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FUNDAMENTALS OF KNOWLEDGE II

"Andragogy essay about Battery Revolution"

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The Battery Revolution

The imminent need for energy sources in human history takes us to analyze the history and potential of a well know market, the industry of batteries. When we think of batteries we not only reach the thought of an energy source, but we also must recognize the extra value they have by being portable. Let us think of the great benefits we receive from having portable sources of energy, think of a mine, think of a rescue, a trip, and many other situations that may come to mind. In my head a modern society could not be pictured fully without these ingenious devices we commonly call batteries.

The modern history of batteries takes us back to the 1780's when Luigi Galvani created an electrical circuit, unaware. It consisted of two different metals (iron and brass), one connected to the leg of a frog and the other that touched both the leg and the first metal at the same time. Luigi noted that the leg of the frog moved even when the frog had no life.

Galvani's studies were continued by a scientist named Alessandro Volta whom in 1791 realized the frog's tissue could be replaced by cardboard soaked in salt water. He had some previous knowledge of electrostatic and electrical force but after his creation of the voltaic cell he was able to prove the presence of electromotive force (emf/voltage), which can be measured in volts. In 1799 Volta invented the battery by piling many voltaic cells in series, one on top of the other. He was able to produce a voltage of about 50 volts for a 32 cell pile. Volta thought though, that his cells were an endless source of electrical force, and ignored the fact that this electrical energy sourced from a chemical reaction which eventually ran out. This was proven by Michael Faraday around 1830.

By the year 1836 batteries provided more reliable current and were adopted in industry and a few households, we must bear in mind that electrical distribution networks did not exist then. Near the end of the 19th century the creation of the dry cell batteries made them even more practical and reliable.

Batteries had not evolved much since the 1800's, proof of it would be the commonly used automotive battery. The basic principle had prevailed, the heaviness and toxicity of the large vehicle battery remains the same. Even with such limitations business has gone well for those in the battery industry. The global market for large and advance batteries alone went from \$8.4 billion dollars in 2006 to \$8.9 billion dollars in 2007. And this market is expected to reach \$11.4 billion by the year 2012. (1)

Things are changing rapidly now, due to the high demand for environmentally friendly vehicles. A great challenge has presented itself to scientists all over.

Earlier articles talk about the two main categories of the battery, these being the primary (non-rechargeable or disposable) batteries and secondary (rechargeable) batteries. During the last twenty years several entirely new classes of advanced batteries have been commercialized. The demand of new technology in portable energy sourcing is evident and demanding. We now find nickel-metal hydride, secondary lithium, and zinc-air designs that make portable devices function without the impracticality of heavy, toxic and disposable batteries. This new arena does not only offer a new possibility in the marketing of just batteries, but along with these the accordingly devices, wiring and recharging gadgets to go with them.

The battery market I find is a very attractive one considering that for primary batteries the market was worth \$975 million in 2006 and is expected to grow to \$1.2 billion dollars by 2012, on the other hand the rechargeable secondary battery market was approximately \$4.6 billion dollars in 2006 and is expected to move onto more than \$6.3 billion by the year 2012. (2)

Much of the evolution, or revolutionary change in the battery technology is due to the need of finding an alternate mean of powering vehicles for transportation. The hybrid cars and electrically powered vehicles are a present reality, and positive news for the average commuter, with gas prices going up, economical instability and great pollution issues, I believe that it may have taken us over a hundred years to modify our battery cells, but the timing could not have been better.

Let us take a look at the potential markets for this new generation of environmentally friendly vehicles. At present time it is estimated that over 600,000,000 passenger cars travel the streets and roads of the world. (3) In the year 2004 there was a production of 44,554,268 cars; 2005 showed 46,862,978 cars with an increase of +5.18% from the previous year; in 2006 there were 49,886,549 passenger cars produced in the world, that shows an increase of 6.45% from the previous year. Various experts agree the estimated increase for 2007 is to be 4.2%, which is expected to go even lower for 2008. (4). Car production might slow down closing the 5 year cycle of record global auto sales, but the new generation of ecological vehicles might reactivate it in a shorter amount of time.

There are several implications as rules and demands change around the globe, but several manufacturers have proven capable to step up to the challenge. For instance A123 is currently one of the leaders in manufacturing high power lithium ion in the world. They have demonstrated their ability to effectively compete by winning key customers in the cordless tool market. And their experience could help A123 lower costs in the future of powering the automotive industry.

Many others are not far behind but their ability to lower costs of production and thus offer a competitive price to the end customer, are still at struggle.

For instance Myers Motors offers a personal all electrical vehicle or what they call a NMG (no more gas) that can carry only one person and has a storage space of 6 cubic feet at \$36,000, with a consumption of \$20 for every 1,000 miles. (5)

Compare this to a 4 cylinder sedan that costs around \$20,000 with plenty of space for up to 5 passengers and an average consumption of 31 miles per gallon (approximately \$106.45 for 1,000 miles). Environmentally speaking we must bear in mind the first vehicle has 0 emissions. Monetarily speaking the scenario is not all that great. The price for a transportation vehicle for one individual is high.

The roadster made by TESLA MOTORS, on the other hand is a more spacious vehicle with 0 emissions as well and low "fuel" consumption, but it's still high in price. Starting at \$98,000 it offers 0 to 60 miles in 3.9 seconds, 220 miles per charge, 13,000 rpm redline, 135 miles per gallon equivalent, less than 2 cents a mile. (6) Not bad for a sports car, but not very promising for the average commuter.

GM on the other hand is not far behind in this race, but has recently announced that their famous Volt vehicle will not be readily available until 2010. This is what they published in their web site: "We have put tremendous design and engineering resources in place to make this vehicle a reality. The Concept Chevy Volt, with its revolutionary E-Flex Propulsion System will be different that any previous electric vehicle because it will use a lithium ion battery with a variety of range-extending on board power sources, including gas, and in some vehicles E85 ethanol to recharge the battery while driving. When it comes to plugging in, the Volt will be designed to use a common 110-volt household plug. For someone who drives less than 40 miles a day, Chevy Volt will use zero gasoline and produce zero emissions..."(7)

Now consider the Toyota PRIUS, which I find is not all that out of hand. "The Prius took off in 2007, making it one of the top 10 cars (not just hybrid cars, but all cars) in the U.S. Slight increases can be accredited to the introduction of two new hybrid models, while continued high gas prices are clearly pushing hybrid car sales." (8) The 2008 Prius starts at \$21,100 and goes up to \$23,370. This is a gas/electric car, with a MPG of 48/45/48. Not as great in consumption as the Myers model, but fairly attractive for its 5 person seating. (9)

The main challenge plug-in hybrid electric vehicles (PHEVs), and a new generation of electric vehicles (EV) face is the high cost and instability of the available batteries. This is a problem that is rapidly being solved and whose future seems promising for the new generation of eco friendly vehicles. The most powerful and practical of the previously mentioned batteries would be the lithium ion battery (li-ion). This type of battery is slow to charge and discharge, which makes them unsuitable for cars.

Another problem with this type of batteries is that they can release some of the oxygen bound up in their chemicals, which can lead to an explosion. A123 has managed to find a way to solve this issue. They have managed to create an improved lithium ion battery that not only takes up half the space of the previously used li-ion, but also has no liberating oxygen to cause overheating and fire or explosion. A123 has replaced the cobalt in the lithium ion battery with iron phosphate. Iron phosphate won't give up its oxygen molecules, therefore it will cause no overheating. A small change that goes a long way, not only will they create a safer battery but also a less expensive one. Iron is cheaper than cobalt thus this would lead to lower costs.

Hybrid and Electrical Vehicles still have a long way to go, but evidence shows that the demand and pressure of the consumer is present, the flags have signaled a truly revolutionary change is about to hit the

automobile industry world wide. Better batteries are in high demand and our planet has led us to finding ways to make optimal use of our resources, and polluting as less as possible.

A new door of opportunity has opened for visionaries and concerned scientists around the globe, "hybrid car sales in 2007 increased by 37.9% over 2006 for a total of 347,369 hybrid cars sold."⁽¹⁰⁾ This is with only a few models offered for sale and slow customer acceptance. Picture what could happen after these new vehicles build a solid reputation, and get perfected.

I believe the best of man kind is now working together not only for wealth but also for stability and a greater well of the entire human community. Globalization will ensure the vast production of suited safe batteries at a lower cost reach the makers of this new generation of environmentally friendly vehicles. I forecast a 5 year term of high gas prices and an average growth in the use of hybrid and electrical vehicles. But after 2010 this situation will change into an accelerating growth of the market of green transportation, bringing economical benefits to a new industry, not to mention the decrease in air pollutants and hence a slowing down of global warming.

(1) information taken from Electronics.ca™ is a global research network serving the industry, corporations and investment banks.

http://www.electronics.ca/reports/power_batteries/battery_technology.html

(2) (information is from BCC Research, 70 New Canaan Avenue, Norwalk, CT 06850)

(3) <http://www.worldometers.info/cars/>

(4) <http://www.worldometers.info/cars/>

(5) http://www.myersmotors.com/im1/p/2008_Window_Sticker.pdf

(6) <http://www.teslamotors.com/>

(7) <http://www.chevrolet.com/electriccar/>

(8) <http://hybridreview.blogspot.com/2008/01/hybrid-car-sales-in-2007.html>

(9) http://ebrochure.interx2.net/pdfengine/generate.pdf?zip=&sc=12®ion=T&post_back=true

(10) <http://hybridreview.blogspot.com/2008/01/hybrid-car-sales-in-2007.html>