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Worldwide Electric Powered Two Wheel Market

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Abstract

Electric Powered Two Wheeler (EPTW) market has exploded the past decade. The EPTW is mainly an electric bike today but new electric scooters are entering the market as well and will add to the EPTW product mix. China is the dominant user and producer of electric bikes, with 150 million in use, and powerful electric scooters are beginning to appear there. Europe is the second biggest user of electric bikes with over a million sold each year. North American market is tiny in comparison but there is evidence that is to change. The breaking news is that nations in other continents are beginning to explore and are starting to put EBs and ESs into the market. This bodes well that the EPTW will have a respected place in the mix of local transportation that will be affordable and sustainable. EPTW sales will eventually exceed four wheel vehicle sales worldwide. That will be a permanent shift. New versions of the EPTW, like the General Motors/Segway Electric-Network Vehicle, will appear that will enlarge product choice and increase usage. Annual EPTW sales are projected to be 130 million by 2025 and 800 million by 2100. Four Wheel EVs annual sales are projected to grow to 2.5 million by 2025 and 100 million by 2100.

Keywords: EV, bicycle, scooter, PAS, market

1 History

In 1993, the modern commercially sold electric bike appeared in Japan (Yamaha Power Assist System) and simultaneously early EB (Electric Bike) products appeared in China, Europe and USA. Sales were a few hundred thousand units worldwide, mostly in Japan, until 2001. The China market exploded from a million in 2002 to nearly 30 million in 2011. Japan leveled out at 400,000. In 2010, Europe crossed one million units and only around 80,000 were sold in the USA [1]. India is embracing ebikes but, as with other southeastern Asia nations, gasoline scooters are still the main transport mode there.

Half of China ‘ebikes’ are called Scooter Style Electric Bikes (SSEB) since they look like scooters, but have pedals. By law, they are designated electric bikes. But they might be more properly called electric motor scooters with pedal assist. SSEBs are included in our ebike sales estimates. To be consistent, we henceforth use sales estimates of Electric Powered Two Wheelers (EPTW) to include, bikes, scooters, mopeds and motorcycles powered by battery and electric motor as well as two wheel Segway-type vehicles.

The Yamaha PAS in 1993 used a lead-acid battery to drive a motor located at the crank. Others used a friction drive (“tire scrubber”) driven by a fractional horsepower motor. Batteries migrated

from lead-acid to Nickel-Metal-Hydride to Lithium Ion today, though China ebikes mainly use lead-acid. Motors today are in the wheel hub or in crank configurations. Government rules set motor power limits from 250 Watts in China, Japan and Europe to 750 watts in USA. Top speeds are 15 mph in Japan, China and Europe and 20 mph in the USA.

Examples of EPTWs are shown in Fig. 1,2,3,4.



Figure 1. Guewer Scooter Style Electric Bike with small pedals (China)

China has over 150 million electric bikes, where workers use them for daily commutes. An ebike is affordable there (\$300 to \$600) and a step up from a manual bicycle. China had 18.5 million vehicle (14.5 million cars and 4 million trucks) sales in 2011 but cars will never completely replace manual bicycles and ebikes in China due to limited parking space and the low price of a bicycle and ebike compared to a car.

In Europe, the bike dealer has learned that ebikes offer higher profit per unit sold. Customers are responding. As motor, battery and controller technology has improved, European customers are interested in high quality, high end ebikes that are priced up to 3,000 euros. German and French postal services use specially designed ebikes for mail deliveries.

In the USA, the relative low price of gasoline, now \$3.50 a gallon compared to \$7.50 in Europe, keeps American using cars and not bikes for short trips. This has produced a modest ebike market of only 80,000 units estimated for 2011. US cities are adding bike pathways that will help. Contact with USA EB manufacturers/distributors indicate that EB sales may begin to grow more rapidly. Around 10% of Independent Bike Dealers are estimated to offer electric bikes, 400 out of 4,000, up from only a handful five years ago. Thus we project that USA ebike sales may reach a half million units in five years.

There is evidence that EB companies are starting to ship their products to locations in South America, Africa and the Mid-East. Countries like Brazil and South Africa could see a major growth in EB usage in the near future. Countries in these regions have a need for low cost transportation and the EB will be an effective solution. It will take diligent effort by manufacturers and retailers to convince the bike riding public that ebikes are a practical way to commute to work and to the market.



Figure 2. Optibike USV\$10,000 electric bike (USA)

3 World Demographics

The world population crossed the 7 billion mark in 2011 and is projected to hit 10 billion by 2100 though some analysts say population may decrease by then from lower birth rates. Light vehicle population today is close to a billion and in the USA is 250 million with a population of 310 million. If all nations achieved the USA

vehicle/population ratio (80%) then 2100 would see 8 billion vehicles on the planet. That large number does not seem sustainable and would place worldwide material and fuel resources under great stress, even if the majority of those vehicles were Four Wheel EVs (FWEVs) and hydrogen fuel cell cars.

The human race will continue to be under stress due to overpopulation with higher food and fuel prices. High traffic density and vehicle gridlock wastes resources, both human and material. Thus governments will seek policies for more efficient transport systems including banning four wheel vehicles from city centers. Some locations allow FWEVs in fast lanes and have established bike rental programs in city centers to reduce car traffic. The tremendous growth of EB use in China the past ten years shows that the EPTW can be a practical solution to the short trip needs of the public.



Figure 3. Mercedes Smart Pedelec concept (Germany)

4 The Future of the FWEV

We define the Four Wheel EV, for this paper, to include the BEV (Nissan Leaf), EREV (Chevrolet Volt), HEV (Toyota Prius), PHEV (Ford C-MAX Energy), and NEV (GEM) and similar four wheel products by all manufacturers. Many more makers, such as Chrysler, Honda, Hyundai, Mercedes, BMW, Volkswagen and others will have BEVs and a multiplicity of hybrid variants in the market over the next few years.

The media is ecstatic over the introduction of twenty plus FWEVs in the next few years and governments are touting them as the savior of the planet from global warming. The USA has a law mandating 54.5 mpg vehicle fuel economy by 2030 that can be achieved only by a high percentage of new car sales being FWEVs. Public acceptance of FWEVs, however, is not guaranteed--remember the General Motors EV1.



Figure 4. GM Electric Networked-Vehicle, Detroit Auto Show 2011 (USA)

The General Motors sleek and peppy EV1 was an outstanding success to the 800 people who had the good fortune to lease one in the mid 1990s. But it did not have the sales success of the Toyota Prius that has sold over a million units worldwide to date. Lack of customer demand for the EV1 BEV killed it since gas was only \$1.25 a gallon then. But the world supply of oil is uncertain with foreign sources in jeopardy, from political unrest and reluctance of politicians to allow drilling, so the FWEV is in a resurgent mode of interest. USA gasoline at \$3.50 a gallon is still cheap relative to Europe and Asia prices.

GM introduced the Chevrolet Volt Extended Range EV and Nissan introduced the Leaf BEV in the market in 2011 with USA sales of 7,671 for the Volt and 9,674 for the Leaf (21,000 world

wide) thus around 30,000 units worldwide. This startup number is five times larger than the 5,600 sales of the Prius hybrid in the 2000 startup year, suggesting the market may be ready for much larger FWEV sales.

Thus sales estimates for FWEVs (Fig. 5) show a ramp up to 700,000 by 2015 from the 50 or so models in the queue to be introduced in 2012-2014. Carlos Ghosn, CEO Nissan-Renault, projects 1.5 million cumulative EV sales by 2016 that also can be obtained from numbers in Fig. 1, though not visible on the chart. If the continued ramp up to four million sales in 2030 holds, then the FWEV market is projected to escalate to 100 million units by 2100 (Fig. 6).

FWEV sales in the USA are sensitive to gasoline

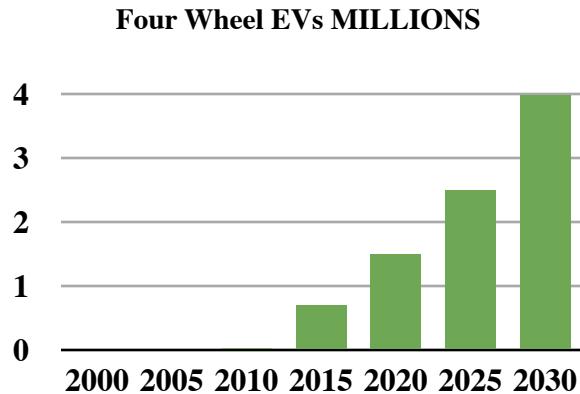


Figure 5: Worldwide FWEV sales estimates

price and if gas goes to \$5 plus a gallon, FWEV sales will escalate even higher. Also, the acceptance, or non-acceptance of the FWEV will have an influence on the acceptance of the EPTW, and vice versa. These FWEV sales are estimates with large plus/minus variance of perhaps 50%.

Intuition suggests these numbers may be underestimated as the FWEV is a paradigm shift in transportation and new technology, once accepted, becomes the norm, like the transistor replacing the vacuum tube that disappeared once the semiconductor revolution matured. The EV will eventually replace the Internal Combustion

Engine Vehicle (ICEV) in similar fashion, count on it.

5 The Future of the EPTW

It is expected that 50% of all "bicycles" manufactured in the future will be electric bicycles due to increasing wealth of consumers, increasing age of bicycle commuters, and increasing utility of the bicycle in either manual or electric format. In addition, migration of humans to dense urban environments - which seems to be accelerating - where there is no parking, not enough traffic lanes, and only short trips are required, will be favorable to the use of EPTWs.

Four Wheel EVs MILLIONS

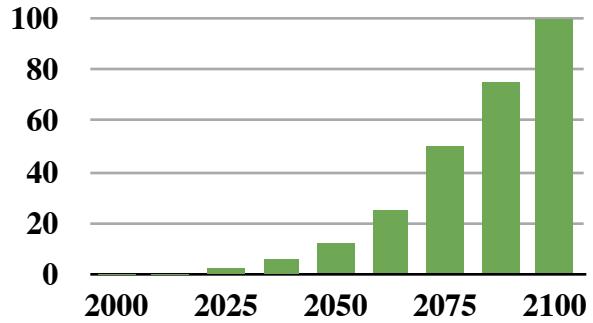


Figure 6: Worldwide FWEV sales estimates

In the future, nearly all small gasoline motorcycles and motor scooters will be replaced by electric versions, due to total cost of ownership being lower for electric, and the fact that fuel costs will continue to rise making electric more affordable. Such costs are already a problem for the biggest gasoline motorcycle cultures in Taiwan, Thailand, Vietnam, India, etc. Also, very important, government regulation will push gasoline motorcycles out due to noise, pollution, and the high costs / less availability of fuel (keep in mind that fuel price is often subsidized in the third world, and that cost to the government is now huge). Thus the scooter (top speed 50 km/h) and motorcycle (top speed 100 km/h) are included in the EPTW category.

EPTWs use minimum energy with a tiny footprint and allow for comfortable travel for short trips. EPTW usage will grow as the populace accommodates to increased living in city centers that will not allow four wheel vehicles but offer safe EPTW lanes for local travel.

It is interesting to note that the following auto companies exhibited concept electric bikes, electric scooters and Segway two wheelers of unique design during 2010 and 2011. These include Ford (ebike), Honda (escooter), Peugeot (escooter and ebike), Mercedes (ebike with BionX and Grace), BMW (escooter), Volkswagen (escooter they call a bik.e), Opel (ebike with BionX), Hyundai (ebike), Lexus (ebike) and General Motors/Segway (EN-V Electric Network Vehicle).

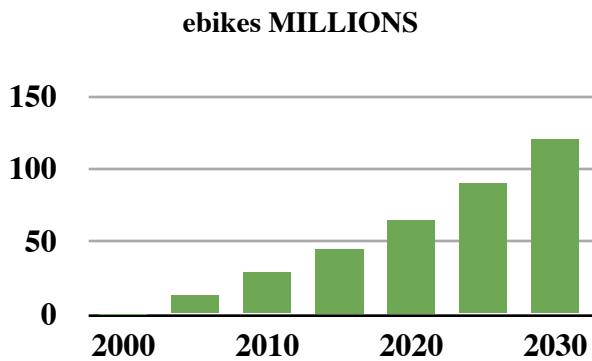


Figure 7: Worldwide ebike sale estimates

Bosch, a major auto parts supplier, developed an electric drive system for a bike and is teamed with Cannondale. Magna, the large Canadian auto parts maker, purchased BionX that makes a popular ebike drive system. Matra, a French auto supplier, purchased WaveCrest's ebike drive system. Thirteen global auto companies showing EPTWs at around the same time is significant, with implications that as yet are hard to determine. However, this could be the beginning of major auto companies entering the Light Electric Vehicle business and would be a fulfillment of Lee Iaccoca's vision of marketing ebikes in auto dealerships. Iaccoca tried that with his EV Global Motors ebike in the mid 1990s but did not succeed.

At this juncture, the Mideast, Southeast Asia, India, South America and Africa, all have the potential to become another China by embracing the EPTW in multi-millions of units. Populations in these regions today primarily use normal bicycles and gasoline scooters for daily transport. As two wheel riders see the advances in EPTW technology that is becoming more affordable, an explosive future worldwide growth of the EPTW is guaranteed. Government support of the EPTW will be essential in most countries as happened in China.

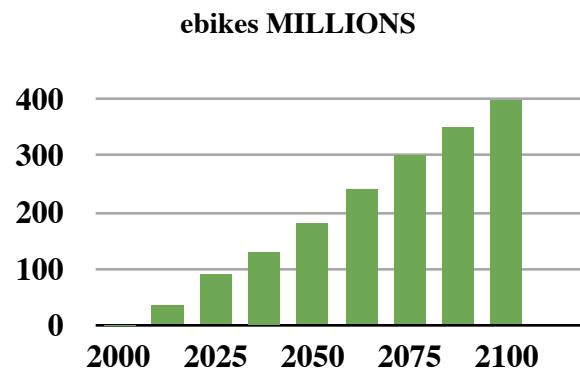


Figure 8: Worldwide ebike sale estimates

The USA government offers no support to the electric bike and bike dealers have no interest in selling a product unless customers line up at their doors demanding it. There are no lines for electric bikes since there is no awareness, or appreciation, of them by the public. That is slowly changing as more media stories in the USA describe the positive experiences of electric bike owners. Perhaps a USA President will endorse use of an electric bike as a "green transport solution" that will improve public awareness. President Obama has an ebike that was presented to him by the Chinese government in 2009 but he has never ridden it publicly.

The open environment of the EPTW will undoubtedly change, in time, to an enclosed version for all weather use. The General Motors / Segway EN-V, Electric Networked Vehicle, is an enclosed EPTW that has all weather capability

with a small footprint like the ebike. Vehicles of the EN-V type will be the future for in-city travel when cars will not be allowed in city centers. Thus the EPTW of the future will include electric bikes, electric scooters and EN-V type vehicles that will meet the needs of people for mobility.

Electric Bikes Worldwide Reports has reported estimates of ebike and escooter sales since 1995. Each edition sales estimates cover a five year period with the year of issue in the middle. Thus sales estimates are continuously updated. EBWR sales estimates have generally been underestimated in the past. The projection in Fig. 7 for ebike sales is an extrapolation of recent EBWR estimates with 120 million units worldwide estimated in 2030. As we extend the estimate to 2100, in Fig. 8 annual sales will grow to around 400 million units but will have a large error range of plus/minus 50% for numbers out to 2100.

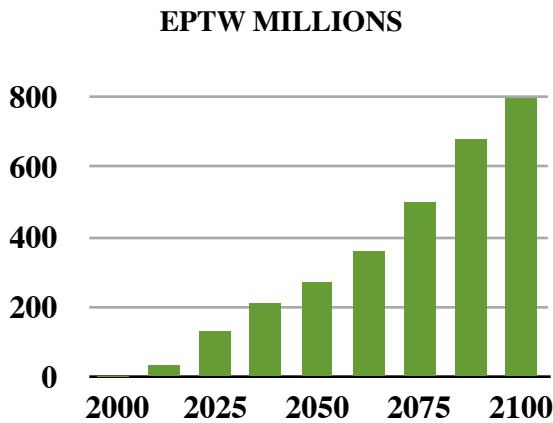


Figure 9: Worldwide EPTW sales estimates

As the electric scooter and electric motorcycle and the two wheel GM/Segway EN-V move into the market, over the next ten years or so, their sales will add to ebike sales to produce the EPTW sales estimate of Fig. 9. As battery, motor and controller technology surely will improve, EPTWs of a wide variety of designs and configurations will explode on the market to a ready public wanting convenient, small footprint vehicles for short trips. It is projected that by 2100 annual worldwide sales of the EPTW will be in the range

of 800 million units, with the caveat that an error of plus/minus 50% is probable.

The world now has close to a billion four wheel ICE vehicles and about a billion bicycles on the road, with 150 million being ebikes. By 2100 there could be around 500 million FWEVs on the road but the number of EPTWs on the road could be much larger, around 5 billion. Thus the EPTW will make a dramatic contribution to the local travel needs of the 10 billion inhabitants of the planet earth. Readers of this paper in 2100 can verify, or reject, these estimates.

6 Caveats

Our projected sales estimates to 2100 probably have an error range of plus/minus 50% as the unexpected will surely happen in the next 90 years to change these numbers up or down dramatically. Projected sales estimates to 2030 may have a smaller error range, plus/minus 10%. Growth of the FWEV and EPTW markets to 2100 will be influenced by the many factors, some known, but most unknown, that could dramatically impact vehicle sales. Here are a few knowns, and some conjectures, that could impact FWEV and EPTW usage in 2100, or earlier:

- Large population moves to urban centers increases EPTW demand
- World population decrease from lower birth rate that is in decline today to lower demand for all vehicles
- Smaller families will use smaller FW vehicles-- favoring FWEV over EPTW
- All major city centers worldwide only allow EPTWs (no cars in day-trucks at night) lowering FWEV sales
- Hydrogen economy succeeds that allows fuel cell EVs to replace BEVs/EREVs/HEVs but not EPTWs
- Communication technology allows people to work at home that reduces vehicle use and vehicle sales
- New oil discoveries combined with evidence of global cooling favors ICEs again (CO₂ needed to warm planet)

7 Conclusion

Although there are caveats, this is the future of personal transportation: Electric Powered Two Wheelers will supplement the four-wheel vehicles of today to help reduce congested roadways and reduce oil use dramatically. There will be billions of EPTWs on the road in 2100, and along with FWEVs, will limit the internal combustion engine to EREVs (but large trucks may still use the ICE). FWEVs and Fuel Cell EVs will be the only four wheel alternatives to the EPTW for personal transport. Count on it!



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