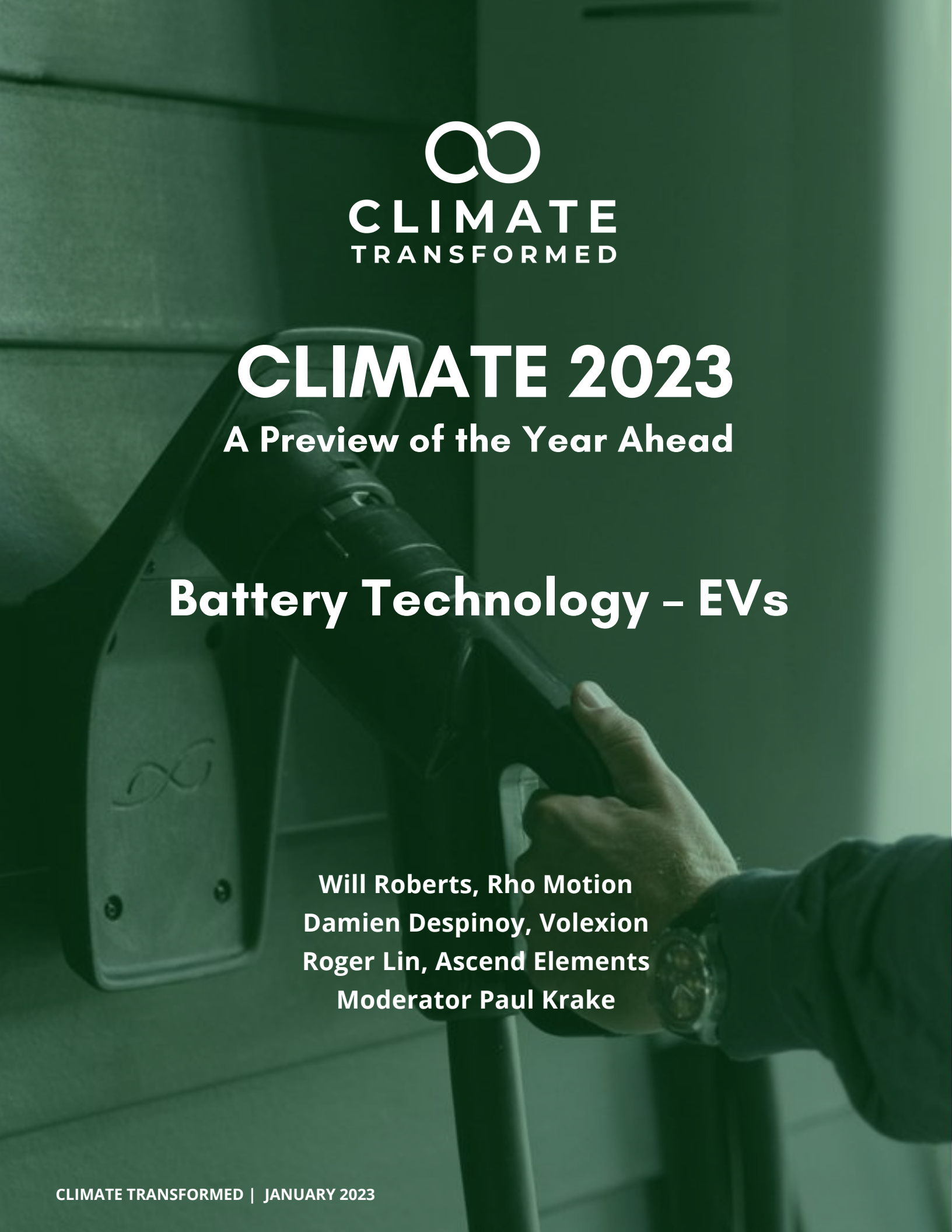


CLIMATE TRANSFORMED

CLIMATE 2023

A Preview of the Year Ahead

Battery Technology – EVs

Will Roberts, Rho Motion
Damien Despinoy, Volexion
Roger Lin, Ascend Elements
Moderator Paul Krake

Battery Technology – EVs

Will Roberts is a research analyst at Rho Motion working on electric vehicle, battery, and charging market analysis.

Damien Despinoy is the CEO of Volexion, a developer of next-generation lithium-ion batteries.

Roger Lin, is the VP of Marketing & Government Relations at Ascend Elements, a US-based battery recycling tech firm.



Summary

We bring back the great innovators in EV batteries to discuss critical issues such as supply chain security, the quest for range, innovation trends and commodity shortages in one of the most influential sectors for the future of the global economy.
Watch the full discussion **here**.

Key takeaways

- Despite economic headwinds, electric vehicle (EV) battery demand:
  - Will continue unabated
  - Despite multiple forecasts of peaking input prices, demand from Lithium, Nickel, and Cobalt remains robust.
  - The Inflation Reduction Act (ITA) provides another enormous tailwind for battery manufacturing in the United States, and the European Union (EU) needs to respond.
- The BloombergNEF energy storage forecast shows the largest year-on-year increase in lithium-ion batteries on record, driven by the lithium price spike. This must be an enormous headwind for EV price parity with cheaper combustion engines. So much for Moore's law of Batteries.
- Nickel Cobalt Manganese (NCM) is still vital, but NMx and Lithium Manganese Iron Phosphate (LMFP) will start making their way into EVs. Chinese EV manufacturers are experimenting with these different chemistries.
- It would be oversimplistic to dismiss range anxiety as a lack of informed opinion. It takes people time to get used to new ways of thinking about a journey, and at the same time, EV infrastructure along highways is still very much under development, with many issues still to resolve. Charging stations and infrastructure is the next significant shift needed to enable the broader uptake of EVs.

Paul's observations

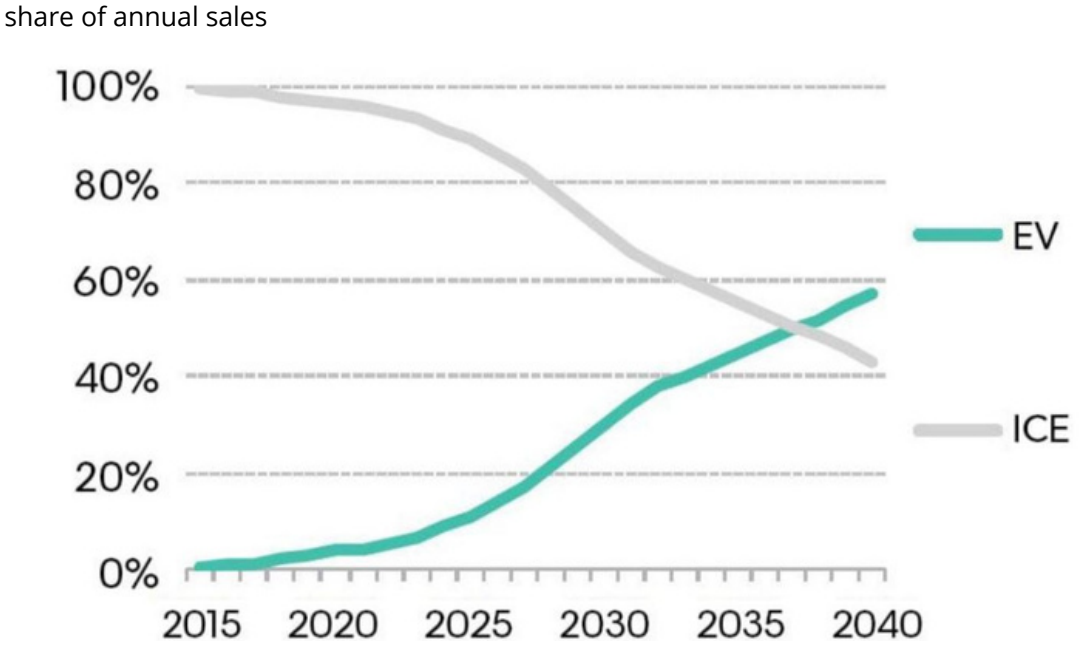
Of all the verticals we cover at Climate Transformed, Battery technology is all-encompassing and the most logistically complicated. All-encompassing in the context of storage being the linchpin for renewable success and being at the epicenter of the transition towards more sustainable transportation. Logistically complicated due to geopolitics and the practicalities of reliable supply chains. We should all be encouraged by the quality of the slew of innovative companies developing next-generation battery technologies, but we should be concerned that the components to build those batteries remain in short supply and will be at the center of ongoing geopolitical jockeying between the United States and China.

Books will be written on the topic, but the five-year outlook is succinct. Price parity between electric vehicles and combustion engines is a decade away. Key metals shortages, especially regarding lithium and cobalt, will mean that the price of lithium-ion batteries will not fall to the extent that they need to ensure mass adoption in the western world. Government subsidies will be omnipresent, but as the price of an EV battery rose in 2022, dispelling any notion of Moore's Law for batteries, US adoption rates will lament. The IRA's rollout of infrastructure helps, but it does not bring down the price of the vehicle itself. The cost will be the key constraint on EV adoption this decade.

Diversifying the supply chain away from China only increases the price of batteries in the next five years. More gigafactories will need metals inventory, which will increase demand further from 2024 onwards. We can worry about a lithium glut in 2028. In the meantime, the path to price parity is a dream.

"Cost will be the key constraint on EV adoption this decade."

Global EV and ICE share of long-term passenger vehicle sales



Source: BloombergNEF

Questions & Answers

What is the outlook for battery production, given the prospect of peak input prices?

Damien Despinoy:

I work on the assumption that the lithium supply curve will come back into balance, whereas the other metals are the most significant bottleneck in the supply chain. Three years ago, all of the focus was on nickel-rich cathode materials that were high energy and low-cobalt. At the time, cobalt was the ultimate bottleneck in the supply chain. More recently, the Department of Energy stopped funding research and development associated with nickel-rich materials, so they are already seeing that the next bottleneck in the supply chain is likely to be nickel, which might force the industry to rethink where it sources its metals.

Roger Lin:

The price of cathode materials hinges on the price of the metals. For example, lithium is the highest-value element within the cathode material at $70-80 per kilogram, roughly 10 times what it was 2 years ago. Lithium prices are likely to remain high. The relentless pressure from the gigafactories being built worldwide to feed EVs with the lithium-ion batteries they need is unlikely to let up anytime soon. There is more likelihood that nickel resources will come online to reduce price spikes there, but it is difficult to see that happening with lithium for a few years. The BloombergNEF energy storage forecast shows the largest year-on-year increase in lithium-ion batteries on record, driven by the lithium price spike.

What are the exciting trends in battery chemistry going into 2023?

Will Roberts:

Nickel cobalt manganese (NCM) battery technology will continue to be an essential part of the mix. There is always lots of talk about the next silver bullet or the next thing that will knock NCM out of the water. However, even if a revolutionary new technology comes in in 2025, we already have capacity locked into NCM chemistries up the supply chain.
Furthermore, In 2023, NMx and LMFP will start making their way into EVs. NMx, from nickel-manganese chemistry, has been ready for a while and will be used in Good Cat EVs (produced by Great Wall in China), which have been ready for about a year but have not entirely made it onto the road yet. A version of the same car has a lithium-iron-phosphate (LFP) battery, which is now on sale. Lithium manganese iron phosphate (LMFP) looks close to commercialization.

What are the characteristics of an NMx and an LMFP battery?

Will Roberts:

LMFP is a progression of LFP, adding some manganese to raise the energy density of the cells slightly.

"Charging stations and infrastructure is the next significant shift needed to enable the broader uptake of EVs." – Roger Lin

Are the safety issues around NMC batteries overblown?

Will Roberts:

I do not think it can be called an overreaction to ask for a car to be safe. Safety will always be a critical factor for EV batteries, and if we cannot be confident that chemistry is safe, it is better not to use it until we are sure. We have seen a few recalls, so there is still a learning curve for qualifying batteries and ensuring they are safe.

Roger Lin:

There are certain hazards associated with lithium-ion batteries, and they need to be respected and well-handled. While EV fires are less frequent than petrol car fires, the difference is in the nature of the hazard itself. While the hazard for petrol cars is that they explode after a crash, the EV risk might be that they go into thermal runaway while on a charge, potentially with the car parked in a garage that could be under a home.
Any lithium-ion battery has some level of volatility. Rising nickel content in NMC stability is traded off against energy density. People say that EVs are dangerous, which is true, as our regular cars. However, we don't live in a world of absolute safety but a world of measured risk.

How is range anxiety developing or affecting the takeup of EVs?

Will Roberts:

It would be oversimplistic to dismiss range anxiety as a lack of informed opinion. It takes people time to get used to new ways of thinking about a journey, and at the same time, EV infrastructure along highways is still very much under development, with many issues still to resolve. In addition, there will continue to be problems for people charging within smaller communities where people don't have access to off-street parking.
The price of charging is affected by rising electricity prices in Europe and falling gas prices in the US. Moreover, EVs may exacerbate a wealth gap because those with a private driveway and perhaps solar panels will enjoy cheap electricity and guaranteed access to charging. At the same time, those who rely on public charging points may end up paying higher rates, which could see them pay more for fuel than they would in a petrol car.

Roger Lin:

Charging stations and infrastructure is the next significant shift needed to enable the broader uptake of EVs. The batteries already charge relatively quickly, but it is longer than a petrol car which gives people that anxiety. Charging an EV in 30 minutes might reduce battery life.

What does Europe need to do in response to the Inflation Reduction Act (IRA)?

Will Roberts:

Europe needs homegrown innovation to stay in Europe. The EU emissions legislation has successfully supported the development of the EV market. Now that the US has delivered on the IRA, Europe needs to consider how to attract innovation.

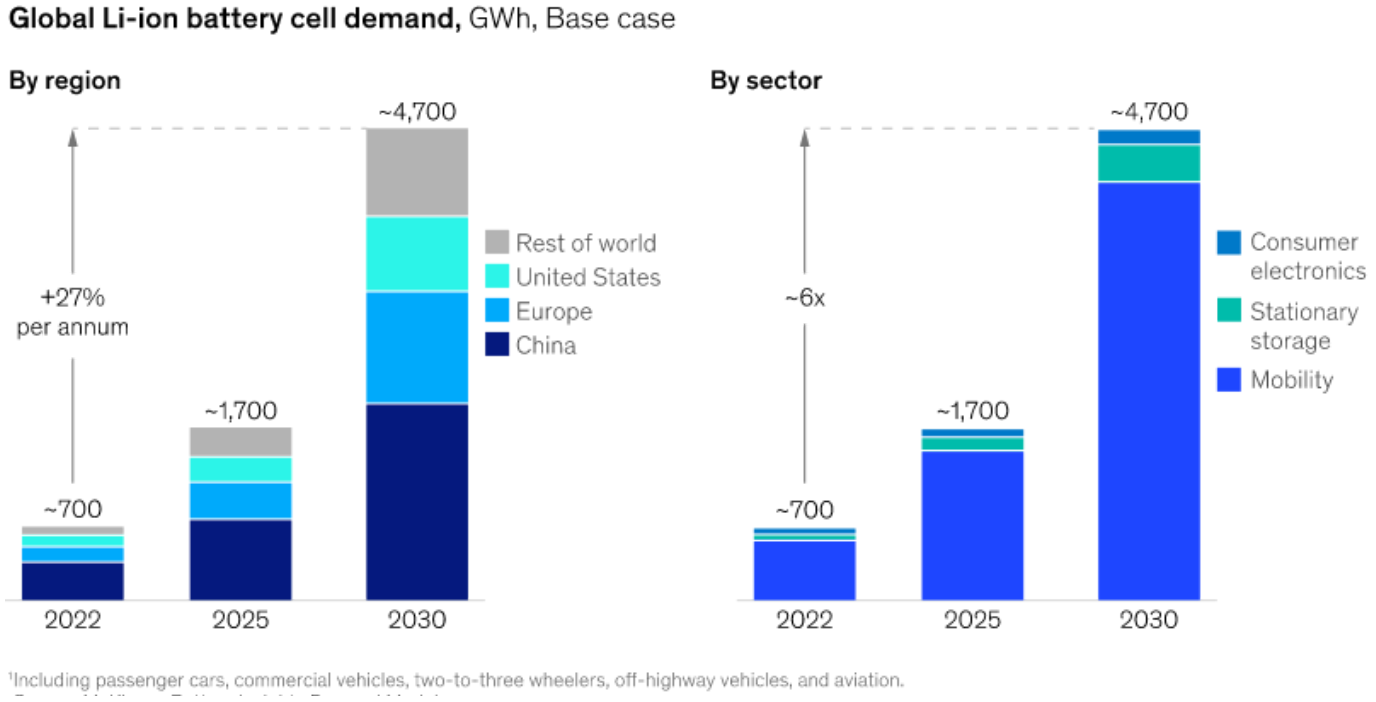
Damien Despinoy:

We must consider the lithium-ion industry on a massive scale, with the major end market being the EV industry. I read that the materials for EV batteries go on a 50,000-mile journey to get to the EV, which needs to be shortened with the development of supply chains to be sustainable. EV manufacturing and battery manufacturing should co-locate at least per continent.

Roger Lin:

The timing of where and when different factories and operations go is affected by tax breaks and other incentives. For example, we secured two Department of Energy grants to build the factory in Kentucky, with a total of $480 million. That helps us to scale up, but we are paying attention to the EU and the UK. We need to locate our operations close to our feedstock and market, so to achieve market share, we still need to build in Europe.

Li-ion battery demand is expected to grow by about 33% annually to reach around 4700 GWh by 2030



Source: McKinsey Battery Insights Demand Model

Do a third of batteries that come out of gigafactories not work and are sent straight to recycling?

Roger Lin:

Any new lithium-ion batteries could have scrappage rates of 50-60%. It requires a lot of precision, and if you do it wrong, you can have batteries that short circuit internally in the worst-case scenario. They could also be unsafe or have high cell discharge. The quality of the assembly and the build are the main factors. Overtime yields can increase to 90% or above, but a new factory takes time to bed in the processes and new cell design. It can be described as months of production hell, trying to get the batteries to come out at required performance levels. We are constantly striving to improve energy density, so there will always be product changes and an ongoing production development process.

How labor-intensive is the process of building a lithium-ion battery?

Damien Despinoy:

It is a multi-step process, and one of the most delicate parts is laying out electrodes. First, the materials are mixed and then painted onto the current collector with aluminum on one side and copper on the other. Modern gigafactories are highly automated, taking the process through pressing, cutting, etc. In small factories, there may be a way to make electrodes to be bought and assembled in-house, which is quite a manual task. Scaling up is causing a reduction in the cost of batteries. The US production credit also significantly impacts the cost of production down to about $100 per kilowatt-hour (kWh). The IRA intends to jump-start the industry.

Roger Lin:

The IRA is relatively straightforward, and we will receive $35 per KWh of battery produced, and there is no financial cap. It is the same strategy used to stimulate solar and wind production.

Will Roberts:

Seeing the bill go through quickly surprised people in politics and the industry because the financial commitment is enormous.

How does the IRA affect your business?

Damien Despinoy:

We are looking at new materials development and scale-up side, which might be the next frontier after the IRA. A significant amount of money has been poured into battery research from the Department of Energy and other agencies. The US government is trying to avoid making the same mistakes as they did with semiconductors, and they see battery technology as critical to the new world coming our way. There is funding and investment in various parts of the supply chain.

"The IRA intends to jump-start the industry. " – Damien Despinoy

Reasons to be optimistic in 2023

Will Roberts:

Chinese original equipment manufacturers (OEMs) are moving into Europe at quite a rate that will give European consumers better access to a broader range of EVs.

Damien Despinoy:

Diversifying chemistries in batteries presents all sorts of exciting opportunities, considering end-user applications.

Roger Lin:

It will also be good to see resources come online to improve the battery bottleneck for EVs and renewable energy applications.

Thank you for reading. Click here to access all of the sessions from Climate 2023.

Learn more about the companies featured in this interview:

- **Rho Motion**
- **Volexion**
- **Ascend Elements**