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A NEW ARCHITECTURE FOR STORED POWER

Energy Density in batteries is the primary bottleneck to the global mass adoption of Electric Vehicles (EVs) and Renewable Energy (like solar and wind power). Today's batteries have a short life, are too costly, too large, and too heavy, so they limit a vast array of applications. Batteries often require specialized manufacturing facilities for different applications, which limits the opportunities to cost-efficiently scale manufacturing and create enough power to meet global stored energy demands.

Currently, the total global annual production capacity for battery technology stands at 150 gigawatts. By 2050, the global renewable energy demand for the grid alone will be 42-terawatts, according to the IPCC (Intergovernmental Panel on Climate Control). Additionally, multiple terawatts will also be needed for transport and the electrification of other emerging markets. And, this volume of power, will not come from the grid because according to Lawrence Livermore Labs, 68% of all energy that is contributed to the U.S. grid is "wasted" through resistance, transmission, transfers, and curtailment (energy that is rejected when it cannot be used or stored, since the grid is not a battery).

There is clearly an overwhelming need to find a cost-efficient, scalable manufacturing architecture for batteries that can meet changes in density, size, weight, and shape for every use case, including Transport, Grid, Consumer Electronics, the Internet of Things, and everything in between. Moreover, this architecture would need to facilitate the mass production of batteries that are safe, tunable, and affordable.

Such an application, could, in itself, make renewable energy viable to meet the exponential global growth of stored energy demand.

The Solution

XNRGI, with its new architecture for stored power, is the solution. It is the only technology that is able to scale battery production, using existing battery manufacturing infrastructure, to terawatt capacity. All other battery technologies require extremely large capital expenditures and several years to build-out the capacity that XNRGI already has in place. XNRGI can immediately enable battery manufacturing to scale to the cost levels necessary to meet demand of emerging markets and ultimately replace fossil fuel energy.

"The arrival of cheap battery storage will mean that it becomes increasingly possible to finesse the delivery of electricity from wind and solar, so that these technologies can help meet demand even when the wind isn't blowing and the sun isn't shining. The result will be renewables eating up more and more of the existing market for coal, gas and nuclear." Bloomberg NEO 2018

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XNRGI: A New Battery Architecture

XNRGI, recently funded by a US Department of Energy (DOE) grant for advance manufacturing of the **X-PowerChipTM*,* has developed a game-changing, high-performance, rechargeable lithium metal battery (using a 3D porous silicon structure as the electrode substrate),** which can be manufactured using a low-cost, contract-based, semiconductor foundry model to reduce CapEx costs by 95% (compared to traditional battery factories that require billions to build and years to construct). Most importantly, the semiconductor manufacturing foundation of the XNRGI battery will allow the technology to improve along the same path as semiconductor improvements (i.e., Moore's Law), while lithium-ion technology is approaching its limited potential for improvement.

The XNRGI technology platform is based on the most versatile manufacturing platform that the battery industry has seen in its long history. It has solved numerous disadvantages of old conventional legacy battery technology that has plagued the battery industry during the past 30 years. XNRGI's Lithium Metal anode has 10-times the energy density of a standard Lithium Ion anode. Combined with XNRGI's 3D pores that increase the active surface area of the battery by 70-times, performance is dramatically improved. At the same time, XNRGI's 3D pores create a cool and safe architecture for any battery chemistry, basically eliminating concerns of overheating and fire, which have plagued other Lithium Ion batteries. The XNRGI battery design is "chemistry" agnostic as it does not restrict use of almost any cathode material, including the most common LCO, NMC, NCA, or LFP cathode materials. The main advantages of this method include: high energy density today demonstrating Lithium Metal battery at **(> 1600 Wh/L) 405 Wh/kg** and, XNRGI's next generation battery in 2020 Lithium Metal Air at **(4400 Wh/L), 680 Wh/kg** with high currents that enable fast charge and discharge, long cycle life based on elimination of lithium dendrite formation, greatly improved safety, and low-cost batch fabrication. XNRGI's 3D architecture provides a safe house of new chemistries to be safely contained for future high energy density materials, which can be manufactured in high volumes - a flexible architecture foundation platform for the evolution and design of batteries in the future.

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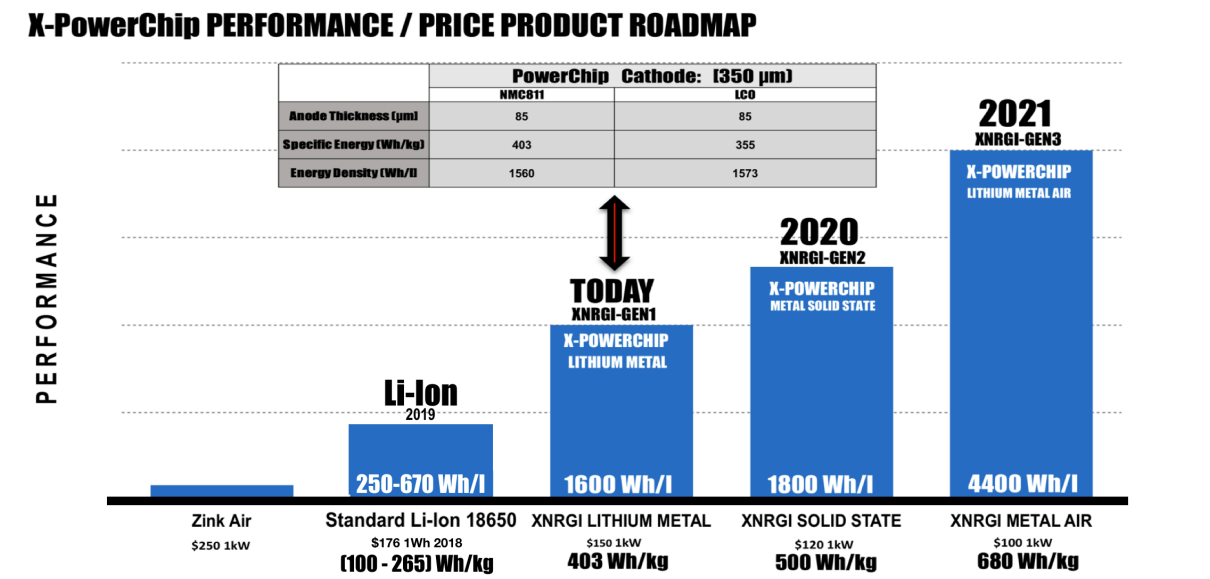
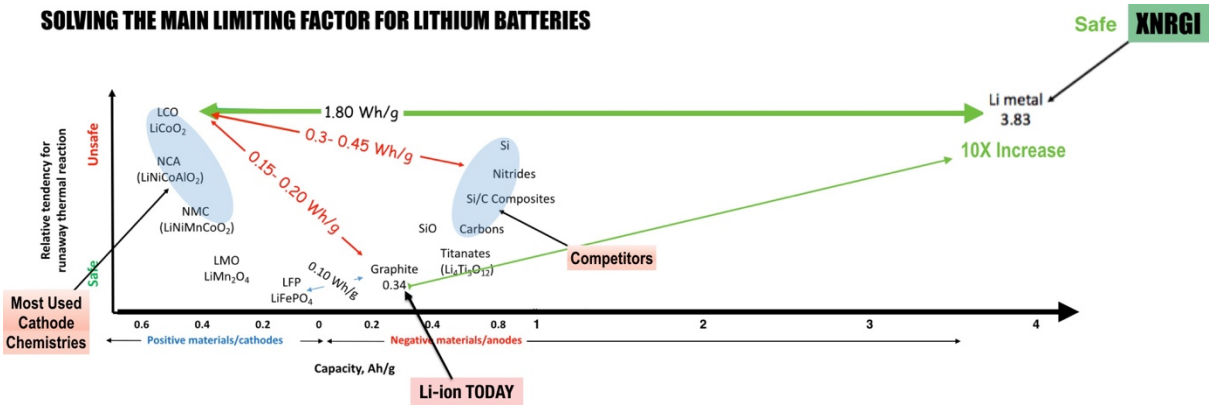


Logan Goldie-Scot, head of energy storage research at BloombergNEF. Lithium-ion battery pack prices, which averaged $1,160 per kilowatt hour in 2010, reached **$176** per kWh last year Sourcce: 2018 BloombergNEF

Li-ion batteries have one of the highest energy densities of any battery technology today **(100-265 Wh/kg or 250-670 Wh/L)**. Source: (c) 2019 Clean Energy Institute
https://www.cei.washington.edu/education/science-of-solar/battery- technology/

Performance / Price Product Roadmap

XNRGI has produced 1000 working samples (10 billion micro-batteries) for a wide range of clients, and proven its ability to manufacture its batteries at less than $150/kWh no matter what the application or scale.



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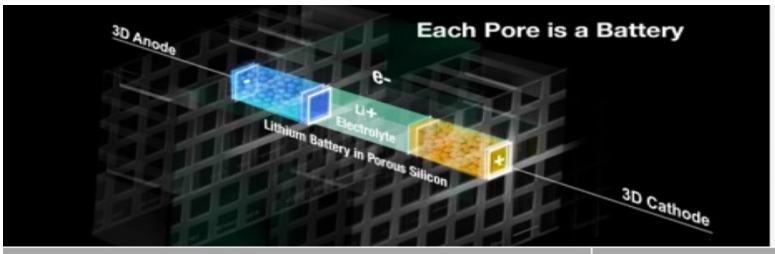
Technology Advantages:
XNRGI believes that our silicon architecture enables various advantages in performance, cost, manufacturability, and technology extendibility, including: packaging, safety, power and energy density optimization, and an application for a range of sizes from micro batteries (for the Internet of Things) to large batteries (for EV and Grid scale storage). XNRGI also has the ability to innovate battery enhancements every 18 to 24 months, thereby allowing continuous improvements unlike conventional battery architectures.

XNRGI is the ONLY flexible architecture platform that enables high performance, low-cost high-volume production of batteries that will bring about the mass adoption of EVs and Renewable Energies.

XNRGI's Proprietary PowerChipTM Battery

In addition to XNRGI's IP Portfolio of 15 issued patents, 13 applications, and 6 patent disclosures, XNRGI's PowerChipTM technology has a number of unparalleled, first-ever features that set it apart from any other battery technology:



Feature	Benefit
3D structure gives 70X increase in area	High (3.5X) energy density, low local currents
Vast array of micro batteries	Rapid Charging and Discharge. Safe! No thermal runaway
Physical wall of separation, no separator	Eliminates dendrite growth, SEI, reduces cost
Silicon based foundry production	Low cost, short lead time to manufacturing
Lithium metal anode	10X better anode than conventional anodes
Technology platform	Serves range of battery types

XNRGI's Competition

XNRGI addresses all five key performance characteristics, Energy Density, Safety, Low Cost Capital Efficient Manufacturing, Flexible Technology Platform (unlimited applications), and short lead-time for manufacturing to secure a new supplier qualified for mass production (typically 3-6 months). Conversely, its competitors typically address only one or two of the five key areas of battery performance (Energy Density and/or Safety), they are burdened with the large capital costs that are associated with long lead times for manufacturing, and are limited to one cathode, and thereby limited to one type of application.

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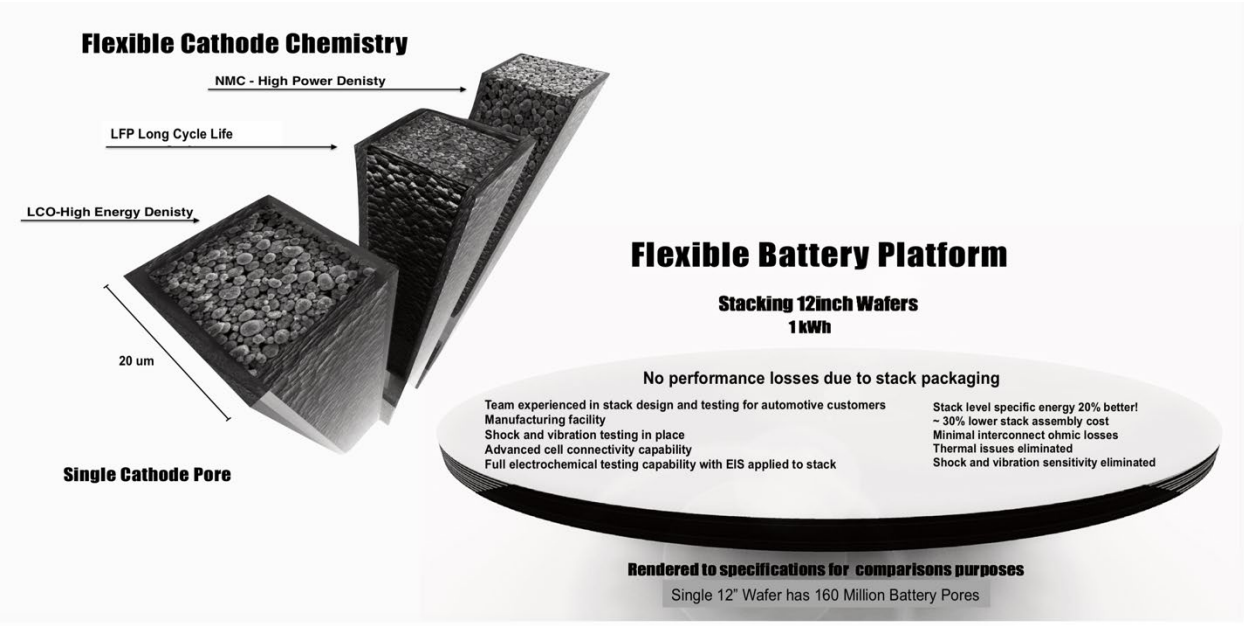

Anode	Cathode	Purpose
Lithium metal	Counter-electrode	Anode only tests (anode licensing)
Lithium metal	LCO	Consumer devices
Lithium metal	NMC	Automotive and storage
Lithium metal	XNRGI Proprietary	Multiple applications, ease of manufacturing

XNRGI's Scalable and Tunable Market Application Advantages

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While XNRGI's Early Adopter Program (EAP) has already built more than 600 working samples (8 billion micro-batteries) for a wide range of clients, the company is looking for high volume launch partners who can demonstrate the unique storage applications of its technology.

Early Adopter Programs have proven the effectiveness of XNRGI technologies in several areas, including:

- Grid Scale Storage for intermittent renewables like Solar/Wind and Back-up Power
- Electric Vehicles with 3-6X High Power Density, 2-3X lighter Weight, at a considerably lower cost.
- Consumer Electronics: Highest watt hours per liter at 1600 Wh/l for long lasting performance.
- Internet of Things with micron-size high power and slow discharge advantages.

Summary

Driven by mobility (transportation) and grid-scale storage, the battery market is set to grow at a compounded annual growth rate of more than 40% over the next few years.

XNRGI is uniquely positioned solve the industry-wide challenges of performance, cost, safety, outsourced manufacturing, and short lead-time to manufacturing. The architecture serves as an innovation platform that will enable an evolutionary path for battery advances for many years to come.

With significant inroads to and Early Adopter Programs with the worlds-largest EV, Grid, Consumer Electronics, and IoT manufacturers, XNRGI is equally well-positioned for rapid, profitable growth and the ability to supply the world's demand for electric energy storage.