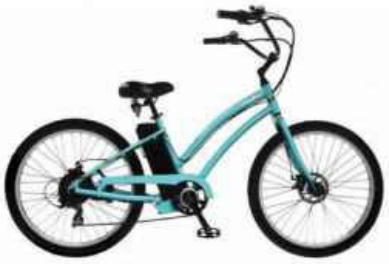
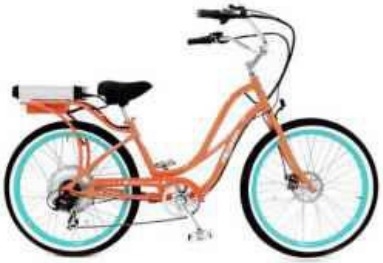




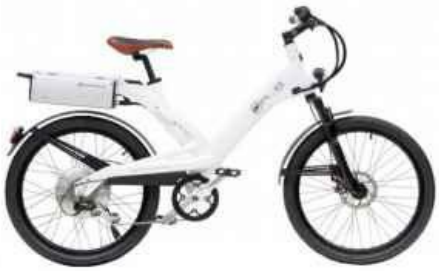
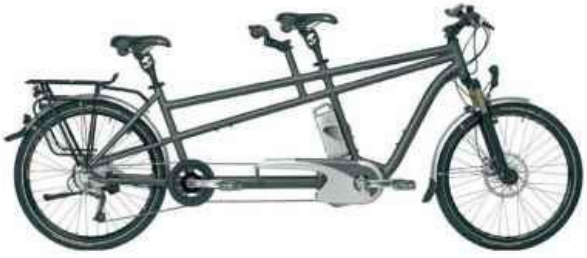
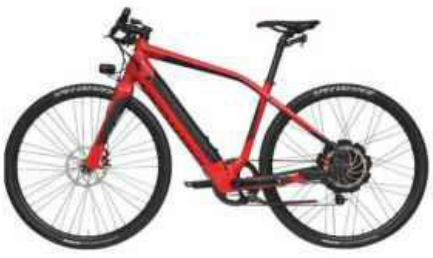
THE ELECTRIC BIKE BOOK






BY JIM TURNER


Join the electric bike revolution and discover how these amazing machines can improve your life and quite literally change the world!

THE POWER OF ELECTRIC BIKES
BY JIM TURNER

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INTRODUCTION

There is an electric bike revolution taking place around the world, yet most Americans are unaware of it. Indeed, most Americans couldn't answer the question, "What is an electric bike?" If pressed, they might answer that it's an old fashioned bicycle modified with a clunky little electric motor assembled in a neighbor's garage. And just a few years ago that might have been an acceptable answer, at least as far as electric bikes in America are concerned.

But for high-population areas of the world like China, Japan, Vietnam, India, most of Africa and Southeast Asia, and much of Central and South America – where the bicycle has long been regarded as primary transportation – the inevitable evolution of that simple but marvelous machine into a power-assisted vehicle has long been underway. There are over 150-million electric bikes in use today in those areas of the world and some experts project that number to double in less than five years!

The reality is that hi-tech, modern electric bicycles have now also come of age in Western Europe and America, where quality manufacturers and some of the world's best engineers are introducing amazing new technologies and design. The results are innovative and highly efficient electric bicycles that provide safe alternative transportation in such a fun, healthy and environmentally responsible manner as to make urban automobile use obsolete.

The intended goal of electric bikes in the Western world is to truly affect positive change on a large scale basis by getting you out of your car, enjoying fresh air and the benefit of physical activity while you accomplish all the running around of daily life. Think of all the trips to the grocery store, the hardware store, the video store… even your daily commute to work. Electric bikes turn errands into joy rides. Electric bikes do not take away from your daily exercise; they add to it. But better yet, they often initiate it – with no previous fitness required. Enthusiasts range from teenagers to grandparents. Riding couples refer to electric bikes as the great equalizer, no longer is the stronger rider waiting for the other. Older customers are now enjoying longer rides in more varied terrain. Electric bikes are durable and low-maintenance, they can go 50 miles on literally pennies worth of electricity, and they generate zero emissions while being ridden. Commuters are cutting their commute time by as much as half and arriving to work fresh and ready to go – all while having fun, saving money, and making the world a cleaner place.

What is an electric bike? Come on along for the ride and find out.

MY ELECTRIC BIKE JOURNEY

I was born and grew up in Northern California. I was the third of four boys. There was a large white cross on the hills behind our house, that stood at least 100 feet tall. From the hill at the base of the cross we could look down at Hoover Tower on Stanford University and much of the San Francisco Peninsula. My brothers and I, as well as the other kids who lived at the base of the cross, were known as the “Cross Kids," not because of any affiliation with the cross, but because we were a bit different. This area, above Redwood City and into Woodside was semi-rural and hilly. We all roamed the gravel roads around our house for miles with dogs running free.

We lived at the top of a hill and our driveway wound down towards the gravel road below. Form a young age we built soap box cars from plywood, 2 X 4's and wheels and flew down the driveway into the street below, oblivious to the dangers of cars coming around the road. We built forts in the trees and dug tunnels in the hills, picking fresh fruit from the apple, peach and pomegranate trees my mother had planted on the property. In spite of all this apparent risk taking, we were not allowed to have a bicycle until I was ten years old; my father was a doctor and thought that bicycles were too dangerous.

I was good at saving money, and when I was twelve, my older brother John asked me to buy a mini-bike with him (because he didn’t have all the money needed). I had no interest in a mini-bike, wasn’t really sure what one was, but I went along and put in $150 towards the $300 for a Honda mini-bike. At first I didn’t ride it much, but eventually I started wandering the roads by my house for miles. The mini-bike probably didn’t go over 15 miles-per-hour. I remember one intersection of two roads at which many dogs use to congregate (as I mentioned earlier, there were no leash laws where I lived and dogs roamed freely). The intersection was at the bottom of a slight hill and I would gain speed as I came towards the dogs, hoping to get by before they could catch me. My heart always went crazy as I approached them. This time a big German shepherd ran besides me and sunk his teeth into my left leg. Luckily, his two fangs were stopped by my shin bone. I tried for more speed as I continued down the hill, but the Shepherd kept a tight grip as the pack ran howling and barking behind me. I could see the shepherd was trying to get a better bite and as he released his jaw I veered away and made it home. That evening I told my Dad about the dog bite and asked him if I should worry about rabies. He said I would probably be alright, as no dogs had rabies around us. I avoided that intersection on my mini-bike form that day forward.

Somehow, my mini-bike evolved into a 100cc Hodaka dirt bike that I would ride in a big county open space a few miles from my house. There were many people riding there, some local “Cross” kids and others who drove from out of town. My 100cc soon became a 125cc and I was riding on some tracks the older riders had created on the hills. One day, one of the riders said I should try racing motocross, as I could ride pretty well. I asked him what motocross was and he

told me about it. It was the summer before I entered high school and I asked my mother to take me to a motocross race so I could compete. She didn't want to and said no, but I continued to bug her. Finally she agreed to take me to ONE race and that was all! There was a race a few miles away in San Francisco. The first 125cc moto started. In a few laps I was leading and by the end of the race I had lapped everyone. For the second moto, my mother said I should move up and start racing with the PROS. That wasn't allowed my first day because I was too young (you had to be sixteen to have a PRO license), but in a few years I would become a pro racer, with my mother as my greatest supporter!

On my sixteenth birthday I received my professional license and raced my first Pro race the next day. For the next few years I raced various Pro races, but no big races. In 1975 I finally entered my first National Motocross in Ohio on my Bultaco. I drove out with my friend Ron Huffman. To race the National, you had to first race a qualifier on the day of the race. Ron asked me how I was going to do, and I said I would win the qualifier. The race started and I led from start to finish. Talk about positive thinking! In two hours I settled at the start line for my first National 250cc motocross, with all the heroes I had read about in the magazines. I was about to learn one of the most important lessons in my life.

The gate dropped and I was in about fifth place after half a lap. The riders in front seemed to be going very slow so I passed them until I was in first place. I came by the mechanic area (where they give the riders signals on their positions) and they just stared at me. The next lap I was 10 seconds ahead and the following lap 15 seconds. I thought something must be wrong, that they had stopped the race and I was an idiot still riding around. How could I be beating all the stars so easily? The next lap I was 20 seconds ahead and the Bultaco team started to give me signals on my lead, all the time looking dumbfounded. Well, my mind got the best of me and I started to make mistakes, eventually fell and finished ninth. I was so excited and called my sponsor Dan, and told him how I had be leading. His only response, was, why didn't you keep leading? I replied that I never really thought I could win. This is when I learned how one's focus and expectations create their outcome. I have never forgotten that. In 1976, I was hired by the Suzuki Factory Team, moved to Canada and won both the 250cc and 500cc the Canadian National Championships.

In 1978, I joined the Fox Racing Team. That year I won the Canadian National Championship again, the first privateer (non factory-sponsored competitor) to ever win a National Championship. My mechanic at that time was a rookie named Mike McAndrews, who went on to become Specialized Bicycle Components Suspension Director.

I was always looking for something new and Europe was where motocross had started and the ultimate place to race. For 1970 I convinced Geoff Fox to sponsor me for the 250cc World Championships. I had a great time, loved the challenge, but didn't win. In Europe it was a challenge just to get to the races as we traveled from country to country. My mechanic in Europe, Keith Bontrager, went on to found Bontrager Bicycle Components, which now are a staple to the Trek brand. While riding for Fox, I became involved in shock development and helped develop

Fox’s new front fork, that I used in Europe.


BELL
HELMETS
JOEL-RAY
12
CAT
MOTO-CROSS
WORLD-CHAMPION

Jim Turner as motocross racer

I retired from active racing in 1980 to pursue a college education. In 1983 I graduated from the University of California at San Diego with a BS in Applied Mechanics. I then attended graduate school at Stanford, where I studied human/mechanical integration in the prestigious Mechanical Engineering Design Division. I focused on human anatomy, nerve and muscle actuation, along with tendon and joint movement in order to integrate human movement and mechanical design in a synchronous system.

While at Stanford, I used to ride my bicycle 12 miles from my father's house in the foothills to campus. My graduate project at Stanford involved developing an electronic shock absorber in collaboration with Ford Motor Company. I had finished my MS degree and was enrolled in the PhD program when Ford Motor Company recruited me to continue my electronic shock development as a Senior Product Engineer in the Advanced Vehicle Controls Division. At Ford I worked on the next generation of electronic suspension systems.

I left Ford in 1986, move back to Santa Cruz and designed a patented revolutionary chemical dispensing system that quickly became the world standard. In 1990, my wife, Sue, and I began an around-the-world cycling trip. We made it through several countries, before retuning mid-year, due to some family emergencies.

From 1991 to 1997, I worked in the rapidly expanding Silicon Valley semiconductor industry. It was there that I designed the equipment used to scribe and break wafers used in cell phones around the world. This machine has been the standard of the industry for over a decade and is capable of accuracy to a 1/10th of a human hair.

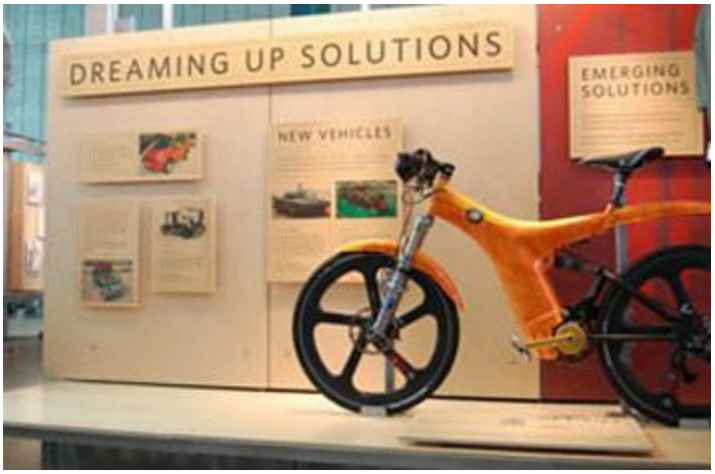
During that time I purchased my first electric bike manufactured by California based ZAP. I thought electric bikes were a good idea, but models from the first generation of electric bikes were poorly constructed. They couldn't climb hills, had poor handling, weight distribution and range.

I had always been intrigued with how the bicycle revolutionized transportation – extending man's range from perhaps 20 miles a day by walking to over 100 miles a day riding a bike. In fact, the bicycle has transformed civilizations throughout the world. In the United States and Europe, urban dwellers abandoned the horse for the bicycle. Women were free to travel as they pleased without having to own a horse and carriage. Their fashions even changed to accommodate the bicycle. Years later when the bicycle was assimilated by Asian countries it allowed laborers to ride from the country to the city to pursue jobs in the emerging new economies.

I began to seriously consider if this simple tool – the bicycle – could change civilization yet again by saving it from the related problems of energy, health and the environmental degradation. I believed the answer was an electric bicycle, which greatly improved the conventional bicycle.

So, in 1998, I decided to merge my expertise in human muscle/mechanical integration, high performance suspension and vehicle design with my expertise in engineering and custom motocross bikes. This was the genesis of my electric bicycle company I would call "Optibike."

A decade later, in 2008 the Optibike was featured in the California Academy of Sciences Museum as "The Future of Transportation." The dream had become a reality.



ELECTRIC BIKE EPIPHANY – PAUL C, GREAT BRITAIN

Occasionally in life we make a discovery, either after extended research and design, but more often by sheer luck and chance. Even more rarely those discoveries may have a huge effect on one's life. For me, discovering electric bikes was an example of all of the above. It would not be overstating it to say the electric bike revolutionized my life.

In 1988, at the age of 16, I was in a severe traffic accident. While initially being lucky to have survived, the damage to my legs would prove to be life changing. After a year or so in the hospital, having undergone nearly 30 operations involving skeletal and vascular reconstruction, I was left with a fused left knee and a greatly weakened lower right leg with inverted foot. Walking was, and still is, particularly painful. For the next 22 years I limited my physical activity to that which was wholly necessary.

Andrea my wife had heard about electric bikes before, but having experimented briefly, they had proven unsuccessful. Andrea forced me to keep looking because she knew it could be good for me, and as usual, she was right. It was during an extended session of Google searching, buried in some obscure article, that I discovered Optibike. I read what I could about the bike and started to wonder; could this be a solution for me? So, giving a brief history of myself, I sent Optibike an email looking for more details. I needed to understand how powerful it was, was it big enough for me (I am just under 2 meters tall), what, if any, solution could there be for my unbending left leg?

Late one evening (London time) Jim Turner called me up. We spent nearly an hour discussing my physical abilities, the capabilities of the Optibike, and what else I needed the bike to do. Jim said he needed to go away and think about it. After six weeks of thinking, experimenting, and having his engineers try to re-enact what it would be like for me to ride the bike by strapping broom sticks to their legs, Jim called me back with a solution. He had redesigned the left peddle crank, lengthened it a touch, but more importantly, he had housed into the crank a bearing system that would let the pedal hang freely, thus allowing my left foot to rest on it as I pedaled with my right leg.

In November 2010, this amazing red bike arrived. Indeed, the *New York Times* description of Optibike as the "Ferrari of electric bikes" could not have been more fitting! Not only was it fast and functional, but it looked fantastic! So, why is this so revolutionary? Suddenly I could do more with my boys, Sam, Tom and Charlie. We could go riding in the park as a family. A small thing to most, but to me this was huge. In addition, I had something that I could use as a source of rehabilitation.

Optibike owner Paul C. from the UK

I was somewhat reticent early on. It had been 22 years since I had been on a bike and I was nervous about myself, never mind having to make sure the boys were safe also. But I soon got over that. As they say, "its like riding a bike." My two oldest were riding solo, but my youngest was on a "tow-along" attached to the seat post on my bike. The Optibike dealt with this beautifully, providing ample power to pull Charlie along with limited help from me pedaling.

It wasn't long until I got very brave and decided to ride the bike to work, 11 miles away. That was a bit nerve-racking given the hair-raising commute through one of the busiest cities in the world. Fortunately, the first third of the journey is through the picturesque Richmond Park – which is right beside my house. Early on a summer's morning, when no cars are allowed in the park, this is just the most stunning place. In winter when it is cold and dark, it is beautifully eerie. You would be surprised at how much cycle traffic there is in the park at this time.

The route takes me through the park, down to Putney, over the Thames, along the Kings Road through Chelsea, to Victoria, around Buckingham Palace, up St James Street into the heart of Mayfair where I work. This takes approximately 40 minutes. The route home is slightly different in that I go through Hyde Park, trying to avoid heavily congested roads. After some weaving through side streets I end up back on the Kings Road and retrace my route in from there.

London is awash with cyclists, which is no bad thing at all. They are a very collegiate bunch, but I might have upset the natural order somewhat. Every day I hear gasps of astonishment like, "How does a guy pedaling with one leg go so fast?" or "Wow, what is that thing?" I am not supposed to able to keep up with them as they flood in waves of fluorescent yellow down the Kings Road, and over Putney Bridge, etc. On occasion I have the effrontery to actually overtake them. But as the cyclists gather at the intermittent road traffic lights their curiosity is inevitable. "Where did you get it? I couldn't understand how you were going so fast! What speed does it do?"

And uniformly there is nothing but respect shown for the bike. I have a sense of pride when I

am on it, but also a sense of normality, finally being able to do something that is pretty much natural for nearly everyone else. My leg is getting stronger and my general fitness has greatly improved. The electric bike has dramatically improved my quality of life.

SO WHAT IS AN ELECTRIC BIKE

What is an electric bike? An electric bike is actually a human-electric hybrid. Similar to the way an electric car like a Toyota Prius is a hybrid between a battery and a gasoline engine, an electric bicycle is a hybrid between a battery and your leg power. The key elements for this human-electric hybrid are essentially a battery and a motor. In most cases you also need a motor controller (throttle or adjuster) to control or adjust the power.

A Brief History of Electric Bikes

The first electric bikes appeared in the late 1890s and were documented by various U.S. patents. According to Wikipedia, in December of 1895, Ogden Bolton Jr. was granted U.S. Patent 552,271 for a battery-powered bicycle with "6-pole brush-and-commutator direct current hub motor mounted in the rear wheel." There were no gears and the motor could draw up to 100 amperes from a 10-volt battery. Two years later, in 1897, Hosea W. Libbey of Boston invented an electric bicycle (U.S. Patent 596,272) that was propelled by a "double electric motor." The motor was designed within the hub of the crankset axle. This model was later re-invented and imitated in the late 1990s by Giant Lafree electric bicycles. By 1898 a rear wheel drive electric bicycle, which used a driving belt along the outside edge of the wheel was patented by Mathew J. Steffens. And in 1899 U.S. Patent 627,066 by John Schnepf depicted a rear wheel friction "roller-wheel" style drive electric bicycle. Schnepf's invention was later re-examined and expanded in 1969 by G.A. Wood Jr. with his U.S. Patent 3,431,994. Wood's device used 4 fractional horsepower motors; connected through a series of gears.

In 1992 Vector Services Limited offered and sold an electric bicycle dubbed Zike. The bicycle included Nickel-cadmium batteries that were built into a frame member and included an 850g permanent-magnet motor. Despite the Zike, in 1992 hardly any commercial electric bicycles were available. Torque sensors and power controls were developed in the mid 1990s and production grew from 1993 to 2004 by an estimated 35%. By contrast, in 1995 regular bicycle production decreased from its peak 107 million units. Some of the less expensive electric bicycles used bulky lead acid batteries, whereas newer models generally used NiMH, NiCd and/or Li-ion batteries, which offered lighter, denser capacity batteries. Performance varied; however, in general there was an increase in range and speed.

By 2001 the terms E-Bike, power bike, pedelec, assisted bicycle, and power-assisted bicycle were commonly used to refer to electric bicycles.

The Modern Electric Bike

In the world today, there are two broad classifications of electric bicycles. One is called a "Pedalec" and the other is a "Throttle Assist" or "On-Demand." The Pedalecs have a powe

limit generally legislated by different countries. A Pedalec doesn't have a throttle, like a motorcycle, but uses what's called a "Torque Assist" instead. So when you pedal, the motor adds a certain amount of power, which you can generally adjust.

The Pedalec operates just like a regular bicycle. You turn the pedals and it gives you some assistance. This style is mandated in most of the European Union, Japan, and in China. These countries limit E-bikes in terms of power and speed. They're typically limited to 250 watts of power and a speed of no greater than 16 miles an hour. So the motor cannot assist you after the bike achieves 16 miles an hour. If you're only riding around in a flat city, weigh 140 pounds or so, and you're limited to slower speeds, the 250 watts is probably fine. If you live in San Francisco or if you're trying to ride in Colorado and go up into the mountains and you weigh 250-pounds, it may not be enough.

Internationally, most electric bikes are used in the inner city and Pedalec bikes with the 250-watt classification are the largest segment of the world market. China is the largest market, adding 20 million electric bikes a year. Europe has about a million, meaning the rest of the world is probably another million or so.

In America electric bikes are much more powerful (up to 750 watts) and are used to commute to and from the suburbs. That is why people are attracted to them, because they can go long distances at relatively high speeds. Bikes designed for Asia or Europe are really limited in the US market. China's high-end bicycles are considered low-end here.The average price of an E-bike in America is over $3000; in China it's in the $600 range.

The other type of electric bicycle has a throttle similar to a motorcycle. They're called Throttle Assist (or On-Demand), meaning you can control the power at will by the throttle. You still pedal like a normal bicycle, but you can adjust the power as you need it. In the United States, Australia and Canada, On-Demand bikes are legal. In China you can have On-Demand bikes also, though they're limited in power. In America, the power of On-Demand bike is limited to 750 watts by the government. So there are some differences in legal requirements, but there's also quite a big difference in the way the products perform when you're riding them.

With Pedalec bikes the amount of power assist is proportional to how much the rider pedals. The rider can usually adjust the level of assist with a control on the handlebar. As you're pedaling, you can adjust from power level 1, 2, 3, or 4 to give you more power. So if you go up a hill, you might hit level 4. Some Pedalec bikes always have the motor on if you pedal and they'll just use a little power to overcome the resistance of the motor itself and the gears. So it might feel like the motor isn't getting any drag, but it actually is. And with some of these bikes when you're pedaling you're actually turning the motor and thus have a lot of resistance. So you can't ride them as regular bicycles. On-Demand bikes have a series of clutches that allow you to pedal the bike without any motor drag, so it rides just like a regular bicycle.

Two Main Types of Electric Bike Drive Systems

There are two main types of electric bike propulsion motor systems. The first type is a hub motor, generally located in the hub of the rear wheel; and sometimes in the front wheel. They propel the wheel by driving the hub with the motor. The second type is a motorized bottom bracket, or mid-drive system. These systems are placed where the bicycle cranks are normally located. They drive the front sprocket and work more in combination with the rider pedaling, because they go through the gears on the rear wheel.

So the question becomes: Is one type of motor system preferable? This is a debate that continues today, just as the debate between front and rear wheel drive in cars continues. They both have their pros and cons.

The Case For Hub Motors

Hub motors are simple and easy to retrofit a bike with. There are a large number of hub motor manufacturers in China, so the price is very low. There are two primary disadvantages of the hub motor.

1. Since the motor is driving the wheel directly, there is no mechanical advantage from the gears in the bicycle. This means efficiency will drop when climbing hills.
2. The weight of the hub motor is in the wheel as "unsprung" weight. For good vehicle handling, unsprung weight is to be avoided.

For some applications, the hub motor is a great solution. They work well when there is flat ground and the bike does not have to climb hills or go over uneven terrain. Higher speeds should be avoided as the weight of the hub motor in the wheel may make handling difficult.

The Case for Mid Drive Units

The mid drive system is a more natural bicycle hybrid system. To understand the advantage of the mid drive motor unit, it is necessary to look at this history of bicycle development.

When bicycles were first invented in 1862, they had big front wheels because they didn't have gears at that point. In order for someone to pedal those bikes, they had to have a giant wheel because the pedals were direct drive. Jump ahead nearly 40 years to the advent of the DeRailleur system, which created gears on the rear of the bicycle. This enabled the bicycle to have more standardized wheel sizes and by eliminating the giant front wheel, allowed people to sit on them normally. The advent of the derailleur and gears allowed bikes to climb hills with ease. By changing gears, the riders can keep a comfortable load on his leg muscles, regardless of the type of terrain. This allowed people to travel further on bicycles.

The mid-drive system is a more natural bicycle operation. In a mid-drive system the rider and the motor are turning the front sprocket in parallel, both utilizing the bicycle gear system,

allowing the bike rider to climb hills and go fast on the flats.

The disadvantage with mid-drive systems is that they tend to be more costly than hub motors, due to lower production volumes. The mid-drive system also requires the frame of the bicycle to be designed to hold the mid-drive motor.

Human Muscle and Battery/Motor Are Similar

Think about your leg when pedaling a bicycle. You can peddle at a moderate speed, which is typically about 80 cadence, (about 80 revolutions per minute), and you can usually do that all day. If you need to you can spin faster, but you tend to get winded and tired. On the other hand, if you come to a hill, you can really start to peddle hard; your muscles kick-in and turn the pedals, allowing you to sprint up a hill like they do in the Tour de France, but you're limited because of your glycogen instant energy sources that only give you 10 to 20 seconds at that speed.

This is very similar to a battery and a motor, which prefer to run at just an average speed. You can accelerate and add a lot of current, which is the same as muscle-power, but eventually the battery and motor will start to get hot and their efficiency will drop; they're not designed to run that way. This is why the mid drive units are so efficient. If the bicycle is the most efficient means of transportation ever made and the energy system used by human muscles is very similar to a battery motor, the combination in the mid-drive makes a super efficient system.

ELECTRIC BIKE EPIPHANY – JAMES HILL, POLICE OFFICER, SEABROOK, TEXAS

On September 8, 2008 the city of Seabrook, Texas took a direct hit from Ike, a category 4 hurricane that would prove to be the costliest storm to ever hit Texas and the third costliest hurricane to hit the United States. Seabrook suffered major damage and a complete collapse of infrastructure. Chris Hunt, founder of Hi-Power Cycles received this email from a customer just a couple of weeks after the storm.

I cannot convey in words how bad it is here. We were hit by a 16 1/2 foot storm surge of water plus 110 mph winds. All I can say is it was complete devastation. Our police department building was flooded and half of our department was trapped on the second floor until the water receded. The other half of the department was operating out of our local Holiday Inn Hotel. We did this so at least one half of the department could be functioning. After the storm, we emerged and secured our city. That was on Saturday, September 12th. By Monday morning the 14th I was ordered out on bike patrol because we no longer had enough fuel to run our patrol cars. We had numerous agencies helping us and that is what consumed all of our fuel supply. FEMA was not able to get additional fuel to us until the 16th.

Our regular police bikes were stored at the Police Station and were destroyed by the storm surge. We were only able to get one functioning. Luckily I had taken my Hi-Power electric bike to work before the storm, and I was now able to use it in a real-world disaster situation. The bike was the only way to access certain areas in the aftermath of the storm. Unfortunately I had left my bike helmet in my car which was lost. I found a bike helmet in a ditch and used it for two days until a store opened and I could buy another one.

I want you to know that my electric bike literally saves lives. I could not have accessed certain areas of the city with out it. There were broken gas lines, fuel spills from boats, plus sand and tons of debris everywhere. The bike has been thru hell and back along with me. Just today I was riding with my partner and we were flagged down about a man beating up a female. I was able to catch and tackle the suspect who never saw or heard me coming. I also responded to a 84-year-old elderly female who had fallen and split her skull open about seven inches. I beat all other units to the scene and was able to apply direct pressure and stop the bleeding.

The bike is being used constantly with the batteries being charged back up as soon as they go dead. Today was the first day I got to go home to my family and I'm taking the opportunity to send you this story in an email. Even though my house is damaged I felt it was necessary let you know what is going on while everything is fresh in my mind.

I now work everyday on bike patrol. The looters are still everywhere and the bike is a must-

have at this point. I work 12 hours on and 12 hours off with no days off. The bike is taking some very serious abuse but it is still functioning. I just wanted to say thank you for making me a very good bike that is saving lives including my own. When the SHIT hit the fan your bike had my back and I thank you for it.

UNDERSTANDING BATTERIES

The key to any electric vehicle is the battery and how much energy it can hold. The battery is the gas tank. The battery holds energy. Power accelerates the car, but the size of the gas tank (energy capacity of the battery) determines the distance. For a gas-powered car, you buy energy in the form of gasoline. In an electric vehicle, you buy energy in the form of kilowatt-hours (kWh). A kWh is a unit of energy equivalent to one kilowatt (1,000 watts) of power expended for one hour of time, or 1,000 watt hours (Wh). This is the way you buy electricity in your house. Your house electricity bill charges you for the amount of kWh of energy you use in the month.

High Power With a Small Gas Tank Doesn't Get you Far

If a high-horsepower Corvette has a small gas tank, the car doesn't go very far. An electric vehicle needs a battery with a high-energy capacity to go far. The amount of energy is measured in kWh. An electric vehicle's range is constrained by batteries. Batteries don't have the energy density of gasoline, meaning they provide less energy in terms of size and weight compared to gasoline.

Electric Vehicles Need High Energy Batteries, Not High Power

Energy is the amount of power used over time. An electric vehicle must be more efficient with the use of energy than a gas car. With an electric vehicle, a battery with high-energy, not high power is preferred. This gives the vehicle the ability to travel long distances. Some batteries put out a large amount of power, but they don't have very much energy. That means the vehicle will accelerate very quickly, like a high horsepower Corvette, but will not go very far, because the size of the gas tank is small.

Humans Have Energy and Power Differences Too

In the Olympics, there are sprinters and marathoners. The sprinters who run the 100-meter dash have very large muscles. They can run very fast and have huge amounts of power, but they don't have much energy left because they use it all up in 100 yards. The sprinter isn't interested in energy density; he wants all-out horsepower. In contrast, the marathon runner can run a marathon averaging 10-minute miles because he uses his energy so efficiently. The marathon runner wants a balance between power and energy. He needs power to have the speed and energy to go the distance. This is the same with an electric vehicle. Electric vehicles need high energy density in their batteries to go the distance.

A Short History of Batteries

Lead acid batteries were invented in the 1860's. The first cars ran on these types of batteries

because they were easier to make than gasoline engines at that time. However, lead is very heavy and it's a toxic material. After lead batteries came nickel cadmium batteries. They had about twice the energy density level as lead, but were also toxic. Then came nickel medal hydride batteries, which got rid of the cadmium – the toxic element – and also upped the energy density by 50% (again we're talking about energy density, not power density). Then came lithium ion batteries in the 1990's, which are used in laptop computers today and basically tripled the energy density of all other battery types. That means a car, the same size and weight, with a lithium ion battery will get three times the distance as the same car powered by a nickel cadmium battery.

There are different types of lithium batteries: lithium phosphate, lithium iron cobalt (used in laptops and Tesla cars), lithium manganese (a derivative without the cobalt), and lithium polymer (a pouch type cell used a lot in remote control planes). These lithium batteries are the most commonly used batteries today. The lithium cobalt has the highest energy density at over 200 Wh per kilogram. Lithium polymer is similar, but it has some reliability issues due to its pouch nature. Next in energy density is lithium manganese, which is slightly lower, in the 170 watt hours per kilogram range. Lastly, there is lithium phosphate, which is in the range of 110 to 130 watt hours per kilogram. Lithium phosphate batteries can put out extreme power for short periods of time, but they don't have the energy to keep going.

Electric Cars and Bikes Have Different Needs

In hybrid cars, where the engine is constantly filling the battery, power density is more important than energy density. The high power density lets the gas motor recharge the battery quickly. The gasoline in the hybrid car is providing the energy, not the battery.

Even though the electric bike is a hybrid between the human and the electric motor, it is not like a Prius in power needs. In the electric bike, the person and the battery are both contributing energy and the battery is not re-filled by the rider. This requires a high-energy battery for an electric bike. All electric bicycles are charged like a laptop, with a wall charger. You could charge the battery by peddling, but that would defeat the purpose of the electric bicycle. If you had to peddle to fill the battery, you'd be using all your energy to fill the battery and you wouldn't get any boost to your speed or range.

RANGE OF ELECTRIC BIKES

The range of electric bikes varies greatly. There is no common standard for determining electric bike ranges as there are with EPA mileage estimates for cars. An electric bike can claim a long range, but only if the rider pedaling is doing most of the effort or the bike is moving at a very slow speed. The range of an electric bicycle, when propelled by motor and battery alone is determined by these factors:

1. The speed
2. The steepness of the terrain
3. The weight of the rider
4. The aerodynamic drag of rider and bike.
5. The efficiency of the motor drive system
6. The energy of the battery measured in watt-hours (Wh).

If two bikes and riders have items 1-4 equal, then the range is determined by the efficiency of the motor drive system and the energy of the battery. If the efficiency of the motor drive systems is the same, then the energy of the battery alone determines the distance the bike will travel. A bike with a higher energy battery (measured in Wh) will travel further. Remember this!

Battery Charge Time and Cycle Life

Batteries can be charged in as little as 15 minutes, but a shorter charge times strains the battery and decreases cycle life. Most bikes charge in 2 to 8 hours. When evaluating your needs in charge time, two factors should be considered:

1. What is the size of the battery in the bike and how far can you travel before a charge is necessary?
2. The average distance you will be traveling on a regular basis on your electric bike.

Example: You have an electric bike with a 20-mile range. Your commute is ten miles and you can recharge the bike at work. In this case, a bike with a 4-6 hour charge time is fine, as it can be charged while you are work. Don't invest in fast charging unless you really need it. Faster charge times can also reduce the life cycle of the battery in many cases. Generally, batteries with higher power ratings can recharge faster, but they tend to have lower energy densities. Fast charge times will still lower the cycle life of high power batteries.

Every time you recharge a battery it is considered a cycle. The "cycle life" of batteries has received a lot of media attention because batteries are expensive to buy and people want them to

last. This is especially true with all the new electric cars coming out; people question how long the batteries will last. There are a lot of ways to look at this, but batteries are usually rated by their cycle life - or how many cycles (charges) they can achieve before their capacity is reduced to a certain level.

The cycle life of a battery does not mean it is dead, but typically it is the number of cycles the battery has completed and yet still has 75 to 80% of its original capacity left. There is still a lot of life left in the battery at this time. Lithium cobalt tends to be in a 500-700 cycle range, where the lithium phosphate might be in the 2000 cycle range. Modern lithium batteries do not have the "memory" affect as NICAD batteries have. They will actually last more cycles if the discharge and charge are less than 100%.

These are ideal condition laboratory results. The actual real world cycle life depends on the temperature of the battery and amount of current used during discharge (as well as several other factors). The current that's drawn from the battery is what affects its efficiency. This current is analogous to the amount of fuel flowing from your gas tank on a car; the faster the fuel flows out, the quicker the tank empties, meaning the battery depletes faster. Therefore, the faster the current comes out of the battery, the less efficient the battery is. Faster current also reduces the number of cycles in the life of the battery.

The Relationship Between Cycle Life and Mileage

It's helpful to think about this as it relates to an electric car. If your car can travel 300 miles per charge and you can recharge it 1,000 times, the car's battery pack will last 300,000 miles. And again, once the cycle life of a battery is up it's not that it's dead; it just means that it's now at 70% to 80% of its initial capacity. So, after 300,000 miles your 300-mile per charge car probably is still going 220 miles on a charge. The Nissan Leaf estimates that after eight years, the battery will still have 70% of its charge left.

The truth is that batteries in electric cars actually outlast the cars and that's with only a 1,000-cycle life battery. A 2,000-cycle life battery has a 600,000 mile range. That's why batteries in delivery vehicles are becoming so intriguing for UPS, because they can last a million miles and can pay for the upfront cost after 80,000 to 100,000 miles of driving, at which point the battery pack is paid for in terms of gasoline costs. After that it's free; you're not buying fuel anymore.

It's the same with a battery for an electric bicycle. At Optibike, our batteries are rated at up to 1,000 cycles. So if you can ride 50 miles on a charge in "eco-mode," then that battery is good for 50,000 miles. That's a lot of miles, and that's only at 70% of battery capacity.

Battery Quality

It is important when shopping for an electric bike to analyze the quality and performance of the battery. The quality of different brands of batteries varies greatly. Just because a battery is

advertised to have 1,000 cycles doesn't exactly mean it will deliver that. There was a Chinese company advertising their batteries at 1,000 cycles, but when they were tested they completely failed after 100 cycles. They didn't wear out, they didn't go to 70%, they just failed because the quality wasn't there. So the quality of the battery pack is very important. You want the battery quality to be verified and guaranteed with a warranty.

How are Batteries Rated?

Batteries are rated in either amp-hours or watt-hours. Amp-hours indicate how many amps a battery can discharge in one hour. A 20 amp-hour battery can discharge 20 amps for one hour before it's drained. But that's not the whole story; the entire amount of energy (watt-hours) in the battery is the amp-hours times the voltage of the pack.

A 12-volt pack with 10 amp-hours capacity has 120 watt-hours and is not the same as a 36-volt pack with 10 amp-hours capacity, which has 360 watt-hours. The 36-volt pack at 10 amp-hours has three times the energy of the 12-volt battery at 10 amp-hours because the voltage is three times greater. So the standardized way to look at batteries is in watt-hours, measured in volts times amp-hours, which indicates total energy.

We all know watt-hour because our electric bills charge us by the watt-hour. It's not only how big your light bulb is, but also how long you use it for. In other words, they're charging you for the duration that your bulb is on, in addition to how many watts the bulb is to obtain the bill in watt-hrs. We're used to paying the utility in watt-hours, which is energy.

Remember the difference: power is in watts and energy is power over time measured in watt-hrs.

The Cost of Driving an Electric Bike

Most Americans have trouble understanding energy for an electric car, because we buy a gallon of gas for our car, but we pay for kilowatt-hours in an electric vehicle and there's no exact correlation between the two.

A 100-watt bulb burning for 10 hours is a kilowatt-hour. In the U.S., you're typically charged $0.10 for that kilowatt-hour. So if you have an electric bicycle with a 500-watt motor, it will run for two hours on one kilowatt-hour of electricity and cost $0.10. If it's doing 20 mph, it means it goes 40 miles for $0.10 worth of electricity.

The common denominator in all this is money, which is easier to understand than kilowatt-hours. We know that for most cars to go 40 miles, it takes two gallons of gasoline, which is becoming ever more expensive at almost $4.00 a gallon, so that's $8.00. Compare that to an electric bike, which costs $0.10 to go 40 miles. I can pay $8.00 for gasoline in the car, or $0.10 in electricity for an electric bike to go the same distance of 40 miles. Which is the same as

saying that for the $8.00 to travel 40 miles in the car, you can travel 3200 miles on an electric bicycle.

The other factor to consider is that gasoline prices can fluctuate widely; they are $3.00 now, but they were $4.00 a year ago, and they could easily be $6.00 or $7.00 in a couple of years. If you look at your electric bill, it probably has not changed more than 10% over the same number of years - it's far more stable. Most electric cars use about 1/3 to 1/2 the amount of energy in terms of costs. When you fill up a Tesla electric car, it may cost only $12 versus $40 or $50 if it were a gas car. But the big difference with an electric bicycle is you drop that extra 3,000 lbs that an electric car weighs, meaning it's far more efficient.

WHERE TO BUY AN ELECTRIC BIKE

Throughout the United States and the rest of the world, there are a growing number of stores that sell electric bikes. Electric bikes can be purchased at some independent bicycle dealers, or through big box retailers like Wall Mart.

A new breed of stores is selling electric bikes and other low speed electric vehicles exclusively. There are about 400 of these specialized dealers in the USA today. By and large, these stores are owned by experts in electric bike technology who can recommend the type of electric bike that will fit your needs. They'll let you take a test ride to see how easy it is to handle an electric bike.

Pete's Bikes Store in Boulder, Colorado is a great example of a specialized dealer and has been a leader in marketing the electric bike revolution. Pete's Bikes offers customers a retail store experience where they can learn about electric bikes and take them for a ride to see how they perform.

Pete's Electric Bikes is owned and operated by Dean Keyek-Franssen and Chuck Ankeny both inventors and serial entrepreneurs whose careers collided completely by accident – or so it would seem - in mid-2009. When asked where the name Pete's comes from, Chuck likes to tell the story that Dean wanted it to be called Dean's Electric Bikes and Chuck wanted Chuck's Electric Bikes. So they settled on Pete's. That seems to make perfect sense to most people. Dean likes to tell it a bit differently. For Dean and brother Mark, a co-founder, it all started with Grandpa Pete; a crazy inventor-cum-environmentalist who always had a better way to do things. However the story gets told, the vision is the same. Pete's is on a mission to become the premier source for electric bikes, motorcycles, cars, trucks and charging solutions. At Pete's, they're passionate about electric bikes. They have commuted by bicycle for years and understand the benefits of adding electric assist. They use what they sell.

A store like Pete's Electric Bikes is all about electric vehicles. They rent, service and sell electric bikes, motorcycles, cars and trucks as well as products designed to make living with electric vehicles easier. They strive to provide the customer with the best selection of products that provides the optimal balance of affordability, reliability, and performance.

Here's a partial list of retailers/dealers/resellers in the United States ordered by telephone area code ebikestorehq.com/category/electric-bike-stores/ . Many of these local retailer shops are willing to convert your existing bike into an electric bike in addition to offering test rides, sales and maintenance/repair of e-bikes. Two other sources of dealers are E-bikedealers.com and ElectricBikeReport.com, both offer an interactive database for listing & locating "E-Bike Friendly" local bike shops offering or specializing in electric bicycle sales, service, conversion and repair. If you don't find a nearby dealer on this list, check with the manufacturer for the

address of a retailer near you. Some manufacturers offer a “dealer locator” online. And, of course, there’s Google; just enter the vehicle type you are seeking (e.g. “electric bikes") and the name of your city. (Link here to list of Electric Bike stores)

ELECTRIC BIKE BRANDS

Electric bikes are a little bit like digital cameras, in that the large brands of traditional bicycle makers, who should be the leaders in electric bike evolution, are in last place and the startup companies are leading the field. It doesn't make sense, but there's a resistance from the traditional bicycle makers, just like there was with traditional camera companies to the innovations in the marketplace.

In the world market today, Schwinn and Trek are traditional bike manufacturers that make electric bikes, which are sold in the US and in Europe. In Europe, there are also big brands like Derby and others. Those bikes are often made in Asia to European specifications. And in China there are literally hundreds of electric bike companies making 20 million units a year. In the US and Europe there are a number of very high quality boutique manufacturers making a wide variety of electric bikes.

The manufacturing method of a bicycle company is typically to make the frame and buy all the other components: the brakes, the crank arms and the wheels from other manufacturers. Almost everybody follows this except Specialized, which tends to make some of their own components. But, generally, that's what a bicycle company does. They make a frame and they buy everything else and put it on that frame. To follow, in the electric bike world there are a lot of makers of parts, motor drives and components.

Sanyo and Panasonic are the oldest makers of electric drive systems; they make a 250-watt mid-drive motor system that came out of Japan, so it's a Pedalec version. It's been around a long time, and it's used in Europe. They sell those motor drive systems to bicycle companies that integrate them into their bicycles.

Bosch is the new player in the field. They entered the field in 2010 with a mid-drive motor system similar to Panasonic's and Sanyo's and they're now on 21 different electric bike brands throughout the world. Bosch has huge distribution and manufacturing capabilities enabling them to do that.

Optibike makes a mid-drive system, the Motorized Bottom Bracket, that is capable of a thousand watts or more compared to the only 250 watts of the others; and it's actually smaller and more compact as well. Trying to package a lot of horsepower like this is a challenge. As you make a bigger and bigger system, if you add too much weight and size you don't have a bicycle anymore, just like having an iPad that's twice the size is no longer an iPad. Size is important and that's what's lost in a lot of systems – they don't scale. They're fine at 250 watts, but if you were to make them four times the size, you'd no longer have a viable product.

On the hub motor side there's Bionix in Canada that was bought by a Canadian car part

manufacturing company that's become a pretty large player in the world. And then there's just a whole host of Asian hub motors out there.

Lack of Electric Bike Range Standards

There are no electric bike range standards in the USA. With cars, there is an EPA rating for electrics and hybrids that's standardized and administered by the government, giving the consumer standard, certified conditions so they have some way of comparing cars. Now, in real life the car may not actually perform to those specifications, but you can compare one car to the next, as certified by the EPA.

With electric bicycles, however, there has never been such a standard until just recently. Up until 2012, it's been completely up to the manufacturer, which really presents a problem, because in a car if the motor battery doesn't work the car doesn't move, but with a bicycle you can pedal without using the battery. A conventional pedal bike has unlimited mileage. So, a manufacturer can put a battery on it and say the mileage is anywhere from 200 miles to unlimited. It's confusing for the consumer because there's no standard. A manufacturer will say they have a range of 50 miles and the battery is one-third the size of another manufacturer, which means they're going a third the speed; or maybe it's just that you're doing all the pedaling and the motor barely helps. Remember, every bicycle in the world can travel 50 miles or even 100 with the right person riding it. In other words, past claims by electric bicycle companies are basically worthless because of the variable of pedaling and non-standardized ratings.

At Optibike we list the mileage range of the motor without pedaling. This way the consumer can see, for example, that the bike will go 50 miles with no pedaling at 20 miles an hour with a 160 lb. rider on level ground. And if every other manufacturer did that we could truly compare electric bicycle range: one bike would say it does 20 miles, another that it does 40 miles, etc. But when we see bikes with a quarter of the battery capacity of an Optibike, saying they have the same range, we know something is wrong judging by battery capacity alone, but those are the types of misleading claims faced by consumers about electric bicycles.

There is a new standard being pursued by the Light Electric Vehicle Association (LEVA). They have created a standard test for electric bikes to determine their range. This test will allow consumers to compare electric bikes, knowing that the same standard has been used for all the bikes. The test became operational in 2012, but using the test is currently voluntary by the manufacture.

What is that old saying, "The proof is in the pudding?" All these claims are just claims until you go out and compare electric bikes by riding them on the same course. We recommend to people that are interested in an electric bike to test out several different brands wherever they'll be riding. It's not only about determining the distance the bike will go and at what speed over that distance; you also must take your weight into consideration. Heavier people will need a more powerful bike, and if you have a more powerful bike you'll need a bigger battery. That's

another problem with electric bikes manufacturers: they advertise that they have a 750-watt "motor," but they only have a 250-watt hour battery, which will run that motor for 15-20 minutes. And then they tell you the range is 30 miles, which requires you to run for 1.5 hours – the numbers don't add up.

With common sense and a little bit of math it's not that hard to figure out the truth behind most manufacturers claims. And indeed, the proof is in the pudding. Ride up some hills on one electric bike, and then go try another brand and see how it works going up the same hill. One bike may use up all its power to go up that hill, meaning its range is greatly reduced. And that's something one has to remember about an electric bike; it's just like your car climbing a steep hill, the gas mileage goes from 25 mpg down to 6 mpg. The same thing is happening with your electric bicycle. So although it can take you up that hill, it may be greatly sacrificing its range to do so. The range on the flat might be 20 miles, but once you've gone up that hill, for even just a few minutes, your range may be cut in half. Therefore, you need to really test the bike to see how much energy you used on that ride.

In an ideal case you'll go take the actual ride you'd be doing if you bought the bike. If you have a daily commute of 10 miles, you'd test ride that bike on the commute, measure how much energy went back into it, verify that's how much you used, and if it works for you, that's great. But don't do a four-mile test ride when you plan to regularly ride 20 miles.

THE VERY REAL HEALTH BENEFITS OF ELECTRIC BIKES

Most of us in the Western world struggle with the lack of time and the lack of exercise. Many Americans sit in their cars for an hour or more each day. If that time was spent riding an electric bicycle, it might take slightly longer, but in the process you'd get over an hour of exercise. If we all got an hour of exercise each day, we would start to solve the health crisis in America. Because, in spite of all the talk of the health crisis in terms of insurance costs and rising health care costs, the real root cause of the health crisis is our health. We need to fundamentally change our lifestyles and therefore our health in order to solve the health crisis financial problem.

One of the greatest misconceptions about electric bikes is that it is not possible to lose weight riding one. Admittedly, at first glance, it seems counterintuitive. With a motor to assist, one would think the rider did less work. The truth is, the electric bike makes it easy to use the bicycle to replace the car, and in doing so increase one's amount of daily exercise. Hill climbing is easier (so you will actually ride up them), and speeds are faster so you can ride longer and go further, hence burning more calories. You can effectively replace sitting in car with easy exercise, which is the best type for longevity.

So how does an individual take responsibility for their life and get more exercise if they're pressed for time? I believe strongly that electric bikes can be the answer for a large percentage of the population. Of course there are all sorts of ways to get cardiovascular exercise other than biking (running, swimming, etc). The great advantage of biking, however, is that it is very low impact; it doesn't have a jarring effect on your joints. Running, on the other hand, is harder on your body; somewhere in the range of 75% of all runners will be injured in a given year. And, especially as the country ages, it becomes harder and harder for people to maintain a consistent running regimen.

There are huge health benefits in riding an electric bike for just 30 minutes a day. The basis of a healthy lifestyle isn't necessarily high intensity exercise – it's consistent, moderate exercise. Throughout history, humans mostly just walked around and that's what we're made to do – light-duty exercise. Intensity exercise can be good, but you're muscles aren't designed to handle it in large doses.

So the electric bike allows you to modulate the amount of intensity you're getting regardless of the terrain. If you climb a hill with a regular bike, you send your heart rate screaming, start perspiring and become winded. But with an electric bike you can get over that hill easily and it remains gentle exercise. And when your muscles are gently exercising day in and day out, it greatly improves your health. The accumulation of a half hour a day of exercise makes a fundamental difference. Most health studies claim that only a few hours of moderate exercise a

week puts you into the top few percent of Americans health-wise. It's not that hard to do, but it's hard to find the time to do it. An electric bike provides a convenient way to exercise while pressed for time.

Electric bikes also offer a great assist to people who have had knee or hip replacements. The electric bike removes the large strain on the joints and makes getting exercise possible again. With the added assist of the motor, the pedaling is smoothed out and less instantaneous strain is created on the joints.

Electric bikes are also great for people recovering from heart operations as the amount of cardiac output can be controlled, so the heart is not strained during the recovery period, but exercise can still be achieved.

ELECTRIC BIKE EPIPHANY – ERIC, BOULDER, COLORADO

In 2010, Optibike started a weight loss fitness challenge. We started it because in 2009, Optibike riders were telling us how owning an electric bike was changing their lives, sometimes losing up to 50 lbs and lowering their blood pressure significantly. These were amazing benefits. We decided to see if we could expand this into a more structured program. So, we hired a professional trainer, Traci Brown, who developed a fitness program for electric bike riders. Riders participated in the program and their doctors monitored their changes.

A man named Eric lost over 50 lbs riding his electric bike and won the competition. Eric was an interesting case study. He was a 50-year-old stock trader whose physician told him that in three years he'd be dead because he was chronically overweight and had high blood pressure and diabetes. His doctor told him to go to the Fat Farm, which he did. However, despite spending over $8000 in a few weeks, the Fat Farm didn't work out. Somehow, he heard about electric bikes and decided to get one. He actually used his retirement fund to buy it, which is interesting because he rationalized he wouldn't need the retirement fund if he died, so it was a good investment.

Once he started using the bike the results were fascinating because he didn't change his diet at all, he just started riding mostly on the weekends, and in our "Century Rides" program with regular cyclists. It got him out for hours and hours at a time. His wife was even getting mad because he was off so much riding his electric bike! But it enabled him to get in shape, and he would come home exhilarated. He couldn't do that on his regular bicycle at all. Eventually, he went off his blood pressure medication and his Lipitor. For Eric, it was an amazing success.

VALUE ADDED HEALTH ON A BIKE!

We need to remember that weight loss reduction programs can cost a lot of money. Whether it's Jenny Craig or Lipitor, we forget that there's quite a cost there. A lot of those costs are covered by health insurance, so you don't pay them directly, but the whole country pays them. It was recently reported that Type 2 diabetes, or adult onset, has doubled in the last 10 years and it now consumes 2% of our entire GDP.

The problem is that we've lost the practice of integrating healthy habits into our lives. A century ago we walked, we had to walk; it wasn't a problem like it is today. Food wasn't as rich. With all these changes, we're struggling for a new paradigm, which would allow people to integrate health into their lives, or what I like to call "Transfitation" – transportation mixed with exercise.

Now, it takes some initiative, like with any health program, to say, "I'm going to ride my bike instead of take my car." You have commit to it. But as more and more people do it and cities adopt initiatives like producing roads with bike paths, it becomes easier to do. Traci Brown is an ex-collegiate cycling champion. She went one step further with our fitness program and added coaching to make it even more effective. She's done a wonderful job and she continues weekly or monthly conference calls with the group and also does one-on-one coaching. The clients are scattered all over the US, so it's all via phone. She helps them take more of an integrated approach; using diet and other exercise along with their cycling provides a more effective way of losing weight.

For most of these people, the average weight loss goal is 40 or 50 lbs. They really need and want to lose weight. In 2011, an Optibike client named Bob lost 75 lbs. It's amazing; he was diabetic and he's no longer diabetic. He doesn't take any drugs. He is 50 years old, very successful in his business, and money wasn't an issue anymore. But now he's fit and his quality of life is higher. It's just amazing to see people do this, and the point is that it isn't that hard.

ENERGY USE, FUEL ECONOMY AND ENVIRONMENTAL IMPACTS

A Toyota Prius can get about 50 miles per gallon. Compare that to an electric bike, which runs on the equivalent of around 2,000 miles a gallon (on a dollar basis); meaning it's about 40 times more efficient. Another way to look at this is that for the same amount of energy we could have 40 electric bikes on the road for every one Prius. Additionally, we can build about 50 electric bikes with the raw materials that go into a single Prius. So if we really want to solve the worldwide energy and transportation crises we face, electric bikes are the way to go.

Electric Bikes as the Total Solution

-Electric bikes are zero emission vehicles when being operated and totally so when charged with a single 150-watt solar panel.

-Electric bikes use 96.5% less raw materials to build than cars

-Even hybrid cars consume about 40 times more energy than electric bikes

-Electric bikes use space more efficiently: 20 bikes fit in one parking space

If you're an average American, you take your car out on the road 19 times a week and drive about 11 miles each time. For every mile you drive, one pound of carbon dioxide, which would fill up a two-and-a-half foot wide balloon, is released into the atmosphere. By the end of the month, you'll have driven 836 miles and released 836 pounds of carbon dioxide, the main cause of global warming.

Our cars are responsible for 50% of urban Green House Gas pollution. The duration and strength of hurricanes has increased by 50% in the last three decades. There will likely be no glaciers left by the year 2070. Nineteen of the 20 hottest years on record have occurred since 1980. Due to drought there has been a 700% increase in forest fires from 1970 to 2003.

The average adult breathes 3,000 gallons of air per day. In Los Angeles, you breathe 10,950 lbs. of polluted air every year. Last year air pollution deaths outnumbered breast cancer and prostate cancer deaths combined. Yearly US traffic fatalities are 40,000, while the yearly deaths caused by air pollution are 70,000.

Asthma in children has increased by 87% since 1982. The average American produces 90,000 lbs of trash in a lifetime, and to store all that garbage there are over 3,000 active landfills in the United States and 10,000 retired landfills.

The only way to save our environment is to reduce waste and conserve energy.

The bottom line is there are various methods to get exercise, reduce emissions and conserve energy. But there's one way to get the exercise you need, reduce emissions and conserve energy all at the same time. Which is to invest in an electric bicycle.

USING ELECTRIC BIKES FOR TRANSPORTATION

There is an intimate relationship between the energy efficiency/environmental impacts of electric bikes, as we've discussed, and the notion of using electric bikes to replace cars for much of our transportation needs. It's really a matter of being forward thinking and adjusting our thought process in regards to transportation. For example, I spoke to a customer the other day who runs a small business and needs a truck for his day-to-day operations. In order to save mileage and wear and tear on this truck, he was shopping for a commuter vehicle for grocery shopping, errands around town, etc. His initial impulse was to purchase a car, maybe a hybrid, but when he looked at electric bikes he quickly realized how much more efficient they are and how much money he'd be saving. In addition to the huge fuel savings and health benefits, with an electric bike there is virtually no maintenance or up-keep; no oil changes or radiator flushes, no insurance or registration is required, etc.

So maybe this gentleman uses an electric bike to replace 25-50% of the trips he was taking with his truck; what he's effectively done is double his overall fuel economy as if he'd bought a Prius. But instead he purchased a much more affordable electric bike and he still owns his truck. American households own an average of 2.2 cars; the last we need is more cars!

What electric cars have going for them is that they are, well, cars. So, I understand that there's more interest in electric cars than electric bicycles because people aren't making a paradigm shift. Plus, you don't have to deal with the weather aspects, or the balance aspects and you can bring the family. The thing to remember is that an electric bicycle isn't for everybody all the time, even though in Holland they tend to bike all year and it's quite amazing. But, in general, there are certain things you can't do on a bike. For instance, you can't bring four kids on your electric bike. However, there are a lot of trips that you can take with your electric bike that will make a difference, not only in terms of the environment and fuel, but in your health. As a nation we're struggling to find time for health and that's where the idea of transportation becoming 'transfitation' comes from; we desperately need an active lifestyle, as well as a new energy economy and a cleaner environment.

It's extremely practical to get around with electric bicycles; we have people doing up to 50-mile commutes. Electric bikes allow you to increase the speed that you would transport by regular bicycle, and that speed starts to approach a car, making them a viable alternative because you're not making a huge sacrifice in time and not getting as sweaty or as tired if on a traditional bicycle. Again, most of us in the Western world struggle with both a lack of time and lack of exercise. So if you're sitting in your car for an hour a day, and you could replace that with an hour and fifteen minutes of exercise on an electric bike, we would begin to solve the health crisis in America.

Another benefit of electric bikes is the potential to take safer routes. With a conventional

bicycle in a commuting situation, people are pressed for time because of the speed limitations of their bike; they'll tend to want to take a direct route. Often time, the direct route is the main artery and potentially the most dangerous to be on with a bicycle. With an electric bike's' enhanced speed and power, you can take a safer route; maybe a bike route that isn't a direct route, takes you out of the way - maybe up a hill incline - and you're able to ride that and not be so slow and exhausted that you can't get there. So they really are an improvement in safety. I'm able to take an alternate route on my commute by going over the mountains and coming in to work, which I'd never do on a regular bike because it would take too long. But on my electric bike it barely adds any time and is much safer and a lot more enjoyable.

In Europe, most people engage in intra-city commuting with their bicycles, and they're fine with a 250-watt bicycle. The 250-watt international electric bike and the 750-watt US electric bike have very different capabilities. A less powerful bike can be great for riding around in town if you need a little extra speed or if you're not physically able, but they're not the answer for a 10- to 20-mile commute. There was a RAF pilot in England who was a cyclist and also a bicycle racer. He would ride his bike about three hours to get to the airbase to go flying and then bicycle back home at night. That was his training for racing. And then he had a baby and he didn't have as much time in his life, so he had to start making tradeoffs. He loved to ride and wanted to stay in shape for bicycle racing, but he didn't have three hours in the morning anymore. His alternative was to drive his car to work, but then he got no exercise. So, he bought an electric bike and his bike ride to work that used to take three hours now took 70 minutes. With the electric bike he was still able to ride for the hour and 10 minutes to work and back and get the conditioning he needed to be a competitive cyclist, and he was freeing up two hours of his time. It was the perfect solution.

LAWS AND REGULATIONS

Electric bikes in the United States are legislated by the federal government. There was a law passed in 2001 that states if electric bikes meet certain criteria they are classified as bicycles for regulatory concern, but states can regulate them more. So it's perhaps far more complicated than a car because electric bikes are illegal in New York City but legal in New Jersey. In Boulder, Colorado they're legal on the bike lane but not on the bike path, plus Boulder has a different power requirement when you ride on a county road versus in town. And if you ride to Denver you might run into another set of laws, because everybody is regulating them differently and there is no uniform law for the entire U.S. So even though there is an umbrella federal law, states and cities are free to make more strict requirements, sort of like what California does with pollution controls on cars.

One important thing to consider about electric bikes is that most countries have 250-watt bikes and 16 mph speed limitations. That includes most of Europe, China. Japan, Australia, and even Canada. So most electric bikes are focused on that market, and with those 16 mph limitations you are manufacturing a very low speed vehicle that's made for congested areas. In America, the land of wide-open spaces, we have lots of room between our suburbs and our towns (in spite of our average trip in a car being 3 miles).

The US law allows for 750-watt electric bikes with real no practical upper speed limit, which means they can be designed to go much faster than electric bikes in other countries. And whenever you're dealing with faster bikes, handling plays a bigger factor. If you look at the bikes in Europe and Asia, they tend to be very utilitarian; they're carrying things on them and not going very fast; they utilize a step-through design and the handling isn't optimized for higher speeds. So it's a bit like taking a truck on a Formula One track. If you compare driving a race car and a truck around town, they'd both handle fine, the truck might actually be better; but you don't want to take the truck around the Indy 500 track, not at those speeds.

So it's important when looking at bikes, like any vehicle or piece of equipment you buy, to consider what you're going to do with it versus what it's capable of. And if it's good enough for what you're doing with it, then fine. Obviously, certain things are built into a higher end electric bike so that it can perform at a higher speed. Take, for example, giant slalom downhill ski racing. Those skis are long, and rigid as hell because they're hitting such high speeds. It's the same with downhill mountain bikes, which have great suspension, bigger tires and are stronger and heavier bikes, because they're going 60 mph so they have to be able to take the speed. And it's no different on an electric bike if you want to go faster or if you're a bigger person. Americans tend to weigh more than people in the rest of the world, so a bike that's designed for a 135 lb person to go 16 mph is not going to work well with a 250 lb person going 25 mph; the durability just won't be there.

Now, if you're 300 pounds, there's definitely a difference between a 250-watt bicycle and a 750-watt one. The argument is that speed is important, not power. So, if you can limit the speed of bikes, why does it matter how powerful they are? If you have a 300-pound guy living in Colorado versus a 130-pound guy living in Venice Beach, and if they're both limited to, say, 20 miles an hour, why should we care about power? The answer is that if the 300-pound guy in Colorado wants to ride up hills, he needs that power. So it is an arbitrary limit. Cars are not limited by horsepower, they're limited by speed. So they can limit the speed and the weight and that would probably be fine. They could argue that they can't weigh more because of kinetic energy. You do want to limit these things to something reasonable.

Again, the fact that there are different electric bike laws in almost every state is a problem. Car laws don't change from state to state. You don't drive into one state and suddenly find you can no longer drive your car there because you have a 600 horsepower Porsche and it's somehow illegal in that state. So bicycle laws are confusing to people and difficult to understand.

Edward Benjamin on Current Trends and The Future of Electric Bikes

Ed Benjamin has been designing, selling and promoting electric bicycles for decades. He has led such electric bike companies as Wavecrest Laboratories and Ultra Motors. He is also the founder and chairman of the Light Electric Vehicle Association (LEVA) www.LEVAssociation.com, an organization dedicated to promoting and facilitating the use of electric bicycles and other light electric vehicles world-wide. Additionally, he is a co-author of the highly-influential Electric Bikes Worldwide Reports www.ebwr.com, which are published annually and are viewed as the industry "Bible" on the current state of the electric bicycle industry as well as on future trends.

Here is an interesting thought: In 2016 we can expect that there will be more electric bicycles in use, worldwide, than the total number if cars and SUVs in use in the USA. I projec worldwide use of electric bikes to grow from 150 million today to 300 million in 2016, compared to the 220 million cars and SUVs in use in the U.S. today (a number that's expected to be about the same in 2016 since people are using their cars longer). That's 300 million electric bikes in 2016 on the road worldwide, not including the many electric motor scooters / motorcycles that are coming soon. And this is all happening in a very short time.

When we consider the forces that are promoting electric powered two wheelers, the increasingly urban human population, increasing costs of fossil fuel, challenges of limited roadway and parking, and environmental issues - we can foresee a day when, worldwide, Light Electric Vehicles (LEVs) will outnumber cars substantially. It is clear to any thoughtful person that the world is close to the end of the time when personal transportation can rely on fossil fuels. Never mind the constraints in supply, rising price, environmental and political issues; it is no longer necessary. Battery electric works. More than 150 million humans now use battery electric vehicles on a daily basis, mostly in China.

And with oil prices headed north of $100 a barrel, and a number of successful battery electric and hybrid electric vehicles of many sorts on the market, it seems that the LEV business is looking at an even brighter future. Consider that more than half of the human race now lives in cities. And the largest cities in the world are really, really big. Those mega-cities are usually located in flat, coastal terrain. In many cases there are 40-50,000 people living in 20 plus story towers – per square kilometer! One of the features of such a living environment is no room for parking, no room for roadways, and no need to go very far – a typical trip is measured in blocks or to the nearest metro station. And in turn, a lot of need for quiet and emission-free transport.

The perfect vehicle for such environments is the bicycle: no noise, no emissions, easy to park, no need for multi-lane roadways. It is important to realize that in China, Japan, Vietnam, India

most of Africa, most of South East Asia, and much of South and Central America (that adds up to a LOT of people, far and away the majority of the humans on earth), bicycles are regarded as primary transportation.

After the numbers were all tallied, we added an estimate of sales by large retailers, like Best Buy, and bike manufacturers that sell E-bikes, like Trek, that do not provide data. The final tally was 80,000 EB units sold in the USA in 2011, the same as in the 2010 survey. That suggests 2011 was neither a growth year, nor a down one for EB sales in the good ol' USA. The only way to go now is up.

Even in Western Europe, home of many famous automakers – more than 33 million people claim bicycles as their primary mode of transportation. And yes, even in the USA, there are millions of people who depend on bicycles; workers in low paid jobs frequently use bicycles for transport. Every year, humans buy something in the vicinity of 130 million bicycles. Worldwide, far more bicycles than cars are in use. And most electric bikes are defined as "bicycles" by law. This privileged category is, in most places, a very desirable designation; almost all roadways are useable, but no helmet, license, registration, or insurance is needed.

Since there can easily be confusion between electric bicycles and human powered bicycles - since both are "bicycles" by law - I propose the use of the terms "Manual Bicycle" and "Electric Bicycle," much the way we refer to human powered typewriters (only a few readers will have had experience with these, and that is a good thing), called Manual Typewriters. I note that even Electric Typewriters are a mystery to some readers, as those had a short reign before being replaced by word processors. I suspect that we will see "electric bicycles" (a term that reminds me a lot of "horseless carriage"), being replaced by a transportation device that we simply cannot imagine now. Just as word processors were unimaginable to the users of Manual Typewriters or Electric Typewriters in the 1960's. Manual bicycles require sweat and effort, and frankly are not fun or easy for transportation. Manual bicycles are for exercise, sport, and recreation.

Electric bikes, however, are for transportation. This thought is inherently abhorrent to bicycle people. But my belief is that the future of manual bicycles is going to resemble the situation of sail powered watercraft today. There was a day when it was unimaginable that steam, or anything other than sail, would carry humans across the water; the fuss and resistance to steam is found detailed in many historical accounts. But in less than 100 years, sail was pushed into a role of sport and recreation, while motorized vessels have taken over all other roles. Today we admire sailboats for their elegance and enjoy them for recreation. But when we need to get from A to B by water, we use a motorboat. That is a glimpse, I believe, of the future of human powered two wheelers: sport and recreation vehicles as art and nostalgia. But they will have no role in transportation. It will take many years, but not as many as it took steam to replace sail boats.

The world and most humans are getting richer. And one of the first things a person does when

his or her pocket is full is buy new wheels. We like to travel, we want to be comfortable, and in many places our wheels are part of our image to the world. Most of us have a daily commute to work or errands, and we use some form or transportation. For billions of humans, the upgrade from a bicycle is a motorcycle. Motorcycles sell well in most of the places that have a bicycle culture, and in many more places that do not. While data varies, it seems that humans buy about 80 million gasoline powered two wheelers every year, worldwide.

Motorcycles have some disagreeable attributes. They are noisy, and the fuel is expensive. In some places, like India, Italy, and Taiwan, there have been experiments with programs to replace gas motorcycles with electric or alternative fuel bikes. In China, they are often banned outright. And the rising cost of fuel is hard on the owners, or in the case of nations where the government subsidizes the price of gasoline to keep motorcyclists on the road; it is hard on government budgets.

Today, the growth in powered two wheelers is in the form of the electric bicycle. But soon it will be the electric motor scooter / light motorcycle. The China Bicycle Association (which is really a semi-government body that governs the two wheeler business of China), says that 2010 saw 29 million electric bikes sold in China. Constraints of lead-acid battery supplies in 2011 may have kept major growth from happening, – not a lack of customers. It is widely commented in China that while a car is wonderful, there is no place to park it and traffic jams are always a problem. Thus, even for car owners in China, an electric bike is better for nearly every daily function.

Major bicycle brands and original equipment manufacturers (OEMs) worldwide are placing more and more research and development, and design effort, on electric. The near legendary Fairly Bike Manufacturing of Taipei is a well established original design manufacturer (ODM) as well as OEM builder of electric bikes for more than 17 years. In Europe, the Sparta Bicycle Brand of the Accell Group recently celebrated shipping their 400,000th electric bike. There are more than 100 models of electric bicycles sold in the EU, and the total sales are thought to be 1.3 million in 2011.

The largest builder of two wheelers in the world, Hero Group of India, just bought a worldwide electric bike brand, Ultra Motor, and announced intentions to distribute in North America, India, and Europe. This is not surprising, since hundreds of thousands (soon to be in the millions) of electric bikes and eMotor scooters are selling in India now. The Japanese buy over 400,000 electric bikes each year – and remember that Japan is actually a pretty small place, one that is famous for… cars and motorcycles! Yamaha announced in 2009 that their best selling single model, alongside all the many successful motorcycles they sell, is the PAS electric bicycle! KYMCO, the 5th largest motorcycle maker in the world, and the nemesis of established brands worldwide (KYMCO motor scooters simply work very well, are inexpensive, and last many years) has just established an electric bicycle brand called Klever.

The big domestic Chinese builders of electric bikes and components are now reaching out to

build their brands in the West. Some of the Chinese companies enjoy millions of units in annual sales. Companies like 8Fun motor company of Suzhou, Lishen Battery Company of Tianjin, and the famous Flying Pigeon Electric Bicycle Company of Tianjin are significant, powerful international players. Add to this the explorations into the electric bike industry by several car manufacturers and car parts makers: Ford debuted an electric bike at the Frankfort Motor Show in 2011, Honda is not only showing the Moto Compo, but has an electric motor scooter in test in Barcelona. Peugoet, BMW, SMART, VW, Hyundai, Piaggio, and GM / Segway, are all showing concepts or approaching production of electric bikes. The big parts makers - Mando of Korea, Bosch, Matra of France, and Magna of Canada - are already in the electric bike / scooter or component business. As are LG Chem, LG Innotek, Panasonic, Sony, and nearly every other battery maker. The Mitsubishi JV in Taiwan, China Motor, has a line of electric bikes and motor scooters now, in reaction to the importance of the electric powered two- wheeler.

It is my belief that not only will battery electric motor scooters become a favorite with consumers on their own merits, but also that many governments will ban fossil fuel scooters once acceptable and affordable electric ones are available. Given the clear trends and forces described above, my prediction is that the electric bicycle business will rise to a world wide volume of about 90 million units, or half of normal bicycles will be replaced with an electric version by 2025. And I predict that electric motor scooters and motorcycles will reach a volume of about 40 million or more by this time. This would get us to a total sales number of 130 million electric powered two wheel units per year, by the year 2025. Furthermore, unlike the staid electric car category, and the nearly frozen state of manual bicycle design, there is great creativity being applied to the electric two-wheeler.

The billions of urban dwellers who will need and use battery electric personal mobility will inevitably shape these products into machines that I may not even be able to imagine today. But I do believe they will have a battery, motor and a couple of wheels.

An Interview on Electric Bikes with Forbes Black

Forbes Black is an influential cycling blogger.

Q: Do you think that electric bikes have proven to be economically viable at this point?

Forbes Black: Well, somewhere around 200 million people so far have voted with their pocketbooks and said that they are. Somewhere between 115 to 200 million people in China ride electric bikes, as well as millions in Europe at this point as well. So, I think the people of the world have spoken and they have resoundingly said that electric bikes are a very practical commuter vehicle. You know, life is different in the U.S., the distances tend to be longer and hauling kids around is more of an expectation, so I don't think at this point in time in our society e-bikes are the answer for every commuter. But I think 50% of American commuters would probably do just fine on an electric bike and they'd be a lot happier for it. They'd be happier, healthier, breathe clean air more often and get a little exercise. So the answer is a resounding

yes.

Q: Do you think American cities have to do more to encourage the type of urban planning to make it more practical?

Forbes Black: I think if we wait for government to make biking easier, we're going to be disappointed. I used to be a bike messenger in Boston. And if there's ever a bicycle unfriendly city in the planet, it's Boston. Everyone is driving like maniacs and they look at bicycles as annoyances, and the weather is certainly not conducive to cycling. But still, Boston is a pretty big bicycle city, just because people have the will to make it so. I think once people get out and realize that bicycling isn't scary and it isn't dangerous that they'll pick it up. And I think you can do that in virtually any city at this point; be it in a big city or out in the countryside - wherever you happen to be.

Q: I think that's a good point you just hit on: don't wait for government to do it. If we get out there and the numbers start growing, they'll adapt accordingly.

Forbes Black: I know from having interviewed officials in the City of Santa Clarita tha government officials are under a lot of pressure to reduce the number of car trips in and out of their city and within their city. So, they're trying the best they can right now but, like I said, I don't think that government regulations and infrastructure improvements are the answer. I think the people have to have the will first and then I think the infrastructure will follow.

Q: Good point. Now, you were involved in the recent documentary, "What is the Electric Car?" which presents some evidence that even some of the bigger players in the auto industry are now making versions of electric cars. But do you see electric bikes being developed by a company like Ford?

Forbes Black: I think that the big auto companies have too much bureaucratic inertia, if you will, to continue to build what they build. I don't see them making such a radical change to start building electric bikes. I think electric bikes are going to come out of the bicycle industry. And if they go big, who knows? Maybe if all of a sudden it's something that's really on the big car companies' radar screens, they may jump on it. But if you look at the difference between motorcycle companies and car companies, in general with a few exceptions, car companies have not jumped on motorcycles even though there's huge market share there. So I don't see them jumping on the electric bike bandwagon, unless they have overwhelming reasons to do so.

Q: As you touched on in the electric car documentary, electric bikes really provide environmental and economic advantages, especially in terms of energy efficiency.

Forbes Black: The environmental advantages are great. But, you know, if you talked to any venture capitalists, they'll tell you, "Well, you know, environmental advantages, are nice and a good marketing tool. But if you want venture capital, if you want to start a company, you don't

try to sell your investors on environmental benefits. Sell your investors on the economics, sell your investors on the fact that people are going to buy these for reasons other than the environment". Recently I was thinking about the bike ride I used to make in Southern California I was working about 15 miles away from where I live, but I had two monster hill climbs, going from Porter Ranch to Simi Valley. So I designed an e-bike specifically for that task and I had a very big motor on it, probably not technically legal in terms of the law.

The point is these types of powerful transportation technologies should be pragmatic. For example, I designed the bike around a 20-amp power pack, which at 48 volts is one kilowatt hour. And I know that that a one kilowatt hour pack would have gotten me at least 20 miles on a charge. So, at roughly 20 cents per kilowatt hour the energy cost on that alone was a penny a mile. Now, you look at the fuel costs on a car, if you get around 20 miles per gallon, you pay about 20 cents a mile. So fuel cost-wise, you're paying five percent of what a car costs when you're on an electric bike. And that's the worst-case scenario. You could probably ride on half the battery power, but I weigh 250 pounds and had 2,000 feet of climbing.

Q: So it's far cheaper to own an electric bike as opposed to a car?

Forbes Black: Right. I've seen figures that estimate the cost of ownership and mileage on an electric bike at about 2.7 cents per mile. Compare that to a car, which IS far costlier—for example, my company reimburses me 55 cents a mile on my car.

Q: Even electric cars require much more of an investment energy-wise than electric bikes, correct?

Forbes Black: Yes, it requires a significant investment in order to charge electric cars, whereas if you're just using an electric bike, virtually no additional investment is needed, whether you're using standard energy sources or renewable such as photovoltaic panels, wind power, etc. Personally, I have got a small photovoltaic solar panel on my house, which provides plenty of electricity to charge my bike and the bikes for my entire family as well. I've got several friends who charge up their electric cars from their photovoltaic arrays, but it takes a big bite out of their energy bills. And I think in terms of environmental sustainability that's huge, because if most people switched to electric bikes, they could produce their transportation energy easily and cheaply from their rooftop.

Q: So, since you're out there in the electric vehicle world, do you have a sense that people in general are becoming more aware of the capabilities and potential of electric cars and bikes?

Forbes Black: Well, let me answer the question in two parts: first, outside of the U.S. electric bikes are huge. People are highly aware of electric bikes as an alternative, primarily in China and in Europe. Secondly, in America, there's been so much of a backlash against electric vehicles; I mean you look around and you see all these naysayers saying that electric vehicles

are not viable.

Now, when you point out that they're much more efficient and so they require a lot less energy in general, they come up with crazy, nonsensical arguments. But I think that that's a real indication that the electric car has permeated the American sensibility, because if it wasn't on anybody's radar screen, there wouldn't be this backlash. Twenty years ago your average American might have said, "I don't know anything about electric cars or I saw one on a science fiction movie once," or something like that. And now, whether they support electric cars or they're skeptical of electric cars, I think your average American at least knows something about them. They'll be able to say, "Well, look, the Chevy Volt is out there," or, "I want an electric car that can go 200 miles on a charge," which shows you they've been thinking about it.

Q: Right, it's in the culture now, you even have ads on TV. And now the priority of the electric bike community is to get the word out because people just don't know what electric bikes are in this country. So, first, you've got to start at the basic level and try to explain it to them.

Forbes Black:: Yeah. Well, unfortunately many people who drive cars think of electric bikes as not manly and fast. And even people who love bicycles say some of the same things.

Q: So, if we're not getting a lot of support from the car people and we're not getting a lot of support from the bicycle people, where do you get your support?

Forbes Black: I think you're going to get your support from people's wallets, because if we see gas hit five bucks a gallon, demand for electric bicycles will shoot up, just as it did a few years ago when gas prices spiked. I don't have the exact numbers but there was a huge spike in electric bicycle sales. So I think what's going to drive electric bike demand more than anything is necessity.

Q: When people actually see someone riding an electric bike, they take notice; you see somebody zipping around and realize, boy, he's really getting somewhere quick.

Forbes Black: I think that's important. It's also important to recognize the difference between the laws in the USA and in Europe. In the electric bicycle industry group we've been talking a lot about this specialized bike that goes 45 kilometers per hour off a 250 watt motor. In America you can have up to a 750-watt motor and the law says you can only go 20 miles an hour—on electricity only. But I'm thinking that Americans with their love for speed and power and everything, you put them on a 750 watt, one horse power bicycle that gets them up to 20 miles per hour very quickly - they're going to start saying, "Hey, this is pretty cool." People will start to think of electric bicycle riding as fun. You know, when you're dealing with a little a Dutch designed bike with a 250 watt motor pedelac, and you're pushing on the pedals and you get a little boost, I think most people have fun with that but I think you can provide even more power to increase the fun factor.

Q: Especially in a place like Boulder - a real hot bed of cycling- where people love to ride in the mountains and foothills, but for most of us it's such a challenge to make those vertical climbs on a regular bike; electric bikes introduce a whole new dynamic.

Forbes Black: Exactly. I was camping in the mountains recently and whipped out my mountain bike, had tons of fun riding from about 10,000 to 11,000 feet of altitude, but even though I was in really good shape I had to accept a ride from some nice person in a station wagon the last two miles back to the campground because I was so exhausted. So that's a major selling point, especially in America where we're all power mad and love speed and acceleration, I think you've got to get Americans on these powerful, accelerating bikes.

Also, to convince them that e-bikes are for anyone: serious cyclists, frumpy middle-aged commuters like me, grandma just going over to the supermarket, everyone. And sell them on the idea that these are fun powerful toys that will make them sexy and attractive to the opposite sex and are just a kick in the pants to ride.

Q: I think you just kind of summed up the marketing campaign, "Pocketbook savings and exhilarating to ride."

Frank Jamerson on the Origins of the Worldwide Electric Bike Business

Frank Jamerson is the founder of Electric Bikes Worldwide Reports (ebwr.com), a service that reports on electric bicycle sales worldwide. He shared with us his perspective on the origins and future prospects of the worldwide electric bike business.

The year was 1993 and the country was recovering from the mild recession of 1990-1991 (GDP dropped 1.4%). General Motors was working on the "productionizing" of the Impac electric car concept, unveiled at the 1990 Los Angeles auto show to rave reviews and a public demand to buy them. So CEO Roger Smith announced that it would go into production and a team was organized, with Ken Baker as Program Manager, to make it happen. Frank Jamerson after a long career at GM Research Labs, joined as Assistant Program Manager for USABC, U Advanced Battery Consortium.

USABC was a partnership of Chrysler, Ford and General Motors along with the Departmer of Energy and the Electric Power Research Institute (electric utility research arm) to select and fund companies in advanced battery technology to replace lead-acid batteries that were the only choice for electric cars at the time. USABC selected Nickel-Metal-Hydride and Lithium Ion a the top candidates to develop and both technologies are in use today in EVs and hybrids.

In the spring of 1993, at a meeting on EVs and batteries in Bregenz, Austria, Jamerson's wife Joy saw some electric bikes having races and pointed them out to Frank. After riding one, the idea occurred to Frank that the electric bike could be a way to get the public used to the idea that a motor and battery makes for a clean, efficient, silent transport system and move them to buy

electric cars, like EV1. So a deal was done with Diamant, an east German company, to impor the Citiblitz EB and sell it in the USA.

The first major company to introduce the electric bike was Yamaha in Japan in 1993 that announced the PAS, Power Assist System, called the Pedelec today in other models, tha energized a motor when pedaling to provide power assist. Other companies, like Panasonic followed and quickly sales grew to the one hundred thousand range in Japan.

The Citiblitz was shown to bike dealers in Naples, Florida and most owners would say, "nc interest, we only pedal". Undeterred, the Electric Battery Bicycle Company was founded and rented a booth at the Interbike show in Las Vegas in fall 1993. A test stand was set up to show how the front wheel was driven by a battery powered motor with a tire-scrubber roller held against the wheel. Dealers really liked the demo but never bought a single one. Today, Diamant is owned by Trek and based in Switzerland.

There were two other USA start-ups at Interbike in 1993, ZAP and Chronos, both with tir scrubber motors and lead-acid batteries. Both Chronos and ZAP sold kits to convert a regula bike to an electric bike for a few hundred dollars. Today ZAP is ZAP Jonway (Chinese smal car manufacturer) with small EV offerings and Chronos is gone.

Jamerson gave up selling the Diamant Citiblitz and tried to sell ZAP electric bikes to loca dealers in southeast Florida. One potential customer was Ed Benjamin, who owned a bike store in Fort Myers and became intrigued with the electric bike concept. After some discussion about the Cologne, Germany electric bike exhibition attended in 1995, Ed Benjamin became very interested in this new class of bike and set out to start a new as a consultant in this new branch of the bicycle industry. The rest is history as Ed Benjamin today is the leading consultant in the Light EV (LEV) industry having also founded the Light Electric Vehicle Association that will be a growing force for standards and other activities to serve the worldwide electric bike industry. (www.levassociation.com)

In1995, Dr. Malcolm Currie, retired CEO of Hughes Aircraft, then owned by General Motors was starting a company with Malcolm Bricklin called Electric Bicycle Company. EBC had a electric bike that used a tire scrubber motor on the rear wheel and was designed as an electric bike. Currie wanted to know about motor developments for electric bikes in Europe and Jamerson offered to make a study since he was to give a talk at the electric bike exhibition established by Hannes Neupert, founder of ExtraEnergy, at the Cologne bike show, September 1995. Neupert and Jamerson met at the first solar bike race, for high school teams, held in Indianapolis, Indiana the spring of 1995.

At Cologne, Jamerson learned of the Heinzmann hub motor and met Heinzmann engineers who had developed this motor especially for electric bikes. The report for Dr. Currie included information obtained at the Cologne show, an estimate of electric bike sales, articles on the industry, battery and motor technology, along with the proceedings of the meeting Neupert had

organized. This first report was called Electric Bikes Worldwide: Intercycle Cologne 95. I projected that electric bike sales would be around 370,000 units with 150,000 in Japan for 1995, and only 3,000 in the USA.

There were many electric bikes at the Cologne show including MBK Ax-Ion Yamaha owned in France, Citibike from England, Schachner Elektro from Austria, and from Germany Diaman Citiblitz, Hercules Electra, and Sachs Electro. Honda Racoon Japan, Twike Switzerland, an Omni-O Taiwan also were exhibitors. This showed that there was really a global beginning to the electric bike business as component makers from China and Taiwan also were present at the Cologne exhibition.

USA electric bike companies, reviewed in EBW95, included ZAP, Chronos, EVWarrior b Electric Bicycle Company (Dr. Currie's company), AeroVironment, Omni Instruments an Monticito Research Easy Going Rider that all had friction wheel drives to power the bike B.A.T. Electrobike had a direct drive to the rear wheel hub. All these companies are gone except for AeroVironment that is a major developer of charger systems for EVs and many military products, like drone aircraft.

AeroVironment also led the GM/Hughes solar car project that built the Sunraycer that won the 1987 first solar car race across Australia. This led Hughes to propose to GM that it develop the Impact sport EV that GM produced and sold as EV1 in the mid- 1990s. Only 800 EV1s wer leased from 1996 to 1999 to customers in California and Arizona through Saturn dealers as gasoline was only $1.25 a gallon and the public did not have the enthusiasm of the LA show viewers of the Impact. Such a low sales rate was unsustainable, so the EV1 was terminated. This resulted in much national criticism of GMs decision from a public that never leased enough of them to make a successful business, which was strange.

Fritz Heinzmann GmbH, of Schönau, Germany, showed a hub motor at Cologne designed especially for electric bikes rated at 400W with peak power at 700W, and used rare earth magnets to achieve good torque. This was the beginning of hub motor usage in electric bikes. Heinzmann offered a kit to convert conventional bikes to electric drive. Jamerson was USA representative for Heinzmann from 1996 to 1998 and introduced it to EV Global Motors, Lee Iacocca's company, that did use the Heinzmann on its electric bike that Iacocca hoped to sell via car dealerships. But it too was not successful.

EBW95 discussed Asia being the big market as the Chinese would step up from conventional bikes to EBs and predicted Europe would be at one million units by 2000 (actually happened in 2010). But in 1995 Japan was the leader with 150,000 units.

Jamerson decided to market EBW to other companies, starting with battery companies that might want to know that a new and major use of batteries in electric bikes was on the way. A second edition was issued in February 1996 and other customers were found. That was then the true beginning of EBWR, called EBW then, and other editions followed as the customer base

grew.

A customer of EBW95 invited Jamerson to visit China in September 1996 to discuss the state of electric bike developments worldwide with Chinese officials. The founder of Shanghai Oltra Motors was starting a new company to manufacture electric bikes and official approval was essential to start a new business. We attended the Shanghai International Bicycle Exhibition and saw the first electric bike products offered in China. Companies exhibiting included Shanghai Forever, Shanghai Phoenix, and Flying Pigeon. Sixteen China electric bike companies were discussed in EBW96, the third edition.

Surprisingly most companies at the Shanghai show used hub motors with only a few bottom bracket drive motors. A number of the companies, including hub motor and battery makers, were run as local government entities. It was obvious from the intensity of the individuals at these electric bike booths that there was something big about to happen with electric bikes in China.

We also went to Interbike in September 1996 ahead of the Shanghai show to learn of electric bike growth in the USA. There were more exhibitors than the three at Interbike 1993. GT Bicycles teamed with AeroVironment to show the Charger with 415W motor driving a second chain. Dahon and Citibike of the UK showed folder electric bikes. B.A.T. Electrobike, Electric Bicycle Company EV Warrior, Procycle a Peugeot Canadian company, Electric Transportation Co. Traveler and ZAP were there. Most of these companies are gone now.

The third edition of EBW issued in January 1997 was called EBW96:China Exhibition Shanghai / Interbike Anaheim. It had the first articles on electric bike regulations in various countries and the solar bike race, now an annual event. Total sales were estimated worldwide to be 190,000 units for 1996 with a revised number of 116,000 for 1995 based on information learned on the China trip. This established the style of updating yearly sales estimates in subsequent editions as more accurate information became available.

Progress was slow in the early years with only a few hundred thousand electric bikes sold yearly worldwide. EBW was issued once every two years. The report was only available in color print version in the early editions and sales were made by “cold calling” and e-mail to companies in the bicycle business. Price was in the $350 to $475 range for editions 3-9 and edition 10, EBWR11/12, at $595, with 2006 edition not issued. Internet download PDF format or CD, as well as colored print version is now offered.

Since the 2004 seventh edition, the report was renamed EBWR for Electric Bikes Worldwide Reports with an Update issued for the off year. The main edition typically is 200 pages long with 300-400 photos and tables while the Update is around 30 pages with 50 photos. The Update includes new sales estimates for the seven countries / regions and nearly 20 European countries that are tracked in all editions. The EBWR website, eight years old, is the main vehicle for EBWR sales. www.ebwr.com

Ed Benjamin became a co-author since the 2004 edition, contributing many articles and insights from his participation in LEVA and all the major electric bike shows in Asia, Europe and the USA. Articles are also written by top executives of important electric bike manufacturers and distributors and officials, such as those from the China Bicycle Association and ETRA in Europe, that works on European Union electric bike regulatory issues. EBWR ha tracked the explosive growth of the China electric bike market from established contacts with the China Bicycle Association and others there. Editions of EBWR in fact show the historical trend with sales estimates updated yearly since 1995. This shows that Japan was the dominant market leader from 1993 to 2000 when total worldwide sales were 440,000 units. China vaulted from 400,000 in 2001 to 1,600,000 in 2002 and on to 12,000,000 in 2005 and 30,000,000 electric bikes projected for 2012. Over 150 million Chinese use their electric bikes daily and those numbers will continue to grow.

Feedback from customers over the years has been most positive and EBWR sales seem to be steady in recent years even with the global downturn. This suggests that the electric bike is finding a real niche in the worldwide transportation business. EBWR estimates the worldwide electric bike sales will be 32,259,000 units for 2012 with 30,000,000 in China alone and 1,283,000 in Europe and only 100,000 in the USA. But the USA numbers could change dramatically upward as the price of gasoline appears to remain at $4 a gallon into the 2012 summer season with projections to be higher in future years.

The reason for optimism in the USA is that a new breed of electric bike manufacturers/ distributors are appearing on the scene. These are individuals who have a lot of business and technical savvy and understand that quality and reliability are the most essential elements of the electric bike business. Such individuals include Don DiCostanzo of Pedego in California, Jim Turner of Optibike in Colorado, Bill Hebb of Hebb Bikes in Texas and Bob Provost of Prodeco in Florida. Currie Technologies, the second and most successful company founded by Dr. Currie, has been led by Larry Pizzi and it was purchased by Accell Group of The Netherlands in 2011. These companies are offering products designed for the USA market to meet the needs of USA customers along with some success in selling to several overseas markets.

Recently, auto companies in Europe and Asia are taking a look at the electric bike market as they are showing prototype electric bikes and escooters at international car shows in Europe. As cities get more densely populated and restrictions appear for four wheel vehicle travel in city centers, car companies will seek alternative two wheel approaches. The General Motors / Segway Electric Networked Vehicle, EN-V, is an example of a small footprint vehicle with enclosed canopy for driver and one passenger that could be used in city centers. GM has recently given it the Chevrolet brand name, so look for it in production sometime. This is the new approach to covered two wheelers that could operate under all-weather conditions. These will be called Electric Powered Two Wheelers, or EPTWs.

Thus EBWR projects that the future for local personal transport will be in EPTWs, Electri Powered Two Wheelers, of designs we cannot imagine today and will include electric bikes as

well. EPTWs surely will come and EBWR projects that by the year 2100, with a globa population of ten billion people, there will be 800 million EPTWs sold to accommodate local travel needs as people on all continents achieve greater freedom and economic growth that surely has to happen to achieve peaceful stability on planet earth.

THE POWER OF ELECTRIC BIKES
BY JIM TURNER