

A Memo on Climate Risk and the Role of Sustainable Battery Materials

FROM THE BATTERY TO THE SUSTAINABLE BATTERY

Earth is approaching a set of irreversible climate and ecological tipping points. Rising global temperatures, accelerating biodiversity loss, ocean acidification, freshwater depletion, and atmospheric instability are no longer future risks, they are active system failures already underway.

At current trajectories, the planet's climate and ecological systems will not remain stable enough to support modern civilization, let alone the natural systems upon which all life depends. To prevent catastrophic ecosystem decline, and eventual collapse, global greenhouse gas emissions must decline rapidly and permanently within this decade. Electrification of energy, transport, and industry is essential to that outcome. And electrification, at scale, is impossible without batteries.

In 2019, the World Economic Forum correctly identified the battery as *the enabling technology of the global energy transition*. But six years later, a critical realization has emerged: A battery that enables decarbonization while being built on expensive carbon-intensive fossil-derived mining and materials, with a fragile high-carbon footprint, (90% of batteries and battery materials come from China), is not a climate solution, it is a delay mechanism.

The world does not just need *more batteries*. It needs **Sustainable Batteries**.

This whitepaper argues that *the Sustainable Battery*, defined by low-carbon materials, waste-to-value feedstocks, high energy density, and domestic manufacturability, is one of the most powerful tools available to reverse global environmental destruction.

The Climate Reality: A System Under Stress

Earth's climate system is governed by feedback loops. When pushed beyond certain thresholds, those loops accelerate damage rather than dampen it.

Key indicators now show atmospheric CO₂ concentrations at levels not seen in millions of years, global average temperatures approaching thresholds associated with ice-sheet destabilization, ecosystem degradation occurring faster than natural recovery rates, mass species loss undermining food webs, soil health, and ocean productivity.

Without rapid emissions reduction, climate models consistently show declining agricultural productivity, increased extreme weather and heat stress, large-scale ecosystem collapse, severe economic and humanitarian instability

This is not ideology. It is physics, chemistry, and biology.

Electrification Is Necessary - but Not Sufficient

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Decarbonization pathways rely on electrification such as renewable power replacing fossil generation, electric vehicles (EVs) replacing internal combustion engines, and an electrified industry transition replacing thermal fossil processes. Every one of these pathways depends on batteries.

However, today's dominant battery technologies carry significant hidden emissions upstream such as polluting mining and refining of iron, nickel, cobalt, manganese and other materials that go into many battery products, with long, fossil-powered global logistics chains, and carbon-heavy manufacturing in coal-dependent regions. As battery deployment scales, so does this embedded carbon. If battery materials remain fossil-intensive, electrification alone will not stabilize the climate.

The Battery Industry's Blind Spot

Current climate strategies focus heavily on EV adoption rates, renewable capacity installations, and grid-storage deployment targets. Far less attention is paid to what batteries are made of. This has created a dangerous paradox: *Clean energy systems increasingly rely on dirty polluting material foundations.*

If left unaddressed, these paradox risks are slowing net emissions reductions, undermining ESG credibility, locking in new critical material extractive dependencies, replacing fossil geopolitics with battery-material geopolitics. To remain credible, the battery industry must decarbonize itself.

From "The Battery" to *The Sustainable Battery*

A Sustainable Battery is not a marketing claim. It is a new ecosystem platform foundation defined by five criteria; 1) reduced or eliminated reliance on mined critical minerals, 2) dramatic lifecycle carbon intensity, including upstream raw and waste materials, 3) domestic or allied-nation supply chains (shift from Asia to the West), 4) higher energy density battery cell performance, thus reducing total material need and demand, and 5) lower product cost and commercial scalability, enabling global deployment. Battery systems that fail these criteria will become transition bottlenecks, regardless of performance or cost.

Waste-to-Value: Turning Pollution into Climate Infrastructure

One of the most powerful climate strategies available is waste-to-value transformation. Certain industrial byproducts already exist in massive quantities, sulfur, generated by petroleum refining, and lignin and tannin, generated by the pulp and paper industries. These materials are often treated as disposal liabilities, in many cases simply burned.

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Yet, when engineered correctly, they can become high-performance battery materials, without new mining, without new extraction, and with far lower carbon footprint.

This approach does more than reduce emissions, it avoids new environmental damage, it reduces industrial waste burdens, and creates domestic, circular economic supply chains. This is climate remediation, not just mitigation.

XBM and the Leapfrog Pathway

Xponential Battery Materials (XBM), a small US based early-stage innovative technology company is advancing a practical and scalable Sustainable Battery materials platform built on this exact principle, it is called CarbonX™. Rather than competing with yesterday's lithium-ion battery (LIB) based chemistries, XBM is leapfrogging them by converting industrial waste byproduct streams into high-performance battery cathode and anode product solutions. The company's CarbonX lithium-sulfur (Li-S) cathode utilizes sulfur lignin/tannin (all industrial byproducts) into a low cost high-capacity cathode active material (CAM) and its CarbonX high-capacity silicon-carbon Si-C (50% silicon/50% lignin-based graphite) anode use a proprietary silicon process coupled with a novel synthetic (lignin based) graphite to replace conventional graphite anodes as a stand-alone product. When deployed by a battery or EV manufacturers as their battery cell cathode and/or anode, these XBM materials will help them achieve much higher cell level energy density, at lower cost with dramatically lower carbon footprint. The company is engineering Tonnes per Annum (TPA) commercial scale modular automated manufacturing line systems that can be replicated and deployed globally. In some configurations, the net effect of CarbonX cathode and anode solutions approaches carbon-neutral or carbon-negative material production, when waste avoidance and displaced mining are considered.

This is not theoretical. It is being built now.

Why the Sustainable Battery Can Help Reverse Ecosystem Decline

Higher-density, lower-carbon batteries enable faster displacement of fossil fuels, lower total material extraction per unit of energy, reduced land, water, and biodiversity damage, and electrification of sectors previously impossible to decarbonize (aviation, heavy transport, AI infrastructure, etc.).

By reducing both direct emissions and systemic environmental pressure, Sustainable Batteries act as a force multiplier for ecosystem recovery.

Replication Is the Measure of Survival

No climate solution matters if it cannot scale globally. Sustainable Battery materials based on widely available industrial byproducts, in scalable modular lines, in region-adaptable

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manufacturing, using domestic supply chains that can be deployed in every industrialized and emerging economy, makes the Sustainable Battery not just a technology, but a global climate infrastructure platform.

The Cost of Inaction

If the world fails to decarbonize battery materials emissions reductions will stall, ecosystem damage will accelerate, climate instability will deepen, public trust in climate solutions will erode, and the planet's natural systems **will not continue to function as they do today.**

Conclusion: A Narrow Window, A Real Solution

The World Economic Forum was right: the battery is a cornerstone technology of the 21st century. But the defining challenge of this decade is more nuanced and sharper. Only the Sustainable Battery built from abundant, low-carbon materials and produced through resilient, domestic supply chains can help prevent catastrophic climate and ecosystem collapse.

The science is clear. The technology exists. The window to act is narrow. The choice is no longer *whether* to transition but how fast we choose to build the right foundation.