EXECUTIVE SUMMARY

AUTHOR NAME: IGNACIO LUQUE-HEREDIA

04/06/2025

OVERVIEW

We are creating an innovative electric battery designed to significantly enhance the integration of renewables necessary for reducing carbon emissions and mitigating climate change. Silbat's battery utilises the fusion latent heat of silicon, functioning as a melting silicon battery. Unlike conventional lithium-ion batteries, which rely on rare materials sourced from a limited number of countries—leading to supply chain challenges, environmental degradation, and potential human rights violations—silicon is abundantly available. It ranks as the second most plentiful element in the Earth's crust and coincidentally holds the second highest fusion latent heat in the periodic table. This makes it a cost-effective option for Long Duration Energy Storage (approximately 100 hours), enabling energy-related capital expenditures below $20/kWh. According to the Massachusetts Institute of Technology, this cost target is critical for electricity storage to effectively integrate with solar and wind power, allowing for fully dispatchable electricity generation around the clock—fulfilling the long-held vision of a 100% renewable energy future.

PROBLEM SUMMARY

Governments, utility companies, and industries must significantly increase storage capacity to enhance the integration of variable renewable energies, particularly solar and wind, so they can effectively mitigate the most severe effects of climate change. Ideally, this involves transforming renewables into dispatchable electricity sources. Research from MIT (Ziegler et al., Joule 3, 2019, 2134–2153) suggests that achieving this economically, to compete with existing fossil-fueled plants, requires long-duration stationary storage solutions with approximately 100 hours of capacity and energy-related capital expenditures below $20/kWh. Currently, only two location-limited technologies—pumped hydro storage and compressed air energy storage—approach this cost target. Silbat is developing a modular and portable (containerised) storage solution that aims to achieve $10/kWh during its early industrialisation phases. This innovative technology from Silbat could facilitate the realization of a 100% renewable energy supply paradigm!

INDUSTRY INFORMATION

Currently, Pumped Hydro Systems (PHS) account for the majority of the world's installed electrical storage capacity, recognized as the most cost-effective and established long-duration stationary technology. With energy-related capital expenditures ranging from $50/kWh to $200/kWh, it is the only storage technology projected to approach the $20/kWh threshold necessary for the integration of 100% renewable energy in the future. However, despite its maturity and gradual cost reduction, it remains location-dependent, with weather and topographical factors influencing its performance. Additionally, new installations are subject to social and environmental impact assessments, resulting in protracted approval processes. In contrast, our melting silicon battery offers significantly greater cost reduction potential and is designed to be portable (containerized, similar to lithium-ion batteries) and modular.

OUR SOLUTION

Silbat's battery is constructed from low-cost, readily available metal-grade silicon, which stores electricity in the latent heat of fusion. The metal-grade silicon is housed in a refractory container within a thermally insulated cavity. Electricity is converted into thermal energy through resistors via Joule heating. As the cavity's temperature reaches 1410°C, the silicon begins to melt, and the battery is fully charged when the silicon is entirely molten. Electricity can be harvested from the silicon's radiant heat using thermophotovoltaic cells, designed to convert the infrared emissions from a 1410°C source efficiently. Additionally, the thermal energy can be directly utilized as 300°C steam. The battery discharges completely as the silicon solidifies. To enhance shipping and field installation while promoting localised manufacturing, we plan to offer a modular, portable solution. For instance, if contained in a 40-foot shipping container, it could achieve an estimated power output of 100 kW and approximately 100 hours of capacity.

COMPETITIVE ADVANTAGE

First and foremost, it can be extremely affordable; achieving around $10/kWh would meet MIT's criteria for making renewables dispatchable. Second, thanks to silicon's exceptionally high fusion latent heat, it offers the highest energy density, rivaling that of hydrogen and surpassing commercial lithium-ion batteries. Its density can even be enhanced by alloying silicon with boron. Third, the battery primarily relies on silicon, a raw material that is 1,000 times more abundant than lithium, cobalt, manganese, or nickel, which are essential for conventional lithium-ion batteries and whose reserves are often concentrated in volatile regions. Fourth, it can provide a lifespan exceeding 30 years with relatively low operational and maintenance costs, compared to the 5-10 years typical for lithium-ion batteries. Lastly, it operates quietly and efficiently, as its heat-to-electricity conversion utilizes solid-state electrical and electronic devices, eliminating the need for moving parts such as turbines.

COMPANY BACKGROUND

Research into the principles of storing electricity in melting silicon and extracting it through thermophotovoltaics (TPV) began in 2011 at the Institute of Solar Energy of the Technical University of Madrid (IES-UPM). In the book by R. Wolfe, "The Solar Generation," IEEE Press, 2020, it is recognized as one of the top 10 PV research centers globally, significantly contributing to the growth of this industry. IES-UPM possesses a deep understanding of silicon as the primary material in solar PV and extensive expertise in TPV, having achieved several world records in efficiency. Silbat was established in 2019 as a spin-off of IES-UPM to commercialize this early-stage research and bring it to market. Since its inception, while maintaining a productive partnership with IES-UPM, Silbat has filed multiple patents and secured over €7 million for its initiatives, partly from corporate shareholders, including oil and gas leader Baker Hughes, Spain's renewable energy champion Soltec Power Holdings, and the European Commission's Greentech accelerator, KIC InnoEnergy. Additionally, it has received backing from the esteemed Shell Gamechanger program. Silbat is currently completing its TRL6 and aims to be market-ready within three years.

OUR TEAM & PREMISES

Silbat was founded by Professor Antonio Luque, one of the fathers of present-day PV, and his son, Dr. Ignacio Luque, a seasoned Greentech entrepreneur. Its development is currently driven by a core team of eight engineers and scientists from its lab in Madrid, near Ciudad Universitaria (the university campus), and its testing facilities in Las Rozas, on the outskirts of Madrid. Additionally, it has established a compelling collaboration network with top deep tech companies and research centers, several of which have a seat on its Scientific Advisory Board. Company management is overseen by its Board of Directors, which includes representatives from its founders and corporate shareholders.

CONCLUSION

Silbat is a deep-tech university spin-off developing a radically original and potentially disruptive storage technology that can realise the long-sought paradigm of fully dispatchable variable renewable energies, primarily solar and wind. Following a course technically outlined by Prof. Antonio Luque, Silbat's team has achieved a TRL5 in its development journey, with invaluable cooperation from some of the finest companies and research centres, along with the sustained support of our corporate shareholders. We plan to be ready to commence industrial production of our portable, modular melting silicon battery by 2028. We are working diligently toward this goal!

We are seeking partners and investors. If you are interested in learning more about our mission, please don't hesitate to contact us.

Silbat Energy Storage Solutions, SL
Engineering: Av. Doctor Federico Rubio y Galí, 75, 28040, Madrid, Spain - **Testing premises:** C/Estocolmo, 23B - C/Lisboa,8, 28232 Las Rozas de Madrid, Spain
Registro Mercantil de Madrid, Tomo 39387, Folio 51, Hoja M699332, C.I.F. (VAT no.): B88425236
www.silbat.com