Terra Supreme Battery (TSB)

Executive Summary

There is a significant shortage of battery energy storage manufacturing capacity in the United States. Storage demands of Clean Tech and renewable power generation have put increasing demands on the existing battery manufacturing base which struggles to keep up. Storage for residential solar and large-scale solar power installations is increasing at a rapid rate. The increasing number of electric vehicle charging stations is stressing our national grid capacity. This stress is creating a huge opportunity for battery energy storage to shift battery charging loads away from periods of peak demand on the grid. The ability to store energy generated by renewable energy sources and deliver it during periods of inadequate base-load power generation capacity is the central focus of green energy/clean tech. TSB battery technology is ideally suited to become a significant participant in these rapidly growing energy storage markets.

TSB's bipolar battery technology provides industry-leading power, energy, and service life in industry-standard packaging formats. This adaptable prismatic packaging capability enables TSB to address motive as well as stationary applications in the highly popular BCI Group 31 format and is the company's launch go-to-market product. Current over-the-road, local delivery trucks and military vehicles have higher electrical load requirements than previous generations of these vehicles. TSB's bipolar technology provides the additional power and energy in standard Group 31 packaging to meet these increasing load requirements while significantly extending service life.

An important metric for assessing battery performance is the number of charge/discharge cycles the battery can deliver before capacity per cycle falls below 80% of its nameplate capacity. As an example, if the nameplate capacity of a battery is 100 Ampere hours (Ah), a typical metric is the number of cycles the battery can deliver 80 Ah under constant current load to a specified Voltage. All battery chemistries can be characterized by this metric. Once characterized, cost per kilowatt hour (kWh) delivered by a particular battery can be computed and used to select the battery best suited for a particular application. TSB's bipolar Group 31 AGM battery is warranted to set new standards for Group 31 AGM cycle life at all depths of discharge. TSB's Group 31 AGM battery provides the lowest cost of service in both stationary and mobile industrial applications.

Recently Lithium-based batteries have received much attention as an energy storage solution that provides 2000 80% depth of discharge cycles. While Lithium batteries are lightweight and cycle well in controlled environments, they exhibit several deficiencies in both stationary and mobile applications.

1. *Lithium batteries have intrinsic safety issues. Current Lithium battery chemistries are volatile and occasionally experience thermal runaway and/or spontaneous combustion. These weaknesses have been publicized by the grounding of the Boeing 787 fleet, numerous internet videos showing EVs engulfed in enormous fireballs and in many cities by regulations prohibiting Lithium energy storage installations in high-rise buildings.*
2. *An added expense incurred by storage systems based on Lithium chemistry is equipment to control battery temperature. Lithium battery power and energy capacity are significantly derated at cold temperatures. Lithium batteries require heat supplied parasitically by its stored energy to be able to do useful work.*

3. *Lithium batteries present challenging logistical issues in shipping and transportation. As a dangerous material, certain transportation modes require shipping Lithium batteries at 20% capacity with special packaging.*

TSB technology replaces industry-standard cast- or stamped lead grids with a lead-impregnated glass yarn woven into a square-mesh grid. The grid is dimensionally stable over the life of the battery, eliminates active material shedding and connects positive and negative plates in contiguous cells in series, eliminating the need for secondary manufacturing operations to connect cells in series. TSB's "bipolar" electrodes and cell topology provide uniform material utilization which enables its batteries to deliver 15-25% more capacity per pound of battery weight than the energy per pound currently available in conventional AGM batteries. Uniform material utilization provided by TSB's cell designs eliminates "hot spots" and dendrites between electrodes and significantly extends cycle life. Packaged in BCI Group 31 format TSB's bipolar battery will deliver up to 55% more power at -18^{o}C, and four to five times the 80% capacity cycles of AGM batteries in current production. TSB technology is priced at $250.00/KWh ($398 /Group 31 battery), greatly exceeds Lithium battery specific power, and requires no temperature management to operate at reduced capacity under extreme low-temperature conditions.

TSB technology is ideally suited to accommodate partial state of charge (PSOC) service required in large-scale energy-storage applications powered by either renewable or fueled power supplies. It is perfectly suited to the reserve capacity and power performance required in commercial trucking, military vehicles, industrial vehicles and marine pleasure and workboat applications. In partial state of charge (PSOC) cycling applications centered at 50% State of Charge the bipolar technology in TSB's Group 31 AGM battery has delivered millions of PSOC cycles with +/- 5% change in SOC per cycle.

TSB's Albion manufacturing facility is comprised of 5 standalone buildings with a total facility footprint of 120,000 square feet. TSB plans to activate the new plant in May 2024 and commence deliveries of its bipolar Group 31 AGM battery in Q3 2024. Group 31 batteries are the standard form factor utilized for the target markets described above: heavy trucks, marine and railroad applications, residential, data centers, commercial and utility stationary energy storage facilities. At full capacity in 2026 TSM will produce 360,000 Group 31 batteries per year.

It should be noted that the lead acid battery was invented in 1859 by French physicist Gaston Plante. His invention literally changed the world. In 1889 a Lead acid battery-powered electric car set a world speed record of 60 miles per hour. In the 165 years since Plante's invention Lead Acid battery technology has continually evolved to today's impressive state.

TSB batteries are environmentally friendly and safe due to strict standards for plant emissions and safety closely monitored by the Environmental Protection Agency and the Occupational Safety and Health Administration (OSHA). Lead acid batteries today lead all other battery chemistries in achieving recyclability of 96% setting the standard for environmentally friendly Greentech.

Currently there is, and for the foreseeable future there will be, a significant shortage of batteries due to rapidly growing energy storage market. Recently a single major US-based battery manufacturer indicated an annual shortfall of 2.5M Group 31 batteries. TSB production is targeted to fill this shortfall. Given the shortage of all batteries in the United States and elsewhere, TSB potential customers indicate that the Albion plant capacity outlined above for TSM's high-performance Group 31 AGM battery will be fully absorbed with long-term contracts.