OurCrowd

Powering the Future: The Battery Technology Revolution

September 2024

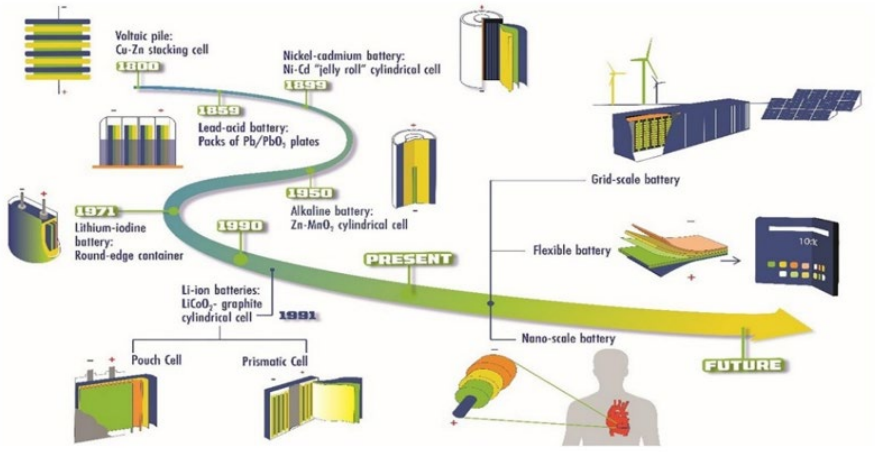
Powering the Future: The Battery Technology Revolution

Takeaway Points

- Demand for EVs, edge devices, and efficient power-storage systems is fueling explosive battery demand growth.
- BatteryTech companies addressing the challenges of higher performance, faster charging, longer duration, safer, and more sustainable batteries present investment opportunities in a growth industry propelled by – and itself accelerating – commercial and economic growth worldwide.
- Revenues across the battery value chain are forecast to increase 5X from 2022 levels to more than $400B by 2030.[1]
- Investments in technological solutions are ramping up with $7B invested in BatteryTech companies in H1 2024 – more than in the entire then-record year of 2022.[2]
- Corporate investors with downstream interests – EVs, device manufacturers, electronic conglomerates, utilities – have been investing heavily.
- Risks for all investors include choosing a winner among new or improved electro chemistries such as sodium-ion and solid state or supporting significant enhancements to lithium-ion (Li-ion) structures or battery management systems (BMS).
- Korea and other countries whose champion national industries depend on battery innovation are also racing for new solutions.
- With Li-ion forecast to dominate the battery market through the decade, many startups are focusing on peripheral technologies to improve Li-ion efficiency and sustainability.

On the cusp of a battery-powered future

Batteries which we once bought as AA or AAA cells to power our radios, flashlights, and other mundane electrical devices, or as heavy 12-volt bricks to start our cars, have morphed into a major catalyst for the expansion of industries and economies. Battery advancements accelerated growth in consumer sectors including electric vehicles (EVs), smartphones, internet of things (IoT) and other edge devices, as well as national and regional utilities around the world building ever larger grid-scale battery energy storage systems (BESS) powering the energy-hungry demands of data centers and regional electricity companies aiming to meet net-zero sustainability goals.



Frontiers in Energy Research, Sep. 3, 2020

[1] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-2030-resilient-sustainable-and-circular%23/

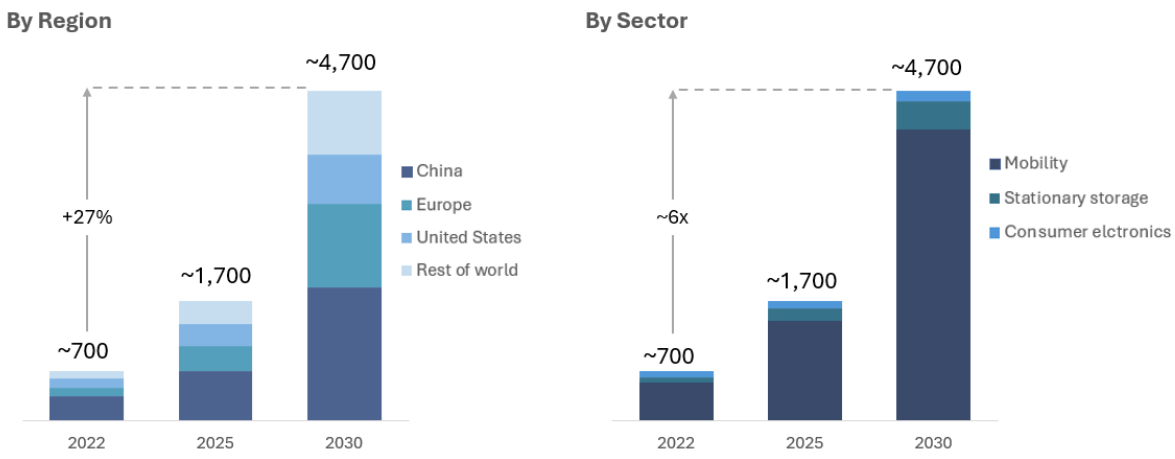
[2] Source: Pitchbook, OurCrowd calculations

Since the start of the lithium-ion (Li-ion) revolution in the 1990s,[3] batteries have become a dominant driver of growth and profits in these downstream markets. As a result, investment in battery technology has been ramping up to meet ever-increasing industry demands. Funding has come both from traditional VC investors as well as downstream manufacturers – especially EV interests – and splits into two different approaches: (1) next-generation battery alternatives to Li-ion; and (2) improvements in the efficiency and sustainability of Li-ion batteries. Given that Li-ion is forecast to continue to dominate the battery market at least through the end of this decade,[4] this report focuses on exploring investment opportunities in companies aiming to improve Li-ion battery efficiency and sustainability through its components, thermal management systems (TMS), and recycling and reuse.

Surging demand fuels opportunities across value chain

Battery demand as measured by GWh[5] is forecast to grow almost 7X by the end of the decade compared to 2022, driven by the surge in EV and edge-device adoption, particularly with AI integration in IoT and edge devices, and the construction in the US, Europe, and Australia of grid-scale BESS. McKinsey forecasts that global demand for Li-ion batteries will grow at a compound annual growth rate (CAGR) of almost 30% from 2022 to 2030 to nearly 5TWh, compared to 700GWh at the start of the period.[6]

Global Li-ion battery cell demand, GWh, Base case



'including passenger cars, commercial vehicles, two-to-three wheelers, off-highway vehicles and aviation.

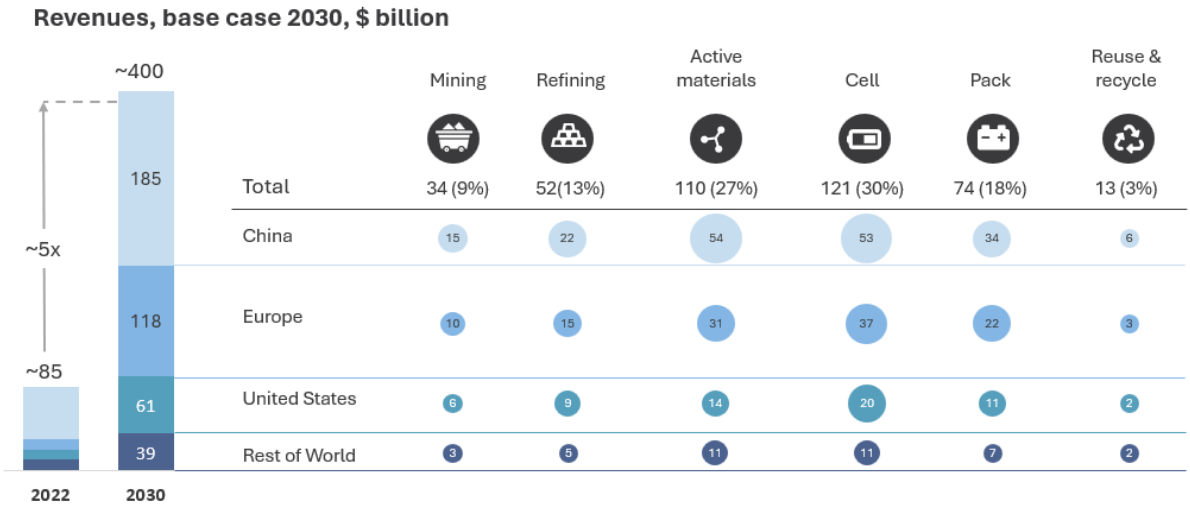
[3] See appendix for more information on Li-ion batteries

[4] https://thestlouisgroup.com/global-battery-demand/

[5] The amount of electricity generated, consumed, or stored over a period of time

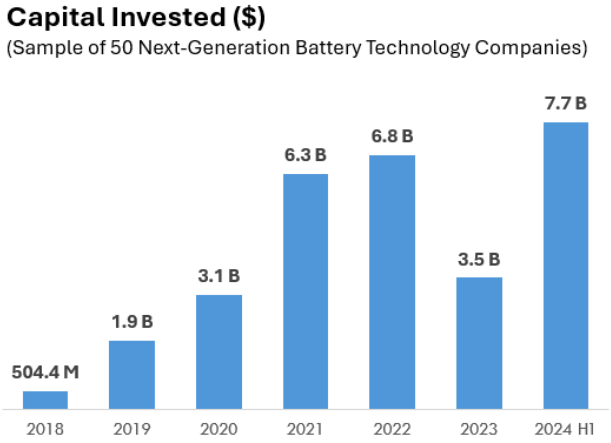
[6] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-2030-resilient-sustainable-and-circular#/

Over the same period, McKinsey estimates that revenues across the battery value chain, from mining to recycling and reuse (particularly in new installations of BESS), will increase 5X across industries, from about $85B in 2022 to over $400B in 2030.[7]



Virtuous cycle of batteries and downstream markets

Growth in the battery sector is being driven by downstream demand ranging from faster charging and longer range EVs, edge devices capable of AI, and smaller smartphones and wearables, to immensely larger BESS. At the same time, demand for these products and installations is driven by higher density, longer duration, safer, and more sustainable batteries. All of this is made possible by accelerated investment in the battery technology sector. As illustrated in the chart on the right, extracting the global cross-sector investment decline in 2023, investment in battery technologies has been gaining momentum. In just the first six months of 2024, almost $7B was invested in battery technology companies – more than in the entire then-record year of 2022.[8]



Among the largest recent transactions are: [9]

northvolt	GROUP14	Sila	StoreDot	Factorial	Polarium
$11.75B*	$3B	$1.97B	$1.27B	$962M	$741M
Last Post Valuation	Last Post Valuation	Last Post Valuation	Last Post Valuation	Last Post Valuation	Last Post Valuation

*The company was valued at over $20B for an IPO originally planned for 2024 but postponed until a projected public offering in 2025.[10]

[7] Ibid.

[8] Source: Pitchbook, OurCrowd calculations

[9] Source: Pitchbook

[10] https://eulerpool.com/en/news/business/northvolt-postpones-ipo-plans-now-for-2025

Funding Activity 2023-2024

Company	Type	Deal Size ($)	Post Money ($)	Latest Post Money ($)	Lead Investor	Date	Company Description
CLARIOS	Debt	1.16B	-		JP Morgan	Jun-24	Manufacturer of advanced, low-voltage battery technologies for global mobility and industrial applications
VERKOR	Debt	1.77B	-	6.46M	ANZ Group Holding	May-24	French startup focused on low-carbon battery manufacturing
ASCEND ELEMENTS	Series D	621.90M	1.61B	1.61B	Decarbonization Partners and Temasek	Feb-24	Developer of a battery resources technology designed to provide sustainable and battery materials systems
northvolt	Debt	5.00B		11.75B	EIB and Nomura	Jan-24	Swedish maker of Li-ion batteries with a focus on lower carbon footprint production processes
PLUS POWER	Project Finance	1.8B	-	1.5B	Norddeutsche Landesbank and Deutsche Bank	Oct-23	Manufacturer of battery energy storage systems
REDWOOD MATERIALS	Series D	997.2M	5.25B	5.25B	Capricorn and Goldman Sachs	Aug-23	Developer of a sustainable battery recycling technology designed to optimize circular supply chains
	Debt	2.00B	-		US Department of Energy	Feb-23	
SK	Private Equity	944.00M	10.49B	10.49B	Blackrock	May-23	Manufacturer of rechargeable EV batteries specialized in manufacturing safe and fast-charging batteries.
CALB	IPO	1.29B	8.58B	7.79B	Nuode New Materials and PurePressure	Oct-22	Specialized on lithium-ion batteries, battery management systems and related integrated products, and lithium battery materials.
CATL	PIPE	6.70B	-	89.33B	Undisclosed	Jun-22	Chinese battery manufacturer specialized in lithium-ion batteries for EVs and energy storage systems
Factorial	Series D	200.00M	1.00B	1B	Mercedes Benz and Stellantis	Jan-22	Manufacturer of nano-engineered batteries designed for electric vehicles, homes, and critical applications.
HTHIUM	Series C	628.99M	4.19B	4.19B	China Life Private Equity	Jun-23	Manufacturer and developer of critical material of lithium-ion battery and lithium iron phosphate battery

M&A Activity

Company	Deal Amount ($)	Post Valuation ($)	Acquirer	Date	Company Description
PROTERRA	210.00M	undisclosed	Volvo Group	Feb-24	Designer and manufacturer of zero-emission heavy-duty vehicle batteries intended to offer a cleaner and quieter transit system
vitesco TECHNOLOGIES	4.05B	13.50B	Schaeffler	Nov-23	Manufacturer of powertrain technologies designed for the electrification and sustainable mobility for all kinds of vehicles.
routejade	16.5M	15.4M	Enovix	Oct-23	Manufacturer of lithium-ion rechargeable batteries intended to provide high-power applications for energy storage.
	23.14B	28.92B	MTA (Italy)	Jun-23	Manufacturer of onboard battery chargers and converters catering to the electric and hybrid vehicles markets.

Who's investing downstream?

Investors in battery technology range from VCs, private equity firms, and universities to multiple downstream companies with vested interests in improvements to battery performance, size, duration, safety, and sustainability. The driver for the investments is to improve aspects critical to performance, safety, and sustainability including storage substances, cell components (electrodes, cathodes), adjacent peripherals (e.g., TMS), and the recycling/reuse of existing batteries. Among the corporates investing in the sector are auto manufacturers, electronic conglomerates, and battery manufacturers.

Auto manufacturers: Reuters projects that by 2030 automakers will be producing some 54 million battery electric vehicles (BEVs) and that to support that quantity of EVs, carmakers and their battery partners are planning to install 5.8TWh of battery production capacity by 2030.[11] Car companies and their suppliers are reported to be investing almost $40B through 2026 to reduce range anxiety, increase charging speeds, and boost battery production in the US alone.[12] A sampling of auto manufacturer investments in battery technology includes:

[11] Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030 | Reuters

[12] Battery investment moves onshore to kick-start US EV production | TechCrunch

- Tesla's 2023 announcement that it will invest $3.6B in a plant dedicated to making next-generation 4680 Li-ion cells, as well as a facility to produce the new Tesla Semi.[13] The company said it expects the next-gen battery cells to be about the size of a beer can and to be more energy dense and lower cost than its current 2170 cells.
- Toyota's 2021 announcement of a $13.6B investment in battery technology, including the in-house development of solid-state batteries.[14]
- Volkswagen's investment and collaboration with US-based battery startup QuantumScape with the goal of industrial-level production of solid-state batteries.[15] It has also been reported that VW was converting engine factories into EV battery plants.[16]
- BMW Group's plan to spend $1.7B to build EVs and batteries in the US.[17]
- GM's partnership with startup OneD Battery Sciences on a joint R&D agreement focused on the use of OneD's silicon nanotechnology in GM's Ultium battery cells to drive significant increases in energy density to facilitate longer range and reduced costs.[18]

Global electronic conglomerates are actively investing in new battery technology to miniaturize and supercharge batteries for edge and IoT devices – by vastly increasing energy density – and also to bolster energy-storage solutions. Notable players include:

- South Korean corporations such as LG Chem and Samsung SDI, both now major players in the battery industry, are focusing on Li-ion batteries for EVs, grid storage, and portable devices.[19]
- Samsung has also been investing in the development of solid-state batteries and recently announced that it is developing an innovative solid-state battery that can be fully recharged in just nine minutes, has a lifespan of up to 20 years, and a range up to 999 km for EVs.[20]
- Panasonic, the Japanese electronics giant, has been a long-standing partner in supplying batteries for Tesla's EVs, and continues to invest in battery technology. Panasonic's current research covers thermal management, fast charging, and extending battery lifespan.[21]
- Even consumer electronics companies such as the innovative household appliance manufacturer, Dyson, invested $90M in a battery startup.[22]

Battery manufacturers: Among the largest battery manufacturers, research is ongoing and varied with a focus on improving energy density, safety, and cycle life.

- China's Contemporary Amperex Technology Co. (CATL), the world's largest battery manufacturer, has been a major player in Li-ion batteries. Its research includes solid-state batteries and advanced materials for EVs.[23]
- LG Energy Solutions of South Korea is researching higher-energy density cathodes, solid-state batteries, and recycling solutions.[24]

---

[13] https://www.forbes.com/sites/alanohnsman/tesla-pouring-36-billion-into-nevada-plant-for-ev-battery-semi-production/
[14] https://www.motortrend.com/news/toyota-battery-bev-hev-solid-state-future-investment/
[15] http://www.volkswagen-group.com/en/press-releases/volkswagen-increases-stake-in-quantumscape-17068
[16] globalEDGE Blog: The Future of Electric Vehicles: Why Auto Companies are Investing in Solid-State Battery Technology
[17] BMW Starts Building Construction At Woodruff Battery Assembly Plant (bmwblog.com)
[18] https://news.gm.com/newsroom.detail.html/Pages/news/us/en/2022/sep/0929-oned.html
[19] Top Battery Technology Companies | Battery Technology Industry Players (marketsandmarkets.com)
[20] https://www.ynetnews.com/business/article/h15jpzuya
[21] https://www.expertmarketresearch.com/articles/top-lithium-ion-battery-companies
[22] https://fortune.com/2015/10/15/dyson-buys-battery-startup-sakti3/
[23] Top 12 Lithium-Ion Battery Companies in the World (expertmarketresearch.com)
[24] Electric Car Battery Companies - Which Are the Top Manufacturers? (caranddriver.com)

- BYD Company Ltd, a multinational Chinese manufacturing firm (now with an EV subsidiary), explores blade battery technology, which enhances safety by isolating cells.
- SK Innovation Co., Ltd. in South Korea, is focusing on nickel-manganese-cobalt (NMC) cathodes, solid-state batteries, and recycling, with the aim to improve energy density and charging speed.

Chemistry vs Physics – and risks with both

Innovation in the battery sector is a race involving both chemists and physicists. The holy grail for all investors is to find the fastest charging, highest density, longest duration,[25] safest, and most sustainable battery. Among the leading R&D projects mentioned above, investment is divided between improving battery chemistries such as solid state or sodium-ion as competitors to Li-ion batteries or developing new cathodes and battery management systems to significantly increase the efficiency of Li-ion batteries as well as their recycling and reuse. The power of the physics-based approach is outlined below, while a selection of the chemistry-based approaches is covered in the appendix to this report.

The Physics: Li-ion remains uncontested champion for the near future

Li-ion is still considered the gold standard among batteries in terms of current standards of battery optimization, particularly energy density and duration, and is expected to dominate the battery market at least until the end of the decade.[26] Given its preeminent status, significant battery sector investment is being directed toward companies focusing on battery physics to develop new elements for the battery cell, peripheral technologies, battery management systems (BMS), and thermal management systems (TMS) to improve efficiency and performance with the application of AI and machine learning algorithms. The algorithms make possible real-time optimization by analyzing data (temperature, voltage, current, state of charge) to make informed decisions. BMS adjusts parameters in real time, optimizing battery performance and extending lifespan. The following is a sampling of startups in this segment of the BatteryTech sector.

- **Addionics**, an OurCrowd portfolio company, is developing a 3D current collector technology designed to be compatible with all battery chemistries being used in the industry and which will enable gigafactories to produce more kWh at lower costs.
- **Carrar,** an OurCrowd portfolio company, is developing the technology to provide TMS for drivers, commercial fleets, and manufacturers of EVs and batteries to optimize the temperature of the battery and in-vehicle components so that the vehicles can operate at maximum safety and efficiency, as well as significantly extend battery life.
- **Sila** is a late-stage startup developing silicon anodes as an alternative to graphite anodes currently used in Li-ion batteries which the company says have reached their energy limits. Sila is producing a market-proven nano-composite silicon anode that powers breakthrough energy density without compromising cycle life or safety.[27]
- **Advano** is a Y-Combinator graduate developing a battery-grade silicon-carbon composite anode material for Li-ion batteries. The company is commercializing its proprietary technology REALSi™ in the US.
- **Echion Technologies** is a startup based in Cambridge, UK, developing a niobium-based anode material aimed at enabling Li-ion batteries to fast charge safely in less than 10 minutes, with high-energy density and a life of more than 10,000 cycles.

[25] Lithium-ion Batteries | How it works, Application & Advantages (electricity-magnetism.org)

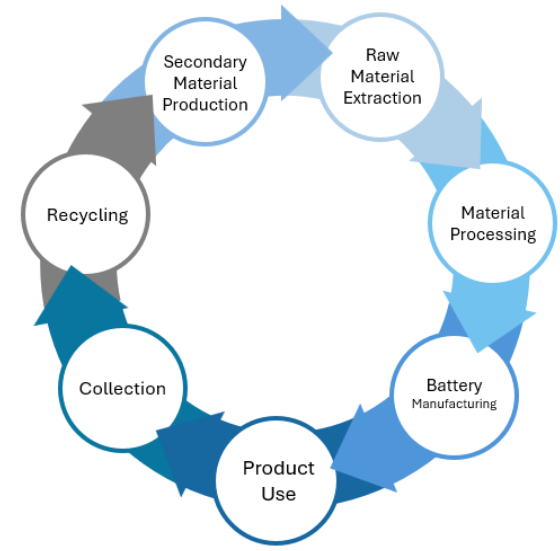
[26] Statista Research Department, Battery market size worldwide by technology 2018-2030, Oct. 19, 2023

[27] https://www.silanano.com/

- **SilLion,** a startup acquired by Tesla, is developing a technology which incorporates high-loaded silicon anodes, nickel-rich NMC cathodes, and a non-flammable ionic liquid electrolyte with the aim of producing a more cost-effective energy storage system.
- **HELENA,** part of an EU-funded project, is developing halide electrolytes, lithium metal anodes, and nickel-manganese-cobalt cathodes for batteries with high current cycling and improved thermal stability, addressing fire safety concerns and enhancing industrial application potential.

Investing in the circular value chain

Technological advances in Li-ion battery recycling, especially regarding second-life batteries, are transforming the traditional linear value chain of battery production towards a circular value model. In the linear model, raw materials are mined, and batteries are produced, used, and discarded without much consideration for recycling or reuse, leading to resource depletion and adverse environmental impact. The closed circular value chain prioritizes sustainability and resource efficiency.



EV batteries have a useful life of approximately 10 years. After that time, the batteries no longer provide sufficient range to be useful in vehicles, but they still retain 75-80% of their original capacity. These second-life batteries, which are no longer suitable for high-demand automotive use, retain substantial capacity and can be deployed in less demanding applications such as stationary energy storage, grid stabilization, and renewable energy integration. Innovations in battery diagnostics and refurbishing techniques are improving the efficiency and safety of repurposing these batteries, ensuring optimal performance and longevity. Additionally, advancements in recycling processes, including more efficient methods for material recovery and the development of closed-loop systems, are enhancing the overall lifecycle sustainability of batteries. By extending the useful life of batteries and reducing the need for raw material extraction, these technologies play a crucial role in reducing electronic waste and supporting the transition to a circular value chain. The following startups are among the companies developing technologies to accelerate this transition.

- **Connected Energy**, an OurCrowd portfolio company based in the UK, is a pioneer in the circular economy, solving two problems at once: efficient recycling of discarded electric vehicle batteries and reliable storage for intermittent renewable energy systems. Connected Energy takes advantage of the remaining capacity in EV batteries following their first lives in vehicles by repurposing them to create scalable, stationary BESS for renewable energy generated by major commercial customers. The company's proprietary technology aggregates thousands of individual retired batteries sourced directly from battery OEMs and operates these diverse units as one singular, optimized system.
- **4R Energy** focuses on extending the environmental and economic value of EV batteries aiming to refabricate, recycle, resell, and reuse (hence, 4R) EV batteries, not just for their scrap value but to power other applications.

- **BeeplanetFactory** manufactures energy storage systems reusing Li-ion batteries from EVs for photovoltaic, wind, and off-grid installations.
- **Li-Cycle** is a Canadian startup that specializes in the resource recovery of Li-ion batteries, offering innovative recycling processes to efficiently recover valuable materials.
- **Aqua Metals** has developed an electrochemical process called "AquaRefining" to recycle lead-acid batteries efficiently.
- **Li-Carbon** focuses on creating a closed-loop system for battery materials. It aims to reduce reliance on raw material extraction by reusing recovered components.[28]
- **American Battery Technology Company (ABTC)** focuses on environmentally friendly and low-cost battery recycling processes, aiming to create a circular economy for battery materials.
- **Battery Resourcers** is working on a vertically integrated process to recycle and manufacture cathode materials directly from spent Li-ion batteries.

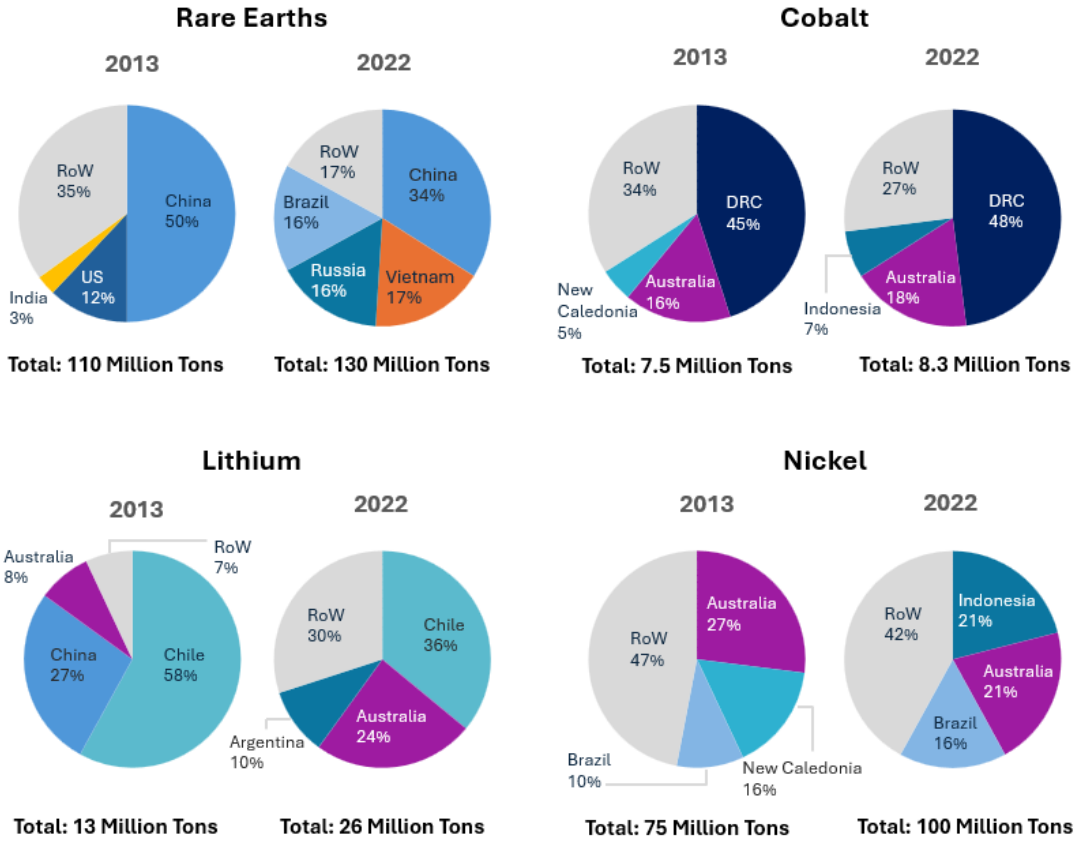
Key risks and challenges faced by the battery industry

1. Energy density constraints: hydrocarbons still winning the energy vs weight competition
Energy density (energy content per kg of weight) is a critical factor in battery duration because it determines the amount of energy a battery can store relative to its size and weight. Higher energy density means that more energy can be packed into a given volume or mass, leading to longer-lasting batteries without increasing their size or weight, which is as important for EVs as for smartphones or other edge devices. Li-ion batteries have the best energy density currently in the commercial market – around 200–300-watt hour (Wh)/kg. However, hydrocarbons such as gasoline or diesel still have significantly higher energy content per kilogram, measuring approximately 12,000 (Wh)/kg. Thus, while Li-ion batteries can be used in light passenger vehicles, hydrocarbons still dominate sectors such as aviation, long-distance trucking, and shipping where, for example, the weight of the batteries required to power a container ship would either make the vessel too heavy to sail or the required volume of batteries would take up most of the cargo space.

2. Limited supply key raw materials and supply chain disruptions
The battery industry relies on globalized supply chains with multiple choke points and any disruption can lead to sudden shortages. Li-ion batteries rely on lithium and cobalt, nickel, magnesium, and graphite, which are subject to supply shortages. Production of lithium is limited to a few key countries and mining operations. The majority of world lithium production in 2023 was mined at seven mineral operations in Australia, one mineral tailings operation in Brazil, two brine operations each in Argentina and Chile, two mineral operations in Canada, five mineral and four brine operations in China, and one mineral operation in Zimbabwe.[29] Most of the world's cobalt supply comes from the Democratic Republic of Congo[30] which poses risks related to geopolitical stability, ethical sourcing, and potential supply disruptions.

[28] Top 10 Battery Recycling Startups | Green Tech Innovators (ttconsultants.com)
[29] U.S. Geological Survey, 2024, Mineral commodity summaries 2024: U.S. Geological Survey, 212 p.,
[30] The Challenges Facing Battery Manufacturers | Technology Networks

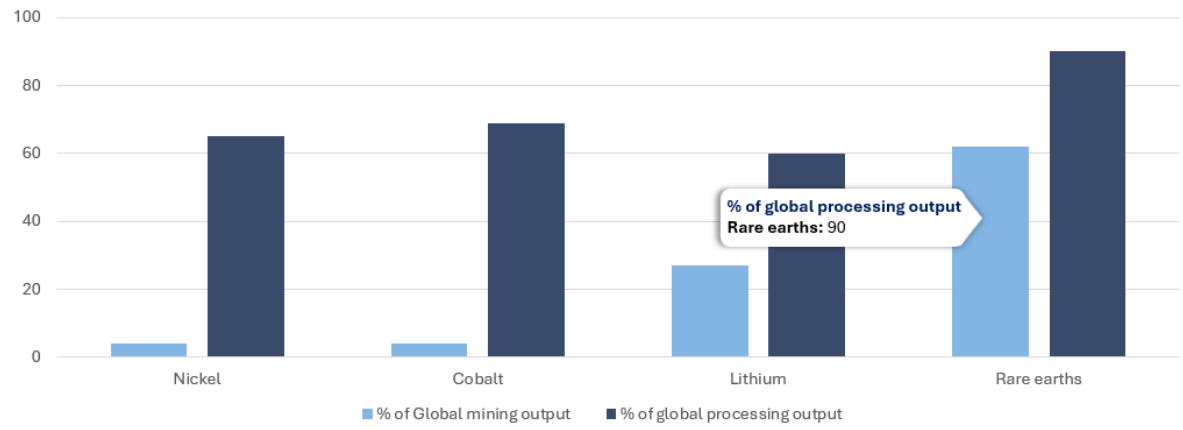
Top countries with reserves of select critical minerals and REEs
(% of Global Reserves, as reported by USGS in 2023 and 2014)



Source: Goldman Sachs Research [31]

Moreover, it is not just the sourcing that may be concentrated in select countries, but as the chart below illustrates, also the global processing of critical minerals for the battery manufacture where countries like China dominate the market.

China's percentage of global mining and processing output for nickel, cobalt, lithium and rare earths



Source: Goldman Sachs Research [32]

[31] https://www.goldmansachs.com/intelligence/pages/resource-realism-the-geopolitics-of-critical-mineral-supply-chains.html
[32] Ibid.

3. Environmental sustainability

The world needs hundreds of new mines in operation by 2035 to produce the gigatons of energy conversion materials to meet electrification goals. However, the extraction and processing of these materials can have significant environmental consequences including habitat destruction, water pollution, and substantial carbon emissions. Environmental issues arise not just with the mining of key materials, but also with the use of carbon in Li-ion batteries. The carbon used in Li-ion battery electrodes is crucial for their performance. Aside from the common use of carbon-based materials such as graphite in most Li-ion batteries, carbon black and other conductive carbon-based coatings are often added to enhance ion and electron conductivity and overall performance in battery materials.[33]

4. Safety

The fire risk and hazard associated with high-energy batteries, particularly Li-ion, has become a major safety concern for EVs with the threat of intense fires that can be generated from Li-ion batteries.[34] According to a white paper from Siemens, "these batteries present special fire safety hazards. Aging or damaged batteries can lead to an internal short circuit, causing an uncontrolled temperature increase known as thermal runaway. Once started, thermal runaway cannot be stopped and can lead to electrolyte vapor explosions and intense fires.[35]

The path ahead

Achieving higher levels of battery density, duration, safety, and a truly carbon-free economy will require better-performing batteries than current Li-ion technology can deliver. Demand for EVs, smaller and more powerful edge and IoT devices, and larger capacity BESS, is a significant factor promoting investments in new battery and peripheral technologies. In addition, achieving decarbonization in a sustainable way will require a multifaceted approach to the battery value chain from raw material sourcing and manufacturing to recycling capabilities. Battery manufacturers are increasingly prioritizing sustainability, circularity, and resilience across the entire value chain. New technologies will play a critical role in disrupting this sector.

Investment in the sector is accelerating and opportunities abound both for new battery chemistries and for improvements in the efficiency of Li-ion batteries. Given that Li-ion batteries are forecast to remain the preferred battery chemistry throughout this decade, OurCrowd is focused on investing in companies developing new components for Li-ion batteries, thermal management systems, and the newly emerging subsector of second-life batteries and recycling.

[33] https://www.frontiersin.org/articles/10.3389/fchem.2022.914930/full

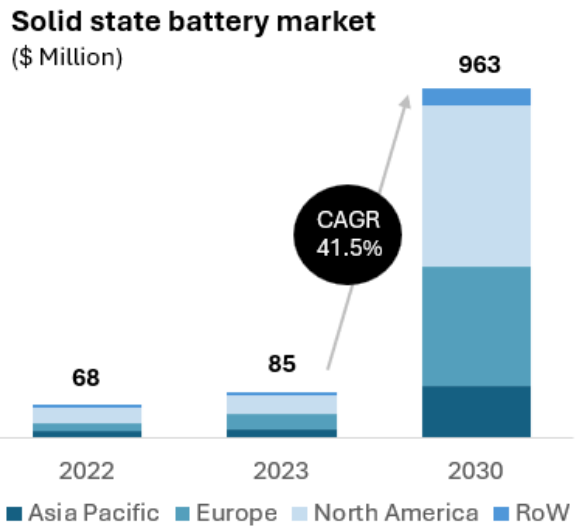
[34] https://www.researchgate.net/publication/338542510_A_Review_of_Battery_Fires_in_Electric_Vehicles

[35] https://assets.new.siemens.com/siemens/assets/white-paper-fire-safety-in-parking-garages-with-electric-vehicle.pdf

Appendix: Li-ion and next-gen competitors

Lithium-ion batteries, first developed in the 1980s, revolutionized the battery industry with their high energy density, lightweight nature, and long cycle life. Because Li-ion batteries store more energy per unit of weight (energy density) compared to previous technologies, such as nickel-cadmium or nickel-iron, devices could be lighter and run longer on a single charge. For portable electronics, this enabled the development of smaller, more powerful devices such as smartphones and laptops. For EVs, the high energy density and efficiency of Li-ion batteries extended the driving range and reduced the overall weight of vehicles, making electric cars more practical and appealing to consumers. However, despite Li-ion batteries' higher level of energy density, it is still far below the energy density of hydrocarbons,[36] and Li-ion batteries have serious issues around sustainability, key mineral-component scarcity, supply chain disruptions, and safety.

Solid state batteries utilize a solid electrolyte for ionic conduction between the electrodes, instead of liquid or gel polymer electrolytes found in conventional batteries.[37] Replacing the liquid electrolyte with a solid ceramic would be a phase change, unlocking batteries with higher energy density, faster charging, and improved safety. Solid state batteries are not new but were subpar compared to Li-ion on performance. Solid-state batteries could revolutionize the EV industry with higher energy density, improved safety, shorter charging times, a wider range of operating temperatures, and a longer lifespan.[38] Demand for small and compact solid-state batteries will also be driven by the need for the further miniaturization of devices such as smartphones, lightweight medical and IoT devices, smartwatches, and other wearables which will benefit from the higher density, longer lifespan, and safety aspects of the solid-state batteries.[39] Advances in other materials for anodes in solid state batteries, such as silicon, have the potential to further enhance the stability, chemo mechanics, and aging behavior performance of solid-state batteries.[40]



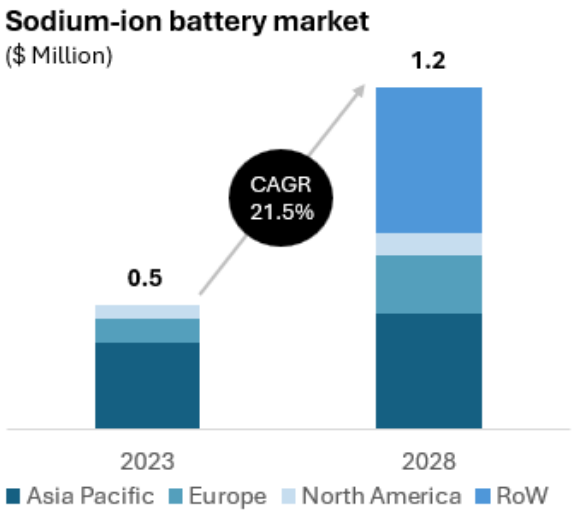
MarketsandMarkets reports that the global solid state battery market size was valued at $85M in 2023 and is projected to reach $963M by 2030, with a CAGR of 41.5%.[41]

Sodium-ion (Na-ion) batteries use saltwater rather than lithium as an electrolyte and they do not rely on nickel, cobalt, or manganese. Na-ion batteries were first developed in the 1980s. Among the advantages of Na-ion are the abundance of sodium as a base material, lower acquisition costs, and less environmental impact – all of which contribute to producing a less expensive product than a Li-ion battery. They also have increased thermal stability compared to Li-ion batteries. However, Na-ion batteries have traditionally had lower energy density than Li-ion,

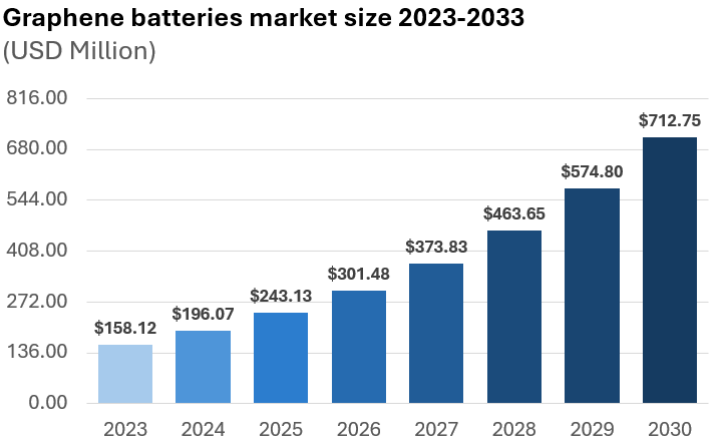
[36] Lithium ion batteries: energy density? - Thunder Said Energy
[37] https://en.wikipedia.org/wiki/Solid-state_battery#cite_note-C&EN-2
[38] Solid-State Batteries In Electric Cars: What They Are And What They Do
[39] https://www.marketsandmarkets.com/Market-Reports/solid-state-battery-market-164577856.html
[40] Research on silicon anodes in solid-state batteries shows promising potential for enhanced battery performance – pvbuzz.com
[41] https://www.marketsandmarkets.com/Market-Reports/solid-state-battery-market-164577856.html

storing only about 66% of the amount of energy of a Li-ion battery of the same size. The Korea Advanced Institute of Science and Technology (KAIST) announced in Apr. 2024 that its scientists had succeeded in developing a next-generation Na-ion battery that had much improved performance (247 Wh/kg),[42] could charge in a few seconds, and was both less expensive and safer than Li-ion batteries.

Prior to the breakthrough by KAIST, MarketsandMarkets forecast that the Na-ion market would grow at a CAGR of 21.5% from 2023 to 2028 to a total market value of $1.2B.[43] However, the advances in the KAIST may serve to accelerate that growth further.



Graphene batteries are being developed which demonstrate exceptional durability, increased resistance to wear, and longer lifespan than Li-ion. Graphene is a single layer of carbon atoms arranged in a hexagonal lattice which, when used in the electrodes of batteries, charge faster and exhibit higher energy efficiency, enhancing overall EV performance. Although graphene batteries offer advantages like rapid charging and longer lifespan, their energy density has not yet surpassed that of Li-ion batteries, which limits their utility with EVs requiring high energy density to achieve longer driving ranges. In addition, graphene production at scale is still challenging and costly, although Chinese car manufacturers have been investing in graphene.



Lithium-sulfur (Li-S) batteries: Unlike conventional Li-ion batteries, Li-S batteries employ sulfur as the cathode material. This choice offers several advantages, including higher theoretical energy density due to the lightweight and abundant nature of sulfur. However, there are challenges to overcome. Sulfur tends to form soluble lithium polysulfides during cycling, which can degrade battery performance. Researchers are actively exploring strategies to mitigate these issues such as designing stable solid electrolyte interfaces (SEIs) and optimizing electrolyte formulations. The goal is to harness Li-S batteries' potential for longer-range EVs and more efficient energy storage systems.

[42] https://www.electrive.com/2024/04/23/korean-researchers-are-fine-tuning-a-hybrid-sodium-ion-battery/
[43] https://www.marketsandmarkets.com/Market-Reports/sodium-ion-battery-market-207269067.html

About OurCrowd

OurCrowd is a global investments platform that empowers institutions and individuals to invest in private assets. We have a particular focus on building global champions in emerging technology sectors like AI, Cybersecurity, Med-Tech and Semiconductors.

We are a partner trusted by some of the world's largest institutional investors and HNWIs. They enjoy access to a selection of curated investment opportunities via OurCrowd, both directly into emerging companies and into investment funds. Our deal flow comes from companies and funds that we source directly, and from some of the world's leading venture capital firms, with whom we co-invest.

Together, these give us unique insights that enhance our deal flow; give us a powerful due diligence advantage; and power our proprietary research for valued institutional clients.

For more information about working with OurCrowd, please contact Ely Razin, Chief Strategic Investments Officer at ely.razin@ourcrowd.com.

Disclaimer

THIS DOCUMENT IS FOR INFORMATIONAL PURPOSES ONLY AND ALL INFORMATION CONTAINED HEREIN IS SUBJECT TO REVISION AND COMPLETION. THIS DOCUMENT DOES NOT CONSTITUTE OR FORM PART OF AN OFFER TO ISSUE OR SELL, OR OF A SOLICITATION OF AN OFFER TO SUBSCRIBE OR BUY, ANY SECURITIES NOR DOES IT CONSTITUTE A FINANCIAL PROMOTION, INVESTMENT ADVICE OR INDUCEMENT OR INCITEMENT TO PARTICIPATE IN ANY PRODUCT, OFFERING OR INVESTMENT. ANY OFFER OR SOLICITATION WILL BE MADE ONLY BY THE MEANS OF FORMAL CONFIDENTIAL OFFERING MATERIALS THAT WILL BE PREPARED AND FURNISHED TO PROSPECTIVE INVESTORS AT A LATER DATE. IN ADDITION, THIS DOCUMENT DOES NOT CONSTITUTE NOR SHALL IT OR THE FACT OF ITS DISTRIBUTION FORM THE BASIS OF, OR BE RELIED ON IN CONNECTION WITH, ANY CONTRACT THEREFORE. NO REPRESENTATION, WARRANTY OR UNDERTAKING, EXPRESS OR IMPLIED, IS GIVEN AS TO THE ACCURACY OR COMPLETENESS OF THE INFORMATION OR OPINIONS CONTAINED HEREIN. TO THE FULLEST EXTENT PERMITTED BY LAW, IN NO CIRCUMSTANCES WILL OURCROWD, OR ANY OF ITS RESPECTIVE SUBSIDIARIES AND AFFILIATES, STOCKHOLDERS, REPRESENTATIVES, PARTNERS, DIRECTORS, OFFICERS, EMPLOYEES, ADVISERS OR AGENTS BE RESPONSIBLE OR LIABLE FOR ANY DIRECT, INDIRECT OR CONSEQUENTIAL LOSS OR LOSS OF PROFIT ARISING FROM USE OF THIS DOCUMENT, ITS CONTENTS, ITS OMISSIONS, RELIANCE ON THE INFORMATION CONTAINED WITHIN IT, OR ON OPINIONS COMMUNICATED IN RELATION THERETO OR OTHERWISE ARISING IN CONNECTION THEREWITH. THIS DOCUMENT IS CONFIDENTIAL AND IS INTENDED SOLELY FOR THE INFORMATION OF THE PERSON TO WHOM IT HAS BEEN DELIVERED. IT IS NOT TO BE REPRODUCED OR TRANSMITTED, IN WHOLE OR IN PART, TO THIRD PARTIES, WITHOUT THE PRIOR WRITTEN CONSENT OF OURCROWD. THIS DOCUMENT CONTAINS TRADEMARKS, SERVICE MARKS, TRADE NAMES AND COPYRIGHTS OF OURCROWD AND OTHER COMPANIES, WHICH ARE THE PROPERTY OF THEIR RESPECTIVE OWNERS.

CERTAIN STATEMENTS CONTAINED IN THIS PRESENTATION MAY CONTAIN “FORWARD-LOOKING STATEMENTS.” THESE STATEMENTS CAN BE IDENTIFIED BY THE FACT THAT THEY DO NOT RELATE STRICTLY TO HISTORIC OR CURRENT FACTS. THEY USE WORDS SUCH AS “ESTIMATE,” “EXPECT,” “PROJECT,” “INTEND,” “BELIEVE,” “ANTICIPATE,” AND OTHER WORDS OF SIMILAR MEANING IN CONNECTION WITH ANY DISCUSSION OF FUTURE, OPERATING, FINANCIAL PERFORMANCE OR CONDITIONS. THESE STATEMENTS ARE BASED UPON CURRENT BELIEFS AND EXPECTATIONS OF OURCROWD AND ARE SUBJECT TO SIGNIFICANT RISKS AND UNCERTAINTIES. READERS ARE CAUTIONED THAT STATEMENTS REGARDING FUTURE ACTIONS AND FUTURE RESULTS MAY DIFFER SIGNIFICANTLY FROM THOSE SET FORTH IN THE FORWARD-LOOKING STATEMENTS. THIS PRESENTATION MAY CONTAIN SIMULATIONS BASED ON ASSUMPTIONS DRAWN FROM HISTORICAL PERFORMANCE DATA, AS WELL AS CURRENTLY AVAILABLE INFORMATION. THESE ASSUMPTIONS ARE MERELY INDICATIVE AND ARE SUBJECT TO SIGNIFICANT BUSINESS, ECONOMIC AND COMPETITIVE UNCERTAINTIES AND CONTINGENCIES, AND MAY THEREFORE PROVE TO BE INCORRECT GOING FORWARD. NOTHING CONTAINED HEREIN REPRESENTS OR SHALL BE DEEMED TO IN ANY WAY PREDICT ACTUAL RETURNS FOR ANY CURRENT OR FUTURE OURCROWD INVESTMENT VEHICLE. ANY GRAPHS, CHARTS AND OTHER VISUAL AIDS ARE PROVIDED FOR INFORMATIONAL PURPOSES ONLY. NO REPRESENTATION IS MADE THAT THESE WILL ASSIST ANY PERSON IN MAKING INVESTMENT DECISIONS AND NO GRAPH, CHART OR OTHER VISUAL AID CAN CAPTURE ALL FACTORS AND VARIABLES REQUIRED IN MAKING SUCH DECISIONS. TO THE EXTENT THAT THIS PRESENTATION CONTAINS MATERIAL OBTAINED FROM THIRD PARTY SOURCES, OURCROWD BELIEVES SUCH SOURCES ARE RELIABLE BUT DOES NOT AND CANNOT MAKE ANY REPRESENTATION AS TO THE ACCURACY OR COMPLETENESS OF SUCH INFORMATION. THE OFFER TO INVEST IN ANY OURCROWD-LIMITED PARTNERSHIP CAN ONLY BE MADE ON THE OURCROWD WEBSITE AND ONLY TO INVESTORS WHO HAVE BEEN FULLY QUALIFIED AS ACCREDITED INVESTORS IN ACCORDANCE WITH THE LAWS AND REGULATIONS OF THEIR RESPECTIVE JURISDICTIONS.

PLEASE BE AWARE THAT INVESTMENTS IN EARLY-STAGE COMPANIES OR IN VENTURE CAPITAL FUNDS CONTAIN A HIGH LEVEL OF RISK AND YOU SHOULD CONSIDER THIS PRIOR TO MAKING ANY INVESTMENT DECISIONS. PAST PERFORMANCE IS NOT INDICATIVE OF FUTURE RESULTS.

IN RESPECT OF CANADIAN RESIDENTS, OURCROWD OPERATES IN CANADA THROUGH OURCROWD CANADA INC., AN EXEMPT MARKET DEALER REGISTERED IN THE PROVINCES OF BRITISH COLUMBIA, ALBERTA, MANITOBA, ONTARIO, QUEBEC AND NOVA SCOTIA.

IN RESPECT OF HONG KONG RESIDENTS, THIS COMMUNICATION HAS BEEN REVIEWED AND APPROVED BY OURCROWD CAPITAL (HK) LIMITED (“OCHK”) FOR DISTRIBUTION TO CLIENTS OF OCHK THAT MEET ITS SUITABILITY REQUIREMENTS. OCHK IS LICENSED WITH THE SECURITIES AND FUTURES COMMISSION OF HONG KONG FOR TYPE 1 (DEALING IN SECURITIES) AND TYPE 4 (ADVISING ON SECURITIES) REGULATED ACTIVITIES.