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GES EXECUTIVE SUMMARY, 1 JANUARY 2016

Since 2009, Global Energy Science, ("GES") has been engaged in the research and development, in energy storage and high power delivery for (1) rechargeable batteries, (2) fuel cells, (3) supercapacitors, (4) water electrolysis for hydrogen production and (5) flow batteries using particle suspensions. By far, the largest and most familiar market relates to batteries; especially high power rechargeable versions used to motivate electric vehicles (EV's), tools and distributed off-grid energy storage. Therefore, the focus of this executive summary is GES' transformative and paradigm changing development in rechargeable batteries.

Important concepts in the electrochemistry of these devices are unfamiliar to many readers so we would like to use a more familiar analogy to explain what GES has achieved and why it is so important. There are many ways to store energy and retrieve it quickly (which is the definition of power). Dams use a reservoir above to store potential energy and let a significant volume of water flow quickly at pressure first through very large low friction pipes (so as not to lose a significant part of that energy) and then through a generator below. Sluice gates allow a controlled release of water to regulate power. Stored energy is limited by the size and height of a reservoir above but power is limited by the size of a pipe conveying water to generators below. It is not commonly appreciated that present electrochemical cells are obliged to use very narrow high friction 'pipes'. That is a fact supported by a fuller explanation in the accompanying Technical Summary.

In a further useful example, imagine a sled on skids carrying a heavy weight slides down an incline. Energy is stored by weight and height of the incline and can be retrieved by tying the sled with a rope to a generator at the top of the incline. Power can be sought by a steeper incline but friction resists movement and increases with the addition of weight and speed of travel. Ultimately friction will heat the sled to the point of ignition. This is not as farfetched as one might imagine except designers of such systems would put the sled on wheels to virtually eliminate friction. Then, not only can greater power be extracted, it becomes possible to pull the weight back up the hill quickly to recharge the system. Due to 'friction', caused by **resistance** in present day batteries, power is limited and recharge time is prolonged. No analogy is perfect but this one describes the state of the art rather well. What GES has done is fit wheels to the sled whereby friction and the heat it causes become negligible. A valuable benefit is realized when a rope pulls the sled back up the hill to recharge the system quickly. Wheels are clearly needed for the system to function with any reasonable efficiency. Existing batteries operate without wheels, i.e. **high electrical resistance**. That is a surprising but indisputable fact not widely appreciated by those of ordinary skill in the art; although fully recognized and understood by experts.

Existing batteries impose an **electrical resistance** barrier wall impeding flow of electrons from the chemistry that produces them to terminals that connect to a useful function, e.g. motor. GES has taken down the wall, put wheels on electrons, accelerated ion flow and eliminated both heat production and associated power loss.

Competition mitigates resistance by greatly expanding electrode area. Energy storing material is more widely distributed in order to reduce friction pressure; at the expense of a crucial ratio of energy stored to cell volume. Even this is insufficient for high power required by cars so the volume is further increased to accommodate obligatory cooling and the relevant range controlling ratio suffers further. When all factors are taken into account GES batteries yield three times more range than any other cell.

GES has redesigned what comprises electrochemical cell **ELECTRODES** *(a conductor through which electricity enters or leaves an object, substance, or region)* which have virtually eliminated a battery's **internal RESISTANCE** to transmission of electrical current, thus removing **internal HEAT** creation. That permits novel battery design to regulate electrical energy flow with high electrical current and voltage (power) in **new ARCHITECTURE** for energy storing systems using rechargeable batteries by which, in effect, the following is allowed to occur:

(i) Delivers and receives (for recharging) an unprecedented amount of electrical energy FASTER (i.e. **POWER)** than currently possible or even imagined in the marketplace today;

(Electric Vehicle charge times would be greatly reduced from approximately 2 to 9 hours to as little as 4 to 20 minutes depending upon charger power)

(ii) Allows for more **3-D ENERGY** storage in the same volume or space currently occupied by less efficient battery storage system because GES batteries do not require membrane separators, cooling apparatus or provision for internal battery cooling volume and are therefore more compact;

(Electric Vehicles could travel 3 times the distance of currently advertised capability on a single charge or; reduces the volume or space required by energy storing systems for specified range and energy storage)

(iii) DOES NOT CREATE HEAT during battery discharge or the recharging process;

(Electric Vehicles would no longer require battery coolant, which would reduce manufacturing cost and ultimately eliminate dangerous heat combustion incidents as evident in hoverboards and aircraft electronics bays)

(iv) Reduces the **COST** to manufacture energy storing battery systems by using more cost effective materials, e.g. simply by eliminating expensive ion selective semipermeable membranes.

An important issue attached to using batteries for powering cars is cost and availability of electricity for charging batteries. Overnight charging at home suffers from limitations affecting most potential users. Distributed charging stations may not be able to provide easy access and rapid service that the traveling public takes for granted. But the biggest challenge by far is the power drain demanded from an already overburdened grid by millions of EV's. GES's ultralow resistance high voltage electrodes containing at least three times more energy density can be fully recharged in a few minutes but 85 kWh (250 miles in a Tesla Model S) cannot be supplied in under five minutes with less than 1 MW of charging power or 2 MW for 500 miles, etc. No other battery can do that so demand has not existed. GES direct oxidation and convection fuel cells using low resistance electrodes will deliver low cost concentrated power for that purpose.

Demand creates opportunity and this is a readymade opportunity for GES fuel cells installed in an existing network of service stations using natural gas (methane) or propane fuels. Only propane must be delivered thus eliminating most fuel delivery trucks. Absent costly ion selective semipermeable membranes and noble metal catalysts required in competitive fuel cells, GES cells operate at high enough temperature to benefit from comparatively cheap non-noble catalysts and no membrane. Cost of manufacture is very significantly less so profit margin should be high. It is a matter of scientific fact that energy extraction efficiency of the fuel cell process, respecting any fuel, is three times that of internal combustion engine generators. That cuts the carbon footprint by the same factor and may even be 0 using molten carbonate electrolyte in GES fuel cells. In effect, it is like putting a fuel cell in a car because charging efficiency can exceed 90%, i.e. electric energy is made by the fuel cell and stored in the car battery. A 2 MW unit working continuously for 24 hours in conjunction with batteries and supercapacitors to smooth demand peaks can fully 'fuel' (for 500 miles) 36 cars per hour over an 8 hour shift. These units can supply the grid with any excess power to help amortize cost rather than burden it. We can also put 150 kW (200 horsepower) fuel cells directly into SUV's, trucks, busses, etc. They would also run on LNG or methanol which is far cheaper than hydrogen.

SUMMARY:

Electrical resistance of commercial battery electrodes is ≈10 ohms/cm^2 yielding ≈0.01 amp/cm^2 current density; indisputable facts that have yet to change for over 100 years. Scientists understand that fundamental architecture in batteries and their electrodes must change if better energy storage density and higher power is to be realized; still, many are trying to improve the mechanical typewriter with better ribbon ink. A 3-D nanotechnology model is the 'right target' according to AP*. GES's version is precisely that with significantly less resistance to permit 100-times higher current density and power, meaning much faster recharge and higher energy density. Volume is reduced because negligible heat production needs no extra provision for cooling as required in prior art. It is accomplished by an astounding reduction of electrode resistance by a factor of 10^4 which adds a 4th dimension, time, because charging is 100 times faster. Furthermore, voltage in a single cell can also be increased 100-fold.

GES, LLC is an R&D advanced technology company offering patent licensing opportunities to manufacturers enabling them to compete using transformative and disruptive products in the fields of secondary batteries, supercapacitors and fuel cells. Our ultralow resistance, high voltage, fast charging, cool, high power battery has been proven with actual test data obtained at Launchpoint Technologies Inc. that can be provided in response to inquiries by qualified parties subject to execution of an appropriate confidential disclosure agreement (CDA) for the purpose of enabling independent investigation. Our data can be confirmed by others with a basic low cost test bed and a sequence of simple proof of concept experiments starting with a supercapacitor that requires no sophisticated chemistry. When the claimed and unprecedented low electrode impedance is realized there will be ample incentive to add battery faradaics to the mix. We can offer support to current manufacturers in a joint development agreement (JDA) if offered and funded. The technology can be extended to fuel cells for compact cheap energy storage and power using direct oxidation of hydrocarbon fuels. GES's objective is a license with manufacturers for royalties.

Further detail explaining principles governing the design and architecture of GES electrochemical cells is presented in a 'Technical Summary' accompanying this Executive Summary.

*AP - http://bigstory.ap.org/article/da59b9b441e949a5a8f7dd3a32e10cab/race-improve-batteries-nanotechnology-provides-hope

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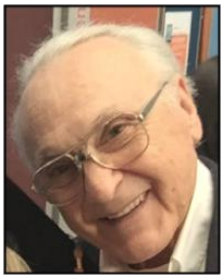

Halbert Fischel, Founder, GES Managing Member, and Lead Inventor

Halbert Fischel is member manager of GES and inventor of issued and pending patents covering the proposed technology. Fischel is principal inventor of many issued patents beginning with space radiation simulation and electro-optical systems for NASA in 1959 and as consultant to various agencies involved in the 'Space Race' in early days. Among his clients were USAF, USN, Honeywell and Hughes Aircraft. As an entrepreneur he founded Sub Marine Systems, Inc (sold to Sterling Electronics, Inc. 1968) based upon several patents devoted to cryogenics. Fischel developed early patents for Baxter Intl. in dialysis and plasmapheresis, co-founded Computer Dialysis Systems, Inc. that was taken public in 1982 and HemaScience Laboratories, Inc. sold to Baxter Intl. in 1983. 55 years ago he started and led a consulting group as innovator for industry, NASA and the military. As a prominent inventor he created new markets with disruptive entrepreneurial inventions that impacted many disciplines and sectors including:

* **Dialysis (membrane) ~$75.0B market:** is a process for removing waste and excess water from blood and is used primarily as an artificial replacement for lost kidney function in people with kidney failure.
* **Plasmapheresis ~$1.1B:** is a process in which the liquid in blood, i.e. plasma, is separated from the cells and used as a donation for medical purposes. In some people, plasma can contain antibodies that attack the immune system. A machine removes the affected plasma which is replaced with good plasma or a substitute.
* **Cryogenic Rebreather:** is a covert underwater breathing apparatus that absorbs the carbon dioxide of a user's exhaled breath to permit the rebreathing (recycling) of unused gas with controlled oxygen content added for each breath.

Philip Lubin, Ph.D. Chief Scientist, GES

Philip Lubin is co-inventor of various GES technologies and a distinguished Physics professor at the University of California, Santa Barbara focusing on creating space probes for measuring deep space microwave background signatures of the early universe**.** Dr. Lubin received his PhD in physics from the University of California, Berkeley in 1980. He is co-recipient of the 2006 Gruber Prize in Cosmology along with the COBE science team for their groundbreaking work in cosmology. He has published more than 200 papers on experimental cosmology. Notable accomplishments, case studies, and published papers from his years of academic experience are the following:

- Experimental cosmology
- Cosmic Background Radiation – spectrum, anisotropy and polarization
- Satellite, balloon-born and ground-based studies of the early universe
- Fundamental Limits of Detection
- Directed Energy Systems

Brad Paden, CEO, LaunchPoint Technologies, Inc.

R&D for GES was carried out at LaunchPoint Technologies, Led by Brad Paden, Ph.D., professor of mechanical engineering at UC Santa Barbara. LaunchPoint is an incubator for GES technology development. **http://www.launchpnt.com/**

GES Investor Group

From its inception, GES has incorporated strategic investors to help facilitate the start-up requirements from conception to proof of concept along with its continuous involvement as lead advisors on the long-term strategic plan for GES.