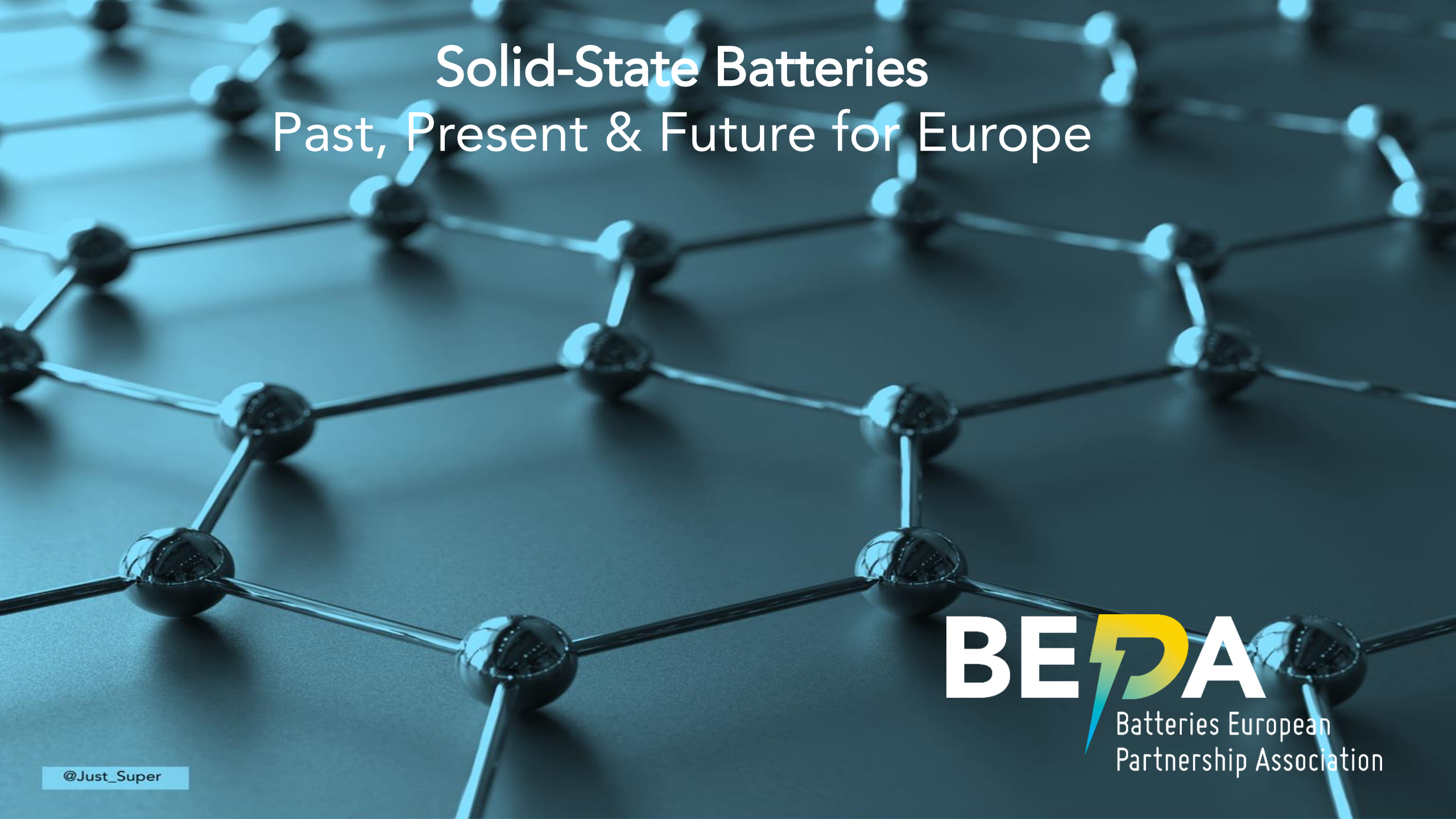
Solid-State Batteries

Past, Present & Future for Europe



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@Just_Super

Difficult but worth it!

We choose to develop solid state batteries in this decade not because they are easy, but because they are hard.

2010s

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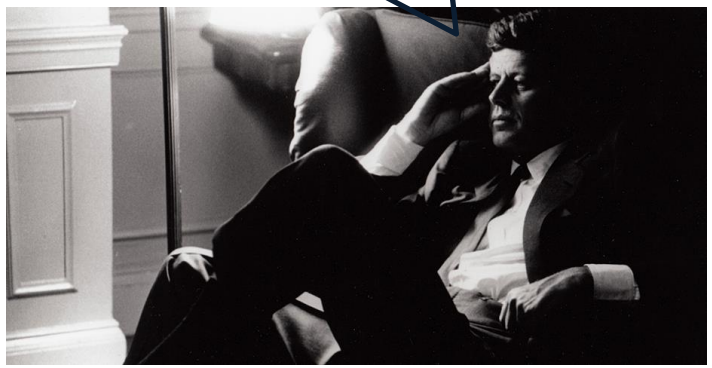
Difficult but worth it!

We choose to develop solid state batteries in this decade not because they are easy, but because they are hard.

2010s

I guess it is too hard!



2025

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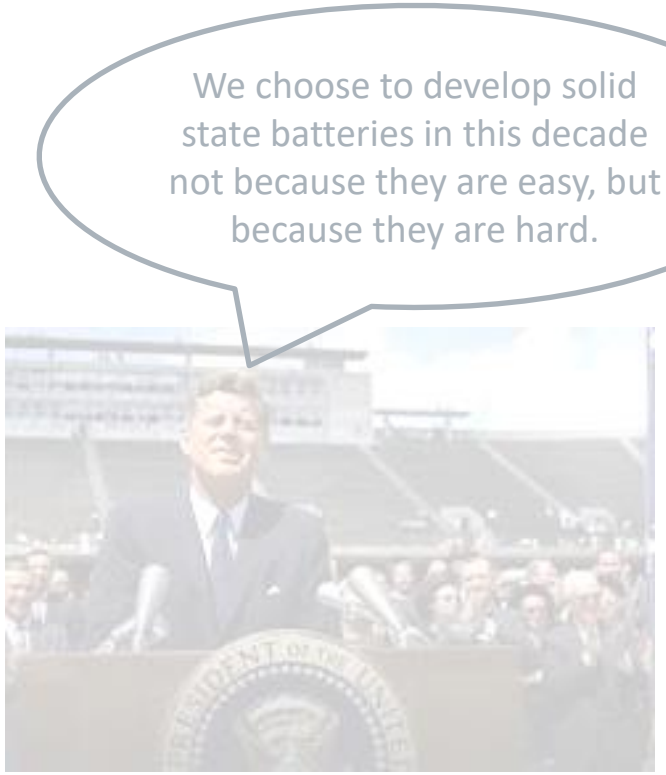
Difficult but worth it!



2010s

"A Nobel Prize was awarded for the invention of the lithium-ion battery.
Industrialization of lithium-metal solid-state batteries, which are superior in every way, would qualify for another!"*

- Prof. Martin Winter

*The race for solid-state batteries by Porsche Consulting

2025

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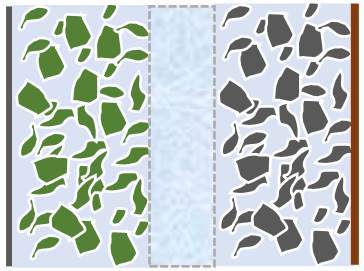
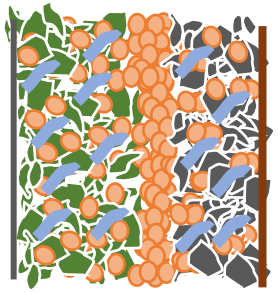
The Technology

Three main family of electrolytes provide opportunity for different applications, cost targets and development processes

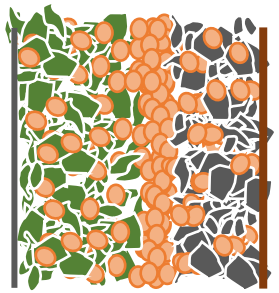
- Sulphide
- Oxide
- Polymer



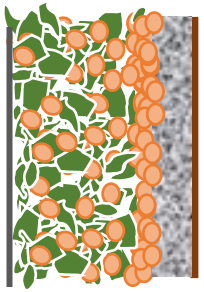
Liquid electrolyte (Gen.3)



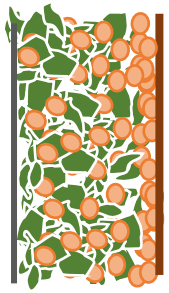
Semi-SSB



SSB with Gr/Si Anode



All-SSB with Li metal



Anodeless SSB

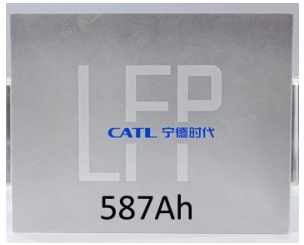
Energy density (Wh/kg)	150-300	250-350	300-500	
Maturity **(for EVs)**	Commercialised	Limited adoption & production	Prototype (commercial. 2030+)	Lab-scale (commercial. 2035+)

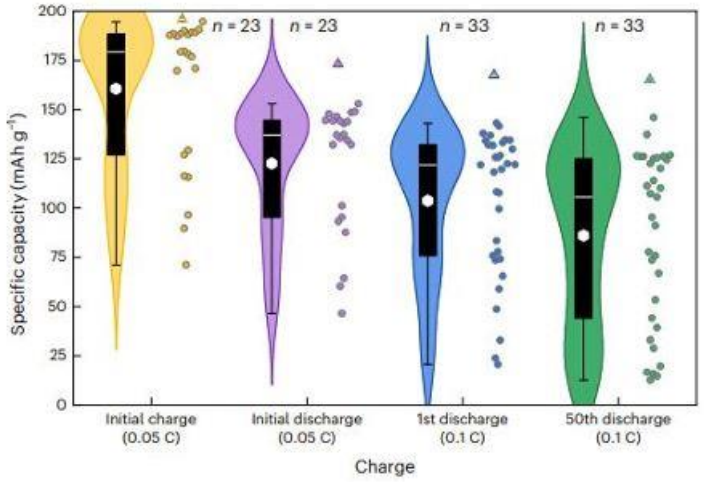
Potentially safer, cheaper to manufacture & capable of faster charging times

Scale: Product

Cell

A major challenge in SSB cell development is to maintain the performance while increasing the cell capacity.

	2015	2025
Gen3	 Commercialised	 Commercialised
Gen4	 Lab-scale	 Cell prototype

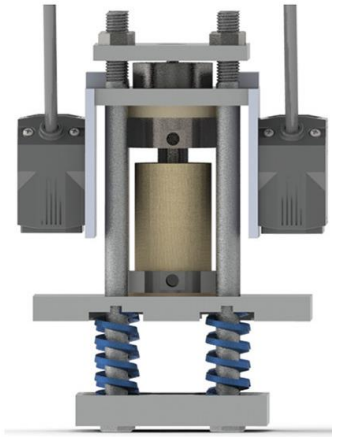


The study tested how consistent ASSB performance is across labs using the same materials. Despite standardized cycling conditions, each group used its own assembly methods, revealing major variability.

https://doi.org/10.1038/s41560-024-01634-3

Pack & Module & Integration into vehicle

While safety potential allows for less thermal management, required elevated temperature, and stack pressure for suppressing li metal dendrite complicate the design



https://doi.org/10.1016/j.ensm.2024.103196

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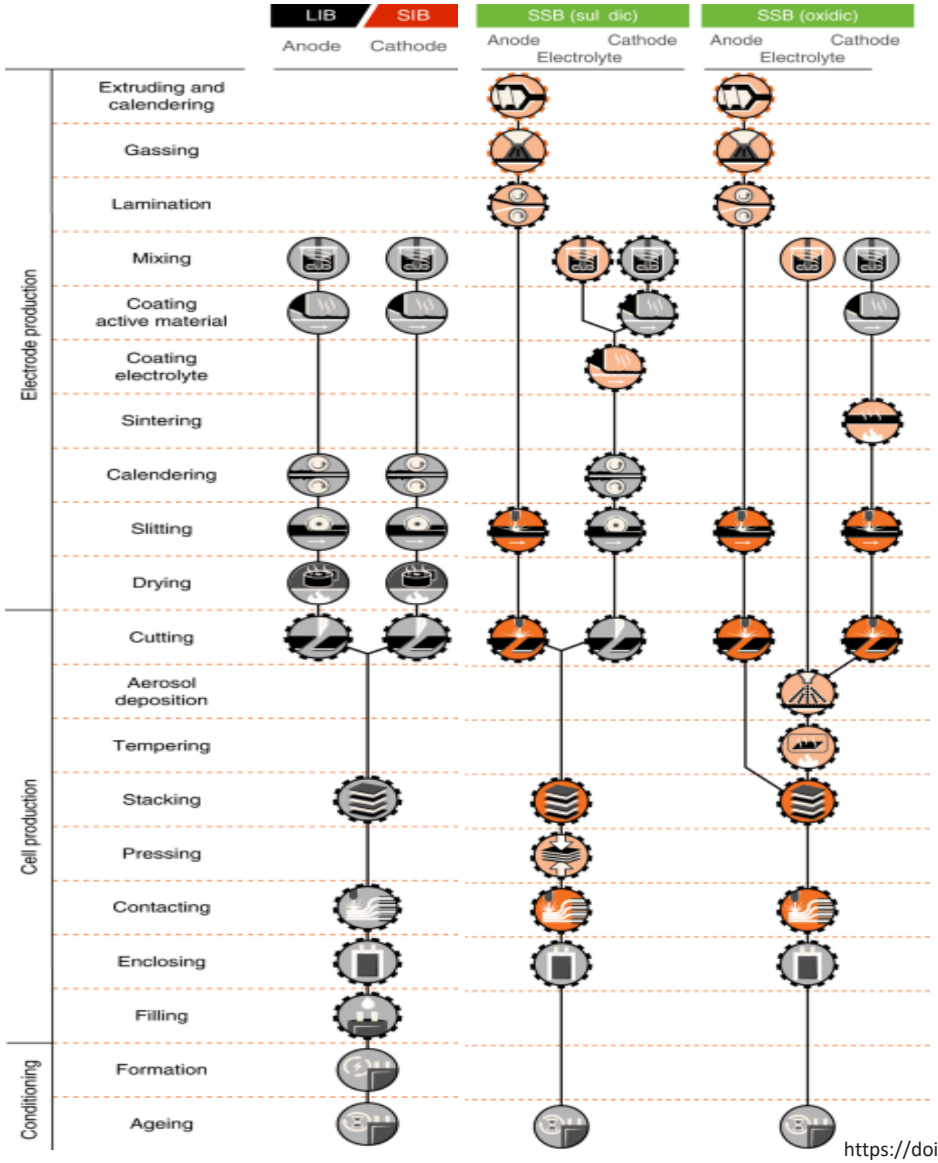
Scale: Cell Manufacturing



SSB cell production shares ≈50% of processes with current generation

- **An Opportunity** as it benefits from mature parts of the supply chain, leverages good part of existing infrastructure and the gained experience
- **A Risk** as it impose high cost for retrofit/adaptation, demands developing new manufacturing equipment & processes, obsoletes gained expertise

The absolute CAPEX and OPEX is higher.
Among many, higher CAPEX & OPEX imply higher ramp-up cost & higher required funding for passing valley of death.

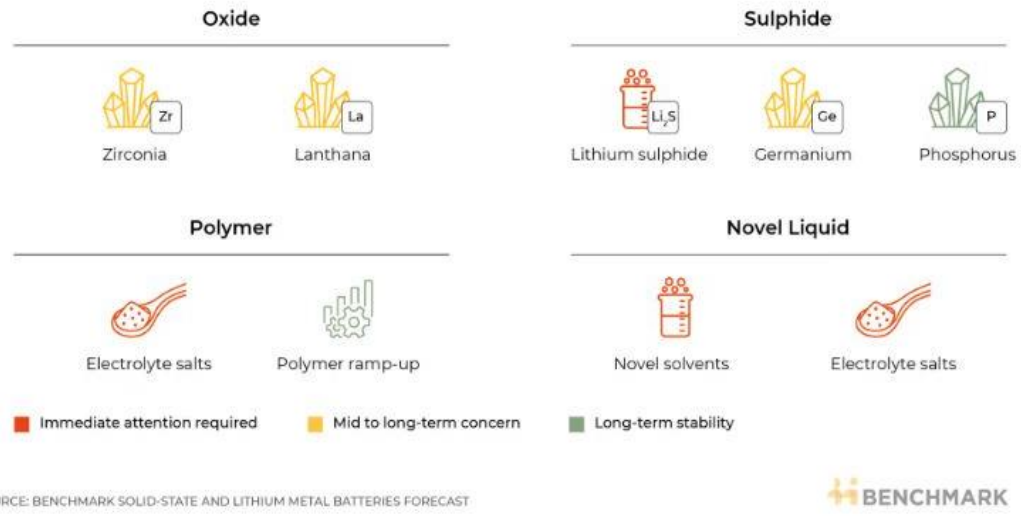
However, **if scaled**, because of higher energy density, the manufacturing costs & environmental footprint are generally lower than current generation

https://doi.org/10.1038/s41560-020-00748-8

Scale: Up& Downstream

Next-gen batteries like SSB introduce new supply chain bottlenecks

Established European specialty chemicals industry provides the opportunity for foundation of new supply chains & strategic autonomy



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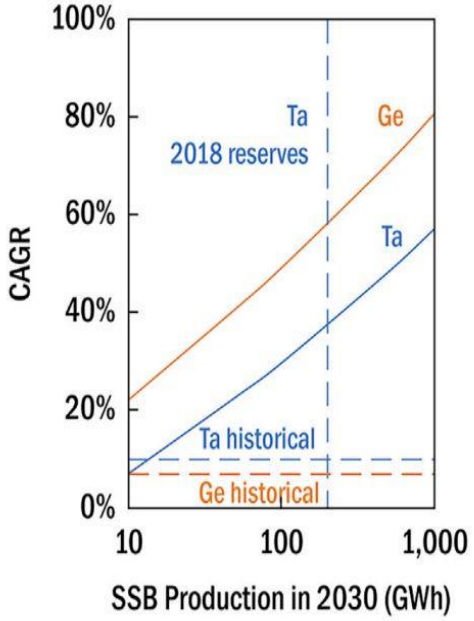
Ambitious scaled cell production demands ambitious raw & advanced materials strategy too!



Long qualification stages by OEMs risk the commercialization and survival of startups. Innovation is a must to accelerate process by developing advanced testing protocols, and adopt digitalization and AI-driven modeling

https://doi.org/10.1016/j.joule.2020.12.001

Scope: non-EV applications & spill-over

A market is niche until it isn't!

The characteristics of SSB technology checks the requirements of many non-EV applications.
The acceptable cost point is much moderated in many of these applications

CLEAN AVIATION

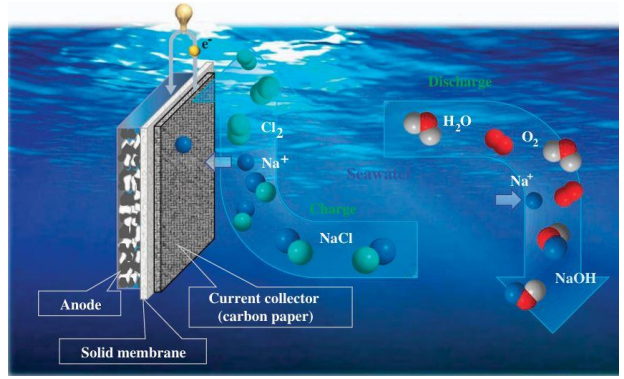
To be powered (partially) with batteries*:
1. Ultra-efficient hybrid-electric regional aircraft
2. Ultra-efficient SMR aircraft
3. hybrid aircraft with hydrogen fuel cell and battery systems

*CAJU SRIA

CATL SSB batteries will enable eVTOLs with 250km range
Announced on CATL tech day
April 21st , 2025

SSB manufacturing and components are enablers of broader battery innovation

Losing the SSB race, not only means losing the future of EVs , but also **other battery technologies on the horizon** for other mobility & non-mobility markets



Rechargeable-hybrid-seawater fuel cell

"‥ I was more optimistic about seawater battery two years ago, but my optimism was relying on technologies for producing thin solid-state lithium-ion electrolyte, which would enable next generation sodium-seawater battery by transposing the knowledge…"*

Prof. Stefano Passerini
*Battery Generation Podcast

doi:10.1038/am.2014.106

Speed: global competition is rapidly intensifying

$830M government investment in National all-SSB Initiative (CASIP)

New safety standards hugely incentivises safe chemistries like SSB

Semi-solid batteries deployed in EV (limited, and no indication of cost figures)

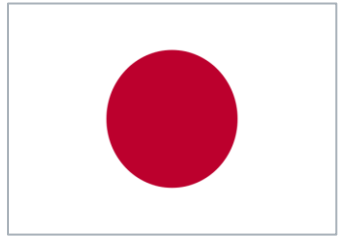
BYD targeting "mass demonstration" of all-SSB in 2027

"CATL's all-SSB development is currently at TRL 4. The goal is to reach TRL 7-8 by 2027, meaning it could produce all-solid-state batteries in small batches by then, but high-volume production would still face challenges including cost". CATL CTO

DoE investing specifically in SSB R&I by "Battery 500" project since 2010, and continuing with ARPA-E under PROPEL-1K targeting 1000Wh/kg next-gen for mobility

Aside from IRA, the Biden administration funded almost $6bill. on battery projects with focus on next-gen in the second round. (continuation under Trump admin. is unclear)

Main European OEMs partnerships for SSB are with American enterprises (QuantumScape, Factorial, SolidPower)



Japan is one of the pioneers of the field, with Toyota leading the efforts for commercialisation

Samsung SDI, aims to mass produce solid-state batteries in 2027

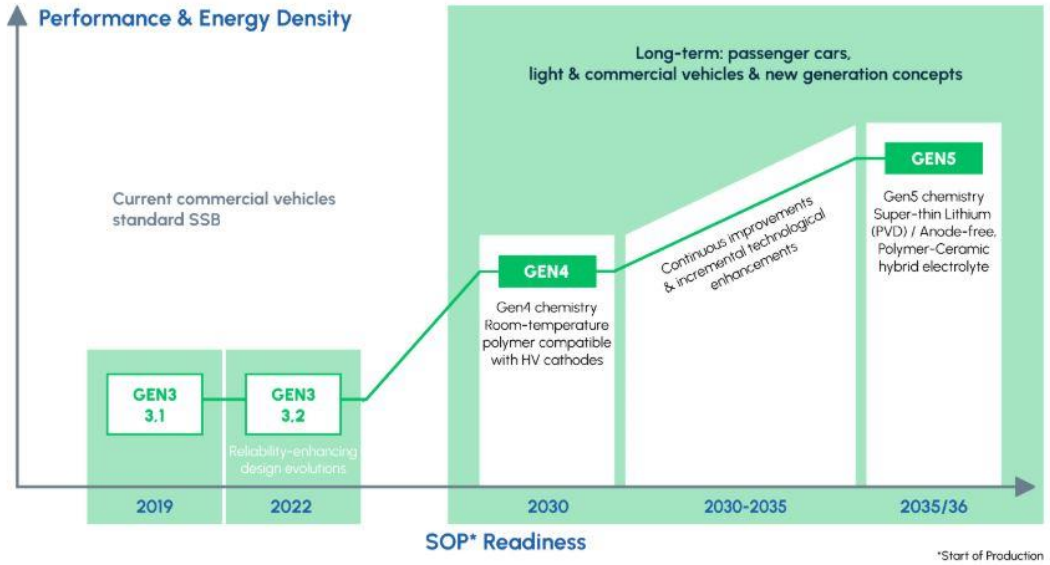
Both LGChem & Sk On in partnership with solid electrolyte suppliers

LG Chem plans to commercialise by 2029

Link to International Observation by Batteries Europe

European Companies: Cell Development & Manufacturing

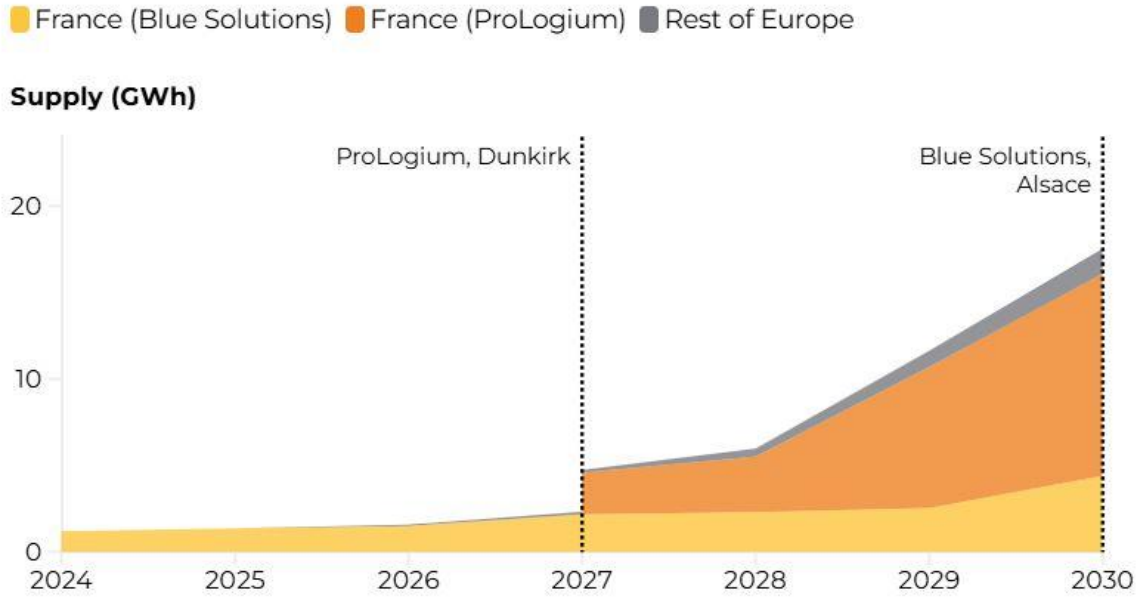
BlueSolutions by Bolloré



ProLogium

Prologium (headquartered in Taiwan) plans to start production of semi-SSB from 2027 in France

Blue Solutions (polymer electrolyte) is the only European company producing commercialized cells

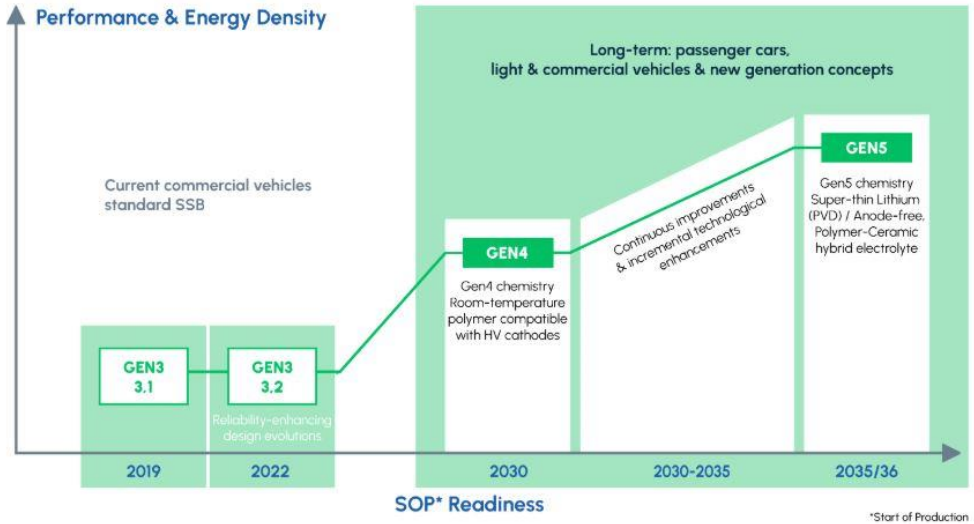


Source: Benchmark Solid-State and Lithium Metal Batteries Forecast

BENCHMARK

European Companies: Cell Development & Manufacturing

BlueSolutions by Bolloré



ProLogium

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BASQUEVOLT

ITEN

LiNa Energy

SO LI THOR

ilika

Europe Companies: Up & Downstream

There is very limited production of SSB electrolyte in Europe, and no lithium metal actor

SAINT-GOBAIN

umicore

SYENSQO

INNOLITH

SOLVIONIC

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Major European automakers have strong partnerships with (non-EU based) SSB companies

PowerCo

QuantumScape

BMW GROUP

Solid Power

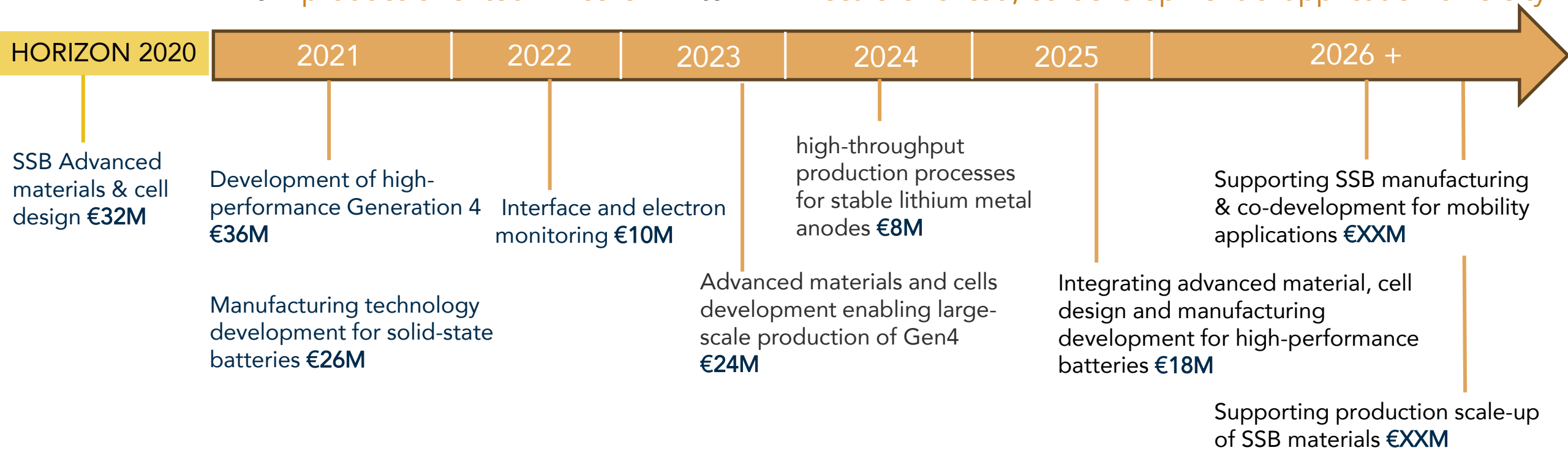
Factorial

STELLANTIS

Factorial

EU funding: BATT4EU Batteries European Partnership topics

From product-oriented EV cells to scale-oriented, co-development & application diversity



So far Between 20-30% of total Batt4EU budget has been dedicated to solid-state battery technology

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BATT4EU Batteries European Partnership Projects

SPINMATE

HyLiST

Hybrid Lithium Metal-based Scalable Solid-State Battery Manufacturing

HELENA

SOLIDBAT

Stay Tuned for BEPA Webinars on Presentation of The Projects Results

SSB in EU Competitiveness Agenda

EU Clean Industrial Deal

A business plan to accelerate decarbonisation and competitiveness for European industry - by boosting innovation and reinforcing EU resilience

- ***Non-Price criteria** in public procurement: Building on Net Zero Industry Act Guidelines*
- *the Commission will work with the EIB Group and private investors to deploy a **TechEU investment programme** to help bridge the financing gap to **support disruptive innovation (no clear details provided)***
- *Simplification and **quick approval of State aid**, including battery manufacturing*
- *making greater use of **resilience criteria** in competitive calls*

In 2025, the European Commission will adopt an **EU Startup and Scaleup Strategy**

- Flagship Action for Innovation: The EU Startup & Scaleup Strategy will be one of the first major actions under the "Closing the Innovation Gap" pillar, aiming to boost Europe's innovation ecosystem.
- Concrete Measures & Legislation: The strategy will lead to specific policy actions, including legislative proposals like the European Innovation Act and the "28th regime" to simplify regulations for innovative companies.
- a series of meetings with founders, CEOs and other stakeholders the European Startups and Scaleup Forum will be organised in 2025.

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Survey Results on EU Startup & Scaleup Strategy

1. Investment funding and financing
2. Competition from Asia
3. Supply chain challenges
4. Regulatory overdrive

Link to the article

SSB in Industrial Action Plan for Automotive Sector

sets out concrete measures to help secure global competitiveness of the European automotive industry and maintain a strong European production base

" .... The EU is putting a strong focus on battery innovation through the ***Horizon Europe partnership BATT4EU****. This focus remains important. The Commission will support the whole EU value chain of* ***next generation batteries****, including recycling"*

- ***Battery Manufacturing Booster***
  - *The document re-introduces the* ***EUR 3 billion of the Innovation Fund*** *for battery manufacturing*
  - *The Commission* ***will look into*** *EU direct production support to companies manufacturing batteries in the EU*
  - *Suggests benefit of the sector in upcoming simplification of the state aid*
- *The Commission will explore additional practical ways to support European battery manufacturing* ***during the critical scale-up phase***
- ***non-price criteria*** *such as resilience requirements will be considered, both for EU and Member State funding.*
- ***European content requirements*** *on battery cells and components in EVs sold in the EU will be addressed in upcoming legislation (i.e., Industrial Decarbonisation Accelerator Act and the Circular Economy Act)*

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Watch the Recording of BEPA Webinar on Implications of the Clean Industrial Deal for the Battery Sector

Looking Ahead

Looking Ahead

- The EU innovation strategy for **next-gen batteries in FP10/Competitiveness Fund should embody a value-chain perspective**: from raw & advanced materials to cell production to applications; **Batt4EU has been instrumental in establishing that network in Europe**
- **End-user diversification** provides the potential for absorbing part of the ramp-up cost while improving manufacturing excellency
- SSB is the field of advanced chemistries & advanced manufacturing
  EU chemical & semiconductor legacy play a vital role in future of the technology
- Despite pressing global competition, different manufacturing than Gen3., underdeveloped supply chain and limited global deployment, and European excellence in SSB research are among many reasons that **keeps the game open**
- The core business is young. A well-designed **EU Startup Strategy** is vital for the future of this technology
- A unique opportunity to leverage **European research infrastructure** and to mobilise universities & RTOs competence to advance the development
- Given the importance of next-gen, as indicated in AIAP, the European OEMs are consumed with developing the technology and supply chain for current generation, hence role of the **public support is needed more than ever**

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THANK YOU!

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