The King is Dead, Long Live The King!

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Introduction to the invention:

Lithium ion batteries are the dead King of the electric vehicle revolution. They were born from the genius mind of Professor John Bannister Goodenough, they reigned supreme for 30 years, and the technology is now dead. Legacy battery systems are the first dead King of the transition from greenhouse gas spewing internal combustion engines to electric vehicles. They served as a bridge to the new King: Power Fuel Solutions revolutionary new fuel cell system.

Power Fuel Solutions invites you to join them in an exciting journey. We are developing the next generation mobile high power supply for electric vehicles that will replace lithium ion batteries. The market potential is unlimited: EVs (electric vehicles), home energy storage systems, electric aviation, mobile robotics, et cetera. The new King is a nascent baby which you can help bring to fruition and change the world. Potential profits are unlimited. LONG LIVE THE KING!

The world is trying to move away from relying upon highly polluting explosions of carbon based fossil fuels in order to generate rotational mechanical movement which is then converted to electricity (e.g. dynamo converter using natural gas as the primary fuel in a fossil fuel plant). The most promising replacement in 125 years for the internal combustion engine are battery powered electric automobiles based upon lithium ion chemistries. Although promising they do fall far short of being able to compete with piston based gasoline fueled cars. Gasoline, energy dense when compared to lithium battery systems[1], is easily stored and transported, exists as a liquid at sea level temperatures and pressures, and is effortlessly obtained from the ground by just drilling into subsurface oil pockets. Battery powered cars rely upon low energy dense, slow chemical energy conversion devices with a limited number of charge cycles. A standard Tesla automobile, costs between $50,000 and $150,000 dollars, and has 8,000+ separate battery cells that will fail within 5 years. One out of five EV owners return back to gasoline powered automobiles because of dissatisfaction with recharge times, cold weather performance, or other factors.[2] Battery powered cars are not yet financially competitive with gasoline powered automobiles and thus their market penetration is stuck at 1% of overall automobile sales.

Even if world governments colluded and banned by fiat all internal combustion engines (an unrealistic thought experiment done here for perspicacity) there would not be enough raw matériel to make the totality of batteries needed for the 1,000,000,000 automobiles that would have to be replaced. Batteries are highly complex mechanical devices requiring a wide variety of exotic and difficult to obtain metals and chemicals: lithium, rare earths, cobalt, nickel, natural graphite, and copper just to name a few. Tesla cannot get enough of these right now and will never be able to obtain what they need to to meet their own internal projections.[3]

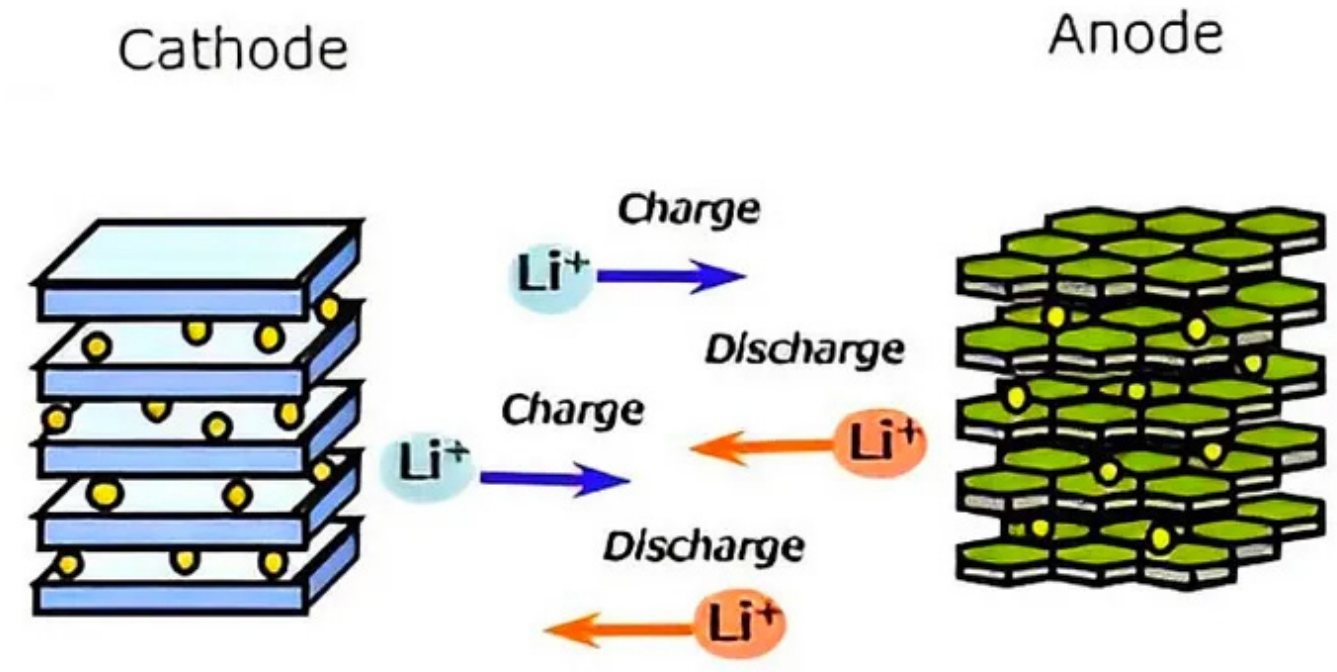
Additionally a large battery for a Tesla stores only 100 kWh (kilo-watt hour - an electric measure of total energy) which is the conversion equivalent to only 2.7 gallons of gasoline. Admirable, yes, that only 2.7 gallons of electrical “gasoline” can push a car for 300 miles but the trade-off is the need for a lighter car manufactured with far more exotically lightened, and very expensive, parts. Our fuel cell technology will bring orders of magnitude more energy storage capability within our liquid fuel. Initial goals are well above 1,000 kWh on car.

Battery chemistry is not robust enough to provide enough power for rapid acceleration without trade-offs of accelerated battery degredation. Tesla has purchased, integrated into their battery systems, and

sold Maxwell's ultra-capacitor technology, and has done an admirable job giving electric vehicles far higher acceleration rates compared to piston powered automobiles. An ability to rapidly dump electrons into electric motors is another area where fuel cells enjoy an advantage over battery systems perhaps without the need for large ultra-capacitor systems.

Fuel cells do suffer one major problem that prevents the technology from replacing earlier legacy battery systems because their performance deteriorates from oxygen fouling of very expensive electrodes. NASA perfected fuel cells for use during the Appollo moon missions but they were practical for the space programme because they were able to carry their own purified oxygen supply with them during the journey which is a luxury we cannot afford to incorporate into our automotive vehicles. Our fuel cell technology does not suffer from electrode fouling because it uses very different, inexpensive, electrode materials which do not degrade during discharge/recharge cycles.

Comparisons Between Legacy & Our New Fuel Cell Technologies:
Legacy lithium-ion batteries function by allowing lithium ions to travel between the positive and negative electrodes during charging and discharging. These electrodes are composed of a thin sheet of metal or metal oxide and coated with a material that can hold and release lithium ions. When the battery discharges, the lithium atoms release electrons into the cathode surface and subsequently move from the positive electrode to the negative electrode thus generating an electrical current that powers devices.



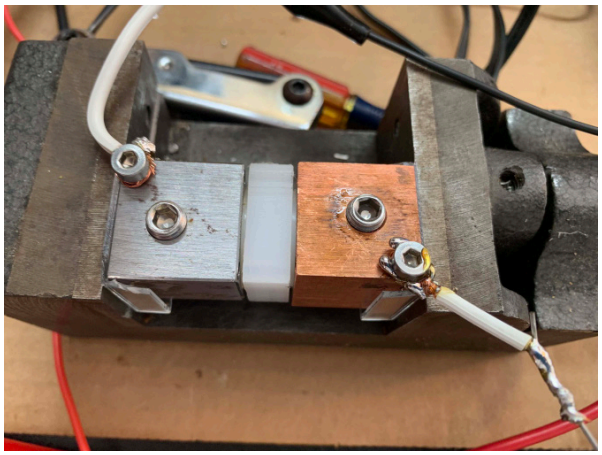
This is the inherent weakness of all battery systems: the physical electrodes are the fuel which supplies the atoms that generate electricity. As the battery is discharged lithium atoms must move out of the positive electrode, into the conductive solution, and over to the negative electrode. The electrode loses mass by losing lithium atoms. Essentially the positive electrode is eventually exhausted of its lithium atoms and the positive electrode is actually consumed and structurally weakened in the discharge process. The negative electrode on the other hand absorbs lithium atoms and also distorts from gaining mass in the form of atoms and swelling. Finally when the battery chemistry is reversed and the battery

recharges the lithium ions move out of the negative electrode and back into the postive electrode. They, however, do not go back to occupy their original positions, but form lithium dendrites (analogous to stalactites) that grow between the positive and negative electrodes during every recharge cycle, and eventually cause battery failure.

Our device does not suffer from this problem. Both electrodes function as catalysts. A catalyst is defined as a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change. The electrodes in our technology do not undergo the structural changes that plague legacy batteries. Legacy batteries lose atoms cyclically transferring from anode to cathode & vice-versa whilst our catalyst liquid fuel cell technology does not. Our technology's electrodes remain unchanged through recharge cycles.

Additionally in legacy lithium-ion batteries the electrode is the fuel so the total energy is limited to the surface area of the electrodes. The lithium-ion atoms are the fuel in the electrodes and are only a small part of the total mass of the electrode material which, ultimately, is a highly limiting factor. In our new technology the fuel is not the electrode but is in liquid form analogous to gasoline in a gas powered engine. This is an enormous advantage because it is an energy multiplier. We are not limited to the battery's electrode surface areas because we can attach highly energy dense liquid fuel.

For our initial proof of concept experiments we made a battery and not a fuel cell. Our power output was robust and stronger than comparable sized D cell batteries even though our "fuel" was only at 12% strength. Our next iteration will incorporate changes that we feel wil improve power output and reliability. The third prototype iteration will actually be a fuel cell with a large resevoir of recirculating liquid fuel.





Legacy battery systems are clearly not robust enough to compete in a free market, without government market intervention, where consumers can choose between an electric powered vehicle over a gasoline powered vehicle, however, the technology to manufacture a far cheaper 3,000 mile EV (electric vehicle) is now available. The R (aka research in R&D) part of the equation is proven and completed. The D (aka development) is now the task at hand. Visionary, early stage investors with capital, business acumen and connections are welcome to join us. We will also consider licensing agreements with established companies.

Currently, we are the equivilent of Tesla in 2003, however our technology covers many more sectors than just automotive. We envision home power storage devices smaller, cheaper, and more robust than AMBRI (seed money from Bill Gates), or gasoline powered solutions such as those made by Generac. There are applications in mobile robotics that would make their deployment into society practicable.

There are also drone, and general & commercial aviation solutions for daunting engineering problems that could be solved only using this technology.

Description Of The Invention:

1) This is a novel fuel cell application that generates electricity using a highly unique electrochemistry, and is currently being fully patented. It consists of an energy dense liquid fuel that is completely non-toxic to our environment and which can be rapidly converted to electrons on demand. Total energy storage and rapid high power output are hallmarks of this technology.

2) Our fuel cell approach is fundamentally different from battery chemistry that occurs within battery cells, which consume the electrodes during the generation of electricity, while simultaneously relocating atomic mass (i.e. charged ions) from said device's electrode and passing them into the battery's paste. When electrical potential is reversed, in order to recharge the battery, the redeposited atoms move back from the battery paste and reorganize into a regrown latttice resembling metallic microstructures similar in shape to stalagmites, and called dendrites.[4,5] Subsequent discharge/charge cycles increase the size and depth disorganization of said dendrites which leads to increased storage capacity loss, and eventually, battery failure. This will not occur with our fuel cell design since the chemistry occurs only in solution for both the anode and cathode and also does not consume the anode or cathode electrodes when charging or discharging. The bottom line is batteries store less and less energy for each discharge/recharge cycle until they catastrophically fail. This does not happen with our fuel cell technology.

3) Energy density is orders of magnitude higher since rolled metal battery is not needed as a mechanical scaffold for chemical paste. Much or what makes up a battery is scaffolding structure.

Original and Unique Design Aspects:

1) This is a fuel cell and not a battery. The electrode is not consumed into the solution on discharge, and then reconstituted back onto the electrode during subsequent recharge as dendritic shaped materials.

2) We use a rechargeable liquid fuel, analogous to liquid gasoline, diesel, or ethanol, and which is highly energy dense. The final effective energy density will depend upon the engineering design however it will be orders of magnitude above that of batteries and will also exceed that of liquid fossil fuels.

3) Waste products output are benign and completely non-toxic for our environment. There are no carbon based pollutants pumped into the atmosphere like that effluxed by fossil fuel powered, piston driven automobiles.

4) There are two general ways to recharge this system: (1) The device can be recharged by applying a reversed potential voltage on the electrodes. This is analogous to charging (as opposed to discharging) a battery. (2) The waste stream, completely benign and non-toxic to our environment, can be vented thru an outside exaust drain and the device can be quickly recharged with fresh liquid fuel much like an automobile's fuel tank is refueled at a gas station. In this case the car can be refilled as quickly as a car that fills up at a gas station. Owners do not have to wait 8 hours to trickle charge their automobile overnight.

Competitive and Comparative Patents:

A competitive patent search has been completed and a patent pending (Application # 63/663,455) was subsequently completed on June 24, 2024. The chemistry and proposed engineering design is unique and fully patentable. Strong patent protection will be in force upon completion of the full patenting process.

References

1) https://upload.wikimedia.org/wikipedia/commons/c/c6/Energy_density.svg

2) https://www.nature.com/articles/s41560-021-00814-9

3) https://www.youtube.com/watch?v=5GYobz2NSc4

4) https://www.batterypoweronline.com/news/a-look-inside-your-battery-watching-the-dendrites-grow/

5) https://www.youtube.com/watch?v=_fu1zvqoDm0

Phase II Plan

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Phase I was successfully completed with all goals being met. We proved that the theoretical described the actual real world physical build response i.e. the chemistry works as theorized.

Phase II-A is the initial performance quantification stage. We need to determine one important criterion: energy density. The ideal fuel cell should have an energy density multiple times that of equivilent weight (and volume) battery systems. In order to arrive at an accurate value I've chosen a proven electrochemistry test platform shown here:



It's hard to pin the exact amount of money that will be needed to conduct this development work however, from experience, and limiting our goals to attainable, quantifiable and highly useful data we will soon have answers that we can compare with legacy battery systems.

Our costs will not exceed:

$	30,000.00	Salary (6 month max)
$	1,000.00	Reagents, Buffers, & assorted Chemicals
$	2,000.00	Ion Exchange Membranes
$	1,500.00	Reaction Vessels (5 units max)
$	0.00	Overhead costs (rent, electricity, taxes, misc.)
$	34,500.00	Estimated Max. Will not exceed.

Phase II will conclude within 6 months of the start date, and most likely, will be completed much earlier. Costs will not exceed those shown above.

Phase II-B is where we will convert the concept rough prototype developed in part A into a potentially highly simplified version our first sellable product. This device is modelled upon competing with a standard total energy capacity of 13.5 kWh Powerwall system using less than 15 gallons of "fuel". Also this design will utilize only two reaction chambers instead of the 6 envisoned for EV (electric vehicle) use. If we have a high enough energy density to exceed that of the firewall and a far lower price, and a longer potential lifespan, then we should be competitive in the marketplace.

The preliminary budget is as follows:

Our costs will not exceed:

$	60,000.00	Salary (12 month max)
$	10,000.00	Reagents, Buffers, & assorted Chemicals
$	10,000.00	Ion Exchange Membranes
$	10,000.00	Design House 3D Printer Solidworks. Outsource to designer.
$	7,500.00	Print Reaction Vessels (5 units max)
$	40,000.00	Learn how to cast ion exchange gels. Interface with chemists.
$	24,000.00	Overhead costs (rent, electricity, taxes, misc.)
$	161,500.00	Estimated Max. Will not exceed.