded and use Lithium batteries. It is remarkable that the shift from Lead-acid to Lithium batteries is happening almost without NiCd and NiMH batteries as steps in between. The leading battery

Angell Police Human Transporter


China Style Ebike


Giant Prototype

technology in China is still Lead-acid. There were about 10 motor companies at the show offering mainly brushed and brush-less hub-motors with very similar designs and specifications. The latest trend on both, China and Western style e-bikes seem to be simple flower patterns as decoration on the frame and often on the battery cases.

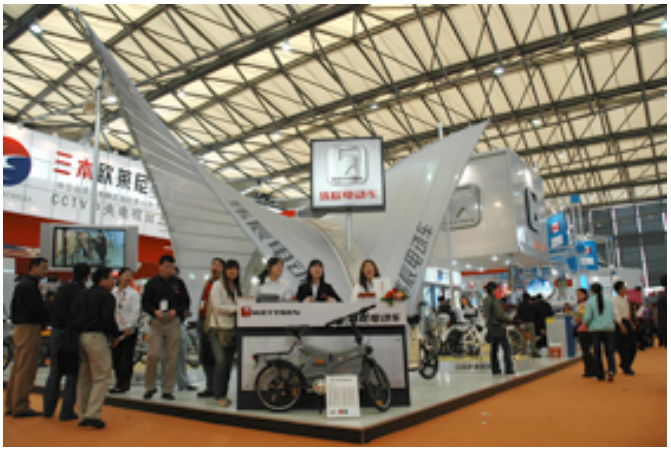
Shanghai show proved again that adoption to Western style in some cases means copies. Tianjin Shuntian (Shundi) Electric Bike Company for example displayed a pedelec that looks just like the Sparta ION and also carries Lithium batteries in the main frame. A similar product but with better workout on cables etc. was exhibited at the JC Electric Vehicle Company booth for export to Europe.

A large number of manufacturers who offer e-bikes for export to Europe did not seem to know much about type approval when asked or they haven't even heard about it or mix it up with CE certificate. Most of them claimed that they can convert e-bikes into pedelecs—no problem. This would allow them to avoid the type approval issue that is required for legal use of e-bikes and scooters in the EU.

The Taiwanese-owned and China-based manufacturer Wettsen hired the German design team Craftsmen to style the decals of their bikes thus making them unique and more attractive to Westerners. Wettsen also manufactures e-bikes for the new American brand Tresterra.

Merida showed a folding pedelec in light green and white with flowers on the frame and Lithium battery. The company is planning to export this new model to Europe.

Although many Chinese companies already export to Europe (mostly France, Italy and England, and some other countries), electric bike production in China is still focused on the domestic market. Mr. Yu, President of Shanghai Bicycle Association and Deputy Manager of National Bicycle Industry Information Center stated that there are 1.200 e-bike manufacturers in China. 650 of them sold 12 million e-bikes in China in 2005. Total production of regular and electric bicycles was 80 million units last year. 50 million regular and kids bicycles including a small share of e-bikes were exported in 2005.



Wettsen-booth

Hub motors

JCE Bike for Europe

TresTerra E-bikes

Typical China Style E-bikes

Typical E-Scooter

FOB for export e-bikes is about 190-400 USD. FOB for sales in China ranges from approx. 150—250 USD. 300 USD is about the limit a Chinese customer is willing to pay said Jean Chen, who has been selling and repairing e-bikes in Shanghai for many years. He explained that customers usually spend one third of the initial purchase price on repair every year. If a customer pays 200 Euros for an e-bike, it will cost him 500 Euros in 5 years of use.

Another difference in Chinese and European e-bike business is the manufacturing culture. In China there are a few companies who do research, develop new models, manufacture the molds for various plastic parts (which Chinese e-bikes use a lot of) and produce electric components. They sell these parts and components to companies who call themselves 'manufacturers' but often are not much more than assembly houses producing their own frames. If a new model sells successfully, all 'manufacturers' can buy the parts for it and bring out an almost identical model under their own brand name. This explains why so many Chinese e-bikes look almost exactly the same.

Susanne Bruesch

Sparta Copy

Merida Pedelec

LATEST CHINA NEWS --2007
CHINA INTERNATIONAL SHANGHAI BICYCLE AND MOTOR FAIR

The 17th China International Bicycle & Motor Fair was held from May 4-7, 2007 at Shanghai Expo Center. Over two halls out of 9 were packed with light electric vehicles. Big electric scooters were the dominant vehicle type. The overall trend: bigger and fancier.

Trend towards big Electric Scooters and copied brand names

This year's Shanghai Show covered an area of 105,000 square meters and attracted around 700,000 visitors over the four days of the event. Among the visitors were more foreigners than ever before. Over 1,000 exhibitors, among them 65 from foreign countries, showed parts, complete bicycles and light electric vehicles in a total of 9 fully booked exhibition halls. Four halls were packed with parts, 3 halls with complete bicycles, and light electric vehicles were shown in 2 halls mainly. These were more of a big party zone with hundreds of promotion girls than a serious business field. In the open-air grounds, more electric bike and scooter exhibitors tried to attract visitors with music and much ado. According to Mr. Yu, Chairman of Shanghai Bicycle Association and organizer of the show, the goal of Shanghai Bicycle & Motor Fair is to reach an international standard. In the aspect of booth setup and design this goal has been achieved.

Product types

Four major types of electric two-wheelers were exhibited in

Electric motor scooters, the dominant vehicle type at 2007 Shanghai Show

Shanghai:
The dominating products were big electric scooters, the electric equivalent of gasoline motor scooters such as Vespa or Honda Dream. They typically use a 350-500 Watt hub motor, lead acid batteries, come in more decent colors than their ancestors that still had pedals, and often with fancy decoration and details. Buffer-bars all around the scooter seem to be very popular. Typical FOB is 500-700 USD.

Last year's dominating product type – E-bicycles that almost looked like scooters, with lots of plastic and hardly functioning pedals – has lost pedals, gained plastics and size to become an electric motor scooter. Only a few E-bicycles are left with the same bulky lead batteries, plastic covers in bright colors, luggage box on the rear rack, and even fancier flower and picture decoration on frames and batteries.

Another type of E-bike that appeared last year was still a major type at this years show: Small wheel e-bikes, often foldable, often with suspension, bulky lead-acid batteries, and lots of decoration.

Bicycle style E-bikes (and some Pedelecs) with 26" or 28" inch wheels, and Lithium batteries are mainly for export to Europe, USA, and Japan. Merida and Giant offer products of their own styles with lead acid batteries to the Chinese consumers.

As a Chinese brand, Taiwan-invested manufacturer Wettsen is outstanding. On one of the biggest booths of the show, Wettsen presented more bicycle style E-bikes than scooter style E-bikes for the domestic market. German designed decals and a complete


Angell electric motor scooter


Dominant E-bike type of 2006 Show


Geoby Pedelec for export


The fancier the better


Giant electric bike for the Cinese market


"Flying" electric bike for export


New Wettsen E-bike line


First Wettsen supported shop in Shanghai


Gasoline and electric ATVs at the show

Electric scooter with foldable roof

Mini 4-wheeler by Phillips

Battery in the rear wheel

JCE electric motorbike

new product line in a European extremely simplified design aim to attract Chinese customers who want something different. Wettsen has started to open up company-own stores in China or cooperate with dealers to set up a store in Wettsen design as they have done in Shanghai.

Other products at the show included quadricycles (electric and gasoline), scooters with roof like the BMW C1, electric toys, a few motorcycles, 3 kW electric scooter, and a hybrid gasoline-electric motor scooter (Angell). An electric Honda Dream equivalent sells for 650 USD FOB to Thailand whereas the gasoline Honda Dream costs 1,000 USD retail.

The new brand name copy fashion

No words

Yamaha becomes Yawana

Ferrari turns into Farrori, Adidas into Abcidos, CK (Calvin Klein) becomes Cavalier Killerdiller ... Copying famous brand names is nothing new in Asia. But it's new to the electric bicycle industry. Copies of products such as the Prima Joe-Fly or the Sparta ION have been out there before, but at this year's Shanghai Cycle Show interesting brand names appeared—just a few letters changed but font and overall design of the original brand are the more or less the same. Even some brands that have nothing to do with the LEV business established a paradigm shift in brand identity. One company calls itself Wanbaolu and from the first glance you know it's Marlboro. Yamaha turned into Yawana, Honda into Holida. Phillips brand name for Chinese electric scooters reminds of Royal Philips Electronics but sells with two "l" – and uses the addition "Since 1892"…

Susanne Bruesch

A real fake?

Shanghai Show now major event in 2-wheel transportation

The first time I attended the Shanghai Cycle Show was 1997. At that show, held in the old meeting facility on Nanjing West Road across from the Porterman complex, I saw only one other American and I do not recall seeing more than one or two Caucasians. There were no exhibitors that were not Chinese companies – even the Taiwanese companies were not there. That show was primarily conventional bicycles, with a few companies exhibiting electric bikes. During that same visit to Shanghai, I spent several days in a taxi riding about Pu Xi (West side of Pu River – or the "old" Shanghai – as opposed to Pu Dong – East side of River- new built) looking for people riding electric bikes. I found one such rider. The electric bikes of that time were pretty poor in performance, looks and reliability. When I visited a few electric bike factories after the show – I saw improvised production lines inside space intended for offices or even apartments with workers squatting on the floor and using minimal tools and no evidence of QC or manufacturing process.

I have attended every year since, and it has been exciting to see this industry grow up. The 2007 show was a show about electric bikes, with a relatively few booths dedicated to only conventional bicycles. And the vigor, energy, and excitement were to be found in the courtyard and halls 4 and 5 – nearly exclusively E-bike territory. This may have been the first year that I saw sophisticated booths, well designed, with well developed product selections supported by marketing – as a normal feature of the show rather than the exception. Quality of E-bike product (especially in terms of the Chinese consumer) has improved greatly. And the bikes have a finished, designed look with attractive plastic, graphics, and colors. And from what I hear from my Shanghai staff – most Chinese consumers are reasonably satisfied with performance and reliability.

The first day of the show was nearly standing room only in the E-bike areas – with masses of people that I cannot even estimate flowing through the show. The courtyard exhibits were surrounded with dense groups. Successive days saw steady drop off in attendance, until the last day – which resembled any busy bike trade fair. The booths reflected the nature of the E-bike industry of today – numerous brands offering nearly identical products.

Among the exhibitors:
China Domestic appliance brands (especially of electronics goods) offering their own brand of E-bikes.
Taiwanese bicycle companies – notably Fairly / Wettsen, Giant, and Merida with large booths and sophisticated presentation. China Domestic Bicycle Brands such as Phoenix and Forever offering E-bikes as their largest product category. Electric Bike Companies like LuYuan, Angell, Cranes, specializing in E-bikes. Component makers, trading companies and accessories makers. And…
USA and European exhibitors such as Trek, Specialized and Pacific.

Foreigners were everywhere – USA, EU, Indian, and many other groups of visitors and buyers. To be a Caucasian at this show is no longer of any note. Equally interesting is the heavy use of electric bikes on the streets of Shanghai. Perhaps my attention was drawn to E-bikes… but there seemed to be more E-bikes than normal bikes. The employee parking area for my hotel was nearly exclusively E-bikes – at least a hundred of them. And the show staff came to work largely on E-bikes.

Summarizing the show would be easy – the electric bike industry of China is no longer an amateur, no resources, and minimal business. It is now the main event in two-wheel transportation in the largest country in the world. It has grown remarkably fast and matured quickly.
Ed Benjamin


View into one of the E-Bike halls

Shanghai Show on international level

Merida booth

Historical Picture

Taipei Pedelec & E-Bike Global Congress 2001
Hannes Neupert, Susanne Brüsch, Ed Benjamin,
Joy & Frank Jamerson

Taipei Bike Show 2001
Frank Jamerson in Ribbon Cutting Ceremony

Section 7

Electric Scooters and Motorcycles

Overview

The Electric Scooter (in EBWR04 the term Heavy Electric scooter was used) is supposed to replace all the high polluting gasoline scooters, mopeds and motorcycles that are used by over 100 million riders in Asia and Europe. But that has not happened yet since products to date have not satisfied the market. But in China an interesting transformation to ESs has been "under the radar" since the focus of news has been on the electric bike and the Scooter Style Electric Bike, SSEB, that is very popular with lady commuters. But the Electric Scooter to replace the small 50cc Vespa type scooter has seen accelerated sales since 2003 as news reports from China indicate that electric scooters are being manufactured in numbers rivaling electric bike numbers. EBWR cautions that there may be some uncertainty in the China media about identifying an electric two-wheeler as a scooter rather than an electric bike so the sales numbers for the scooter may be wrong in fact. Nevertheless, these news articles confirm that the Chinese public is willing to commit to electrification of two-wheelers with much enthusiasm. In the upscale markets of the USA and Europe, the market seems to be ready for the Vectrix Maxi-Scooter that is arriving in the market in 2007 with a lot of pre-orders. eGO Vehicles has seen their scooter sales steady and growing in international markets as well. Asia Pacific Fuel Cell Technologies is doing a fleet test in Taiwan of its electric scooter with hydrogen fuel cell power and ITRI continues to develop Lithium powered scooters to move Taiwan scooters out of gasoline. Electric Vehicle Systems is seeing sales in the thousands for its ES, so the market is beginning to take off in the USA and Europe. Oxygen in Italy offers the Postscooter for delivery vehicle use claiming big fuel cost savings over conventional scooters. The delivery vehicle market will be taken over by the ES and could spill over into other gasoline scooter/moped markets. Intelligent Energy in the UK is developing a highly stylized fuel cell scooter that has great reviews. Electricross has a motorcross motorcycle for the off road enthusiast that is popular in California. The Venture three-wheel motorcycle has a tilt mechanism on the front wheel for efficient cornering. Axle, in Japan, has a very slick looking electric motorcycle with excellent hill climbing specs. TWIKE, the funky three-wheeler originated in Switzerland and now made in Germany has sold over 7,000 units and going strong. Yamaha has sold the ECO2 for two years with success and other models will be coming out, while Honda works on fuel cell scooters making Japan a contender in the ES business. Lastly EBWR attempts to compile the sales of electric scooters worldwide after reviewing worldwide gasoline two-wheeler sales that are bigger than EB numbers. At this time, it is evident that electric scooter sales are starting to grow in China and may be on a similar growth path in India, while Europe and USA are hoping for big time production and customer acceptance. ES sales will be in the multi million unit range in both China and India over the next five to ten years. Electric motorcycles, on the other hand, will have much smaller sales than ESs until large Lithium Ion battery packs will be affordable. Overall, the electric scooter is finally coming into prominence with practical products and will be a significant player in the electric transportation movement going forward. Stay tuned.

Vectrix Electric Maxi-Scooter
EBWR04 reported that Vectrix Corp., Newport, RI, was to start a production plant for it's electric Maxi-Scooter in Europe. The Vectrix plant has been located in Wroclaw, Poland and is expected to initiate production in early 2007 to meet the thousands of European orders already in place with shipments to the USA to follow. Vectrix has been productionizing their scooter with Parker Hannifin that includes NiMH batteries from GoldPeak. Fifty preproduction units were built and used in a ride and drive track at the EICMA show in Milan, Italy, November 2006. Three thousand riders tested the Vectrix Maxi-Scooter with enthusiasm. The Maxi-Scooter has excellent performance with top speed of 62mph, range of 68 miles and goes 0-60mph in 8 seconds. It uses a 3-phase brushless 20kW peak motor (designed and produced by Parker based on 7 years of development by Vectrix), 125V 30Ah NiMH battery, regenerative braking and overall weight of 470 pounds. To the gas crowd, this equates to a 400cc in looks, weight, power and price, around $11,000, but with the torque of an 800cc and licensed like a 125cc. A three-wheel version of the Maxi-Scooter is in the first generation prototype stage and a sport motorcycle is in the concept design stage. Vectrix is taking more orders.
www.vectrix.com


Vectrix Eicma test drive


Vectrix 3Wheel Scooter


Vectrix 06 Eicma Booth

eGO Vehicles
EBWR02 introduced the eGO cycle from eGO Vehicles, Inc, (now eGO Vehicles, LLC) of Cambridge, MA. eGO has grown from a U.S. specialty producer to overseas manufacturing (Taiwan) with worldwide distribution. EBWR has seen eGO scooters on the streets in several U.S. cities. Not as heavy as most ESs it offers a stable platform for cruising to work or recreational activities. Power comes from a 24V 34Ah lead-acid battery and 4,800W max power motor to provide 20-25 mile range in the Go Far mode at 17mph and 18-22 mile range in the Go Fast mode at 23mph. It is street legal for the U.S., European and Asian markets. Latest USA models include the eGO Cycle 2 “Classic,” “LX” and “Special Edition.” The European models are sold under the name “Helio” Cycle and come in four different speeds (20km/hr, 25 km/hr, 30 km/hr and 38km/hr). The eGO / Helio Cycles can be purchased in most European countries with partners being sought in numerous other countries. Americans buy the lion’s share of the Cycles, but Europe is gaining strength. As we said, somewhat prophetically, in an earlier edition of EBWR: “The eGO is a product that will likely endure for a long time.”
www.egovehicles.com


Vectrix Production Model


a Vectrix Cutway


eGO Scooter

Asia Pacific Fuel Cell Tech.
APFCT was founded by aerospace engineer Jefferson Yang seven years ago and today is on the threshold of making a bold step into the fuel cell/battery hybrid electric scooter business. The company is based in Taiwan with an office in California. By perfecting a PEM fuel cell of nominal 1.5kW output that will be coupled to a 350Wh Lithium Ion battery, their scooter will be in a class by itself. Peak power of the system is 3.5kW with 2.5kW from the fuel cell and 1kW from the battery. The fuel cell/battery hybrid scooter is in its fifth generation of development and is scheduled for a 20 scooter fleet demonstration in Taiwan during 2007. An even larger fleet of 150 scooters is also being planned for 2008. Target production date will be late 2008. To provide a hydrogen supply infrastructure as convenient and user friendly as gasoline, APFCT has also developed a metal hydride storage canister that will be used in an infrastructure test in Taiwan with the scooters. The hydrogen will come from an oil company, Chinese Petroleum Corp., which runs 70% of the gas stations in Taiwan and has refineries that produce hydrogen for use in its refineries. Fuel cell scooter users will exchange their two spent canisters at existing CPC gas stations and CPC will reload them with hydrogen at their regional recharge stations. Top speed of the scooter is 60kph with range of 80km when carrying two canisters. That might be increased to three canisters for added range. This could be a significant product that could contribute to cleaner and quieter city centers in Taiwan devoid of gasoline scooters eventually. APFCT needs to succeed to make Taiwan cities cleaner from exhaust pollution.
www.apfct.com.tw

APFCT ZES IV.5

APFCT Hydrogen Fuel Tank

MRL at ITRI, Hsinchu, Taiwan

ITRI (Taiwan) Electric Scooter Programs
Around eight years ago the Taiwan government passed legislation designed to replace all the noisy and polluting gasoline powered scooters with electric scooters. There are 12 million gas scooters in Taiwan that make up much of the traffic in cities and in the country. The plan was to mandate 2% of scooters to be electric by 2002 with rebates for purchase. The Industrial Technology Research Institute (ITRI) was assigned to develop an electric scooter to enter the market fast. However the ITRI scooter was not acceptable to the consumer since it was poorly made and the battery did not provide sufficient range. Thus the government mandate was forgotten though rebates are still apparently on the books. In recent years ITRI has developed an electric scooter, with a 2kWh Li Ion battery pack. The curb weight is 100kg, with range 60 to 75km. The 3kW brushless hub-wheel motor allows a top speed of 60kph. The Mechanical and Systems Research Laboratories also was involved in the development of an electric scooter with two different battery types: lead-acid for the motor propulsion, and Lithium Ion for the energy supply. The Lithium battery can be removed and charged at any household outlet. The weight of the batteries is 15 (L-A) and 2.5kg (LiI), and both of them provide a range of 30km. Thus ITRI continues to be in the R&D mode working on batteries and electric scooters while the country could use an electric scooter product today. The gasoline scooter manufacturers are evidently not willing to move to the use of electricity as the fuel for their scooters. The stalemate will continue until one company decides to take the plunge. Examples of traditional companies changing are General Motors that produced the first production EV (though they dropped it too early) and Toyota with the first production hybrid. Now all carmakers are into EVs (Plug-in or Hydrogen) and hybrids. Electric Scooters in big production numbers will happen too--the question is where and when--Taiwan is a good location but it looks like it will be China and India first.
www.itri.org.tw

Electric Vehicle Systems/ Technologies

Electric Vehicle Systems Corp., Waukegan, IL, partners with Electric Vehicle Technologies, Taiwan, in the manufacture of an All Terrain EV (ATEV) and distribution of electric scooters made in Taiwan. The ATEV-28 will be introduced at Industrial Dealers Expo in Indianapolis, February 2007 and enters dealers shortly thereafter. The ATEV-28 has a 22kW (28hp) 72V motor and carries 50Ah of lead-acid batteries to run at 42mph for 30 miles. Forests will now be quiet without noisy gasoline ATVs. The EVT 168 and 4000-E scooters have been popular and availability is expanding to licensed gasoline powered scooter dealers. This results from recent changes in state laws that make electric scooters come under gasoline scooter licensing laws. With the price of gasoline high, customers are turning to electric alternatives and licensed dealers are moving to electric for that reason. The EVT scooters have a 48V 50Ah battery with 1,500W motor with 45mile range at 30mph. EVS expects sales to move into the thousand of units as dealerships expand and as the ATEV takes hold in the marketplace.

www.evtworld.com

Oxygen World

Oxygen S.P.A., located in Padova, Italy with offices, Oxygen World Inc., in New York City, was founded in 2001 as a leader in the development and manufacture of Electric Scooters for the delivery business. The new Oxygen Postscooter competes economically with conventional vehicles for postal and courier service applications. In 2005 they began to use the Valence Technology Saphion Lithium Ion battery to provide a lighter battery pack with more range. The Postscooter comes in three versions of battery pack that can be selected to match the delivery needs of the customer. The basic battery is 12V 100Ah and the scooter is configured in three pack sizes: 1. 24V to give 60km range and total scooter weight 121kg. 2. 36V / 90km / 136kg, 3. 48v / 120km / 151kg. The motor is in-wheel direct drive brushless with peak power of 3.5kW. The digital controller can be customized and optimized remotely by plug-in laptop computer. Regenerative braking is provided along with reverse running so the scooter can be backed up. The Postscooter comes with all these technological features and a four year warranty which is very impressive. There are two stora-

Oxygen Postscooter with racks

Oxygen 2-seater

Oxygen Deliverence

EVT ATEV-28

4000-E

EVT 4000-E

ge locations for cargo, a front box carries 20kg and a rear box carries 75kg. Overall the Oxygen Postscooter looks like it has great technology and performance and should be a winner in the postal and courier delivery business worldwide. Oxygen is focusing its marketing and sales efforts in Europe targeting postal and business couriers like Pizza Hut delivery and national postal services that are enthusiastic about the electric scooter as a delivery vehicle. This market is growing and within a year or less Oxygen expects to enter the USA market with the Postscooter for the delivery service industry. Oxygen stopped the original Lepton electric scooter production to introduce newer technology in the Postscooter. It seems Oxygen made the correct decision.

www.oxygenworld.it

Intelligent Energy

Intelligent Energy, a fuel cell development company headquartered in the UK, has developed a "CORE" PEM fuel cell that has excellent volumetric power density and low parasitic loss. The CORE is made from thin metal sheets, rather than more common graphite plates, that is more robust, compact and easier to manufacture. The CORE fuel cell has been incorporated into the ENV (Environmentally Neutral Vehicle) motorcycle that is streamlined and functionally designed. The CORE is removable from the bike as shown. The ENV is currently undergoing both an intense development period and further financing and news on its future development is expected soon. This could be the first fuel cell motorcycle on the market. The ready availability of hydrogen will be key to its success. The company is also working on reforming technology that, in the future, will allow the production of hydrogen on demand from ethanol. ENV technical specifications: 1kW PEM fuel cell, 48V 6kW brush motor, hydrogen high pressure gas storage provides 2.4kWh energy for 100 mile range, top speed 50mph, and weight 80kg. IE has received much attention with the attractive design of the ENV but will it receive much attention from buyers? EBWR thinks it will. Stay tuned.

www.intelligent-energy.com

Electricross Motorcycle

Electricross is a startup company in Scotts Valley, CA that designed and builds the Electricross Drift high-performance electric motocross motorcycle. This is a powerful motorcycle that delivers three times more power than a Honda gasoline powered CRF-150 and weighs 100 pounds less, total weight 140 pounds with lead-acid pack. The Drift uses a 19+ horsepower (14,400 watt) Briggs and Stratton Etek motor and a programmable controller from Alltrax. A quick-change battery pack and an ultra-light handcrafted aluminum frame is a unique Electricross package. The standard battery is sealed lead-acid, four 12V modules, with a Lithium Ion option that is 30 pounds lighter and rated at 48V/36Ah. With a top speed of 45mph, Drift is used by off-road enthusiasts and runs on the streets to 30mph with a lower gear to make it street legal. Total run time is one to two hours, depending on use, between battery recharging that takes just a few hours. The Drift electric motorcycle is selling briskly and Electricross is stepping up production. California is always "ahead of the curve".

www.electricross.com

Intelligent Energy ENV

Electricross Drift

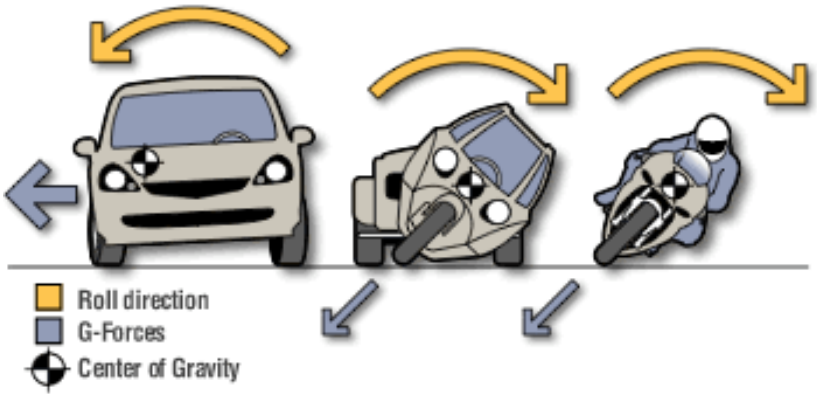
VentureOne Three Wheel Electric Motorcycle

Venture Vehicles, Los Angeles, CA, builds a three-wheel motorcycle for two riders in tandem with a tilting passenger compartment. Venture offers two hybrid drive and one all-electric drive vehicle. The hybrid propulsion system is of a series design with a small internal combustion engine connected to a 15 to 20kW generator, two in-wheel 25kW (or 50kW) electric motors, a four gallon fuel tank, and a 3kWh Li Ion battery pack with regenerative braking. The all-electric propulsion system has two in-wheel 20kW electric motors, and a 17 kWh Li-Ion battery pack. The Venture e50 has the 25kW motors with 100mph tops and 350mile range with 0-60mph time under 6 seconds while the Venture Q100 has the 50kW motors with 120mph tops and 300 mile range and 0-60 time under 5 seconds. The all-electric Venture EV had 20kW motors with 75mph tops and 120mile range and 0-60 at 8 seconds. Prices range from $18,500 for the hybrid VentureOne e50 to $23,000 for the all-electric VentureOne EV.

Carver Cornering

Carver 3-wheel Motorcycle

VentureOne Electric Motorcycle Concept



VentureOne Tilting

The 1,200 pound VentureOne is classified as a motorcycle by the NHTSA since it features three wheels. And similar to a motorcycle, the passenger compartment of the VentureOne can tilt 45 degrees left or right when entering a corner called Dynamic Vehicle Control or DVC that was developed by Carver, a motorcycle company in The Netherlands. They produce a gasoline three-wheeler there that sells for 35,000euros. The hydro-mechanical DVC system uses a combination of the driver's input from the steering wheel and the tilting of the chassis to maintain balance and direction of travel. Chassis tilt is nominal at low vehicle speeds as the steering angle of the front wheel dictates the direction of travel. As speed increases, the angle of the front wheel is not a major factor in changing direction -- the driver's input is instead transferred to the tilt of the chassis that in turn provide direction change. Motorcycles are very heavy so a three-wheeler makes sense and an all electric and hybrid versions should find a niche in the California exotic and green market and perhaps nationwide as USA riders turn green from high gasoline prices. We will see.

www.flytheroad.com

Axle Electric Motorcycle
Axle Corp. of Japan has partnered with Genesis Corporation to overcome some of the greatest shortcomings of electric motorcycles, including insufficient range and lack of torque, with the introduction of the latest version of its Sumo motor, used in Axle's EV-X7 motorcycle. The EV-X7 has a very slick appearance with large plastic body so riders can place their feet on outside running boards. The design is very different from the standard gas motorcycle. The motor produces 2,130W of power at 80% efficiency. It combines permanent magnets and electromagnets to form a variable inductance magnet with improved performance. The EV-X7 motorcycle has a range of 180km (110 miles) with a fully charged battery. The battery requires six hours to charge. The Sumo motor provides enough torque to climb a steep six-degree gradient at 25 km/hr (15 miles/hr). The EV-X7 is being marketed as a quieter and more energy efficient alternative to gasoline-powered motorcycles. One full charge of its battery costs 80 yen (US $0.68) while a comparable 250cc motorcycle would need 4.5 liters of fuel to travel the same 180km, at a cost of 550 yen (US $4.70), seven times more cost, at current electricity and gasoline prices in Japan. Lets see how this "good-looker" does in the market place.
www.axle-group.com

Axle EVX7 Motorcycle

Pedaling Twike

TWIKE
Twike, a three-wheel, two-passenger sharp-nosed electric, comes with pedals or without pedals, and is produced in Rosenthal, Hessen Germany. It started production as SwissLEM AG in 1996 in Switzerland and FINE Mobile GmbH launched production in Germany in 1998. Over 700 TWIKES have been sold, most of them on the streets of Switzerland and Germany and some can be found in Austria, Italy, France, England, and even in the United States. The TWIKE has an energy equivalent consumption of 300-600 miles per gallon gasoline resulting from lightweight construction and an efficient powertrain. The digital power electronics energize the asynchronous 5kW motor that drives the rear wheels via a differential gear. The optional pedal drive is directly connected to the power train by a chain and a freewheel providing 30% more range depending on terrain. The quick-rechargeable NiMH (360V 18Ah) batteries allow for a range of up to 130km per charge and over 260 to 390km per day since the TWIKE can be recharged in 2 hours. The powerful electric motor accelerates the TWIKE fast to a maximum speed of 85kph. People who drive the TWIKE really enjoy this efficient compact three-wheeler that runs pretty fast and can also take the hills and mountains in Europe.
www.twike.com

Japan Yamaha / Honda
The Yamaha ECO2 was introduced in 2005 and has a top speed of 30kph and a range of 43km intended for very local commuting. The handlebars fold down, allowing for transport in a car. 'Switch' is the slogan used for the Tokyo Electric Power Company's campaign to get more people using EV's in Japan. Yamaha is also working on the AQUL Fuel Cell scooter, the Gen-Ryn Hybrid Scooter and the Dinonychus folder prototype. Honda has the FMCL 1 Methanol Fuel Cell Scooter that uses methanol as the fuel that directly converts to electricity in the fuel cell. Distribution and handling of methanol, rather than hydrogen, is another option for the fuel cell power unit.

Yamaha Hybrid Scooter

Honda Methanol FC Scooter

Yamaha ECO2

Electric Scooter Sales are Big in China
Norbert Haller, Designer, Craftsmen GmbH, Berlin, Germany, provided the following Chinese news publications excepts that talk about the growing sales and production of electric scooters that are equivalent to the 50cc Vespa type, EBWR designates as ESs.

More and more electric scooters are plying the streets of large and medium-sized cities, like Beijing, Shanghai and Chengdu. In the past, they were denied registration by Beijing's transport authorities because they were considered an illegal means of transport. Change in the numbers suggests that the debate on whether or not electric scooters should be allowed on public roads has been resolved, while environmental issues open the market. China's electric scooter industry has shown new momentum since 2003. As a convenient and environmentally friendly means of transport, they have quickly grabbed the attention of consumers, replacing cars that are relatively expensive - and push-bikes which are not suitable for longer distances.

In fact, electric scooters have become big sellers across China, with some 16 million electric scooters sold in 2005. **(CAVEAT--EBWR believes the 16 million number includes Scooter Style Electric Bikes plus Vespa type Electric Scooters and that the majority are SSEBs--in 2005 EBWR has EB sales at 12 million units that would leave 4 million for ES sales in the 16 million number in the Chinese publication, but still a too high number by EBWR analysis. The SSEB has small pedals that might not be noticed and thus it might look like an ES.)** There are now 25 million of these scooters nation-wide. Industry sources expect after a number of years at least 350 million of China's 450 million push-bike owners will switch to electric scooters and the total market value, including sale of second-hand vehicles, parts and accessories, repair services and upstream supply chains, could be some Rmb1.3 trillion (US$170 billion). The replacement rate of electric scooters for push-bikes is currently 3% on average, and as high as 18% in some larger cities. The industry predicts good prospects for China's four major electric scooter centres. Beijing currently has 10.5 million scooters with a market value of Rmb31 billion (US$4 billion). Then there is Tianjin with 9.7 million scooters valued at Rmb26 billion (US$3.4 billion), while Shanghai has 9.2 million units valued at Rmb23 billion (US$3 billion). Chengdu has 7.5 million scooters with a market value of Rmb17 billion (US$2.2 billion).

According to industry sources, China is experiencing a period of rapid change where it comes to transport modes. A multi-tier consumption pattern has created demand for different means of transport. From the perspective of consumption, while high-income earners in large- and medium-sized cities will mainly go for motorcars, there is a pressing demand from a much bigger community that wants to upgrade from push-bikes. Electric scooters provide an efficient and inexpensive personal means of transport with low per-use cost. They are seen as a sunrise industry with good market prospects. Most push-bike riders will switch to electric scooters. Women are major consumers of electric scooters.

On the other hand, the popularity of electric scooters also has its practical reasons. -Energy conservation is no doubt a guiding principle for China's future economic development. The runaway growth of petrol-driven motorcycles in Chinese cities has resulted in serious environmental pollution and many large- and medium-sized cities are starting to ban their use. Given China's shortage of crude oil reserves, which are non-renewable, oil prices are bound to rise. The chain effect is that the operating costs of public buses and taxis will increase and transport expenses will go up. For big cities like Beijing, the acceleration of the urbanisation process takes industrial areas further and further away from residential areas. This makes it very inconvenient for commuters. According to some experts, it is still physically tolerable to peddle for five kilometres to go to work. Beyond this distance, it is too exhausting. So, the future trend is to substitute push-bikes with electric scooters.

Wuxi, Tianjin, Guangdong and Chongqing are the four major production bases for electric scooters in China. A report on the electric scooter industry in Xishan district, Wuxi, is now available. According to the report, the core of Xishan's electric scooter industry is in Anzhen, where there are numerous production centres. The streets are lined with huge advertisements, while trading is brisk. All brands and models of electric scooters are available, with price tags ranging from Rmb1,500 to Rmb2,500 (US$195 to US$325). According to dealers, vehicles within this price range sell the best, with buyers from all parts of the country.

Xishan's electric scooter industry started at the end of the last century. Most factories were previously engaged in the production of motorcycles, and despite their late start, the ban on motorcycles in cities, together with rising oil prices provided these industry players with increasing business opportunities. Sales have been steadily on the rise since then. There are now 186 electric scooter plants in the district. Their total output last year was two million vehicles, about a quarter of the

Zhejiang Yiyang Scooter

Adda Scooter

Hirun Pocket Bike

Hirun HelloKitty Scooter

national total and 70% of Jiangsu's total. Output in Xishan is expected to reach 3.5 million units in 2006, with the total value of the industry amounting to Rmb10 billion (US$1.3 billion), or 12% of Xishan's total industrial output value.

Zhang Hongxin, deputy chief of the Xishan industrial district, explained that there are two major reasons for the rapid development of Xishan's electric scooter industry within a few years. In Zhang's opinion, the prime reason is the timely transformation of the motorcycle industry. In the past, Xishan's "Jetta" motorcycles were famous nationwide. When sales of motorcycles declined, enterprises began developing electric scooters, quickly grabbing market share by relying on existing channels and brand reputation.

Another reason for the sales jump for scooters is a vibrant business environment. The district and town governments have increased their support for electric vehicle production by offering preferential land rent and attractive tax options. Besides fostering existing enterprises, officials have also attracted market leaders in production such as Beijing Xinri and Done's to come to the area and invest. The arrival of Beijing Xinri two years ago triggered a new round of competition. Major companies such as Zhongxing, Sinski, Chituma, Laibaochi, Guowei and Done's are investing in new factories as well as bringing in new technologies and equipment. Others are setting up equity and contractual joint ventures for the development of supporting industrial chains.

(Another reminder--this article is written about ESs but EBWR believes the reporters are writing about SSEBs that are the dominant EB style in China today.)

Source Shanghai Daily / China

Electric Scooter Sales

It is apparent that there will be a movement in China to ESs, heavier and more powerful than SSEBs. The China press writes about ESs, but not correctly in the opinion of EBWR. New ESs being introduced in India where the market size potential is as large as for China. This is an attempt to organize ES sales numbers in a "best estimate" way since EBWR believes that electric scooters will be a big part of the transformation of all two-wheeler transportation to virtually 100% electric in the future. This is happening as Lithium Ion batteries are improving and become more affordable and hydrogen fuel cell power becomes affordable and acceptable by the public. Both these technologies will see increasing use in electric scooters making them more attractive for transportation.

To try to understand the potential for the ES market, EBWR reviews an estimate of gasoline scooter and moped production and sales. The gasoline scooter and moped will likely be the vehicles replaced by Electric Scooters. Scooter and moped numbers are often combined with motorcycle production and sales. The motorcycle is a much heavier and more powerful machine. A few pioneering companies, Venture, Electricross and Axle, are working to provide electric motorcycles. These generally use a heavy lead acid battery and customers are venturesome off-road riders. Electric motorcycles are not expected to be a big time product

Vectrix Maxi-Scooter Production Model

Angell Transporter 350W/36V/21Ah LA 15kph/30km Angell Autocycle Jiangsu

Angell Rocket 400W/36V/12Ah LA 40kph/20km

to replace the powerful gasoline Harley Davidson.

In Section 2, the 2006 gasoline scooter and moped sales were estimated as 42 million units. Other sources show 35 million

units in 2006. So the range of 35-40 million may be valid and take 40 million units for the 2006 number. This is broken down to sales by country or continent, based on additional regional data, and 2006 estimated gasoline scooter and moped sales are shown in Table 7.1.

Table 7.1
2006 Estimated Gasoline Scooter and Moped Sales

	Millions
China	22
India	7
Indonesia	5
Thailand	2
Europe	1.4
South America	1.4
Taiwan	0.4
North America	0.2
ROW	0.6
Total	40

Rest of World -- Australia, Japan, Korea, Malaysia, Philippines

Thus the potential is there to replace a large percentage of gasoline scooters and mopeds with ESs as has happened in China with the EB replacing the pedal bike with EB sales now in the tens of millions yearly. This surely is the direction for ESs and will be tracked by EBWR. So the next question is what might be ES sales be in the recent past and in the future?

EBWR has one data point on ES sales. China in 2006 is estimated to have had 16,000 ES sales in 2006, where these are real ESs and not SSEBs. This is in sharp contrast to the 16 million units reported by China Daily above and seems more reasonable based on Ed Benjamin observations of traffic in many China cities over the past five years. Table 7.2 is based on the China data point and estimates of ES sales in the USA, Europe and India and the expectation for these markets to grow significantly. There is a small but rapidly growing market in Europe in the delivery vehicle segment that Oxygen is very active in. This delivery vehicle market is about 25,000 units a year of gasoline powered products and could see a large ES imprint in the next few years. In the USA, companies like eGO, Oxygen and EVT are having success and Vectrix could also become a significant player. EBWR concludes that USA and the Europe will see growth to the 5,000 and 10,000 unit range, respectively, in the next few years. Though smaller in sales than China and India, EBWR expects Europe, and the USA, to more strongly embrace the ES in the future. The expectation is that the ES in China and India will take off with growth rates approaching 100% when products attractive to the public, at acceptable prices, are offered. The time for this to happen appears to be now.

The ES will be a replacement for the gasoline scooter and moped, and will be more powerful and heavier than the SSEB that is included in the sales tables for EBs. These Electric Scooter sales numbers will become millions in future years and the question is--how long will it take? Lets consider the record of the Electric Bike in China. EB sales went from 20,000 units in 1996 (EBWR02 estimate) to 12 million units in 2006, a ten year period, for a six hundred fold increase! The market growth pattern should be similar for ESs. So EBWR predicts China ES sales will approach 10 million units by 2017, just ten years from now. India is now ten years behind China in EB sales but India ES sales could increase faster with a robust economy. Thus EBWR predicts ES sales in the one million year range by 2017 in India, still behind China. Time will tell if these EBWR predictions will be validated.

Table 7.2
Estimated Electric Scooter Sales

	2005	2006	2007	2008	2009
China	10,000	16,000	50,000	100,000	200,000
India	1,000	2,000	5,000	10,000	20,000
Europe	1,000	1.500	4,000	8,000	15,000
USA	1,000	1,500	3,000	5,000	10,000
Rest of World	1,000	2,000	3,000	5,000	8,000
Total	14,000	23,000	65,000	128,000	253,000

Section 8

ELECTRIC VEHICLES: NEIGHBORHOOD and PURE

Overview

The world has changed since EBWR04 and we sense a new awareness and interest in electric vehicles of both the Neighborhood (top legal speed of 25mph in the USA) and Pure (with highway top speed, or higher). The NEVs already in the market are selling well at an estimated 10,000 units (2006) yearly in the USA and half that number each in Japan and Europe. The Neighborhood Electric Vehicle business appears to be growing faster in the USA as well as in Europe. Higher gasoline prices, and the desire for quieter neighborhoods are the big reasons for this change. DaimlerChrysler's GEM is the premier provider with the advantage of an established large network of Chrysler dealers available for sales and service. ZENN and Dynasty, both in Canada, offer NEVs that are more car-like and have sales mainly in the USA. The General Motors EV1 was the first production Pure EV to test the market and failed in the 1990s when not enough customers signed up to lease them. Several new small companies offer two seat sports models in the image of EV1. Tesla has a $100,000 sport EV that will use Lithium Ion batteries to achieve 250mile range. The Venturi, of Monaco, will offer the most expensive sport EV for $390,000, as well as solar panel charging on their Astrolab and Eclectic models. The Tango Ultra Narrow Vehicle provides a unique approach to small vehicle footprint. ZAP has the three wheel Xebra and promises a fast sport EV with help from Lotus Engineering. Universal EV has another sport model with NiZn battery, also a first. Phoenix Motorcars retrofits a Korean pickup and Smith EV in the UK has three large, up to 7.5ton, trucks for delivery service in metropolitan areas and both will deliver vehicles in 2007. Kronosport is selling a Utility EV that has three wheels for local maintenance work or can configure to a two passenger local taxi. Smith is pioneering use of the Zebra battery that operates at 200C and has high performance suited to the truck application. Norway provides many financial inducements to own an EV there and Kewet is resurging and Th!nk, once bankrupt, is restarting. Start Lab in Italy has three small EVs that are entering the Japan market as well. Japanese have NEV like models that all go above the NEV speed limit but are for city streets only, from Matsuoka, Mitsubishi, Nissan and Subaru. Very light one passenger EVs in Japan are designated Quadricycles. China is into EVs, and the last company discussed is a China EV, with NEV speed, just being sold in a Portland, Oregon car dealership. These twenty two companies are testimony to the resurgence and oncoming growth of the EV market in NEV, sport models and functional trucks. Four wheel EVs are coming for real. You heard it first in EBWR.

GM EV1

NEIGHBORHOOD EVs

DiamlerChrysler GEM

GEM e4

Global Electric Motorcars, LLC (GEM), a DaimlerChrysler company, is the market leader in neighborhood electric vehicle (NEV) transportation. GEM has produced over 35,000 vehicles since 1998 (around 5,000 units annually now) and these vehicles are in use within master-planned communities, military bases, college/medical/industrial campuses and local city centers. Communities like Bay Harbor, on Lake Michigan in Petoskey, Michigan, Ladera Ranch in California, Peachtree City in Georgia and The Villages and Celebration, both in Florida, have many homeowners driving GEMs. Sales are distributed: 40% to master-planned gated communities, 40% to government and military entities and 20% to small fleets and city dwellers. GEM has three unique advantages over its competitors. 1. It is tied directly to a major automaker (Daimler-Chrysler) that provides advanced engineering and vehicle development support, as well as selling GEMs through DaimlerChrysler dealers. 2. It provides nationwide on-site service to its customers by GEM factory-trained technicians. 3. It offers optional bumper-to-bumper warranty protection for up to three years, including roadside assistance and towing. GEM is a proven and respected NEV company.
www.gemcar.com

Club Car

Club Car of Augusta, Georgia has been in the golf car and utility vehicle business for 56 years with over 600 distributor, dealer and factory branch locations in around 200 countries and is part of worldwide Ingersoll-Rand. Over 40 base models with applications in golf course, grounds maintenance, industrial, academic and commercial markets are available. Club Car offers both electric and gasoline powered vehicles. Most golf cars and light duty utility vehicles are electric powered with the new IQ™ System that uses a 48V 3.1hp motor. For heavier duty applications, a more advanced version is used that also has a 48V system. These are designed to travel at less than 20mph that is below the NEV standard of 25mph. Thus Club Car does not sell its vehicles into the NEV market but they are nevertheless used in some private gated communities where they meet local requirements. Club Car remains a high quality, successful specialty EV company.
www.clubcar.com

ZENN Motor

Ian Clifford founded ZENN Motor Company, Toronto, Canada, in early 2001. Clifford wanted to develop a "green" car for short trips to his office. The result is the ZENN, for Zero Emission No Noise, a two person 3-door hatchback Neighborhood Electric Vehicle. Top speed is 25 mph that puts it in the legal NEV class. It weighs in at 1,540 pounds with six 12V 90Ah VRLA batteries that give it a range of 40 miles. It has a 72V SEPEX brush type DC motor rated at 5hp on the front wheels. The ZENN has automotive features like electric power door locks and windows, air conditioning and heating in the passenger cabin and the battery compartment, rear-window defroster, fully retractable sun-roof and more. ZENN Motor buys the MC-2 small car, originally equipped with 505cc diesel engine, from Microcar, a French company that is part of the Beneteau Group. The Microcar is shipped without powertrain in containers to a Montreal plant where the 5hp motor, controller and battery pack are installed, then finished and shipped to dealers. ZENN has dealers in twenty locations in thirteen states in the USA that have NEV regulations. Dealers include traditional automotive dealers and independent specialty stores. Base price is $9,995 and ZENN Motor hopes to sell 2,000 units in 2007.
www.zenncars.com

ZENN EV

ZENN Factory

Dynasty Electric Car

Dynasty Electric Car Corporation, of Delta BC, Canada is partnered with Commercial Body Builders Ltd. in the production of NEVs with their trademark IT™ for Innovative Transportation. A Dynasty vehicle is classified as a Low-Speed Vehicle (LSV) that complies with U.S. National Highway Traffic Safety Administration (NHTSA) and Transport Canada Motor Vehicle Safety Regulations. In the U.S., LSV's may operate on roads with posted speed limits of up to 35mph, at a speed not to exceed 25 mph. The Dynasty has an aluminum frame with fiberglass body and a 72V 30Ah lead-acid battery with a regenerative DC motor that provides 30mile range. Fifteen dealers in the western and southern states of the USA, and three in Canada, offer the five models of

Dynasty Utility

Dynasty: Sedan, Sport, Tropic, Utility and Van. Price is in the $8,995 to $14,500 range depending on model. Sales to customers started in 2004 and are running around a hundred annually, most to the USA, that is a good beginning. Dynasty expects to be shipping in the thousands in a few years. Target markets include university or college campuses, resorts, airports, golf courses, industrial plants, planned and gated communities. It looks like the Dynasty has found a niche in the growing NEV market.

Dynasty Sport

Dynasty Sedan

www.itiselectric.com

PURE EVs

Commuter Cars Tango UNV

Commuter Cars of Spokane, WA manufactures the Ultra-Narrow Vehicle (UNV) to distinguish if from an NEV since the UNV can travel at highway speed whereas NEVs top is 25mph. The Tango seats 2 average-proportioned 6'6" persons in tandem. The batteries are mounted low to assure outstanding stability and it takes up the equivalent space of a motorcycle on the road and parking. With over 1,000 ft-lbs. of torque, the Tango 600 can accelerate from zero to over 130mph in one gear. It accelerates from zero to 60mph in about 4 seconds. There is little body roll when the Tango is turned hard into a corner with 9-inch front and 10-inch rear racing slicks. Dimensions of the Tango are: length 8'5" / width 39" / height 60" and weight 3,000 pounds with 1,100 pounds of lead-acid batteries (25 at 12V for 300V motor) with 13.5kWh energy. Commuter Cars will offer three versions of the Tango. The T600 has a carbon fiber body and an electric motor for each rear wheel with a single gear ratio and will be a custom kit. Commuter Cars is in production and will deliver ten T600 UNVs to prepaid (partial) customers over six months, February to August 2007. The T200 at $39,900 will weigh in at 2,000 pounds with fiberglass body and four 50kW hub motors to achieve 0-60mph in 5 seconds. The T100 at $18,700 and 2,000 pounds will have two hub motors for either rear or front drive and go 0-60mph in 7 seconds. Production of the T200 may begin in 2008 and the T100 in 2009. The T600 is available now, is made to order and delivered in around six months. The price is

Commuter Cars Tango

Commuter Cars Tango

$108,000 fully equipped including a 10-year unlimited-mileage warranty. The Tango can be customized or cost reduced by removing items. Standard lead-acid batteries provide range of 40 to 80 miles. NiMH batteries provide 80 to 160 miles range as a $25,000 option, and have a 10-yr warranty that could provide 400,000 miles of travel depending on usage. Lithium Ion batteries will be offered that will provide 160 to 320 miles range at an added price of $40,000. Commuter Cars is also planning a lower cost model. The Tango is a real space saver and could relieve traffic congestion if produced and bought in the millions. Tango might appear in big numbers on the highways when traffic is really grid locked, sooner than later perhaps.

www.commutercars.com

Tesla Motors Roadster EV

Tesla Motors, Inc., based in San Carlos, CA, was formed in 2003 by Martin Eberhard , a Silicon Valley entrepreneur who sold the digital book company NuvoMedia for $187 million, and by his partner Marc Tarpenning. Last year, they began selling their first product, the $100,000 Tesla Roadster, which is powered by Lithium Ion batteries and boasts a range of 250 miles per charge. Tesla will ship its first cars in late 2007 from Britain. Roadsters are manufactured by Group Lotus PLC, the racing-car company. Plans call for selling about 1,000 Roadsters by the end of 2008 and Tesla has received down payment orders for 300 as of January 2007. The Tesla weighs in at 2,500 pounds with 900 pounds of battery and a 185kW (peak power) motor. The battery pack consists of 6,831 cells of the standard 18650 type in series/parallel array to operate the motor at 375V. The light weight of the car comes from use of carbon fiber composites for the outer skin and aluminum structural members for the chassis. The plan is to establish company owned stores in Los Angeles, San Francisco, Chicago, Miami and New York, the largest and wealthiest towns in the USA, an excellent strategy. The next generation EV will be a sedan and expected to have sales volumes ten times larger than the two-seater Roadster at a price of around $50,000. Tesla investors include the founder of PayPal, Elom Musk and Google founders Larry Page and Sergey Brin.

The Roadster has the electric motor drive in the rear with Power Electronic Module on top of it (trunk space is under the front hood) and the Energy Storage System located toward the rear of the car. The ESS has water-cooled batteries to maintain cell temperature less than 35C. Battery operation and charging is closely monitored and controlled with charging from 3.0V to 4.15V for maximum cycle life to achieve 100,000 miles of safe operation. The motor voltage is 375V and 18650 cells with nominal 3.6V 2.0Ah ratings are typical of what might be used by Tesla. One hundred cells in series with seventy cells in parallel will provide over 50kWh of stored energy, around three times that of GMs EV1. Overall price of the battery pack must be at least one-third the cost of the Roadster. Typical of Lotus cars, the Roadster will have a two speed electrically actuated manual transmission with final drive constant mesh gears and inertia lock key type synchromesh. Tesla will include comfort and convenience features, like XM radio, CD, AC, security PIN and valet mode to limit travel with valet parking, found on top end sports cars like the Cadillac XLR Roadster. Future production of a planned four door all electric sedan called White Star is planned in a newly acquired plant in Albuquerque, New Mexico. EBWR predicts that Tesla will make a big hit in the marketplace provided the reliability, performance and safety are demonstrated in the hands of the early adaptor customers with big bucks.

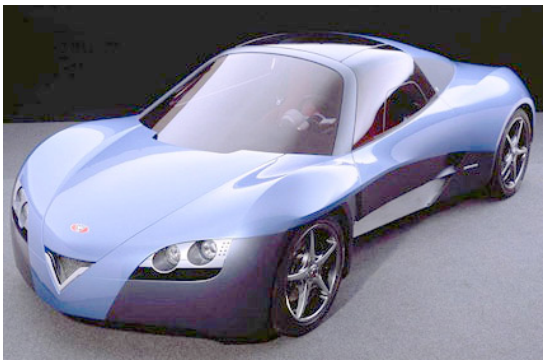
www.teslamotors.com

Tesla CA Governor Schwarzenegger

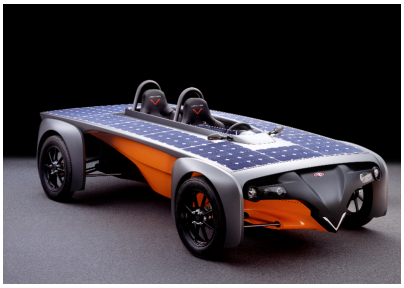
Tesla Battery Location

Tesla Li Ion Cells

Venturi



Venturi Fétish



Venturi Astrolab

Venturi Eclectic

Venturi Automobile Company, headquatered in Monte Carlo at the south of France, is famous for its high speed racing sports cars that ran the LeMans race and others in Europe. Over 700 of these racing sports cars were produced since 1984. Venturi, always wanting a new vision of racing, moved to develop the first commercial true electric sports car and produced the Venturi Fétish in 2004 that has a 180kW motor with 220Nm torque and a Lithium Ion battery to go 250km, and weighs 980kg. Performance is racing car like with 0-60mph in 4.5 seconds and top speed of 160kph. Assembled by hand and made to order, the Fétish has a big price of 297,000euros (US$390,000+VAT). The Venturi Fétish has diminutive proportions, low-slung appearance, and sweeping design. With the engine ideally placed in the rear central position with a carbon monocoque chassis, and aluminum front and rear sub frames, the Fétish architecture is comparable to that of a racing car. Sales are planned through a network of existing car dealers. Two new Venturi models were introduced in 2006 that incorporate solar panels for daytime solar charging of the batteries. The Eclectic has a 16kW motor with 2.5sq.m 300W solar panel and NiMH battery that goes 50km, thus in the NEV class, and weighs 350kg and is priced at $24,000euros ($31,000+VAT). The Astrolab has a 16kW motor with 3.6sq.m 600W solar panel, and NiMH battery to go 120kph, with range of 110km, and weighs 280kg. The Astrolab also has carbon monocoque construction and will be commercial in 2008 with also a big a price of 92,000euros (US$120,000+VAT). The Eclectic and Astrolab would be the first production EVs to offer solar power charging built into the vehicle. Sales will be best in sunny locales. The Fétish sales are in a unique class and will be made to the super rich who support a green environment. Hooray for the rich! And hooray for the buyers of the Astrolab and Eclectic as well!

www.venturi.fr

ZAPWorld

ZAP APX Lotus Concept

ZAP was a pioneer in the EB business when it offered the first electric bike in the USA in 1993. This company has transformed into offering small gas, ethanol and electric vehicles as well as electric bikes and scooters. The Obvio vehicles are manufactured in Brazil by Obvio Automotoveidulos S.A. and run on ethanol fuel that is the dominant fuel in Brazil. This car will be modified to run on E85 in the USA and is scheduled to appear in 2008. There is also an EV version to be offered in 2008. This will be the ZAP Obvio 828 four wheel, two or four passenger EV, with a 120kW peak motor with 35kWH of Lithium Ion battery that weighs 580pounds with total weight at 1,300pounds. Price is not yet available. Range is claimed to be 240miles with top speed of 120mph. Another vehicle, Xebra, that comes from China, runs on gasoline or ethanol and also is available as an EV. The Xebra is a three wheel, two or four passenger, EV that weighs 1,800pounds and goes 25miles up to 40mph, uses lead-acid batteries, and is priced at $10,000. Deliveries of the Xebra started in July, 2006 and sales of around 300 to 500 units per quarter are already being realized. That suggests ZAP is on its way to become an active player in the small, specialty EV market.

ZAP Obvio 828e

Not to be left out of the high end EV market, ZAP announced in January 2007 a joint project with Lotus, the premier UK automotive engineering company. ZAP and Lotus Engineering will begin an engineering project using the Lotus APX (Aluminum Performance Crossover) as a basis for designing a production-ready electric all-wheel drive crossover high performance vehicle for ZAP in the USA market. A combination of the lightweight aluminum vehicle architecture, in-hub efficient motors delivering 644hp and advanced battery management systems should provide range of up to 350 miles, with rapid 10-minute recharge. Top speed of the ZAP-X could reach 155mph. ZAP will have it all then, from very low speed EBs to very high speed EVs. Even General Motors, and even Toyota, can't say that.

ZAP Obvio 012e

www.zapworld.com

Universal Electric Vehicles

UEV Electrum Spyder Convertible

Universal Electric Vehicles Corporation, founded in 1998 and headquartered in Thousand Oaks, CA, plans to produce pure EV cars to be delivered in 2007. The Electrum Spyder is a 2 passenger convertible that will be available in limited production. Powered by a 300V system, the Spyder provides range to 150 miles with top speed of 80mph with nickel zinc batteries. Zero to 60mph time is 7 sec. with 2900 pounds weight using structural steel and composite outer skin. Spyder is priced at $69,995. Plans include offering Lithium Ion batteries with a range to 300 miles. The next production model is the Electrum COM-V3 (commuter vehicle with three wheels) that seats 2 and is designed with front double A arm suspension, single sided swing arm drive system in the rear and three wheel disk brakes. Options for the physically challenged include: automated door entry, wheelchair lift and stow, and hand controls. COM-3 uses lead-acid batteries, 156V 46Ah, with optional NiZn and LiI. Top speed will be 80mph with range up to 70-150 miles depending on battery option. Vehicle weight is 1500 pounds using steel chassis and polyester glass fiber composite body panels. Price is targeted at $29,000 and production volumes ten times that of the Spyder are anticipated. The Spyder would be the first electric car to use Nickel Zinc batteries, a pioneering achievement indeed.

www.universalelectricvehicle.com

Phoenix Motorcars

Phoenix Motorcars SUT

Phoenix Motorcars Inc., headquartered in Ontario, California, has been developing battery-electric, freeway-speed Sport Utility Trucks (SUT) and SUVs since 2001. Phoenix Motorcars has announced the receipt of 75 fleet orders from several municipalities and a utility company for its SUT. The SUT, a converted Korean-built four-door pickup, is quipped with a 35kWh, 386V battery pack and will have a range of 136 miles, a top speed of 95mph and a 0-60mph time under 10 seconds. The NanoSafe™ Lithium Titanate battery by Altairnano claims to have 250,000 mile, 12 year life that will give the truck long range with a gross weight of 6,000pounds. Phoenix plans to outfit and sell 500 fleet-ready vehicles by the end of 2007 and expects to ramp up production to 6,000 vehicles in 2008. The SUV will be introduced in late 2007 with two configurations, having a range of 130 or 250 miles and both configurations can be recharged in less than 10 minutes. SUT price will be around $45,000. Phoenix may have timed it right to introduce a pure EV truck when oil and gasoline prices are high and are expected to remain high. Keep tuned.

www.phoenixmotorcars.com

Smith Electric Vehicles

Smith Faraday

Smith ST

Smith Electric Vehicles Inc., located in Washington, Tyne & Wear, UK, has been building electric vehicles since 1920 for a worldwide customer base for industrial and commercial applications including urban delivery, healthcare, airport and municipal services. The first 7.5ton Electric Truck has been launched by Smith and the first two Newton's were delivered to leading express, mail and logistics operator TNT that will operate in and around London. These use a high performance Zebra battery, 278V with 76Ah cells in a sealed life container that uses Sodium Nickel Chloride chemistry. This is a high temperature battery requiring it to be kept at around 200C. A heater plugged into AC power is used to maintain battery temperature when the truck is not operational. This is a first commercial application of the Zebra high temperature battery. The Newton has a 160mile range with top speed of 50mph using a 120kW motor with 4.5ton payload. Smith offers two other trucks that use large lead-acid batteries. The Faraday has 2ton payload and 35-120mile range with speed 30-48mph. The ST has 2-3.5ton payload and 18-48mile range with speed 15-24mph. Smith Electric Vehicles has some major delivery and service companies lined up for these EV trucks that suggest the UK is on the way to move towards eliminating dirty and noisy diesel trucks with clean and quiet EV trucks. It will take a while but merry ol' England has been around a while.

www.smithelectricvehicles.com

ElBil Norge Kewet

ElBil Norge AS (Ltd.) is a company based in Oslo, Norway, and has more than thirteen years experience of manufacturing, marketing and maintaining electric vehicles. The Kewet was originally developed in Denmark in 1991 and built there and in Nordhausen, Germany for a while, but in 1999 ElBil Norge acquired ownership of the technological and production rights after sales of more than 1,000 vehicles had been achieved. In 2005 the newly developed 6th generation of Kewet – the Buddy – received homologation approval from the European Community. The Buddy is a 3-seater approved for 3 adults. The passenger's safety is provided by the steel tube frame around the cabin, doors with crossbars and deformation zones in the front and rear. The specifications include: 13kW SepEx 72V DC motor, a gear wheel transmission with differential rear-wheel drive and fully automatic electric gearshift system. The Kewet top speed is 80-90kph (50-55 mph) and the standard version uses 8.4kWh lead acid batteries, with 10.5kWh option as well as 10-15kWh Lithium Ion. Lead-acid range is 50-100km with 100-150km for Lithium Ion. Weight with lead-acid batteries is 800kg. The Buddy comes in left- and right-hand drive versions and a Kewet outlet is located in California. The Kewet is a basic pure EV that meets the needs of many commuters and travelers to local shops and is well established in Norway. It now wants to be well established in the entire European Union.

www.elbilnorge.no

Kewet Factory

Kewet Buddy

Th!nk

Th!nk

Th!nk

The Th!nk is the pure EV introduced by Ford in the USA in 2002 and featured in EBWR02. It is now being restarted after Ford dropped it and the Norwegian company went bankrupt. The original company, Pivco (for Personal Independent Vehicle Company) was founded in Oslo in 1990. The Pivco EV had NiCd batteries and was used at the Olympic games in 1994 at Lillehammer. After developing a production model called the Th!nk City it was bought by Ford in 1999. Ford embraced the Th!nk concept as an NEV, and marketed an electric bike as well under the same brand. Production ceased in 2002, after a total of 1,005 units had been made and Ford discontinued the brand and all EV, and EB, products in 2003. The company was sold to KamKorp Microelectronics of Switzerland, but further development of a successor to the City was subsequently halted and the company eventually went bankrupt. The used cars from the US and UK have been re-exported to Norway where they are in high demand due to the government's policy to promote the use of EVs. Owning an EV in Norway allows the EV to be exempt from taxes, have free parking, pass toll roads for free, and are allowed to drive in the bus lanes avoiding traffic congestion. Norway is EV heaven! Production has resumed in late 2006 at Th!nk , the company is called Th!nk Global AS, and Jan-Otto Ringdal, who founded the original company in 1990 is involved. Among the firm's fresh investors is former CEO Chris Neal, and most of those who lost their jobs after the bankruptcy in February 2006 are now re-employed. Around 500 Th!nk EVs will be produced at the Aurskog factory in 2007 with production expected to double in 2008. The new version of the Th!nk car will have a range of 150km. You can't keep a good EV down, Th!nk about it.

www.thinkglobalforum.com

Start Lab

Start Lab Polizia

Start Labs SpA, Milan, Italy, has developed a new electric town car, the Girasole. It comes in three models. The Open Street has a 4kW motor with four 100Ah lead-acid batteries that allows top speed of 38kph and 70km range. Two other models are developed, without doors, to make them more functional for their application. The names are Hobby & Work and Golf that explain the applications. Start Lab and Auto EV, a Japanese car distributor, have announced in January 2007 that the Open Street and other models will be available in the Japanese market. It will be interesting to follow whether Italy or Japan will absorb the majority of these cute and functional pure EVs.

Start Lab Open Street

Start Lab Hobby & Work

www.fimea.it/cars/open/

Mitsuoka

Matsuoka MC-1

Mitsuoka Motor Company offers the Microcar EV models introduced a few years ago. These are electrified versions of their one

passenger Microcars that use a one cylinder gas engine. Two EV versions are produced, Convoy 88 and MC-1. Specifications for both are similar, those for the MC-1 are: 2mx1.1mx1.5x (LxWxH), 320kg, 72V battery (6-12V lead-acid), 0.56kW motor, 40-50km range, top speed 55kph, and price $5,300. The Convoy 88 price is $7,100 to $7,800. It is interesting, and almost unbelievable, that these EVs have motor size, 560watts, in the range of the most powerful electric bikes and can achieve speeds to 33mph, above the NEV 25mph limit in the USA. Presumably Microcar in Japan would be used in gated communities and streets posted with low speed limits.

Matsuoka Convoy 88

www.mitsuoka-microcar.com

Mitsubishi Motors

Mitsubishi Motors Corporation (MMC) in 2006 built a new research vehicle, the Mitsubishi innovative Electric Vehicle (MiEV) for a next-generation EV development project. The electric vehicle will be used for joint research programs with power companies that will conduct field tests jointly with MMC. This EV is based on MMC's "i" mini-car, and named "i MiEV" that is powered by a compact motor and Lithium Ion batteries. The rear mounted ICE is replaced with the single electric motor. Technical specifications include: 330V Lithium Ion battery of 20kWh with range 130-160km, PM synchronous motor 47kW and top speed 130kph with total vehicle weight at 1080kg. EBWR will monitor if it makes production.

Mitsubishi iMini

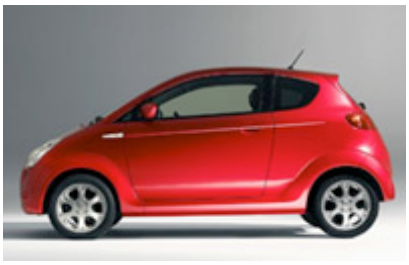
www.mitsubishi-motors.com

Nissan

Nissan Hypermini

Nissan offers the very compact Hypermini as a pure EV with range of 80miles and top speed of 60mph by using Lithium Ion batteries from Sony that are inductively charged similar to the original General Motors EV1. Hypermini is a two sealer with dimensions 2.5mx1.5mx1.5m (LxWxH) that really is in the realm of the NEV. It is really designed for all roads with top speed at 60mph though it would not likely to be used on busy highways. The Hypermini was introduced a year or two ago and EBWR presumes it is sold and in use in Japan.

Subaru



Subaru R1e

The Subaru R1e, an experimental battery electric vehicle, is currently undergoing limited production for selected industrial clients in Japan. Subaru says there is intense interest in this vehicle within the US EV community as it employs Lithium Ion batteries that contribute to a significant improvement in range. The gas powered R1 uses a 50kW engine so the expectation that electric motor size is 40-50kW with similar performance and a top speed of 60-70mph.

Japan Quadricycles

Zero Sports Elexceed QEV

Japan has a quadricycle vehicle designation for small, light EV vehicles that allow maximum speed of 60kph and a weight of 450kg, without battery, as well as a maximum motor power of only 0.6kW. Elexceed RS is produced by a small EV manufacture, Zero Sports Co Ltd. Coms Two produced by Toyota Auto Body is a single seat Japan only vehicle, with a Lithium-Ion battery pack moun-

ted at the rear of the vehicle with a range of 100km from and top speed at 50 kph. Another version of the Coms Two has a fuel cell pack that produces 6kw of energy, for a range of 100km or 5hr on a bottle of Hydrogen.

Toyota Coms Two FC QEV

Toyota Coms Two LiI QEV

Incalcu

The Chinese company Incalcu located in Changzhuo builds a Pure EV that is of NEV size and function. The Incalcu EV weighs in at 650kg with either a 180 or 220Ah 48V battery with range at 85 or 120km depending on battery size with top speed at 45kph. The Sport EV model has similar specifications but lower weight at 550kg. It seems that the Chinese are about to enter the Pure EV and NEV business as the world begins to accept this mode of transport. China is always following world trends now to get into new businesses where they can advantage their low cost to manufacture. Will a Chinese EV be sold in the USA? Who knows? This was written just before EBWR learned the answer to these questions. The answer is March, 2007 when a car dealer in Portland, Oregon announced he has a new Chinese EV for sale, read on.

Incalcu EV

Chinese EV Enters NW USA Market

Tianjin Qingyuan Miles ZX40

Tianjin Qingyuan Miles ZX40

The Miles ZX40 is manufactured by China's Tianjin Qingyuan Electric Vehicle Company, relies on a chassis from Daihatsu, and is distributed in the U.S. by Miles Automotive of Malibu, California. Ron Tonkin dealerships in Portland, Oregon has taken delivery of five Miles ZX40s all electric vehicles and hopes to sell many of them in this market. The ZX40 is a four seater, has a 72V 5.6hp motor and lead-acid batteries that produce a top speed of 25mph with range of 60-70 miles. The Miles ZX40s includes standard features like an AM/FM radio with CD, a heater, and retractable three-point seat belts in two and four-door versions. But it does not include power-consuming items like air conditioning, powered windows, and power steering. Price is expected to list at $16,500 for the two-seater and $16,950 for the four-seater. Time will tell if the ZX40 will be a hit in the NW. EBWR will keep you posted.

jgeffen@tonkin.com

Kronosport

Kronosport is a Philadelphia, Pennsylvania based company that designs and manufactures an innovative line of light duty Electric Utility Vehicles (EUV). These powerful rugged vehicles are perfect for transporting people and equipment around urban centers, gated communities, resorts, airports, universities, parks, stadiums, zoos and other similar venues. Kronosport's product line includes the Taxi, a 21st century rickshaw that can transport two large adults plus a driver, a cargo van, a garden vehicle with a dump-style bed, and a hopper for trash collection and recycling. All of Kronosport's vehicles share a common "skateboard" platform and are easily customizable. The vehicles are powered by a 36 volt 1 kW electric drive system, with 40Ah sealed lead-acid battery, and include a comfortable ergonomic recumbent seat for the driver. Range is 25 miles with top speed of 12mph but customers select an 8-10 mph limit. Certainly not your typical golf cart! Kronosport's vehicles were prominently featured in Eddie Murphy's "Pluto Nash" and have appeared on the Today Show with Al Roker. The company recently developed an optional solar charging canopy in conjunction with the renowned Chewonki Foundation in Maine. Since the Kronosport requires only 1kW of power, the vehicle is a perfect early commercial application for solar and fuel cell technologies. Kronosport is developing strategic partnerships with the world's leading fuel cell and hydrogen leaders and expects to roll out a fuel cell vehicle in early 2008. Originally, as reported in EBWR04, Kronosport came with pedals for the driver but no longer offers that option so the Kronosport is a Pure EUV. Deliveries to customers started in January, 2007 with direct sales and independent sales representatives. The Kronosport EUV is on its way.

Kronosport Taxi

kronosport@gmail.com

Worldwide NEV / EV Manufacturers / Distributors

As Reported in EBWR07

1. Club Car	NEV	USA
2. Commuter Car	EV	USA
3. Dynasty	NEV	Canada
4. ElBil Norge	EV	Norway
5. Global Electric Motors	NEV	USA
6. Incalcu	EV	China
7. Kronosport	UEV	USA
8. Matsuoka	EV	Japan
9. Mitsubishi	EV	Japan
10. Phoenix Motorcar	EV	USA
11. Nissan	EV	Japan
12. Subaru	EV	Japan
13. Smith EV	EV	UK
14. Start Lab	EV	Italy
15. Tesla	EV	USA
16. Th!nk	EV	Norway
17. Tianjin Qingyuan	EV	China
18. Universal EV	EV	USA
19. Venturi	EV	France
20. ZAP	EV	USA
21. ZENN	NEV	Canada
22. Zero Sports	QEV	Japan

QEV--Quadricycle EV in Japan only

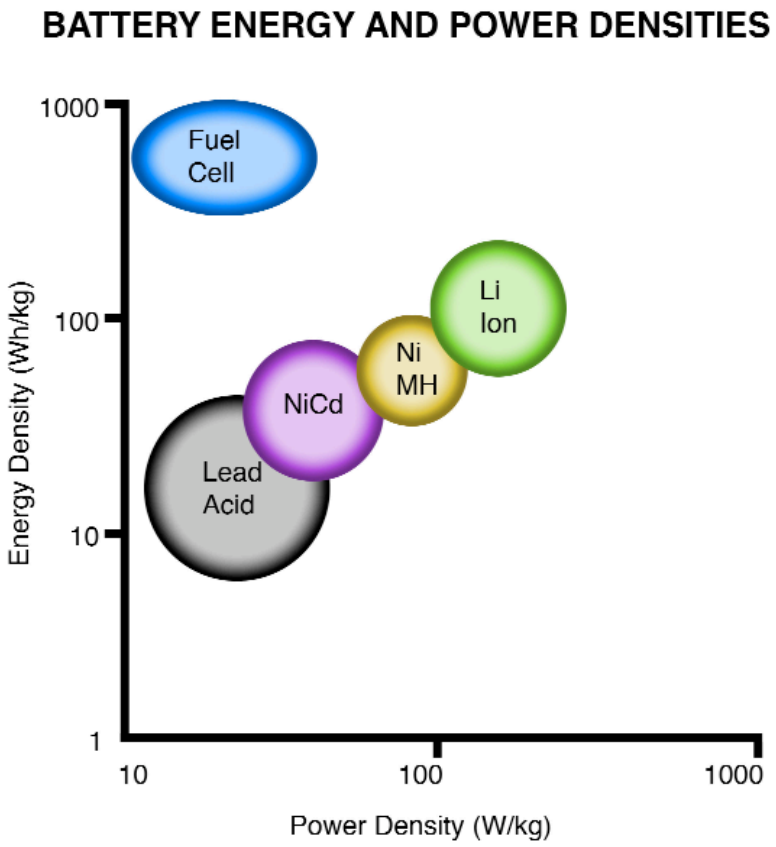
UEV Utility EV

Section 9

Battery / Motor / Fuel Cell Technology

Battery Technology

Overview



There are big changes underway in battery technology as the worldwide demand continues to grow rapidly in the cell phone, blackberry and other hand held electronic devices. The worldwide auto industry is also on the verge of moving again into "almost pure-electric" vehicles that are called "plug-in hybrids" (PIH) and will use more battery capacity to increase range under battery power alone. The goal of these PIH vehicles is to increase gasoline fuel economy up to 100mpg, much higher than traditional hybrids that use less battery storage (0.5kWh) compared to an estimated 4-10kWh for the PIH. These PIH batteries will be improved Li Ion technology that will also find application to the electric bike and scooter market. Lead-acid batteries are on the way out of the EB application as more EBs in China are beginning to use NiMH and Li Ion as battery producers ramp up production and prices drop. This will take some years to accomplish. As shown in the Battery Energy/Power diagram, the world is moving up to batteries that have higher energy and power per unit weight. That means lower weight batteries with more energy and power to propel LEVs. Lithium Ion is the best battery on that basis, but cost is another factor that controls the final decision of battery choice. A table of energy storage and price ranges for rechargeable battery technologies is included. Ed Benjamin provides an update on all the important battery chemistries and impressions of battery trends from his worldwide travels. Chinese companies are becoming more proficient at making batteries and also make batteries, including NiMH and Lithium Ion, for U.S. companies. Lead-acid is dominant in LEVs while NiCd is not used any longer with NiMH and Lithium Ion

usage growing rapidly. NiZn still has some champions with companies in the USA, PowerGenix and Xellerion, and in France, trying to displace NiMH in some applications. EBWR04 reported on Xiamen Three Circles-ERC Battery that had a NiZn plant in production but it has since closed. Valence Technology has a phosphate Li Ion battery that it used in the Segway Human Transporter. A123 Systems, an MIT spin-off, has a nanophosphate Li Ion that is used in power tools. Ovonic is 50% owner of Cobasys, with Chevron Oil, that makes NiMH batteries for General Motors hybrid cars. Electro Energy has succeeded in developing a bipolar NiMH battery that has potential for PIH applications. Hannes Neupert of ExtraEnergy has a proposal for battery rental to stimulate EB use by companies with large local delivery fleet needs, such as the postal service. Finally, the Advanced Automotive Battery activity offers a perspective for batteries in the hybrid automotive field that will have ramifications for the LEV. All this battery activity for electric vehicles will spill over into the electric bike and scooter area with new materials, and lower prices, making one or more Lithium Ion technologies affordable for EBs and ESs. But where will the best quality/priced Lithium batteries come from, the USA or China? USA vehicle manufacturers would like the batteries to be sourced in the USA of course. EBWR will follow the competition.

BATTERY CHEMISTRY UPDATE

Lead-Acid

The dominant battery type for LEVs, world wide, continues to be Chinese made Sealed Valve Regulated Lead Acid batteries. These batteries have adequate performance, weight and cost characteristics for most applications in existing markets. Lead acid remains a remarkably stable and useful metallurgy for small vehicles. There are many, perhaps hundreds of companies making such batteries in China. Some are complete battery factories building the complete unit, and some are simply assembling and filing batteries after buying parts from various suppliers. The best quality producers have improved, but the most important news is that the lower priced makers have also improved greatly. The days of low cost SVRLA from China, meaning that the battery may work for only a handful of cycles, seem to be past. In China, the government is paying more and more attention to the need to keep potentially hazardous / toxic Pb (lead-acid) batteries out of the trash stream and to recycle the materials. (In most of the world, auto starter batteries – Pb – are nearly universally recycled. SVRLA needs to achieve the same situation.) The nearly universal use of Pb in low price electric bikes may not work for some emerging markets. The average ambient temperature for India is 50 degrees C. Pb does not last long at such high temperatures. This is also true for the SEAsian markets. There is one new development that may, or may not, revolutionize the lead-acid battery. Firefly Energy, Peoria, Illinois, reports using a carbon-graphite foam for the negative electrode coated with a thin layer of lead to reduce the volume and weight of a lead-acid battery by fifty percent. Time will tell if Firefly makes it to production.

Lead-Acid Plates and Firefly Carbon Foam

Positives - Low cost, high discharge rates, easily recycled, stable.

Negatives - Heavy, low energy density, toxic, temperature sensitive, 300 cycles or less.

Major suppliers - China: Panasonic, Tianmeng, Leoch, Ritar, Pilot; Japan: Panasonic, Taiwan: Kung Long.

Nickel Metal Hydride

NiMH has many desirable qualities for LEVs and has been used by a number of companies in Europe, Japan, USA and China. Recent years have seen the cost of NiMH come down to a very reasonable level. Improved cells, chargers and Battery Management Systems have made this metallurgy nearly universal for Japan and EU.

Positives - Roughly double the energy (kWh/kg) of lead-acid, high discharge rates, non-toxic, easily recycled, compact, mature technology. 500+ cycles.

Negatives - Poor cold weather performance, needs battery management system to avoid inadvertent failure.

Major suppliers: Japan: Sanyo, Panasonic, China: Lenmark-

Hong Kong, Pisen-Singapore, Powerhaus, Uniross, USA: Cobasys, Energizer, Rayovac, Duracell.

Nickel Cadmium is no longer in use for new production LEVs. Many EU and Japanese products used NiCd batteries in years past, and this long lived but toxic metallurgy is surely still in use in hundreds of thousands of bikes. Environmental laws banning NiCds have nearly forced them off the market, worldwide. This, combined with the lower cost now of the NiMH cells, which perform better in most ways, has spelled their end.

Strengths: Reliable, high discharge rates, long lasting, not particularly temperature sensitive. 600 – 1000 cycles.
Weaknesses: Toxic, memory effect mostly remedied, low energy density, high cost, dangerous to manufacture.
Major makers are Panasonic, Sanyo, Saft, Peace Bay, many small Chinese companies.

Lithium Ion comes in a variety of types. In its more stable and less expensive versions, it is the battery of the future for most vehicle applications. The cost is falling rapidly, and high current use of Li-Ion is more and more feasible as the technology improves. Widely used in Japan and growing fast in use in USA, EU and China.
Strengths: Up to 1000 cycles, wide temperature range, high energy density, cost falling fast, high perception of value.
Weaknesses: Low discharge rate, flammable, potentially explosive, needs Battery Management System and safety precautions in design and use. Needs smart charger.
Major makers are: Japan: Sanyo, Saft, Sony, China: Suzhou Phylion, Tianjin Lishin, Korea: LG, USA: Valence Technology, A123 Systems, Altair Nanotechnologies, Saft.

STATUS OF OTHER BATTERY CHEMISTRIES

Nickel Zinc is promising but seems to be out of the market at this time. Evercel made this in China, but so far as the author knows, the factory is closed and the product unavailable. However there are companies in the USA that continue to work on NiZn, PowerGenix and Xellerion a unit of eVionyx in New York. A French company, Société de Conseil et de Prospective Scientifique S.C.P.S., claims to have a viable NiZn battery. And Universal EV claims to be selling a pure EV soon that will use a NiZn battery, source unspecified.

AGM or Glass Mat Lead Acid is another promising technology, but just expensive enough to keep it out of LEVs so far. It is possible that as LEVs reach hotter and colder climes, AGM will become important.

Gel Lead Acid has similar issues to AGM. The cost is just high enough to keep its superior performance off the main market.

Lithium Polymer refers to Lithium batteries that use a gel type polymer electrolyte different from the usual liquid electrolyte that is soaked into a separator. This allows for a thin package. Sanyo in Japan and Hyper Battery in China make such batteries.

Lithium Sulfur is still under development by Sion Power in Tuscon, Arizona. It claims to have very high energy storage at the cell level, 350Wh/kg and 100Wh/kg at the battery pack level. The Sion LiS battery was described in detail in EBWR04.

Lithium Manganese is what many automakers are exploring as a replacement for lead-acid in car starter batteries. Lower in energy density than the Lithium Cobalt used in phones and laptops but more stable.

Lithium Cobalt is high energy density chemistry. This was the chemistry that had problems in laptops that forced Sony to recall millions of them. The problem was resolved by changing the physical structure of the materials used that originally led to inadvertent shorting and fires.

Silicon Electrolyte Lead Acid is claimed to be less temperature sensitive and higher performance that SVRLA. But the product is hard to buy at this time.

Zinc Air “batteries” or Metal Air Fuel Cells continue to hold great promise, but have unsolved problems and high cost for LEVs. These also are mechanically rechargeable so a sophisticated infrastructure is required that is a tough hurdle to jump.

Manganese-Zinc was to be a low cost rechargeable alternative to other chemistries but did not succeed. This technology has evolved with high rate capability that allows this cheap primary cell to meet the needs of a myriad of hand held devices in the market.

The USA market is dominated by the remaining large makers of primary cells still made in the USA: Duracell, Energizer and Rayovac. They also offer rechargeable NiMH as well as Lithium primary cells for electronic devices.

Fuel Cells (Hydrogen fueled) continue to be promising …. "In just a few more years" as they have been for a long time now. Worldwide emphasis to reduce oil usage will stimulate the hydrogen economy sooner than we think. See the National Academy of Engineering Hydrogen Economy report summary in Section 3.

Hybrid Electric LEVs burning Ethanol or Gasoline have been demonstrated as prototypes, but EBWR is not aware of any commercial production.

Human Hybrid Electric – Meat motors…we call these Pedelecs and they are among the most energy efficient vehicles ever built. The combination of battery electric power and human muscle (low RPM, high torque, very energy efficient and runs on "food") is a brilliant technical solution and widely used in China, Japan, EU and other markets. (This is an example of "LEV Humor" but is also true.)

Li-Ion Safety
Lithium batteries have so many characteristics that make them desirable vehicle batteries that their use is inevitable, and growth is fast and will continue. But they must be used responsibly. The combination of a drive for low price on E-Bikes and the inherent dangers of flammable gas evolving from defective battery metallurgy are frightening. A low price E-Bike rarely has a Battery Management System, or a smart charger, or thermal and over current protections – and the battery cells are likely to be the cheapest ones available – no matter how stable or not.

The specter of a lithium battery fire that causes property damage and injury is very easy to imagine in the current situation of very low price E-Bikes being built by companies that have little or no technical expertise with Lithium and are purchased and sold by importers and dealers with a similar lack of expertise. Lithium batteries used in E-Bikes and other LEVs need to be stable, and protected by a redundant combination of smart charger, battery management system with thermal and current protections, and a minimally flammable cell architecture and chemistry. Lithium further needs to be in crush proof battery boxes, and it needs to be shipped with appropriate attention to safety. As safe Lithium technology evolves that will be used by the automotive industry, EBWR expects that those batteries will be used in LEVs creating a safe LEV.
Ed Benjamin

Valence Technology Saphion Lithium Ion Batteries
Valence Technology, whose headquarters is based in Austin, Texas with R&D in Las Vegas, Nevada, is one of the few USA companies manufacturing Lithium Ion batteries.

Valence 18650 Lithium Cells

Valence has become a fully integrated Lithium Ion battery company that provides cell and pack manufacturing with engineering and electronic control systems as well as mechanical systems to integrate their battery packs into customer products. Valence is the principal battery provider to Segway Human Transporters that are shipped worldwide. Valence focus is on larger format systems, ones that require 12-400V and 24-130Ah, such as emerging electric motive applications. Valence batteries are under test in the Wright Bus in London Transit, in school buses designed by Enova in Torrance, CA (these busses are used in Philadelphia, PA and Miami, Florida) and in delivery vehicles for the Swiss Post office (manufactured by Oxygen in Italy) and many other commercial EV vehicles. Importantly, Valence has a plant in Suzhou, China and is working with electric bike and electric motorcycle makers in China to qualify their batteries in those vehicles.

Valence Technology's U-Charge® Power Systems are a family of 12-volt and 18-volt Lithium-Ion energy storage systems that offer three times the run-time (for the same weight) and lower total cost of ownership than standard lead-acid batteries in target applications. Many of the U-Charge models are conveniently packaged in standard lead-acid battery sizes ideally suited for a variety of mobility applications, including electric bikes, electric wheelchairs and electric scooters. Utilizing Saphion® lithium-ion technology, the U-Charge Power Systems offer the following features: High energy density for long run time (up to 85 Wh/kg), Exceptional cycle life for battery longevity (cell data shows 2000 cycles to 80% rated capacity), Light weight for optimal vehicle design,

Maintenance-free for lower lifetime costs, No toxic heavy metals for environmental friendliness.

Saphion technology utilizes a phosphate-based cathode material in place of the metal-oxide materials typically used in Lithium-Ion batteries. Saphion technology is chemically and thermally stable, enabling the creation of safe, large-format battery systems, and it offers the energy density advantages of traditional Lithium-Ion technology. U-Charge Power Systems may be stored at any state of charge without fear of any chemical degradation. The U-Charge RT Power Systems are designed for applications requiring extended run-time and ease of installation. They include the following features: Built-in automatic protection for over-charge, over-discharge and over-temperature conditions, Built-in electronic monitoring for state-of-charge, current, voltage and temperature, Internal cell balancing, Series connection up to four batteries (60V max. system voltage), Rugged mechanical design – dust and water resistant to IP56 standards, flame retardant plastics, Thousands of cycles, under normal conditions, Maintenance-free, Can be recharged using most standard lead-acid chargers (set for AGM/GEL cells), Communication of monitored data via optional U-BDI or U-BMS (accessed via RS-485 communication port). Valence is now a fully integrated battery pack systems provider and their excellent record with Segway is testimony to their success.

www.valence.com

Valence Segway Pack (73.6V/5Ah)

A123 Systems Lithium Ion Nanophosphate Battery

A123 Systems Lithium cells use a nanophosphate technology with these attributes. Have Power: Over 3000 Watts per kg and 5800 Watts per liter. Safety: Inherently safe and environmentally friendly. Life: Superior calendar life, 10X cycle life vs. conventional Li-Ion. Due to the faster kinetics of the nanophosphate technology, electrodes have lower ASI (area specific impedance). As a result, higher power can be extracted from these electrodes. A new type of

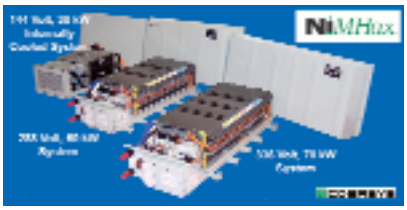
A123 Automotive Cell

cell construction based on a dual plate tubular design is optimized to deliver maximum power with high efficiency. The cell is “all laser welded” optimized for very low humidity penetration over the life of the battery. The A123 design withstands a high degree of shock and vibration, very long calendar life due to a more hermetic package, and more efficient heat dissipation enabled by more thermally conductive materials. A123Systems is already supplying batteries to the Black & Decker Corporation for use in a heavy-duty, 36-volt line of portable power tools. A123 is working with Cobasys to develop a Lithium Ion battery pack for the General Motors Plug-in-Hybrid that is to appear in 2010. This may be the battery technology to move the work to 100% electric transportation. EBWR hopes so!

www.A123Systems.com

Ovonic Battery / Cobasys NiMH

Iris & Stan Ovshinsky Frank & Joy Jamerson at EVS17 Montreal 2000



Cobasys Battery Products

Ovonic Battery Company, a unit of Energy Conversion Devices, originally founded by Stan Ovshinsky, the inventor of the NiMH battery, continues to license around 25 companies worldwide for the production of NiMH batteries that are now more extensively used by the LEV industry. All major manufacturers of NiMH batteries are producing under license from OBC. These NiMH battery manufacturers are located worldwide in Asia, Europe and North America.

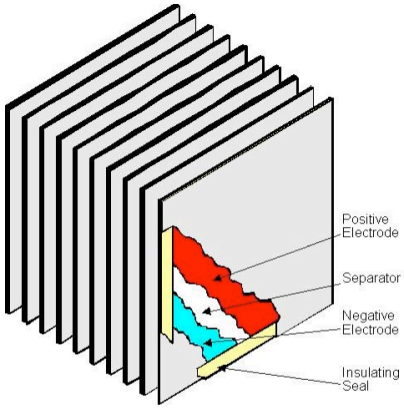
ECD is also a 50-50 partner with Chevron Technology Ventures LLC a division of Chevron Oil Corporation, in a venture called Cobasys, to provide NiMH batteries for hybrid vehicles. Cobasys provides the advanced NiMHax® NiMH battery systems for GM's 2007 Saturn VUE Green Line SUV. Saturn’s VUE Green Line hybrid is a "mild hybrid" that combines sophisticated controls with an electric motor/generator mated to the engine and battery system. The Saturn VUE’s hybrid system provides: an electric power assist during acceleration; increased

fuel economy, of 20% to 27 mpg city and 32 mpg highway, through engine shutoff at idle; fuel cutoff during deceleration; and the capability to capture electrical energy through regenerative braking. The NiMHax 36 Volt hybrid battery system, is built at Cobasys' manufacturing facility in Springboro, Ohio.

Since NiMH entered the high volume marketplace around 1990, EBWR estimates that, through 2005, over 10 billion batteries have been produced, primarily of the size, 1.5-20 Wh, used in cell phones and notebook computers. As the automotive hybrid and LEV market in the last five years has seen an explosive growth in NiMH usage the number of NiMH batteries produced for these applications, through 2005, are estimated to be 1 million batteries with capacities in the 200 Wh to 2 kWh range.

www.ovonic.com

EEI NiMH bipolar (left)
power tool NiCd pack (right)



EEI Bipolar Wafer

Electro Energy NiMH Bipolar

Electro Energy Inc. is headquartered in Danbury, Connecticut where it developed its bipolar NiMH battery, a unique and patented flat wafer cell design. EEI received nearly $30 million in funding from the US Dept of Defense and Dept of Energy to develop this technology design that is smaller, lighter, lower in resistance and more powerful than conventional batteries of the same chemistry. Bipolar refers to the construction of the battery that allows current to flow perpendicular to the plates whereas the prismatic construction allows current flow parallel to the plates. The cells can be made in any shape and are therefore applicable to a wide variety of military and commercial applications. Wafer cells are stacked one on top of another to create multi-cell batteries with the required energy capacity and voltage for a given application. EEI is now developing bipolar Lithium Ion batteries for military and commercial applications. EEI has a NiCd and sintered nickel battery plant in Colorado Springs and has acquired a major facility in Gainesville, Florida for manufacturing NiMH and Li-Ion batteries. EEI has supplied prototype bipolar NiMH batteries to various commercial and government customers. A conventional hybrid car was converted to a Plug-in-Hybrid with a 22mile all-electric range using EEI's bipolar NiMH battery pack. EEI believes that high performance electric scooters have a market in the USA and is searching for a partner in this market.

www.electroenergyinc.com

EEI 350V NiMH Bipolar

PowerGenix Nickel Zinc

PowerGenix Cell Construction

PowerGenix, based in San Diego, CA, has developed a high-energy density, high-cycle life and low-cost nickel-zinc (NiZn) battery ideal for applications that demand high discharge rate capabilities. The technology offers a 30% weight and size reduction compared to lead-acid, coupled with higher power and superior low temperature discharge behavior. Using both a patented electrolyte and a patented electrode composition, PowerGenix has eliminated past issues of dendrite formation and shape change of the zinc electrode during cycling. This results from three developments: 1. Special electrolyte additives. 2.

PowerGenix NiZn

Modified microporous separators, 3. Sealed spiral wound design with starved electrolyte. This results in low internal resistance that provides high rate power capability, higher than NiCd or NiMH. PowerGenix NiZn specifications: 1.6V/cell, 60Wh/kg, 90W/kg with charge time of 1.5 hours. Cell cycle life is at 500cycles and 24V packs under development are at over 200 cycles. Power tools, LEVs, military electronic power, automotive cranking batteries and UPS are some of the target markets for the PowerGenix NiZn batteries. Time will tell which market will be first and dominate with NiZn, maybe an opportunity for LEVs.
www.powergenix.com

Battery Rent Model for Electric Bikes

Manufacturing cost of the battery for an electric bike can be as high as 50% of the cost of the EB. This is many times a disincentive to purchase for both companies as well as individual purchasers. Deutsch Post AG, the German post office company, has pioneered the use of electric bikes for local mail delivery with some success (currently 8500 Pedelecs are in daily use). But a national full scale implementation of EBs by Deutsche Post is inhibited by the high initial cost of batteries and subsequent maintenance and warranty issues. This proposal is to develop a system of battery rental that would make the user and battery company winners in the implementation of such a system. We start with a look at the present postal delivery system for gasoline vehicles.


Biria Pedelec for Deutsche Post AG (HN)

Present division of responsibilities in the Deutsche Post mobile delivery system.
1. Deutsche Post owns delivery vehicles that use gasoline.
2. Energy supplier, oil companies, owns energy (gasoline) distribution, quality control and billing, and also owns oil field and drilling equipment including offshore rigs.
This is a highly developed and well functioning system that has matured to an economical operation for vehicle delivery of mail.

Advances in electronics and business management suggest a new approach to managing the energy needs of electric vehicles that are used by Deutsche Post for local mail delivery. We use the example of electric bikes, though this could also be applied to four-wheel electric vehicles. The battery, normally owned by the electric bike owner, is the energy source and the fuel is the electricity that comes from a utility company. The basic idea is to have the battery owned by the battery manufacturer with an energy service company established to own the charging stations, monitor battery quality and do the billing for battery rental and electricity usage.

1. Deutsche Post owns the electric bike and pays a rental fee for the battery to the Energy Service Company based on the actual watt-hours of energy used each month. If not used, a fee for the calculated Wh turn over loss (battery self discharge) will be based on battery aging. These will take into consideration the time the battery is in service, temperature and SOC of the battery.
2. A new Energy Service Company would own the battery and charging stations. It provides an integrated data-logger with each battery that monitors the depth of discharge, cycle life, storage times and battery temperature. This data is fed back to the battery manufacturer via an energy-data bus that will provide clues on how to improve cycle life.
3. Battery manufacturer will be compensated by the Energy Service Company based on the real Wh turn over performance (usage in postal service deliveries) of the delivered battery and use real time data to track cycle life and other parameters to continuously improve cycle life to get a higher price for the longer life battery.

If this all works out, everyone wins -- battery maker improves cycle life to increase income from more sales with cost per cycle decreasing, energy service company does a good business and provides value to all parties, and Deutsche Post reduces initial capital investment by not owning the batteries and having them improved from the data their fleet generates. The fee payment structure will be designed to minimize the initial capital investment to Deutsche Post and to provide an incentive for the battery maker to increase the cycle life of the battery since longer life will mean more return, profit, to the battery maker. An example of the savings to the battery manufacturer on warranty cost would be to have the warranty valued on the basis of total number of cycles for the entire battery pack fleet and not individual batteries. Example: For a 500 cycle warranty battery

and a fleet of 5,000 packs, say 3,000 die at 480 cycles and 2,000 die at 500 cycles. Total cycles used are 2.44 million out of an expected 2.5 million cycles. The difference is 60,000 cycles that represents 1,200 replacement batteries and not 3,000 based on the individual failure number. Ultimately, if this idea works for Deutsch Post, it could possibly work for the general electric bike market in many other countries besides Germany. This is an interesting idea, but it will take careful negotiating of three parties, Deutsche Post, battery company, and a new energy service company to arrive at a fair and equitable distribution of risks and rewards for all parties. Stay tuned for the negotiations.

Hannes Neupert
www.extraenergy.com

Cobasys Saturn Vue Hybrid Battery

Batteries for Hybrid EVs

Advance Automotive Batteries says that the market for advanced Hybrid Electric Vehicle (HEV) batteries will double from approximately $600 million in 2007 to $1.2 billion by 2009 and is expected to top $2.0 billion by 2012, according to a new study, "The 2007 Advanced Automotive Battery Industry Report", to be published in April 2007. A key to identifying the type of HEV that will continue to expand the market is the availability of an affordable, long-life battery. In this regard the study concludes that in the foreseeable future, the HEV market will predominantly continue to consist of 'charged-on-board' designs. 'Plug-in' hybrids, which are charged from an electrical outlet, are unlikely to gain notable market share, in spite of wide publicity about them in the press—due to the lack of a suitable and affordable battery for this architecture. It will be interesting to see if the General Motors Volt Plug-in-Hybrid will counter this "unlikely" scenario with GMs commitment to use Lithium batteries in the Volt and production expected by GM around 2010-2011.

Nickel Metal Hydride (NiMH) is the incumbent technology for HEVs due to its proven longevity under heavy usage. However, it has performance limitations at high and low temperatures, and at the OEM cost of $500 to $2,000 per HEV battery pack, NiMH batteries are barely affordable to the automakers. Li-ion batteries are under intense development and testing by all major automakers for their potential promise in HEV applications. The AAB study finds that recent reliability problems with Li-ion batteries in portable devices are delaying the entry of this higher-power battery chemistry into the HEV market. However, following extensive system verification tests, Li-ion batteries are still expected to enter the market in 2009, achieve a market penetration rate of 15% by 2012, and grow thereafter. Two Japanese battery producers, Panasonic EV Energy and Sanyo, share over 90% of the HEV battery market (currently essentially all NiMH). Both companies are also developing Li-ion battery products for this market where over a dozen additional battery makers from Japan, Korea, and the U.S. are intending to compete. Market leader Panasonic EV Energy, a joint venture between Toyota and Panasonic Batteries, will continue to enjoy over 60% market share for at least three more years while the other developers are establishing their production capabilities.

The 2007 Advanced Automotive Battery Industry Report also points out that several automotive tier-one electrical system suppliers, including European giants Robert Bosch and Continental, U.S.-based Delphi and Cobasys, and Japanese giants Hitachi and Denso are working on integrating battery modules into a total energy-storage system, an area where the average battery manufacturer lacks experience. Lets plan on multiple winners in this field that is so extremely important to mankind's move to 100% electric transportation. The battery business will be very exciting in the next few years.

www.advancedautobat.com

Battery Energy/Price

Chemistry	Cell Voltage	Energy Storage Wh/kg	Battery Price (B) $/kWh
Lead-Acid	2.0	28-33	30-100
NiCd	1.2	50-60	200-400
NiMH	1.2	65-80	500-600
NiMH (Bipolar)	1.2	65-75	500-600
ZnAir	1.2	(A) 200-500	NA
NiZn	1.65	55-65	400-600
LiI / Li-Ion	3-3.6	100-120	500-900
LiIPo	3-3.6	100-120	500-900
LiIPh	3-3.6	80-120	500-900
LiS	2.0	180-300	NA

(A) - Zn-Air is mechanically rechargeable NA - Not Available
(B) Battery Price is to OEM user
LiI - Lithium Ion LiIPo - Lithium Ion Polymer LiIPh - Lithium Ion Phosphate
LiS - Lithium Sulfur
Lithium cell voltage varies with the composition of the cathode

This table is a "best estimate" of the range of energy and price for each technology.

Section 9

Fuel Cell Technology

Overview

In EBWR04 the chemistry and construction of fuel cells was described. This edition focuses on all the worldwide activities underway at applying the fuel cell power plant to LEVs. Fuel Cell Today reports that 7,000 FC units were built and installed, mostly for building power, in 2006 with 10,000 units predicted for 2007. Fuel cell manufacturing is thus beginning to grow with early adopters in the commercial building market and computer makers waiting in the wings. There are many companies that are working to manufacture cost effective fuel cells stacks and drive units for bikes, scooters and motorcycles. Countries that are reported in EBWR include Finland, Germany, Italy, Japan, Korea, Spain, United Kingdom, and the United States. This level of activity suggests that someone is bound to succeed and the application of fuel cells to commercial LEVs will happen in the next five years, provided that some standard is established for the storage and distribution of hydrogen fuel. That is a gigantic undertaking that is being worked on in the auto industry and governments where those companies reside. The LEV industry does not have the clout of the auto industry so in most countries LEV standards will be slow to evolve. If LEVs start using Direct Methanol Fuel Cells, the fueling infrastructure is already developed and available in the form of methanol cartridges ready for production (for portable electronic devices initially) from Direct Methanol Fuel Cell Corporation in California. In 2006, China announced that spending for R&D would increase to 2.5% of GNP by 2020 from 1.3% now with hydrogen production and distribution and fuel cells high on the priority list. China has nine fuel cell busses and ten fuel cell cars on the road and GM plans to sell their dual-mode hybrid, ICE and battery, bus to the China market. Several major Chinese bicycle companies are reported to be working on fuel cell electric bikes. China plans a hydrogen highway with 10 hydrogen filling stations in 2008, 300 in 2010, and 4,000 in 2020. If those plans become reality, there will be an opening for fuel cell bikes and scooters in China big time. Stay tuned.

Worldwide Fuel Cell Activities

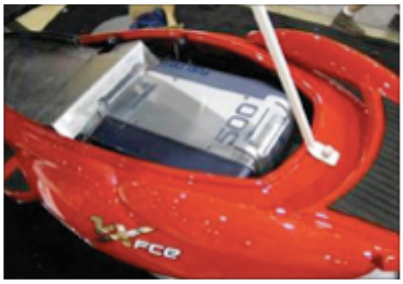
Fuel cells are entering the market in many applications from small electronic device power supplies, to standby and normal power in buildings, and to FC packs for industrial fork lift trucks used in buildings. The number of FC systems made grew by 67% in 2006 to 7,000 units with a cumulative 20,000 units that started to escalate from year 2000. So usage is indeed accelerating. These FC units are roughly split between PEM and DMFC (Direct Methanol Fuel Cell) technology with a few percent only made by other technologies, alkaline, molten carbonate, and solid oxide. The PEM and DMFC are suited to electronic devices and vehicles while the other technologies are mostly for large capacity stationary power. The percentage made in each region was: Europe 50%, USA 25%, Japan 20% and rest of Asia 5%. Around 50 companies service this new market. The number of hydrogen fueling stations has grown from 20 in 2000 to 140 in 2006 with over half in North America and the rest in Europe and Asia. Large stationary fuel cell power units used in commercial sites are also growing in number. Fifty units with total capacity of 18 megawatts were installed in 2006 and cumulative number now stands at 800. Most of these were installed in the USA where funds for fuel cell units are growing with early adop-

ters in hotel and resort chains. North America had half the world's activity (3,000 units) in the portable FC sector driven by military needs. Rapid FC growth in 2006 suggests that FC technology is available now, not ten years away. Another 10,000 FC units will be installed in 2007. The fuel cell revolution and the hydrogen economy have landed as a "small step for man". It will take millions of installed commercial FC units before we can declare a "giant leap for mankind".
www.fuelcelltoday.com

Vectrix Hybrid Fuel Cell Scooter

VectrixProduction Model

Vectrix Corporation, jointly with Parker Hannifin and Protonex, has developed a new fuel cell-electric hybrid scooter based on the Vectrix Electric Maxi-Scooter, that itself is scheduled to go into full production in early 2007. Parker is leading the development of the technology that is targeted for launch in select European and US cities within the next two to three years. The vehicle will fully integrate the Protonex NGen(tm) 500Watt fuel cell system with Vectrix's high performance battery-powered Electric Maxi-Scooter. The hydrogen (carried as a compressed gas or reformed from methanol) fuel cell system continuously charges the batteries that in turn provide power, via the motor controller, to drive the motor. The fuel cell more than doubles the range of the scooter. Both the all electric and fuel cell versions will have a top speed of 62mph, and 0-50mph acceleration in 6.8 seconds. The electric version has a range of up to 70 miles and the fuel cell will double that to about 150 miles. A regenerative braking system will extend range further. Development is at the third generation prototype stage.



Vectrix Scooter with 500-Watt APU

Vectrix Scooter with Fuel Cell

www.vectrix.com

Protonex Fuel Cells for Motorbike's

Protonex' ProCore™ 500-watt fuel cell power system prototype, developed in partnership with Parker Hannifin, provides dual-purpose functionality. Designed primarily as a stand-alone portable power generator, the system also functions as a battery charger/range extender for a high-performance electric motorbike. Incorporating this system into a Vectrix scooter more than doubled the vehicle's range without adding weight. In this demonstration, the fuel cell power system ran on compressed hydrogen. Protonex expects to incorporate a methanol reformer into its 500W fuel cell system, which will enable range extension up to four times the range of battery power at no added weight. This system is not yet in production, but may be developed for future introduction to military and commercial markets

500-Watt Multi-Purpose APU

Protonex 500W FC

www.protonex.com

Disposable Fuel Cartridges for Portable Electronics

Direct Methanol Fuel Cell Corporation, a division of VIA-SPACE , located in Pasadena, CA, focuses on producing disposable fuel cartridges containing liquid fuels, such as methanol, to provide the energy source for laptop computers, cell phones and other portable electronic devices powered by direct methanol fuel cells. In a direct methanol fuel cell, the hydrogen atoms in methanol (CH3OH) are used directly from the liquid which has six times higher energy density than compressed hydrogen. Hydrogen gas is never produced. The advantages of methanol are that the fuel is an inexpensive and readily available liquid, and the fuel tank is smaller. The methanol is catalyzed to hydrogen in a low temperature PEM fuel cell that produces electricity.

Methanol fuel cell powered devices are expected to be introduced into the marketplace by major electronic product manufacturers in 2007/2008. Leading consumer electronic companies including Toshiba, NEC, Hitachi, Panasonic and Sanyo in Japan, and Samsung and LG in Korea have demonstrated devices powered by direct methanol fuel cells. DFMCC plans to supply the disposable methanol cartridges to run the fuel cells in these devices. DMFCC is partnered with Elentec, SMC and Hyun Won in Korea, the Sato Group in Japan and with, Nypro in the US to manufacture cartridges..

DMFCC cartridges hold from 10 to 200cc of fuel. The cartridge pictured holds 50cc of 100% methanol and is designed for a laptop computer and similar applications. One cartridge is expected to provide five to 10 hours of computer operation depending on the efficiency of the fuel cell. DMFCC will work with customers to develop cartridges with custom sizes and shapes for their particular applications. DMFCC also plans to develop cartridges for other fuels such as formic acid or ethanol, as customers require. DMFCC cartridges are designed to meet the stringent safety standards published by the International Electrotechnical Commission (IEC). DMFCC has licensed 56 issued and 63 pending patents from Caltech and USC on direct organic fuel cell technology. DMFCC is offering patent protection to any fuel cell manufacturer or OEM that needs it, and is working to develop the global fuel cartridge infrastructure that is needed to support the industry. The portable electronics industry is focusing on fuel cells to provide longer operating time for their devices that currently run on lithium ion batteries. Fuel cells also offer instantaneous refueling by hot swapping cartridges. No need to find an electrical plug and wait several hours to recharge the batteries. The methanol fuel cell could also find application to electric bikes and scooters and with larger methanol cartridges or even fuel tanks. This approach could enter the market sooner than the pure hydrogen fuel cells. The advantages of a liquid fuel are substantial in any transportation market. Fuel cells are energy devices, and will be hybridized with batteries to provide for instantaneous power both in portable electronics and in transportation. In a laptop computer, the primary source is the fuel cell with only a small battery for power surges. In an electric bike or scooter, the batteries will play a much larger role, and the fuel cell is more like a range extender and battery charger.

DMFCC's Prototype Fuel Cartridges
DMFCC Methanol Cartridges

www.DMFCC.com

2007 instead of 2005 in the Fuel Cells for Bikes and Scooters-2007

As in previous years, EBWR features new fuel cell EVs and FC EBs and scooters. They are not yet commercially available though government groups continue to evaluate them. There is a continuing march of progress toward this ultimate commercialization goal illustrated by the following prototype models.

Fuel Cell Bikes by Masterflex

Masterflex, based in Germany, has received the first order for its fuel-cell powered electric bicycle. Masterflex will supply the first fleet of bicycles with fuel cell propulsion systems to the city of Herten in North Rhine Westphalia. The prototype for the fuel cell bicycle, which was first unveiled to the public in 2004, has been developed to production standard in less than a year. The bicycles, based on the Swizzbee 50cc electric bike, use a Masterflex 250W PEM fuel cell fueled by 45g of hydrogen stored in a Hera metal hydride system to power a 250W electric motor. This FC EB has a range of up to 120km (75miles).

Masterflex introduced a new concept this year the “Cargobike”. The Cargobike is a three-wheel bike for transporting small loads equipped with Masterflex’s fuel cells and an innovative drive concept. The rider himself has to pedal, but is simultaneously helped by an electric motor. In contrast to traditional bicycles, the

cargo bike has no chain to transmit power to the wheels. An electric transmission system completely replaces the high-maintenance chain and the associated gearshift mechanism. In addition, the bike will be equipped with a 250W fuel cell system and will be one of the first vehicles to use 70MPa (Mega Pascal) hydrogen cartridges. This will allow it to achieve a range of approximately 250km with 90g of hydrogen. The joint project is being co-financed by the European Regional Development Fund (ERDF) and the State of North Rhine-Westphalia.

Gore/Aprilia Fuel Cell Bike

Designed by WL Gore & Associates, this fuel cell bicycle, with a frame designed by Italian motorcycle manufacturer Aprilia, was presented at the Fuel Cell Expo 2005 in Japan.

Intelligent Energy's CORE Fuel Cell in the ENV Bike

The Intelligent Energy CORE is a PEM (Proton Exchange Membrane) fuel cell type that is the most popular and appropriate type of fuel cell for automotive applications. Simply put, each fuel cell is a multi-layered sandwich of plates and MEAs (Membrane Electrode Assemblies), in which the MEA acts as a catalyst during an electro-chemical reaction, producing water and electricity form hydrogen and oxygen. The Intelligent Energy Core fuel cell is unique in both volumetric power density and low parasitic loss. It is made from thin metal sheets, rather than the more common graphite plates, making it robust, compact and easier to manufacture. The CORE powers the env motorbike that is lightweight, streamlined and aerodynamic. It boasts a performance that outreaches any existing electrical bike and can reach speeds of 50mph. On a full tank, the env bike could be used continually for up to four hours without any need for re-fuelling.

Cidetec Technology-Fuel Cell Bicycle For Today

Cidetec Electrochemical R&D Technology Center is located in San Sebastian, Spain. Cidetec's Energy Department has designed a fuel cell prototype bike. financed by the Gipuzkoa Provincial Government using an Orbea bike. The fuel cell is the PEM type.

Honda

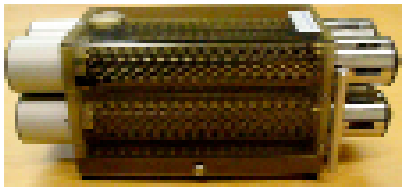
Building on its success with fuel cell automobile technology, Honda has developed a scooter powered by its light, compact fuel cell system, the Honda FC Stack. Capable of starting at sub-freezing temperatures, the high-efficiency next-generation Honda FC Stack has been made even lighter and smaller, and redesigned for use in scooters. The new vehicle is based on a 125cc scooter of the kind popular with commuters worldwide. Space has been conserved by placing the electric drive system on the rear-wheel swing arm, and by placing the Honda FC Stack fuel cell in the center of the vehicle, with auxiliary systems compactly arranged around it. The result is a scooter comparable in size to an internal combustion engine vehicle of the same class.

Yamaha FC-me

The "Yamaha Direct Methanol Fuel Cell (DMFC) System" uses a liquid methanol-water solution as its fuel, which eliminates the need for a hydrogen converter or a pressurized (hydrogen) tank and thus makes it possible to create a lightweight system for a small vehicle requiring power in the 1 kW or less range without compromising on power output characteristics. Based on survey data gathered from licensed public-road use of the Honda early fuel cell scooter, "FC06 PROTO," a prototype mounting the Yamaha DMFC system, the advanced fuel cell motorcycle model "FC-me" has now been created with improved performance in areas like reliability and running distance. By optimizing the control parameters for the fuel cell system, Yamaha's engineers have achieved an energy conversion rate for the FC-me that is 1.5 times that of the FC06 PROTO, with a light machine weight of just 69 kg. The Yamaha FC-me is now leasing it to Shizuoka prefecture government in Japan. It has been tested on public roads since September 2006 at a reported lease cost of $942 per month.

Hydrocell OY Scooter and Bike

Founded in 1993, Hydrocell OY, of Järvenpää, Finland, is developing alkaline fuel cell systems and metal hydride hydrogen storage systems. In 2005 it demonstrated a 400W prototype scooter with integrated hydrogen storage. It is an FC- battery hybrid: with Alkaline Fuel Cell (AFC HC-400) and electric motor, and the hydrogen fuel is supplied by MH storage. Hydrocell is developing systems up to 5kW. In addition it has developed a lightweight, portable metal hydride storage system. The standard hydride product stores 1200 liters of hydrogen and weighs 10kg. It can be refilled in 15 minutes. Pictured is the AFC module HC-400



Also Hyrocell OY developed a fuel cell - battery hybrid: with 60W AFC and electric motor. It features an AFC module HC-100 and can run approximately ~60km on a single hydride cylinder.

Samsung Engineering Co. Fuel Cell Scooter

Samsung Engineering Co. has developed a fuel cell scooter sponsored by the Ministry of Science and Technology and the Korea Institute of Science and Technology. Samsung claims scooter range is 140km on 6 liters of hydrogen fuel. The fuel cell system uses a water-based solution of sodium borohydride, made from sodium borate, to produce hydrogen gas. Samsung says that range with hydrogen is three times farther than a NiCd powered electric sooter.

High School Fuel Cell Bike in Japan

Mr. Masashi Sato, a teacher Tokyo Metropolitan Sumida Industrial High School in Japan

created a fuel-cell bike. “A bike that runs without being pedaled elicits exclamations of surprise - fuel-cell bikes are constantly developing.”

Manny Tsoupanarias
Fuelcellworks - Inside the Industry
fuelcellsworks@yahoo.com
www.fuelcellsworks.com

Fuel Cell Applications Progress

Microcell Corp., Raleigh North Carolina, announced the delivery of the first multi kW PEM fuel cell core for automotive applications based on its novel micro fiber architecture. The "microcell" (500-1,000 micrometers diameter) design concept is an extrusion-based scalable process for cost effective large-scale production. One of the Luxembourg DaimlerChrysler Citaro Fuel Cell Buses passed the 5,000 operational hours milestone. The buses have been extremely reliable.

Cellex Power Products, Inc., Richmond, BC Canada, announced the successful completion of beta trials at two Ohio-based Wal-Mart distribution centers of hydrogen fuel cell-powered pallet trukks. The FC trucks met and exceeded uptime, fueling, environmental and safety targets logging more than 18,500 hours of active work with over 2,100 indoor fueling occurrences by pallet truck operators.

Electro Power Systems of Turin, Italy, works on methane and ethanol fueled fuel cells. Thermal converters change the natural gas or ethanol into hydrogen to fuel the PEM fuel cells. EPS now offers a 7kW PEM unit at a price of around 25,000€. The Electro50 is a 50kW unit designed for the growing distributed generation market with availability at the end of 2007. It provides 400V AC and 60 amp nominal current.

H2 Logic, of Herning, Denmark, is selling the first fuel cell industrial truck that operates inside buildings. The fuel cell unit is under the driver's seat with storage space in the back. The H2 Truck uses hydrogen PEM fuel cells with1.2kW (2kW peak) for 4 continuous hours or 12-16 operational hours. Traction comes from a 24V 2 KW DC motor which runs the truck up to 15kph max speed with 2,000kg traction power and load of 750kg. Vehicle weight is 450kg that includes 90 kg for the fuel cell and 30 kg for two H2 canister hydride storage units. Refueling of the canisters in done using a H2 Logic filling station that uses high purity tank hydrogen to load the hydride canisters in 30-60 minutes depending on temperature.

Fuel cell products are thus beginning to enter the market worldwide and the application to electric bikes and scooters ridden by consumers is virtually assured. Stay tuned.

H2 Logic FC Truck

FC Power Unit

Section 9

Motor Technology

Overview

The EB world is dominated by hub electric motors as the design of choice. Ed Benjamin discusses motor trends and makers outside China who build higher quality motors than China companies. Consolidation and attrition of manufacturers continues as the EB business matures. Jeffrey Ho, a Taiwan motor manufacturer, says that the rare earth permanent magnet DC motor is best for the E-Bike, but there will continue to be a need for better motors. EB motor manufacturers are new and have yet to mature to the sophistication of motor companies who have built hundreds of millions of consumer product motors for a hundred years. Heinzmann continues to produce quality hub motors used in EBs in Europe and North America. Heinzmann also has new approaches to controllers and battery management. BionX, in Canada, has a new brushless motor that is combined with a Lithium Ion battery that seems to be a growing trend in motor/battery technology. The Cosmo Electric Power Unit by Pro-bis Design from Poland claims to have the longest range, up to 200km, with a 42V 10.8kg Lithium battery, of any EB reviewed by EBWR. But the Cosmo is not yet in production.

Motor Trends and Makers outside China

Samhyun 300W Hub Motor Korea

As mentioned by Jeffrey Ho below, the Chinese hub motor makers that specialize in E-Bike motors are the overwhelmingly dominant suppliers. Since their business is 99.9% Chinese domestic market, they are tightly focused on 180 – 240 watt hub motors with top operating speeds of less than 16 mph and expected user weight of less than 160 pounds. Ananda and Aoma are major suppliers to this market. Due to the ease of use of hub motors for the bike manufacturer, there are few designs that use anything else.

Some Japanese E-Bikes use cylindrical motors that drive the bottom bracket (Panasonic, Yamaha), and limited numbers of innovative bikes appear from time to time in the EU using variations of such drives. eGO is an American company that may be the most successful user of cylindrical motors on their moped class scooters. Many electric mini scooters use 200–600 watt cylindrical motors from a variety of Chinese and Taiwanese suppliers. Normally these motors are not intended for electric vehicle use and are simply chosen for low cost.

Ultra Hub Motor India

There are a number of important motor manufacturers outside of China that are important suppliers to the EB industry. Taiwan DC Motor of Taoyuan builds several motors used in electric bicycles and scooters. This com-

pany is noted for quality, long tenure in electric vehicles, and consistent quality. They are an OEM maker for other motor companies as well. BionX of Asbestos, Canada has several models of brushless direct drive hub motors used in DIY kits and original equipment for Matra and other bicycles. BionX has, perhaps, the most commercially advanced of the direct drive motors. Heinzmann GmbH, located in the Black Forest of Germany, has been building high power E-Bike hub motors since the early 90's. Heinzmann hubs are used in EVG, TresTerra, and many European brands of E-Bikes. Ultra Motor of UK, located in Delhi, India, has a brush type, direct drive hub motor used in India E-Bikes.

Attrition and consolidation of motor makers continues. Rabbitt Tool's innovative hub motor was sold to Sanyo and is in production and use as the Sanyo hub motor. WaveCrest Laboratories stopped bicycle and bicycle motor operations in 2005, and the IP and materials for the hub motor was passed to Matra, in France. Matra expects to produce the motor, but this has not happened up to the time of this publication issue date. Smart Wheels never had a commercial product and is rarely heard about now. Wellington Electric, Neodyne, Jim Dunn and others were associated with this hub motor. Worthy of mention is the Revco motor. Originally a windshield wiper motor for US made autos, this 375W motor has been used in Zap, Charger, 3rd Millennium, Electric Bicycle Factory, and other E-Bike products. Revco's motor is now made in China, and is in limited supply.

Ed Benjamin

Electric Motors for E-Bike Applications

The electric power unit is the key component that differentiates an E-Bike from a regular bike. The electric motor is the heart of the power unit. Most consumers are not aware of the motor and the bike industry is not familiar with them. This article will explain the parameters of electric motors that provide performance at affordable cost needed for the E-Bike.

Motors Shanghai Show

Shanghai Ananda Hub Motors 140-250W 2/24/36/48V www.ananda.com.cn

Electric motors are used in applications, like running machines in factories and pumping water, where motors operate 24 hours a day for many years with high reliability. Most power applications are for continuous operation at constant load and use AC (Alternating Current) motors while fractional horsepower motors generally use DC (Direct Current) motors. E-Bike motors have power from 100 to 750 Watts.

For E-Bike applications motors run with a variable load for up to two hours running time, or when the battery charge is drained. The variable load comes from varying road conditions (hills, etc) and varying rider weight. The DC motor is used almost exclusively for E-Bike applications since the power supply is a DC battery and the DC motor has excellent speed control and performance characteristics,

Two key factors that make the DC motor for the E-Bike application possible are the use of high performance permanent magnets and advanced electronic controller technology. First, rare earth magnets, Neodymium-Iron-Boron type, invented in the 1980s, have a "Magnetic Energy Product" of 40 MGOe that is 500% higher than the 8 MGOe of ferrite magnets used in motors (and still used in the automotive industry) since the 1960s. This higher energy product allows for smaller, lighter motors at affordable cost. Second, improvements in performance and cost of electronic components, like MOSFETs and IGBTs, during the 1990s now provides E-Bike motor controllers of reasonable size, weight and affordable price.

E-Bike motor requirements include light weight, small size, high performance with high reliability and quality all at affordable cost. Weight and size are helped by the use of powerful rare earth magnets and performance means high torque needed to start moving the bike or to climb a hilly road. Gears between the motor and the drive shaft can provide a high torque but at a penalty of noise, lower efficiency, added weight and cost. However, reasonable torque performance can be achieved with a gearless hub motor with integrated controller in the motor housing as found in some high end products. **The author's opinion is that the gearless, rare earth permanent magnet DC (PMDC) motor is a good solution for today's E-Bike.**

When pedaling a bike, the pedal action generates a torque, which is the pedal force acting on a lever, the pedal crank. (Torque is defined as the product of force and distance, from a pivot point, over which the force is applied.) Normal derailleur gears provide s u fficient torque at high gear on flat roads and in low gear when moving on hills or in starting to move the bike. This is also true for automobiles that climb hills in low gear and move at high speed in high gear. To accomplish the equivalent of the action of gears in a gearless E-Bike motor, the controller software is designed to provide more current momentarily when the motor needs to provide more torque, as in riding up a hill. The motor can be overloaded 200-300% of its current rating for a few seconds to a few minutes depending on the safety factor overload design of the motor. Since the controller will need to handle a higher current, this will add to the cost of the controller but overall will provide a better safety factor and better quality. **Thus the combination of the rare earth permanent magnet motor with an advanced electronic controller of careful design provides the best solution, at this time, to the E-Bike power unit.**

The electric motor industry is old and has been successful in manufacturing induction motors (e.g. motors to pump water) that are very reliable and low cost. An Asian induction motor factory needs 4 million motors per year to achieve economies of scale and small manufacturers need at least 100,000 unit yearly volumes. The traditional bike industry is also an old industry and desires standard parts and components. Thus the bike industry would like to buy a motor for an E-Bike from a catalog from the traditional large motor manufacturers. But those manufacturers have not entered the E-Bike motor business since it is so new and small by their standards. Thus in China, where millions of E-Bikes are sold each year, the motor suppliers are new and specialize in E-Bike motors, which tend not to have the reliability, performance and cost of motors from the traditional motor industry. Nevertheless, these manufacturers are contributing to the tremendous growth in E-Bike usage in China and expect to improve reliability and performance in the future.

BrushLess DC motors (BLDC) are another approach to motors for E-Bikes. The brushless motor replaces mechanical commutating (as in the PMDC brush motor) with electronic commutating. Commutating is the mechanism that makes a motor rotate, the brush (that transmits electric current to contacts) and mechanical commutator are used in the brush-type motor while electronic circuitry provides the commutating in the brushless-type motor. The BLDC thus has more electronics and thus is more expensive with cost about double of the brush type motor. In very high volumes there should be less difference in cost between brushless and brush type motors.

Brushless motors have more efficiency than the brush type but it depends on the load. At rated load: BLDC efficiency is higher than 80%, PMDC is just close to 80%. At 150% rated load: BLDC is around 75%, PMDC is around 70%. At 200% rated load: BLDC is around 72%, PMDC is at 60% or lower. At 200% rated load, the efficiency ratio of BLDC/PMDC is 72/60=1.2 so the BLDC motor will have 20% less current draw at this load. Another advantage of the brushless motor is the sophisticated digital control that performs the electronic commutation function. This allows the addition of more control functions to easily provide more features to the E-Bike. BLDC motors should be quieter than brush type but in many applications, such as medical, the brush type is acceptable. The brush does wear out eventually and brush/commutator life should be around 500-1500 hours. For an E-bike this represents about 10,000 miles of travel or roughly 2-5 times the lead-acid battery life for a good quality brush motor.

There is no absolute answer to the question of which motor, PMDC or BLDC, is best for the E-Bike, but there will continue to be a need for better motors. The trend is for low price PMDC motors made in China to support the China domestic market now

at well over 15 million units each year. As the global motor industry outside China cannot compete on price, new technology developments will begin to diminish since there is no incentive to develop new technology with the largest market dominated by the lowest cost producers in China. This also holds true for the electronic controller industry that supports the E-bike industry. Thus only small improvements in existing technology will be the trend in motors and controllers for E-Bikes. It will be up to the China motor industry to improve quality and performance without a large increase in price. Then the China motor industry will expand to markets outside China. The rest of the world will try to produce a lower cost motor product but with higher quality than the China product. The outcome of this China versus "rest of world" competition is still uncertain. The consumers and distributors of E-Bikes worldwide will make the choice of accepting the lowest price motor or the higher quality, higher price motor. The good news is that motor manufacturers, like other people, agree that E-Bikes and electric vehicles will be important in the future. So they all will keep an eye on it.

Taiwan DC Motor Co., Ltd. is located in Tao-Yuan Hsien, Taiwan and offers the following products for the LEV market.

1. Ferrite Magnet Motor for power wheelchair & mobility scooter (200W-800W)
2. Rare-Earth Magnet Motor for electric scooter and electric bike (200W-1000W)
3. Brushless DC Motor, controller (200W-400W)
4. DC and AC Actuators

Jeffrey Ho, General Manager,
Taiwan DC Motor Co., Ltd.
www.tdcm-motor.com.tw

Heinzmann Motors for EBs

Heinzmann GmbH continues to be a worldwide supplier of hub motors for electric bikes. Starting with the EV Global Motors brand in the USA 10 years ago it now ships to twenty countries in Europe, Asia, South Africa and North America. There are over fifty versions of the Heinzmann motor with voltage ratings of 24 and 36V that are now powered by NiMH and Lithium Ion batteries. Both brush type and brushless motors are offered with efficient controllers. Power ratings range from 250W to 750W and are controlled both as Pedelecs, for the EU market, and E-Bikes for North America and other locations. Top speed on the "Sport" EB is 36kph (22mph).

Heinzmann has been working closely with the German Post in providing hundreds of EB propulsion kits to Biria (now being part of MIFA), a large German bike manufacturer. The Biria EBs were designed for postal delivery and have been field tested in different districts in Germany. These tests were successful and thousands of Biria bikes with Heinzmann electric drives are in service now at the German Post. This was paralleled by the project “New Electric Postman Helper” (NEPH) that is supported by the EUREKA (Belgium) project that is a cooperative technology activity of 38 European countries. In this project, four European industrial companies (one of which is Heinzmann) and six European postal organizations work together. In the first phase of the project they study, develop and integrate some “Innovative Electric Power Train Systems” for electrically powered vehicles to support postmen on their daily mail delivery route in urban areas. The project is registered at EUREKA under the number ™!3364 . More details can be found at www.eureka.be, then choose “project portfolio” and search for the project number 3364 and keyword NEPH.

All Heinzmann, E-Bikes in the “Pedelec” version are equipped with a “get started easily” function. They operate with “power on demand” like an E-Bike up to 6kph (3.7mph). For higher speed the driver has to pedal as usual on a “Pedelec”. With this function it is very easy to get started at steep slopes or with heavy loads. Another advantage of this function is that pushing a heavily loaded E-Bike up a steep hill becomes very easy. Turning the twist grip makes the E-Bike move itself up the hill with the speed of the walking driver. In countries outside Europe this function must be checked for legality.

Heinzmann Hub Motor
Integrated Transmission

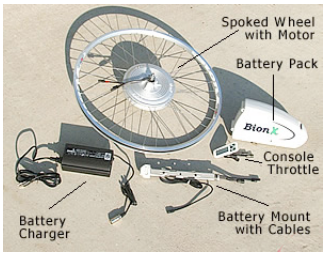
Heinzmann Brushless
Hub Motor Integrated Electronics

Another steadily growing field of applications for the Heinzmann propulsion systems is the rickshaw market. These are known as 'Velotaxi", normally pedaled by the driver. But now a renaissance is occurring to modernize it with an electric drive power assist. This will allow tourists and business people to move in double quick time during rush hour traffic in very congested cities. Most should have a powerful Heinzmann motor.

www.heinzmann.com

BionX Electric Drive

EPS Bionx bike and Electric Drive Kit



Energy and Propulsion Systems LLC (EPS), Asbestos, Canada, is the manufacturer of the BionX system, and is well known for its advanced technology in the power-assisted bike market. The BionX system is distributed in more than 250 bike shops across North America with eight distributors in ten additional countries, seven in Europe, Australia, Malta and South Africa. BionX sales strategy includes sales distributors, retailers and OEMs. With 10,000 satisfied owners of the BionX system, it continues to innovate with new products and enhancements. BionX offers a new brushless, 350Watt motor and lighter, longer lasting Lithium Ion batteries. BionX offers two P-250 models that operate in the Pedelec mode with either NiMH or Lithium Ion battery and two P350 models with 36V Lithium batteries of twice the energy capacity of NiMH that provides pedaled range up to 40 miles. Power-assist kits are offered as well as the P-Series. BionX continues to grow in sales and customer acceptance of their EB electric drive products.

www.bionx.com

Cosmo Electric Power Unit from Poland

Cosmo Electric Power Unit (EPU) is from Pro-bis, a design and production company in Warsaw, Poland. This project on an EB drive, which operates in the E-Bike mode, started in 1998 with a prototype model. By 2001, 14 different models had been designed, the latest of which was installed in a standard bicycle and tested for a distance of several thousand kilometers. Tests included riding on mountain roads (90% of the tests), difficult terrain (sand, stones, mud), down hills at 50km/h, and shock and vibration tests of electrical components. The Cosmo EPU passed all these difficult tests. The Cosmo EB range is 200km with a large Lithium Ion battery and 90km range is provided with a smaller Lithium Ion battery. These large range numbers result from Pro-bis engineers evaluating where the major losses were in the system and designing components to minimize those losses in order to maximize range. The losses evaluated and reduced by good engineering design include those found in the magnetic efficiency of the motor, mechanical connections, battery internal resistance, electrical contacts, and controller. Reducing these losses, along with others, allowed Pro-bis to achieve the highest range reported for an E-Bike that is known to EBWR. The demonstrated performance parameters allow Pro-bis to claim that their design is much better than EB drive units available on the market. EB performance and component parameters include the following:

- Battery: 42V Lithium Ion, weight 5.4kg provides range about 85-90km
- Battery: 42V Lithium Ion, weight 10.8kg provides range about 200km

Cosmo Hub Motor

- Maximum speed: 45 km/h
- Hub Motor continuous power: 2,000 W (Pro-bis design)
- Motor instantaneous power: 6,000 W
- Capacity to tackle hills: limited only by tire grip
- Weight of bicycle with Pro-Bis EPU – around 25 kg

By 2005, models 14M68 and 24M68 had been constructed and also modification and improvements to the prototype model had been worked out.

14M68 is usable to large loads, also for drives with trailer. Designed for intensive exploration, drive in difficult terrain with baggage and on steep driveways. Attractive to long tourism travel. Hub diameter: 165 mm, weight~5.2 kg.

24M68 is designed for drive in heavy terrain on unbeaten mountain paths, extreme steep driveways and advanced endurance drivers. Hub diameter: 165 mm, 6.3 kg.

A production version of Cosmo EPUs is under development by Pro-bis. The EPU is designed so that it can be installed on most bicycles to convert them to E-Bikes. The Pro-bis EPU will be demonstrated at several exhibitions in Poland and other locations. The Cosmo EPU will establish a new high standard of performance for E-Bikes

Michal Zdzienicki.
Pro-bis Design and Production Company
mz@probis.pl www.probis.pl

Section 10

Electric Bike Regulations Worldwide

Overview

USA electric bike federal regulation remains the same as reported in EBWR04. The USA regulations article includes questions and answers about the role of federal and state jurisdiction in EB issues to illustrate that both state and federal laws play a role in how products are built and used. All EBs entering the US are believed to meet the federal standards. Mini Electric Scooters are typically governed by rules established by local community ordinances and to date there is no federal law. California considered a law on MESs but it did not pass suggesting laws will probably come in the future. The European Union now has 27 member nations and the standard regulations for motor power and speed for EPACs (Electric Power Assist Cycles) will finally be adopted in 2007 after many years of negotiation. There is no driver's license necessary for EPACs but the EU has a proposal to harmonize the license for moped riders. Australian regulations limit EB motor power to 200 watts which limits EB usage there. Regulations for the United Kingdom, Canada, China, Japan and Taiwan are virtually the same as reported in EBWR04. India regulations are added as India is emerging as a potential major producer and user of Ebs. All of these countries have different values for maximum allowed motor power and speed. The range of motor power is from 200 to 750 Watts and speeds from 20 to 33kph. Regulations will hopefully be written to protect the publlic but also to importantly encourage the use of LEVs as transportation.

UNITED STATES OF AMERICA

Federal Law

Electric bikes are “bicycles”, not mopeds, not motor assisted bicycles, and not motorcycles. 16CFR part 1512 is the federal law that defines a bicycle that is propelled by both human power (pedals) and a motor of less than 750 watts with a top motor assisted speed of 20 mph as a bicycle and subject to the jurisdiction of the Consumer Product Safety Commission.

There are many laws on state books that refer to a variety of motor equipped two wheelers. Some of these laws are left over from long ago and can be confusing to users and law enforcement. Very few states have any laws that specifically define the design and use of EBs. Except for a very few places in the USA, your electric bike is a bicycle in the eyes of the law. You must obey traffic laws, and have the same rights and responsibilities of a bicycle. (This means you have more privileges than a car in most cases – you can use bike paths!)

The federal law for certain electric bikes is called: "An Act - To amend the Consumer Product Safety Act to provide that low-speed electric bicycles are consumer products subject to such Act". Public Law 107-319 passed by the United States Congress was enacted on December 4, 2002. This law required that the Consumer Product Safety Commission (CPSC) amend its 1974 regulations dealing with human powered bicycles to include the new definition for electric bikes (see 16CFR part 1512). The new CPSC regulations were effective February 12, 2003 and are reproduced here along with the Act of Congress.

The rules for Mini Electric Scooters are still in a state of flux and handled by local communities since there has been no

movement toward a national standard. It is difficult to achieve agreement on such standards with manufacturers who mainly are in China. Poor quality and injuries to young MES riders has provoked communities to limit where these scooters can be ridden and by whom. No country, to EBWR knowledge, has regulations for Mini Electric Scooters, but most have local community rules for use.

Electric Bicycle means:
(1) A two-wheeled vehicle having a rear drive wheel that is solely human-powered;
(2) A two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 hp), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.

Federal Law on Electric Bikes in the Consumer Product Safety Commission Act

7073 Federal Register / Vol. 68, No. 29 / Wednesday, February 12, 2003 / Rules and Regulations

CONSUMER PRODUCT SAFETY COMMISSION
16 CFR Part 1512
Requirements for Low-Speed Electric Bicycles
AGENCY: Consumer Product Safety Commission.
ACTION: Final rule.
SUMMARY: Public Law 107–319, 116 Stat. 2776 (the Act), enacted December 4, 2002, subjects low-speed electric bicycles to the Commission's existing regulations at 16 CFR part 1512 and 16 CFR 1500.18(a)(12) for bicycles that are solely human powered. For purposes of this requirement, the Act defines a low speed electric bicycle as "a two-or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 h.p.), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph." Public Law No. 107–319, section 1, 116 Stat. 2776 (2002). The Commission is issuing this immediately effective amendment to its requirements for bicycles at 16 CFR part 1512 to promptly inform the public of the newly enacted statutory requirement on low-speed electric bicycles.

DATES: This amendment is effective upon publication in the *Federal Register*, that is, on February 12, 2003.

FOR FURTHER INFORMATION CONTACT: Lowell Martin, Esq., Office of the General Counsel, Consumer Product Safety Commission, Washington, DC 20207; telephone (301) 504–7628; e-mail lmartin@cpsc.gov.

SUPPLEMENTARY INFORMATION: Public Law 107–319 (the Act), enacted December 4, 2002, amends the Consumer Product Safety Act (CPSA), 15 U.S.C. 2051, et seq., by adding a new section 38 establishing requirements for low speed electric bicycles. Specifically, section 1 of the Act makes low-speed electric bicycles subject to the Commission's existing regulations on bicycles.

a) Notwithstanding any other provision of law, low-speed electric bicycles are consumer products within the meaning of section 3(a)(1)[of the CPSA] and shall be subject to the Commission regulations published at § 1500.18(a)(12) and part 1512

of title 16, Code of Federal Regulations.

Public Law 107–319, section 1, 116 Stat. 2776.
The Act defines the term "low-speed electric bicycle" as follows:

(b) for purposes of this section, the term "low-speed electric bicycle" means a two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 h.p.), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.

Id.
The Commission's regulation at 16 CFR 1500.18(a)(12) makes the determination that bicycles that do not comply with the requirements of 16 CFR part 1512 present a mechanical hazard within the meaning of section 2(s) of the Federal Hazardous Substances Act (FHSA). 15 U.S.C. 1261(s). The effect of this determination is that noncomplying bicycles are "hazardous substances" for purposes of section 2(f)(1)(D) of the FHSA, and are also "banned hazardous substances" pursuant to section 2(q)(1)(A) of the FHSA. 15 U.S.C. 1261(f)(1)(D), 1261(q)(1)(A). See also, Forester v. Consumer Product Safety Com'n, 559 F.2d 774, 783–786 (D.C. Cir. 1977).
The amendment to § 1512.2 of 16 CFR part 1512 promulgated today incorporates the Act's definition of "low-speed electric bicycle," thereby helping to inform the public of the statutory application of part 1512 to low-speed electric bicycles.
Section 553(b)(3)(B) of the Administrative Procedure Act (APA) authorizes an agency to dispense with certain notice procedures for a rule when it finds "good cause" to do so. 5 U.S.C. 553(b)(3)(B). Specifically, under section 553(b)(3)(B), the requirement for notice and an opportunity to comment does not apply when the agency, for good cause, finds that those procedures are "impracticable, unnecessary, or contrary to the public interest." The requirement reflected in this amendment is imposed by the Act and is not discretionary with the Commission. Accordingly, the Commission hereby finds that notice and an opportunity for comment on this amendment are unnecessary.
Section 553(d)(3) of the APA authorizes an agency, "for good cause found and published with the rule," to dispense with the otherwise applicable requirement that a rule be published in the *Federal Register* at least 30 days before its effective date. The Commission hereby finds that the 30 day delay in effective date is unnecessary because the requirement reflected in the amendment was imposed by the Act and is not discretionary with the Commission.
Because this amendment incorporates a requirement mandated by statute that is not discretionary with the Commission, and thus is not subject to notice and comment, this rule is not subject to the Regulatory Flexibility Act, 5 U.S.C. 601, et seq. Because this amendment incorporates a statutory requirement not subject to agency discretion, it is not an agency action subject to the National Environmental Policy Act, 42 U.S.C. 4321, et seq.
Pursuant to Executive Order No. 12988, the Commission states the preemptive effect of this regulation as follows. Section 1 of the Act provides that its requirements "shall supercede any State law or requirement with respect to low-speed electric bicycles to the extent that such State law or requirement is more stringent than the Federal law or requirements referred to in subsection (a)[the Commission's regulations on bicycles at 16 CFR part 1512]." Public Law No. 107–319, section 1, 116 Stat. 2776.

List of Subjects in 16 CFR Part 1512

Consumer protection, Hazardous substances, Imports, Infants and children, Labeling, Law enforcement, and Toys.
For the foregoing reasons, the Commission amends Title 16 of the Code of Federal Regulation to read as follows:

Authority: Secs. 2(f)(1)(D), (q)(1)(A), (s), 3(e)(1), 74 Stat. 372, 374, 375, as amended, 80 Stat. 1304–05, 83 Stat. 187–89 (15 U.S.C. 1261, 1262); Pub. L. 107–319, 116 Stat. 2776.
§ 1512.2. [Amended]

2. Amend § 1512.2, to revise paragraph (a) to read as follows:

(a) Bicycle means:
(1) A two-wheeled vehicle having a rear drive wheel that is solely human-powered;
(2) A two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 h.p.), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.

Dated: February 6, 2003.
Todd A. Stevenson,
Secretary, Consumer Product Safety Commission.
[FR Doc. 03–3423 Filed 2–11–03; 8:45 am]
BILLING CODE 6355–01–P

SOME QUESTIONS ANSWERED ON FEDERAL / STATE JURISDICTION ON EB`S

1. What happens when the state has old "motorized bicycle" laws that appear to conflict with the CPSC federal regulations on EB's?

Brief Answer: First they must really "conflict" and secondly if the state law if more restrictive (higher safety standard) it would apply over the CPSC regulation. See 15 USC Sec. 2075 below.

2. What is the role of the Federal law and State laws with respect to EB's - for example: Federal laws define electric bikes and states can further define electric bikes?

Brief Answer: There is no "federal" law other than the CPSC regulations for EB's. (see response to question one). Generally federal laws will govern manufacturing and performance standards and states legislate how, where, when and who could use EB's.

3. Various states are starting to create regulations and laws (such as Florida requires you to be 16 to operate an electric bicycle) some of which are created "administratively". Are these binding?

Brief Answer: See question 2. Regulations are created by agencies and laws are created by legislatures. Legislatures give agencies the authority to create regulations to implements certain laws. Both are binding on users and sellers.

Discussion:
The above questions are very complicated to answer as they involve many complex and overlapping principles. Technically the idea of "federal pre-emption" is that federal laws take precedence over or over ride state laws. This is true in areas of law where the federal government (or the state government with respect to pre-empting lesser county or city laws) has fully occupied an area of law so completely that any law that a state or lesser government were to create in that area of regulation would be arguably "conflicting" and thus be preempted by federal law. In some cases lesser government entities are allowed to create laws that are more restrictive than a federal law. (Such as in the case of California emission standards being more restrictive than federal laws governing car emissions equipment and standards) In other preemption scenarios, the federal law is so expansive and pervasive that any lesser entity law (more restrictive or not or even covering an issue not covered by the higher law) cannot override the effect of the Federal law. In many cases Congress will explicitly state the preemptive effect of the law. Drugs, railroads, mines, airlines, maritime activity etc. all have extensive federal laws and regulatory structures

that govern literally ever facet of the business or subject area. That is not to say however that Boeing, for example, cannot create higher standards for planes it designs. It must however meet certain federal minimum design standards. There are also some facets of the airline business that a state could regulate. For example many of the airlines workers are governed by state wage and hour laws. There also may be certain aspect of the airports governed by state law. Much of this is very dependent on the law involved and the circumstances of the regulated activity at issue.

Lets take an example. The US congress has legislated that "Low-Speed Electric Bicycles" are to be within the scope of the CPSC regulatory authority and not that of NHTSA/DOT. (see footnote 1) The problem is that the CPSC has not defined any safety, performance or manufacturing "standards" for such electric bikes specifically, only for bicycles in general. The legislation was primarily done just to define a small subset of electric bikes (EB's) that fall within CPSC's regulatory jurisdiction. NHTSA primarily regulates "on highway vehicles". NHTSA has tried to define administratively what that means and in some cases it has excluded jurisdiction over certain types of EB's. So all this congressional action really did was to define more finely what was and what was not within each agencies jurisdiction. However there are still grey areas as to what NHTSA may regulate. For example if an EB had more than one hp there is still an open question as to whether NHTSA would regulate it. We do know that the CPSC would not under current law.

Now in theory if a state tried to regulate recalls of these EB's over which CPSC has clear jurisdiction (at least over the recall process), the CPSC could tell the state to back off. However there are a whole host of state laws that can be created due to the fact that the Congress has not (in any way) preempted state legislation by federal law as the federal government has failed to define any regulations whatsoever for the electric bikes, other than those performance and safety regulations in 16 CFR Sec. 1512 et. seq. There is also a specific preemption section in the part dealing with EB's that somewhat restricts the CPSC's pre-emptive powers. (footnote 2)

However even if the Congress were to have legislated a complete regulatory scheme for the manufacture of electric bikes and associated standards, like NHTSA has done for automobiles, that would not prevent (or preempt) the states from legislating how, where, when and who could use those bikes or vehicles, in much the same way as states can still regulate how, where, when and who could use EB's. For example NHTSA has regulation on what performance standards lights and tires must meet in order for that car to be sold in the US. However the mere fact that the manufacturer meets those standards is not to say what rules govern the use of that car on the road. For example state laws govern when and how you can use high, low and fog lamps as well as other lamps on the car. In California it is illegal under the vehicle code to drive a car at any time with just the parking or running lamps on. The mere fact that the running lights meet federal regulations does not govern when and how they can be used on state roads. They also govern when snow tires can be used, but not what the tread standards are as that is federally regulated.

Now as for "administrative" regulations created by certain federal or state agencies this is a bit more complex. Essentially what happens is the agency is sometimes given a "mandate" in legislation to take some particular course of action with respect to developing administrative regulations to enforce or implement the "laws" created by the legislative body (congress or state legislatures). There are many ways this can occur. For example Congress passed a "law" that certain types of EB's were under the jurisdiction of the CPSC and not NHTSA. They did not tell the CPSC however to create any regulations to implement that law. So the CPSC can use its general "mandate" to keep consumers safe to recall certain EB's under its current regulation or create regulations for safety standards. It has apparently chosen not to create safety standards. At some point if it sees a need it will do so, or Congress will pass law telling it to create safety regulations like it did for helmets some years back.

Once the administrative agency decides that it is going to create regulations to implement or enforce some law, essentially what it is doing is creating an administrative framework to carry out the wishes of the legislative body (congress or state legislatures), which really does not like to deal with all the minutia of regulation required to implement the laws it passes. The idea however is that the regulations created must have a connection to enforcing or implementing the law. If someone feels that it does not it

can challenge the agency rulemaking process using the agency's administrative procedures (these must be timely and strictly followed) and in some cases if that process is followed but not to the satisfaction of the challenger, then a lawsuit can be filed in that state or federal court challenging the agencies regulations, or the constitutionality of the law itself. Regulations are much easier to challenge than laws, as laws are created by voters or legislative bodies.

Footnote 1

Pub. L. 107-319, Sec. 2, Dec. 4, 2002, 116 Stat. 2776, provided that: "For purposes of motor vehicle safety standards issued and enforced pursuant to chapter 301 of title 49, United States Code, a low-speed electric bicycle (as defined in section 38(b) of the Consumer Product Safety Act [15 U.S.C. 2085(b)]) shall not be considered a motor vehicle as defined by section 30102(6) of title 49, United States Code."

16 CFR Sec. 1512.2 Definitions.

For the purposes of this part:

(a) Bicycle means:

(1) a two-wheeled vehicle having a rear drive wheel that is solely human-powered;

(2) A two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 hp), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.

Footnote 2

15 USC Sec. 2075 State standards

(a) State compliance to Federal standards

Whenever a consumer product safety standard under this chapter is in effect and applies to a risk of injury associated with a consumer product, no State or political subdivision of a State shall have any authority either to establish or to continue in effect any provision of a safety standard or regulation which prescribes any requirements as to the performance, composition, contents, design, finish, construction, packaging, or labeling of such product which are designed to deal with the same risk of injury associated with such consumer product, unless such requirements are identical to the requirements of the Federal standard.

(b) Consumer product safety requirements which impose performance standards more stringent than Federal standards Subsection (a) of this section does not prevent the Federal Government or the government of any State or political subdivision of a State from establishing or continuing in effect a safety requirement applicable to a consumer product for its own use which requirement is designed to protect against a risk of injury associated with the product and which is not identical to the consumer product safety standard applicable to the product under this chapter if the Federal, State, or political subdivision requirement provides a higher degree of protection from such risk of injury than the standard applicable under this chapter.

(c) Exemptions

Upon application of a State or political subdivision of a State, the Commission may by rule, after notice and opportunity for oral presentation of views, exempt from the provisions of subsection (a) of this section (under such conditions as it may impose in the rule) any proposed safety standard or regulation which is described in such application and which is designed to protect against a risk of injury associated with a consumer product subject to a consumer product safety standard under this chapter if the State or political subdivision standard or regulation -

(1) provides a significantly higher degree of protection from such risk of injury than the consumer product safety standard under this chapter, and

(2) does not unduly burden interstate commerce. In determining the burden, if any, of a State or political subdivision standard or regulation on interstate commerce, the Commission shall consider and make appropriate (as determined by the Commission in its discretion) findings on the technological and economic feasibility of complying with such standard or regulation, the cost of complying with such standard or regulation, the geographic distribution of the consumer product to which the standard or regulation would apply, the probability of other State or political subdivisions applying for an exemption under this subsection for a similar standard or regulation, and the need for a national, uniform standard under this chapter for such consumer product.

Mini Electric Scooter California Bill

The Synopsis that follows is of a bill considered in spring 2006 by the California legislature whose intent was to make public entities, local governments, not liable for accidents or injury claims from users of skateboards and mini electric scooters. The statute exists for skateboards and the legislature wanted to include mini electric scooters. The bill was considered by committee and not acted upon by the legislature. This is an issue that will continue to be raised in legislative bodies in those states that have enacted

recreational immunity statutes like those in California. The effect of these laws is to force injured consumers to sue retailers, distributors and manufactures for scooter injuries that arguably my have been caused by a dangerous condition of public property (such as a pot hole).

AB 2696 (which did not pass) did not define what a scooter was but existing law does: Cal vehicle Code section 407.5. (a) A "motorized scooter" is any two-wheeled device that has handlebars, has a floorboard that is designed to be stood upon when riding, and is powered by an electric motor. This device may also have a driver seat that does not interfere with the ability of the rider to stand and ride and may also be designed to be powered by human propulsion. For purposes of this section, an electric personal assistive mobility device, as defined in Section 313, a motorcycle, as defined in Section 400, a motor-driven cycle, as defined in Section 405, or a motorized bicycle or moped, as defined in Section 406, is not a motorized scooter. (b) A device meeting the definition in subdivision (a) that is powered by a source other than electrical power is also a motorized scooter.

BILL NUMBER: A.B. No. 2696
AUTHOR: Huff
TOPIC: Recreational safety: skateboard parks: scooters.
Introduced February 24, 2006
After Judiciary Committee review--No further action (bill dies) June 26, 2006

Synopsis
This bill seeks to expand the current statute which grants local governments qualified immunity regarding skateboarding and other "hazardous recreational activities" (HRAs) by adding scooters to the list of HRAs for which public entities and their employees enjoy a qualified immunity from liability. The bill also proposes expanding the qualified immunity currently provided local governments for skateboarders, currently set at kids fourteen years or older, to include children ten years or older.

In support of the bill, its sponsor, the City of Diamond Bar, contends that adding scooters to the list of HRAs is necessary to protect local governments from scooter injury liability. It also contends that many cities are currently forced to restrict scooter use in their parks out of liability concerns, which causes scooter users to ride their scooters on city streets and sidewalks, which they state is more dangerous to the riders and to the public. In opposition, the Consumer Attorneys of California (CAOC) contends that California courts have already ruled that the simple act of riding a scooter is not in and of itself a hazardous recreational activity, and, more importantly, the assumption of the risk doctrine makes the addition of scooters to the list unnecessary and unwise. CAOC also notes that state case law already appropriately filters out cases that include plaintiffs who truly are engaging in activities that involve inherent risk. However, they note, one must look at the individual facts of each case in scootering situations; while riding a scooter may involve substantial risks depending in some instances (for example, when engaged in tricks), the simple act of scooter riding is not, in and of itself, unlike sky diving or hang gliding, so inherently dangerous that it should be added to the HRA statute. CAOC also contends that lowering the age limit for immunity from liability for skateboard riding, from 14 to 10 years of age, is also ill-advised, as the Judicial Council report on injuries suffered by skateboarders in the public skateboard parks or facilities is not yet completed.

Summary: Seeks to expand the "hazardous recreational activities" statute to include qualified immunity from liability for scooter-related injuries, and to lower the immunity umbrella for skateboard accidents from those 14 or older to children 10 years or older. Specifically, this bill:

1)Adds the use of a non-motorized or electric scooter to the list of "hazardous" recreational activities" (hereinafter referred to as "HRAs") for which public entities and their employees enjoy a qualified immunity from liability.

2)Expands the scope of persons engaged in HRAs by revising the age element of existing law so that skateboarding would be deemed a hazardous recreational activity if the child is 10 years of age or older.

Law Offices of
Steven W. Hansen
Tel. 562.866.6228 (9-5 M-F)
legal.inquiry@swhlaw.com
www.swhlaw.com

Representing and acting as general counsel and third party claims administrator (TPA) for manufacturers, distributors and retailers in recreational product liability matters in California and worldwide since 1986 and providing consultation regarding: Product recalls * Owners manuals and warnings * Structuring worldwide claims coordination programs * Establishing product review teams * Indemnity and release issues * Insurance cove-

rage questions * Product testing and design issues * Risk management * Foreign law and service issues * Assistance with selection of expert witnesses.

Steven W. Hansen formerly served as Secretary to the ASTM Subcommittee F08.10 on voluntary bicycle standards <http://www.astm.org/COMMIT/F08.htm> and formerly wrote the "Legal Viewpoint" column in Bicycle Retailer & Industry News. <http://www.BicycleRetailer.com>.

The information in this article comes from a number of different sources, all of which are checked for accuracy to the extent possible. The Law Offices of Steven W. Hansen does not vouch for the accuracy of the information. This article is intended as a thought provoking discussion, criticism, or analysis of general legal principles and topical matters and does not constitute legal advice. Any opinions expressed herein are solely those of the author.

EUROPEAN UNION

One of the objectives of the European Union is to create an internal market in which goods, services and people can freely circulate. The current 27 member states of the European Union are Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great-Britain, Greece, Holland, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. Therefore, all national barriers obstructing this free circulation must be eliminated. One of the means to attain free circulation of products is the harmonisation of the technical requirements they have to comply with. Harmonised technical requirements allow manufacturers to develop one and the same product for the whole European Union, whereas, without harmonisation they have to develop different variants in order to comply with Dutch, French, Italian, …
national regulations.

EPACs

In this framework, the European Union started the development of a European type-approval for motorized two-wheelers in 1991. It took a few years to complete the whole procedure, but on 17th June 1999, the European type-approval for mopeds and motorcycles became definitely effective. As from that date, national type-approval procedures irrevocably expired and since, all 27 member states have to apply the same European type-approval. By 1999, it had become clear that the legal basis of the type approval, the so-called Framework Directive, which dated from 1991, needed a few updates and corrections.

One of the anomalies was that bicycles equipped with an auxiliary engine had been included in this legislation designed for mopeds and motorcycles. Moreover, since the promulgation of the Framework Directive in 1991, a new type of bicycle with auxiliary engine had come into existence: the Electric Pedal Assisted Cycle (EPAC). COLIBI, COLIPED and ETRA (*) pointed out to the European Union that EPACs were bicycles, not mopeds, since their engine alone could not propel them. Therefore, as a result of the update of the Framework Directive, the 3 organisations asked the European Union to exclude EPACs completely from the type-approval.

Nevertheless, in their agreement on the update of the Framework Directive, the European Parliament and European Council decided not to exclude all EPACs. They felt that technical limits needed to be set in order to avoid possible problems caused by excessive speed and/or tampering with the vehicles, as is the case with traditional mopeds. In other words, they refused to acknowledge that EPACs were not comparable to traditional motorized two-wheelers.

Directive 2002/24/EC was published on 9 May 2002. The text stipulated that exemption of EPACs only applied to the following vehicles: “cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0.25 kilowatts, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling.” In other words, EPACs with a motor output exceeding 0.25 kW and/or assistance beyond 25km/h are still subject to the type-approval for mopeds and motorcycles.

After this publication, the member states had to implement the new Framework Directive in their national legislation before 9 May 2003. This also means that they had to replace their national legis-

lation on EPACs by the above-mentioned provisions. All national provisions concerning insurance, helmet obligation and age limit however could be maintained since these are not regulated by type-approval but still belong to the member states' competence. It is not known to which extent member states have introduced such additional obligations on EPACs that should be excluded from the European type-approval since 9 May 2003.

Although EPACs with a motor output up to 250W and pedal assistance up to 25km/h have definitely acquired the legal status of bicycles, there is no European technical harmonisation for bicycles yet. European technical standards for bicycles are currently being drafted by the Technical Committee (TC) 333 'Cycles' of CEN (the European Standardization Committee). Within the CEN/TC there are several working groups, one of which has been specifically commissioned to draft technical standards for EPACs. That working group has now completed the draft European standard for EPACs. That will probably result in a final European standard sometime in 2007. This will not result in a European type-approval procedure or in compulsory certification, but in harmonised European guidelines for the quality and safety level that EPACs should comply with. As a result, this European standard will replace all national standards such as DIN in Germany, BSI in the UK, AFNOR in France or UNI in Italy.

Bicycles with Auxiliary Engines
Bicycles equipped with an electric or internal combustion engine, which can be propelled by their motor only, are subject to the European type-approval for mopeds and motorcycles in any case. The bicycles with an internal combustion engine must be type-approved as normal mopeds. Those with an electric motor enjoy the "special regime" for so-called low-performance mopeds, i.e. mopeds with pedals with an auxiliary engine of power not exceeding 1 kW and a maximum design speed not exceeding 25 km/h. The Framework Directive stipulates that for these low-performance mopeds specific requirements will be laid down for a number of type-approval aspects. In the table listing all requirements for their type-approval, these are indicated with an asterisk. However, so far the European authorities have developed hardly any such specific requirements.

Electric Mini-Scooters (Light Electric Scooters)
Small scooters equipped with an electric motor are called Mini-Scooters in Europe. Presently, there is huge confusion as to the legal status of these vehicles and member states tend to apply regulations on their own discretion. That appears from the table below. In quite a few member states, electric mini-scooters have not caught on. As a result, regulating their use there is not an issue.

The current type-approval legislation for mopeds and motorcycles is not fully tuned to electric mini-scooters. One simple example: the legal definition of the type of vehicle as which electric mini-scooters could be classified requires pedals. There are many more technical requirements that would need adjustment.

Electric Scooters
They fall within the scope of the definition of mopeds in the European type-approval legislation: "Mopeds, i.e. two-wheel vehicles with a maximum design speed of not more than 45km/h and characterised by an engine whose maximum continuous rated power is no more than 4kW in the case of an electric motor." If their power exceeds 4kW, they are considered motorcycles and should comply with the type-approval requirements in question.

Electric Vehicles and Driving Licences
Today, driving licences for mopeds still fall within the competence of the member states. However, recently the European Commission's proposal to introduce a harmonized European driving license for moped riders that would be subject to a theory test, has been accepted. With that, the European Commission proposes to exclude EPACs with a motor output exceeding 0.25kW and/or assistance beyond 25km/h from that driving licence. However, the Commission omitted to include a similar exemption for bicycles with auxiliary engines and for electric mini-scooters. As a result, as from 2009 the riders of these vehicles will become automatically subject to the new driving license legislation. The procedure contains specific requirements for 47 components and characteristics to which the conformity of the new vehicles must be checked. All electric vehicles are exempted from 12 of these requirements, because these only concern internal combustion engine vehicles. The remaining items to which they must conform are:

Overview of National Regulations Applying to Electric Mini-Scooters

Country	Are electric mini-scooters considered as moped in your country and can they be used on public roads?	In the affirmative, is there a specific Type-Approval (TA) procedure for these vehicles ?	Do electric mini-scooters need a special insurance?
Austria	> 20 km/h: moped (scooter). < 20 km/h: bicycle Both can be used on public roads (incl. in high-way code)	Yes, mopeds > 20 km/h need to have a TA.	Yes + helmet + special driving license if driver < 24 years. Only for > 20 km/h mopeds.
Belgium	Yes, if they have a TA.	European TA for motorized 2wheelers	Yes, if TA as moped.
Denmark	Yes.Type-approval following EU regulations/legislation (as 20 km/h moped). With TA, they can be used on public roads.	EU TA.	Yes + helmet
Germany	Yes.Type-approval following EU regulations/legislation.With TA, they can be used on public	European TA for motorized 2wheelers (mopeds need to have a seat).	Yes (moped insurance).
Great Britain	Yes if type-approved.	Yes, European TA for motorized two-wheelers	
Holland	Yes, European TA (if not exempted). With TA, they can be used on public	European TA for motorized 2wheelers.	Yes.
Italy	Following European Directive: if < 6 km/h: bicycle	European TA for motorized 2wheelers.	
Switzerland (not an EU Member State	Yes. They are considered as mopeds of max. 500 kW	Yes, TA procedure for mopeds	Yes, Moped insurance

1 Make
2 Type/Variant/Version
3 Name and address of vehicle manufacturer
4 Name and address of vehicle manufacturer's authorized representative, if any
5 Category of vehicle
6 Number of wheels and their position in the case of a three-wheel vehicle
7 Outline drawing of frame
8 Name and address of engine manufacturer (if different from vehicle manufacturer)
9 Make and description of engine
10 Type of engine ignition
12 Type of engine cooling
14 Number and configuration of cylinder or stators (in the case of rotary-pistons engines) in the engine

18 Maximum torque and maximum net power, whether this is: of the spark-ignition or compression-ignition type or electric (*)
19 Anti-tampering measures for mopeds and motorcycles (*)
21 Traction battery (ies)
23 Electrical system (nominal voltage)
25 Maximum design speed of the vehicle
26 Masses and dimensions
27 27 Coupling devices and their attachment
29 Tires (*)
30 Transmission
31 Braking system
32 Installation of lighting and light-signalling devices on the vehicle (*)
33 Lighting and light-signalling devices the mandatory or optional presence of which is laid down in the installation requirements under the previous heading (*)
34 Audible warning device (*)
35 Position of rear registration plate
36 Electromagnetic compatibility
38 Rear-view mirror(s)
39 External projections
40 Stand (except in the case of vehicles having three or more wheels
41 Devices to prevent unauthorized use of the vehicle (*)
43 Passenger hand-hold for two-wheel vehicles (*)
45 Speedometer and odometer
46 Identification of controls, tell-tales and indicators (*)
47 Statutory inscriptions (content, location and method of affixing)

(*) The Directives concerned contain specific requirements for so-called low-performance mopeds, a term which includes EPACs and bicycles with auxiliary electric motors

Enlargement
On the 1st May 2004, 10 new countries have definitively joined the European Union. These countries are Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia. On 1 January 2007, Bulgaria and Romania have also definitely become EU member states. This means that, since then, all the above has also become effective in those countries. Turkey, Macedonia and Croatia are negotiating their possible accession.

* COLIBI is the European association for bicycle manufacturers, COLIPED for parts and accessories manufacturers and ETRA is the European association for bicycle, moped and motorcycle retailers.

Annick Roetynck
Secretary General
European Twowheel Retailers' Association (ETRA)
Tel.(32)9-233.60.05
E-mail etra@pandora.be
www.etra-eu.com

United Kingdom
An Electrically Assisted Pedal Cycle (EAPC) which complies with the technical requirements in SI 1983/1168 (an "EAPC") is not considered to be a motor vehicle within the meaning of The Road Traffic Act 1988. An EAPC is not required to be registered, have a vehicle licence or a nil licence, pay vehicle excise duty (road tax) or be insured as a motor vehicle. In the UK, riders of electric cycles must be at least 14 years of age. Electric cycles are classed as pedal cycles provided they conform to the pedelec definition (motor power output inversely related to speed, and power cut whenever the rider stops pedalling) and have a powered-assisted maximum speed no greater than 25kph (16mph, but you can pedal faster unassisted). They must also have average power output limited to 200W (250W for an electric tricycle or tandem) and weight limited to 40kg (60kg for a tricycle or tandem). The Department for Transport produces two relevant fact sheets about electric cycles and the law: Electrically Assisted Pedal Cycle (EAPCs) in Great Britain and Regulations For Powered Two And Three Wheeled Vehicles .

Australia
Australia is a federation of states and territories each of which had its own road rules until year 2000 when national uniform traffic laws where adopted by the Australian federal government. These are known as "The Model Australian Road Rules". However, it is unfortunate that these national rules, that include rules for electric bicycles, in fact constrain the sales of most commercially avai-

lable electric bicycles on the world market that have power outputs between 200 and 250 watts..

The Rules were developed by the National Road Transport Commission, State and Territory transport agencies, police and other organizations and were drafted by the Office of Legislative Drafting in the Commonwealth Attorney-General's Department. The Rules were approved by Australia's Transport Ministers by majority vote and have introduced uniform or consistent road rules throughout Australia for cars and trucks but not for two wheeled vehicles. Since adoption there has been some problems in gaining state acceptance of road rules relating to power assisted bicycles and scooters with electric or petrol engines. For several years the Australian bicycle industry, retail trade and some transport researchers have been advocating an upgrade of the current 200W maximum power output in the Australian national and state road rules because it is denying Australian consumers the right to buy the best and safest electric bicycles on the world market. Furthermore for the heaviest 25% of elderly Australians the maximum output of 200W is inadequate for riding up hills.

A bicycle with an auxiliary motor is commonly described in Australia as a 'power assisted bicycle or an electric bicycle. According to the 'The Australian Road Rules' if the motor has less than 200W output (maximum), or approximately 0.2hp, it is defined in traffic law as a bicycle can be ridden with no license or registration in a public place on shared footways and on all roads and most freeways. All regulations relating to bicycles, including the requirement to wear approved bicycle helmets, apply to power assisted bicycles. Compulsory Third Party insurance is not required . 'The Australian Road Rules' dictionary also defines what is and what is not a bicycle. Note that this definition excludes powered scooters with no pedals because it states that the most important feature of a bicycle is that is that it is built to be propelled by human power (whether or not it has a motor) (a) Includes a pedicab, penny-farthing, scooter with pedals, tricycle and unicycle; but (b) does not include, a wheelchair, wheeled recreational device, wheeled toy or any vehicle with a power output over 200W.

Each state & territory government of Australia has leaflets about power assisted bicycles within their transport departments websites. All indicate the requirement that maximum power output must be less than 200W. Note that, each state is slowly bringing its separate regulations and road rules in line with the model Australian road rules. However, there are still subtle differences in the definition of a scooter between states.

Victoria : VicRoads advertisement 26-1- 05 the Melbourne Age. In January 2005 the state of Victoria banned the use of miniature motorcycles and some scooters on public roads and footpaths. Petrol powered scooters cannot be used on public roads or on footpaths. Electric powered scooters are only allowed on low speed roads with a speed limit of less than 50km/h and have an ungoverned power output of less than 200W. Similar scooter regulations apply in NSW, South Australia, Tasmania and Queensland and may be adopted nationally.

New South Wales: Vehicle Standards Information No. 27, Issued April, 1998 Cat. No.45070705. A cycle that is essentially a pedal cycle with a small auxiliary motor attached need only be registered if the motor output is more than 200W. If power output is such that it is required to be registered, it will be treated as a moped or a small motorcycle. If a motor-assisted pedal cycle is exempt from the need to be registered, the rider does not have to hold a license. However, it is compulsory for riders to wear a suitable safety helmet and obey the "same traffic laws as motorcyclists". Pedal cycles fitted with an engine to which simple adjustment or modification can be made so as to increase the power output should be avoided. If any such adjustment is made, the owner and user would be liable to prosecution for driving an unregistered motor vehicle.

Queensland Queensland Transport webpage 2006 **www.transport.qld.gov.au/qt/LTASinfo.nsf/index/cycling_scooters**
Special rules: to ride a motorised foot scooter you must wear an approved bicycle or motorbike helmet securely fitted and fastened. Be 16 years of age or over. You can ride a motorised foot scooter on: Local streets (streets with no white line or median strip). You cannot ride a motorised foot scooter on main roads. You can only ride on the footpath (where permitted) with the power turned off.

Rules for power assisted bicycles. A power assisted bicycle is a bicycle to which a power source is attached. The power source

must operate through contact with a wheel of the bicycle or be attached to the cycle's drive chain. Power assisted bicycles with a maximum power output of more than 200W are considered motorbikes and are registered as such, providing they comply with all appropriate Australian Design Rules.

Western Australia: Department of Planning and Infrastructure 2000
www.dpi.wa.gov.au/cycling/1976.asp
The adoption of nationally uniform traffic laws in WA (The Australian Road Rules), has seen the introduction of several new legal requirements for bicycle riders in Western Australia. These include: Power-assistance greater than 200W (1/4hp) requires the bicycle to be registered as a motor vehicle. A rider of a power-assisted bicycle must be at least 16 years of age, if the power assistance is engaged.

Northern Territory Motor Vehicle Registry V56 Motorised Scooters and Power Assisted Cycles
Effective Date: 6 December 2002
Postal Address
GPO Box 530 Darwin NT 0801
This information bulletin states that Powered cycles are defined in the NT Motor Vehicles Act as; A bicycle/tricycle that is equipped: (a) with pedals as a means of propulsion; and (b) with an engine or motor which is capable of producing a power output not exceeding 200W. These bicycles are not required to be registered and can be ridden on the road network and in public places. All regulations relating to bicycles, including the requirement to wear helmets, apply. General Information The use of motorised scooters and power assisted cycles on private property is not regulated.

Tasmania: Department of infrastructure, energy and resources
www.transport.tas.gov.au/standards/scooters.html
The Tasmanian Vehicle and Traffic Act 1999 defines a motor vehicle. "motor vehicle" means a vehicle that is built to be propelled by a motor that forms part of the vehicle but does not include; (c) a pedal cycle with an auxiliary motor (or motors) with a power output (or combined output) of not more than 200W; or any scooter with a motor is considered to be a motor vehicle.

South Australia Department of, transport, energy and infrastructure
www.transport.sa.gov.au/publications/road_rules/index.asp
“The Australian Road Rules” have been made into Regulations under the Road Traffic Act (SA) and came into operation throughout Australia on 1 December 1999.

To summarize: In a few years, electric bicycles, coupled with roof mounted solar PV panels for recharging, will be mass-produced in China. The opportunity to sell imported or assembled E-Bikes using batteries recharged by Australian made roof mounted solar cells could reduce oil consumption and reduce carbon emissions. However E-PABs with up to 300W output need to be classified as bicycles in Australia, as they are in New Zealand. To enhance the mobility of the lame and elderly fully powered bikes with up 600W output should be allowed, as they are in NZ.
Alan Parker
Australian Bicycling Advocate
http://web.mac.com/parker15

Canada
In 2001, Transport Canada amended the Motor Vehicle Safety Regulations to allow the introduction of power-assisted bicycles in Canada. Power-assisted bicycles are electric bicycles propelled by either a combination of the cyclist and a motor or by the motor alone. Previously, these bicycles were classified as limited-speed motorcycles; however, they did not meet the safety standards for limited-speed motorcycles, and were therefore not for sale in Canada. Transport Canada has since established rules specifically for power-assisted bicycles, exempting them from the safety standards for limited-speed motorcycles. The rules specify components for power-assisted bicycles including a maximum of three wheels, an electric motor that can assist the cyclist up to a speed of 32km/h and that does not exceed 500W, and an on/off switch or mechanism that prevents the motor from being engaged until the bicycle reaches a speed of 3km/h. Power-assisted bicycles must also comply with the requirements of provincial and territorial regulations. Each province or territory may adopt the federal definition as is or add further restrictions to meet their own specific needs. Consumers interested in determining whether power-assisted bicycles can be used in their province or territory should contact their provincial or territorial Ministry of Transportation. The McGuinty (Ontario Premier Dalton McGuinty) government in Ontario, Canada launched a pilot on October 4, 2006 that allows use of E-Bikes on Ontario roads. Top speed allowed is 32kph and riders have to be over 16 years of age and wear a helmet. Good to have Ontario catching up with the rest of the world that has had E-Bikes on roads for that past fifteen years.

ASIA

China

Since EBWR04 was issued the China market has exploded into the 15 million unit annual range. Many cities sought to ban EBs for unknown reasons but that effort has all but vanished as the public has taken to use the EB as a main source of daily transport in all major, and minor, cities. The new "National Standards for Electric Bikes" Law went into effect across all of China beginning May 1, 2004 and a summary of the main regulations follows.

Top assisted speed is 20km/h.
Motor power continues at 250W maximum.
Total weight must be under 4 kg, and the new 2004 regulation will have require that the weight without battery be under 27kg.
The diameter of wheel well must be more than 20 inch instead of year 2003 which had no requirement. For 2004 the width of bike must be less than 220mm instead of no requirement under 2003 rules. (This will affect many scooter style EBs) The new mud guard width will be under 300mm instead of no requirement. The bike should be capable of turning at a 25 degree angle. The crank arm length should be 140mm.The new regulation will also require the new water resistance test for the EB and more than 100,000 cycle frame shake test.

The China Bike Test Bureau Office has been reorganized. Members of the Test Bureau include, the Consumer Protection Bureau, Product Quality Inspection Bureau, Bike Association, and other knowledgeable and qualified people. The Bike Test Bureau does all the tests and inspections specified by the regulations for products from each manufacturer. Products that pass the test will be given a license permit that allows it to be sold in the public. There are four test offices established in China, in Shanghai, Beijing / Tianjin, Guandong, and Zhejiang, that will coordinate their activities to provide for a uniform application of the government regulations on electric bikes.

India

India has been finally moving into the electric bike business with major and small bicycle manufacturers showing electric bikes, for the first time, at the major India bike show in January 2007. There were no regulations for EBs under the Indian Motor Vehicles Act and Rules. But when manufacturers began to approach individual state governments for approval of their EBs as an eco friendly nonpolluting transport option, the central Indian government finally stepped in and issued a notification in September 2005. This notification exempts E-Bikes having a motor below 250W and a peak speed of below 25kph from being classified as a motor vehicle. Such E-Bikes therefore only need a one-time type certification and then can be sold freely. Users need not apply for a license. E-Scooters that are above these limits need to obtain motor vehicle registration and number plates, while riders need to get a license.

Japan

Japanese regulations that originated in 1993 defined the Electrical Assisted Bicycle-EAB (the Pedelec designation in Japan) as a bicycle. These regulations are still in effect without change. Pedelec pedal and motor effort are used in a power ratio of one-to-one up to 20kph (12mph). Above that speed, motor effort is reduced until it automatically shuts off at 24kph (14.4mph) while pedal effort continues. E-Bikes, throttle controlled, are in a category similar to Electric Scooters that require a license and insurance.

Taiwan

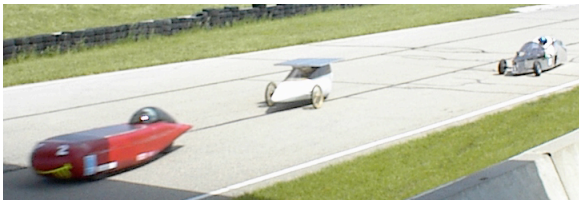
According to the CNS 14126 standard, electric bikes in Taiwan must comply with the following regulations:
Whole bicycle weight (including
1. batteries) may not exceed 40kg.
   Batteries may not exceed 48V.
2. Motors may not exceed 400W.
3. Power output: Battery power
4. must automatically shut off if the rider stops pedaling for more than 3 seconds.
   Automatic power cut off when
5. over the speed limit: When the speed exceeds 30km, power must automatically shut off, or the battery power must temporarily shut off within 3 seconds.
   The battery power must auto-
6. matically shut off after the bike is stationary for 3 seconds.
   The battery power must auto-
7. matically shut off if the motor breaks down

Section 11

Solar Bike & Car Races

Overview

EBWR04 reported on USA solar bike races for high school teams and solar car races for college teams. Solar car races were also held in Japan and in Taiwan in 2006. To show how these activities have grown and matured, we provide the solar car racing history of a small liberal arts college, Principia College, whose teams have traveled to Asia and Europe to compete in international solar car races. A sustainable environment will be the result of the commitment made by so many high school and college students to these races since they will undoubtedly carry that experience with them into their personal careers.



Solar BikeRayce USA

The New Resources Group from Freeman, MO was the original organizer of the first Solar BikeRayce in 1995 in Indianapolis, IN in conjunction with the Solar Car Race. Bike races have been held yearly since that time in Midwestern locations but none was held in 2006. The last race in 2005 was held at the Heartland Park In Topeka, KS with 17 schools and individuals that fielded 23 teams to compete in several categories. The fastest team averaged 24mph over a 60 mile course on a 1.8 mile track. Many of these schools have been to these races each year that shows the strong school and community commitment to support students in this technical activity. The Solar BikeRayce is sponsored and run by the Kansas Corporation Committee, Crowder College MARET (Mid America Renewable Energy Technology) Center, and the New Resources Group. The 2007 Solar BikeRayce will be held at Crowder College Neosho, MO in May 2007.
hq@solarbike.org
www.solarbike.org

Principia College Solar Car Team

Principia College is a small liberal arts college of approximately 550 students. It is located on the bluffs of the Mississippi River in Elsah, Illinois, USA, and is unique as the only college or university in the world solely for Christian Scientists. Students on Principia's Solar Car Team come from every field of study – including nearly every major in both the liberal arts and the sciences. While Principia does not have a self-contained engineering department, it offers an engineering degree through joint programs with other universities.

The Principia College Solar Car Team began in 1991 as a non-credit engineering project for an advanced physics class. In 1995 the team finished its first car, Ra, made of steel and fiberglass and powered by a belt-driven motor. This car did not qualify for Sunrayce 95 and instead served as an exhibition vehicle. Principia returned with a new car, Ra II, for Sunrayce 97 and finished 31st of 40 teams. Then, in the rain-plagued Sunrayce 99, Ra III finished 26th. In both Sunrayce 97 and 99 the team received the Safety Award for best overall safety performance, and in 1999 the team was also recognized for outstanding teamwork and sportsmanship.

Two years later, RA IV outshone its predecessors by placing 1st both in the open class and overall at the 2001 Formula Sun Grand Prix in Michigan. This achievement afforded the team nationwide news coverage from both CNN and the National Geographic Channel and led the team into the 2001 American Solar Challenge, where Ra IV captured 7th place and the Sportsmanship Award. This final standing placed the team ahead of many large engineering schools such as MIT and Stanford. Ra IV also placed 4th in the 2002 Formula Sun Grand Prix in Kansas.

Principia College 2006 Solar Car & Team

Due to the team's outstanding performance in the American Solar Challenge combined with the receipt of an Engineering Excellence award from EDS, manufacturer of the Unigraphics computer-aided design software program, Principia was asked to serve as one of the two solar car teams to represent the United States in the China Solar Challenge and Road Show. Four students along with two faculty members traveled through China for three weeks during August 2002, demonstrating solar technology and sharing technical expertise.

Principia's next solar car, Ra V, expanded on the legacy of Ra IV as the team raced to a 4th place finish in the 2003 American Solar Challenge and earned the Teamwork Award. After finishing the race in Los Angeles, Ra V was shipped across the Pacific Ocean to Australia where Principia competed for the first time in the World Solar Challenge and placed 6th. This 1,800-mile race across the Outback from Darwin to Adelaide was part of a ten-week Australian Science Abroad sponsored by the college. The next spring, the team was invited to represent the United States in Phaethon 2004. This solar car race was part of the Cultural Olympiad for the Summer Olympic Games in Athens, Greece. The team performed very well, earning 3rd place and bringing home that year's first "Olympic" medal for the United States.

Principia's newest car, Ra 6, is lighter and more technologically advanced than any of the team's previous solar cars. It combines aircraft composite construction with satellite grade solar cells, and solid lithium-polymer batteries – all based on an ultra-light aluminum space frame chassis. This past summer Ra 6 finished in 7th place in the 2005 North American Solar Challenge from Austin, TX, to Calgary, Alberta, Canada.

In September, 2006 the Ra 6 team went to Taiwan to participate in the World Solar Rally in Tai-wan. This was an interesting mix of nations and all were friendly in the field of competition. This international event was a first for Taiwan, and featured 10 teams from around the world. Principia was one of two American teams, the other was University of Minnesota. The other university teams included Taiwan-3, Japan-2, Germany-2, Turkey-1 and Iran-1. The Principia entry finished fifth in the track race in Pingtung and participated in the 200km three-day road rally in southwest Taiwan where they placed seventh.

The next Solar Car race will be the North American Solar Car Challenge in July 2008. Many of the corporate and government (including Department of Energy) sponsors have unfortunately dropped out of financially supporting solar car races. The race is organized and run by Dan Eberle who operates the New Resources Group, Freeman, MO. Dan plans to find new financial supporters to continue the solar car competition that is a great experience for college students as Pricipia College can attest to.

solar@prin.edu
www.prin.edu/solar

World Solar Bicycle and Car Races - Japan

The 2006 solar bike races in Japan were again held at Ogata-mura, Akita Prefecture. There were seven racers, four from high schools and three clubs. The 200m speed trial top speed was 63kph (38mph) and the endurance run was 94km long. Participation does not seem as high as in previous years. Solar car races had 12 entries, 6 from high schools and 6 from universities. There were 6 fuel cell cars and 4 of those had auxiliary solar panels as well. Top time trail speed was 72kph (43mph), just 5mph more than the solar powered bike that of course used human pedal power as well.

The Japan World Solar Bicycle Race will be held July 21-22, 2007 and the World Solar-Car Rallye & Fuel Cell Car Championship on 27-29 July 2007, both at Ogata-mura. The 2006 race results can be seen on this website.

http://www2.ogata.or.jp/english/2006/06inf/2006wsr.htm

Topeka High School team

Bloomington South HS Team

Avon High School

Denchi-Kun Fuel Cell Race Winner

Ashida/Osaka Fuel Cell Racer

Wasedau University Fuel Cell Racer

Carroll Family

Section 12

Worldwide Exhibitions Information Sources

EXHIBITIONS AND MEETINGS

There are a number of exhibitions, or shows, that are of importance to the electric bicycle and scooter business community.

1. IFMACologne, Germany, The International Bicycle Trade Show– This is primarily a bicycle show, but for 10 years the non profit Extra Energy V.I.G. has operated a "test it" event that has attracted most of the best electric bike and scooter makers. Location Cologne Germany, Koln Messe Halls, September 13-16, 2007.
www.ifma-cologne.de

2. Taipei International Cycle Show – Includes a four day (March 20-23) **International Conference on LEVs** in Hsinchu, Taiwan sponsored by ITRI and ExtraEnergy with special topics. March20-Energy Bus, March 21-Battery Safety, March 22-Technology, March 23-Global Market and Legislation. Followed by Cycle Show on March 24-27, 2007 in Taipei, Taiwan.
www.taipeicycle.com.tw

3. China Cycle 2007 International China Bicycle and Motor Fair is the main event for hundreds of Chinese electric bicycle companies. May 4-7, 2007 in Pudong China. (Shanghai)
www.e-chinacycle.com

4. Japan International Cycle Show is the place to see the Japanese electric bike product – lots of innovation comes out of Japan. Tokyo Big Sight November 17-19, 2007. 81-3-3833-6036
www.cyclepress.co.jp

5. Interbike is the biggest USA bicycle show. Best place to see electric bicycles, but not scooters. Also has a companion test ride. **Interbike OutDoor Demo** September 24-25, 2007 Bootleg Canyon, Boulder City, Nevada. **Interbike** September 26-28, 2007 Sands Convention Center, Las Vegas, Nevada, USA. 1-949-376-6161
www.interbike.com

6. North China International Cycle Show showcases product from Northern China. This is in contrast to the Shanghai show that focuses primarily on Shanghai area businesses. March 19-21, 2007 in Tainjin, China.
www.norbicycle.cn

7. EICMA 65th International Bicycle Exhibition focuses primarily on the Italian market. Some electric bike and scooter makers. November 8-11, 2007. Milano Fiero, Milan, Italy. Combined with **International Motorcycle Exhibition** November 6-11, 2007 same location. **www.eicma.it**

8. Electric Vehicle Symposium 23 (EVS 23) & Exhibition Theme is Sustainability: Future of Transportation. Anaheim, Californiia, December 2-5, 2007. The International Electric Vehicle Symposium and Exposition (EVS) series is organized by the World Electric Vehicle Association (WEVA). The event attracts academic, government and industry leaders who explore technical, policy and market challenges to a paradigm shift toward electric transportation technologies. Each EVS event is hosted by one of the three members of WEVA. Events held in the Asia-Pacific region are hosted by the Electric Vehicle Association of the Asia Pacific (EVAAP); those held in Europe are hosted by the European Electric Road Vehicle Association (AVERE), and those held in the Western Hemisphere are hosted by the Electric Drive Transportation Association (EDTA).
www.evs23.org

9. EET-2007 - 2nd European Ele-Drive Transportation Conference One of the European Commission's policy is to lower greenhouse gas emissions and to reduce 20% of the fossil fuel use by 2020. Battery, Hybrid and Fuel Cell Electric Vehicles will play an important role. AVERE sponsors this meeting May 30 - June 1, 2007, Brussels, Belgium.
www.ele-drive.com

10. Eurobike One of the biggest bike shows in Europe will have a Demo Day on August 29. Typically has many electric bike companies exhibiting. Friedrichshafen, Germany August 30-September 2, 2007
www.eurobike-exhibition.de

11. China Eco Expo China Eco Expo is well on its way to becoming the signature event for international products, technologies and expertise that will help China overcome its environmental challenges and move towards a sustainable economy. Beijing International Convention Center April 4-6, 2007
www.ecoexpo.com

12. Challenge Bibendum 2007 will showcase innovations for trucks buses, cars and urban two-wheelers as well as technology for road infrastructure. It will be hosted at the new Automotive Exhibition Center, at the Shanghai International Automotive City (SAIC). Michelin owns the Bibendum tire man.
www.challengebibendum.com

13. Moscow International Cycling Show The largest bike show in Russia where the market grew 20% in 2006 with 85% of products imported. Moscow, Russia February 28-March 3, 2007
www.mics-russia.com

14. ISPO China Winter Show A winter snow sports show with some bikes. Beijing, China March 14-17, 2007
www.ispochina.com

15. Velo-City 2007 Velo-City is the international forum that convenes every two years to discuss strategies to promote bicycle transport. The 2007 discussion themes are: plus in quality of life, "bicycle" impact on economy, win-win bicycle for health, and modern urban and regional development. Munich, Germany June 12-15, 2007
www.velo-city2007.com

16. OutDoor Show for outdoor sports products includes some bikes. Friedrichshafen, Germany July 19-22, 2007
www.european-outdoor.de

17. The 24th International Battery Seminar & Exhibit Technical meeting with speakers. from major battery companies. Broward County Convention Center, Fort Lauderdale, Florida March 19-22, 2007
www.powersourcers.net

18. Automotive Battery and Ultracapacitor Conference (AABC-07) Long Beach, California May 14-18, 2007 Technical meeting with speakers from major battery companies with two pre-conference Symposia.: 3rd International Symposium on Large Lithium Ion Battery Technology and Application (LLIBTA) and 3rd International Symposium on Large Ultracapacitor Technology and Application (UCAP) both May 15-16, 2007
www.advancedautobat.com

INFORMATION SOURCES

1. Electric Bikes Worldwide Reports is normally published once every two years. This is the definitive overview of the LEV industry with worldwide clients. www.ebwr.com and publisher contact at **elecbike@aol.com**

2. CycleElectric International Consulting Newsletter comes out on an irregular basis and provides interesting international news of the LEV industry. Publisher is Ed Benjamin. Sign up for email only newsletter at **www.cycleelectric.com**

3. Bike Market Update is published by Grace Ruan, owner of Wheel Giant Inc., Taiwan, that is publisher and distributor of bicycle industry magazines, product source guides and is agent for EBWR in Asia. A special report is issued on electric bikes from the annual Shanghai Show.
www.biketaiwan.com

4. Evolution E-Bikes is published yearly by Japan Cycle Press. All articles are in Japanese, with some tables in English, but is a valuable source of info.
www.cyclepress.co.jp

5. ExtraEnergy website is a gold mine of information on electric bikes and includes LEV conference proceedings and major LEV activities in Europe. Hannes Neupert is the founder and leader of ExtraEnergy.
www.extraenergy.org

6. Tradewinds publishing provides parts source books (Taiwanese) for electric bikes and scooters and B2B information.
www.asiatrademart.com

7. Japan CyclePress is a trade journal published in English and Japanese in the same issue. Includes many articles on electric bikes and scooters.
www.cyclepress.co.jp

8. BikeEurope is a trade journal published in English. Includes many articles on electric bikes and scooters.
www.bike-eu.com

9. Electric Bicycle Businesses in the World is perhaps the best on line resource for locating electric bike businesses around the world.
http://energy.sourceguides.com/businesses/byP/ev/eBike/eBike.shtml

10. Electric Bikes is the best electric bike URL for information about models available in the USA.
www.electric-bikes.com

11. EVWorld.com is the premier website for information on Electric Vehicles, including hybrid and fuel cell vehicle developments, electric bikes and scooters, and timely articles from worldwide news services. Premium subscriber service is available for $29 per year (good value). This service includes feature articles, MP3 audio, wire services, ePoll results and access to archives. EBWR has been featured in an audio interview in 2005. Go to
www.EVWorld.com to subscribe.

12. Electric Bicycles - A Guide to Design and Use by William C. Morchin and Henry Oman published by the Institute of Electrical and Electronic Engineers Press and John Wiley issued in 2006. It includes fundamentals of electric propulsion, batteries and chargers, motor and controller technology, and electric bike system design. To purchase, contact a local USA book store, Wal- Mart or order through **www.Wiley.com or www.Amazon.com**. Price varies according to seller but it is no more than $39.95.

14. Fuel Cells: The Sourcebook aims to be the world's most comprehensive reference report on fuel cells. It contains details of about 3,000 organizations involved in the sector, from six continents, with profiles of almost 1,000. It is updated several times each year by EscoVale Consultancy Services, Surrey, UK. To purchase, contact Frank Escombe at
sales@escovale.com or go to **www.escovale.com**.

15. American Solar Energy Society (ASES) is a national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. ASES promotes the widespread near- and long-term use of solar energy.
www.ases.org

16. Webcom Communications is a publishing and information services company serving advanced technology industries worldwide through its magazines, events, directories, buyers guides, market reports, data products and related marketing services. This includes organizing meetings on motor and fuel cell technologies related to LEVs.
www.infowebcom.co

17. Fuel Cell Works is a news information website about fuel cell companies and related technology, including hydrogen generation and distribution as well as auto company fuel cell vehicle developments., FCWorks is operated by Manny Tsoupanarias of Pointe-Claire, near Montreal, Canada.
www.fuelcellworks.com

18. Complete Builder's Guide to Cheetah Electric Motorcycle, Secrets of El Ninja – Designing, Converting, and Maintaining Electric Motorcycles, and Electric Scooters and Beyond. These three books written by John Bidwell include electric scooters. All are available through www.21wheels.com that has pricing, sales and previews. Other sites include
www.evdeals.co
www.kta-ev.com
www.electricvehiclesusa.com

EV AND LEV PROMOTIONAL ORGANIZATION

There are company associations and government groups that promote EVs and LEVs and some organize test rides and community experiments to encourage the use of LEVs by the general public.

1. Electric Drive Transportation Association EDTA is the preeminent US industry association dedicated to the promotion of electric drive as the best means to achieve the highly efficient and clean use of secure energy in the transportation sector. EDTA promotes the sustainable commercialization of all electric drive transportation technologies by providing in-depth information, education, industry networking, public policy advocacy and international conferences and exhibitions. Membership includes: vehicle and equipment manufacturers, energy providers, component suppliers and end users
www.electricdrive.org

2. Northeast Sustainable Energy Association (NESEA) is the USA leading regional membership organization focused on promoting the understanding, development, and adoption of energy conservation and non-polluting, renewable energy technologies. Programs and activities focus on the northeastern United States, from Washington, DC to Maine. In the past NESEA organizes the Tour de Sol EV ride competitions that included Electric Bikes.
www.nesea.org

3. CITELEC, a European Association of cities interested in the use of electric vehicles, was founded in 1990 under the aegis of the European Community. CITELEC and its members promote electric vehicle, including EBs and ESs, usage in order to solve their traffic and pollution problems.
www.cleanvehicle.com

4. Lightweight Electric Vehicles (LEV) Project of Mendrisio (canton of Ticino, Italy) is the pilot municipality for a large-scale fleet test with light electric vehicles.
www.infovel.ch

5. NewRide is a Swiss program for promoting the market penetration of electric two wheelers in Switzerland. The primary objective is to promote two-wheel electric vehicles by improving the market conditions for the suppliers.
www.newride.ch

6. AVERE was founded in 1978 as a European network of industrial manufacturers and suppliers of electric vehicles. It is a non profit-making association created under the aegis of the European Community. AVERE's goal is to rationalize the efforts of its member companies: in the scientific and technological development of electric and hybrid vehicles in markets development, and thus to promote electric vehicle use. It collaborates with it's USA counterpart EDTA,
www.avere.org

7. International Energy Agency (IEA) is the energy forum of 26 OECD countries and has an Implementation Agreement for Electric and Hybrid Vehicles (HEV). A new Annex XI (Committee) was established in January, 2006 on Electric Two Wheelers, Electric Bikes and Scooters.
www.ieahev.org

8. Eastern Electric Vehicle Club. Located in Valley Forge, Pennsylvania, EEVC, the eastern chapter of the Electric Auto Association publisher of Current Events, is hosting a new event called the "21st Century Automotive Challenge," June 9-10 in Burlington County, New Jersey. The goal is to hold an event that is in the “spirit of the NESEA Tour de Sol” with a Tour-of-the-Shore and other events.
www.eevc.info

Section 13

Technical Definitions
Currency Exchange

BIKE RELATED

EB	Electric Bike
Pedelec	(Pedal-Electric Cycle) motor operates only when pedal effort applied
PAS	Power Assist System – Japanese proportional power Pedelec system.
EPAC	Electric Power Assist Cycle - same as Pedelec
E-Bike	also Power on Demand - pedal effort and motor power independen

VEHICLE RELATED

LEV	Light Electric Vehicle refers to EB, LES and HES and NEV sometime
EV	Electric Vehicle
FC	Fuel Cell
FCV	Fuel Cell Vehicle
NEV	Neighborhood EV
HEV	Hybrid-EV

MOTOR RELATED

All motors are DC except where indicated as AC.

REM Rare Earth Magnet whose composition is NdFeB Neodymium-Iron-Boron.

Torque Nm Newton-meters or In-Lbs Inch-Pounds Nm=0.11xIn-Lbs

DISTANCE/SPEED/WEIGHT etc.

km	kilometer 1 km = 0.6 m
m	miles 1 m = 1.67 km
kph	kilometer per hour
km/h	kilometer per hour
mph	miles per hour = 1.67 kph
kg	kilogram 1 kg = 0.45 lb
lbs	pounds 1 lb =2.2 kg
h	hours
L	liters
CVT	Continuously Variable Transmission
hp	horsepower hp=746 W

BATTERY RELATED

NiCd	Nickel-Cadmium
NiZn	Nickel-Zinc
NiMH	Nickel-Metal-Hydride
MnZn	Manganese-Zinc
LiI	Lithium Ion
LiIP	Lithium Ion Polymer
L-A	Lead-Acid or Pb
ZnAir	Zinc-Air
Ah	Amp-hour
V	Volts
W	Watts = Volts x Amps
Wh	Watt-hour = Ah x V
DC	Direct Current
AC	Alternating Current
C	Temperature in Degrees Centigrade

CURRENCY EXCHANGE

(as of February 9, 2007)

$1.00 U.S. equals

Britain 0.51£ (British pound)

Europe 0.74€ (Euro)

China 7.7RMB (Renminbi)

Japan 119Y(Yen)

Taiwan33NT (Taiwan dollars)

Canada 1.15C$ (Canada dollar)

India 43R (India rupees)

LEV Prices listed are Prices to the retail customer unless noted otherwise.

SCOOTER RELATED

LES	Light Electric Scooter - stand-up or sit-down plat form battery/motor powered scooter – usual ly less than 100 lbs. (used in EBWR04)
MES	Mini Electric Scooter - stand-up or sit-down
plat-	form battery/motor powered scooter – usual- ly less than 100 lbs.
HES	Heavy Electric Scooter - similar to the traditional 50cc gasoline scooter (used in EBWR04)
ES	Electric Scooter - similar to a 50cc gasoline powered 'Vespa type' scooter

BATTERY TERMINOLOGY

Batteries are rated by voltage and amp-hours (Ah). Ten Ah means the battery can provide 5 amps of current for 2 hours or 2 amps for 5 hours. Power is a product of voltage and amps. Multiplying voltage by amp-hours yields the number of watt-hours (Wh), that is a unit of energy. The watt-hour is a standard measure of the energy storage capability of a battery. Normal human power while pedaling a bike at 15kph is around 100 watts. Thus a battery with 200 Watt-hours of energy storage can provide, roughly, 2 hours of running time at 15kph for an EB.

Energy storage is quoted as Wh/unit weight in kilograms (Wh/kg).

Power storage is quoted as W/unit weight in kilograms (W/kg).

Battery volumetric efficiency is quoted as Wh/Liter (Wh/L) for **Energy** or W/Liter (W/L) for **Power**.

Battery price is quoted in $/kilo-watt-hours ($/kWh).

BATTERY CHEMISTRY CELL VOLTAGE

Each battery chemistry has a particular operating cell voltage that is specific to that chemistry though several chemistries have the same voltage. The number of cells used in a 12 or 24 volt battery will vary with battery chemistries.

Cell
Contains cathode / electrolyte / anode in a single case

Battery Module
Contains cells interconnected inside a larger case. 12V car battery has six cells. Also called a monoblock

Battery Pack
Contains several modules to provide higher voltage. 72V pack uses six 12V modules.

Data shown with some pictures includes:

Motor power Watts (W) / Range in miles (m) or km / Top speed in mph or kph

Battery Voltage (V) / Amp-hour rating (Ah) / Battery Chemistry L-A/NiCd/NiZn/NiMH//LiI

Chemistry	Cell Voltage	Cells per 12 volt battery	Cells per 24 volt battery
Lead-Acid	2.0	6	12
NiCd	1.2	10	20
NiMH	1.2	10	20
MnZn	1.2	10	20
ZnAir	1.2	10	20
NiZn	1.65	7	14
LiI* / Li-Ion	3-3.6	4-3	8-6
LiIP*	3-3.6	4-3	8-6
LiS	2.0	6	12

LiI - Lithium Ion
LiIP - Lithium Ion Polymer
LiS - Lithium Sulfur
*LiI and LiIP cell voltage varies with the composition of the cathode

Section 14

Authors / Contributors Acknowledgements

Authors / Contributors

Frank Jamerson
B.S. Physics, Massachusetts Institute of Technology; Ph.D. Physics, University of Notre Dame
6 yrs. U.S. Naval Research Laboratory, Washington, DC, and Westinghouse Atomic Power Division, Bettis, PA, nuclear weapons and submarine nuclear reactor R&D. 35 yrs. General Motors Technical Center, Warren, MI. 18 yrs. Head of Physics and Electrochemistry Depts. GM Research Labs. Physics team invented Neodymium-Iron-Boron magnets. Started GMs Lithium battery and fuel cell programs in mid 80's. GM Electric Vehicles Program, Asst. Program Manager for U.S. Advanced Battery Consortium. Retired from General Motors Corporation 1993. Consultant, 1995-2004, President 1997-2000, RBC Technologies, College Station, Texas, Electric Battery Bicycle Company, publisher of 8 editions of EBWR 1993-

Ed Benjamin
B.A. Education, University of Kentucky
Consultant on EB and LEV products to international companies. 30 yrs. in the USA bicycle industry, lecturer on retailing practices, correspondent for leading bicycle magazines worldwide, author of Internet newsletter, transportation business in North America, extensive traveler to overseas sources of EB products and exhibitions. Speaker at European, Taiwanese and Chinese electric bicycle conferences.
Founder of Electric Cycle Association. President of CycleElectric International Consulting Group 2000-,VP Light Electric Vehicles, WaveCrest Laboratories 2002-2003, General Manager of American Electric Cycle & Fitness, TresTerra brand Human Electric Hybrids 2005-

Susanne Brüsch
Masters degree, Technical Translation, Heidelberg U., Heidelberg, Germany. Introduced Pedelec and E-Bike designators, used worldwide. Journalist on Pedelecs, E-Bikes and E-Scooters, for international bike publications and other media. 7 yrs. as Public Relations Chief for ExtraEnergy, Chief Editor for website on LEV industry, www.extraenergy.org. Associated with CycleElectric International Consulting Group, U.S.A. Speaks German, English, Russian, limited Mandarin and Spanish.

Hannes Neupert
A world authority on the EB industry. Consultant on EB products to international companies. Solar Car and Solar Bike race organizer/participant since1985. Writer on EB business worldwide since 1992. Founder ExtraEnergy, Tanna, Germany to promote use of sustainable energy. Organized EB tests in Modena, Italy, 1999, Thuringen, Germany, 2001/2002, Tanna, Germany 2004/2005/2006 and many EB exhibitions at IFMA /Eurobike shows, Germany since 1995 and CABDA/1999, USA. Project manager of German Post Electric Bicycle Battery Test. Established LEV Museum Tanna, Germany 2006 and Battery Test Facility Tanna, 2006. Book Author, "Das Power Bike", 1996 / ExtraEnergy, President, 1996-

Mike Fritz
B.S. Mechanical Engineering, Marquette University; M.S. Engineering Management, Northwestern University. Engineering and Management positions, including Vice President, at Schwinn Bicycle, Huffy Bicycles, American Harvest, Brunswick Bicycles, EV Global Motors, WaveCrest Laboratories from 1973 to 2005. Since 2005, Chief Engineer of American Electric Cycle and Fitness and Cycle Electric International Consulting Group

Robert Templin
B. Ch.E. Rensselaer Polytechnic Institute. 3 years GM Research Labs research engineer. 7 years Army Tank Division implemented gas turbine engine in tanks. 30 years General Motors - 12 years Cadillac implemented first air pollution controls, 4 years Research Labs Technical Director advanced engine development, President's staff Wankel engine, 14 years Cadillac Chief Engineer first use of electronic engine and emission controls, retired 1987. Joined Paice Corporation 1992 as Director on Board to develop/implement first heavy hybrid automotive system.

Sachin Joneja
Finance and Strategy Consultant for the Alternate Energy and Electric / Hybrid Vehicle Industry in India for the last four years. Total Work Experience of 25 years, the last 18 of which were in the financial services sector.

Steven Hansen
LL.B. Pepperdine University
Practicing attorney representing mid-sized businesses and self-insured entities, product liability, professional liability, and recreational liability. Represents bicycle manufacturers, distributors, and retailers in product liability matters. Participates in ASTM (American Society of Testing and Materials) Subcommittee on Bicycles.

Annick Roetynck
Degree of Civic and Administrative Science, University of Ghent, Belgium
Degree of Licentiate Political Sciences, University of Ghent, Belgium
Freelance journalist for Bike Europe and consumer cycling magazine writing about bicycle, moped and motorcycle issues. Works both as journalist and at ETRA.
Secretary-General ETRA, European Two Wheel Retailers' Association since 1996

Grace S. Ruan
MBA Marketing, University of Cardiff, Wales. World traveler and Publisher and Editor-in-Chief of Wheel Giant Co. Ltd. which publishes Bike Market Update (Chinese bimonthly / English biannually), Chinese Cycling Update, Taiwan Bicycle Source and other magazines for the Taiwan and China bicycle industry.

Acknowledgements
Many individuals and sources helped provide information and insight for this eight edition of EBWR. We are most grateful for their efforts and contributions. All contributors are experts in their fields and it was a pleasure to work with them all. We especially thank Susanne Brüsch and Patrick Knappick for their great job in formatting this report. Susanne also was a contributor to reviews of the European market, and article on the 2006 Shanghai show and 2007 Taiwan LEV conference. Hannes Neupert contributed his ideas on a battery rent model that could change the economics of owning an EB. Mike Fritz provided a model for an Owner's Manual to enhance customer satisfaction. Bob Templin reviewed hybrid vehicle technology and Bill Agnew reviewed the NAE hydrogen economy study. Sachin Joneja provided an insight into major changes in the two-wheeler industry in India. EB regulations were excellently covered by Steven Hansen for the USA, Annick Roetynck for the EU, and Alan Parker for Australia. Grace S. Ruan reviewed the state of EB business in Taiwan.

Frank and Ed worked closely with the following individuals and their effort and time is greatly appreciated: Jim Akridge, Percy Chien, Deba Ghosal, Norbert Haller, Jeffrey Ho, Eric Misoe, Stan Ovshinsky, Mike Reed, Eric Sundin, Manny Tsoupanarias, Jonathan Weinert, and Chen Ding Wu. They all provided various parts to the puzzle of news and activities in all the topics covered in this report that includes technology as well as companies and products. Their inputs allowed the puzzle to be completed for this edition at least.

Additionally Frank talked to a lot of company people who provided information for the many articles on their products. It was a pleasure to learn that there are individuals and organizations out there committed to transform the worldwide transportation system to one that is more sustainable and, of course, will be 100% electric.

Lastly Frank and Ed have to especially thank their spouses, Joy and Kathy, for their continued support, we think and hope, and the assistance they provide whenever there is a need. Thank you Joy and Kathy for your help and willingness to help always.

Ed Benjamin and Frank Jamerson in Florida checking out the latest new TresTerra product from China.

Frank Jamerson
Naples, Florida &
Petoskey, Michigan

Ed Benjamin
Fort Myers, Florida &
Shanghai, China