

Feasibility study of 12 V sodium-ion starting battery

Forum MotoSolutions 2024

Justyna Indrychowska and Jan Wierzba

November 2024



IAV around the World



AUTOMOTIVE INDUSTRY

7900 EMPLOYEES OVER THE WORLD

HQ IN GERMANY

180 PEOPLE IN POLAND

IAV capabilities



Future Powertrain

Because the powertrain of the future has more than one solution in store.



Vehicle Solutions & Autonomous Driving

Because the vehicle must be thought of as a whole.

```
01100100
-----
01100001
-----
01110100
```

Software Systems & Connectivity

Because connected mobility knows no boundaries.



Solutions & Products

Because innovative solutions are in our blood – even beyond mobility.

IAV capabilities

Our services



Future Powertrain

Because the powertrain of the future has more than one solution in store.

Battery development



More than 150 employees in battery development



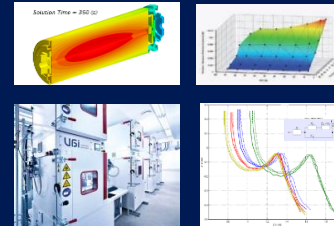
More than 28 years of experience



From concept to series

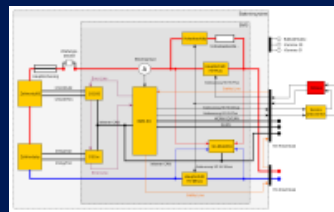


From battery to complete vehicle



Cell / module characterisation

- specification and requirements
- benchmark, market observation
- simulation on cell and system level
- calibration & modelling
- new cell chemistries



Battery system / components

- specification and requirements
- mechanical design and simulation
- electrical design and simulation
- thermal design and simulation



Battery function development

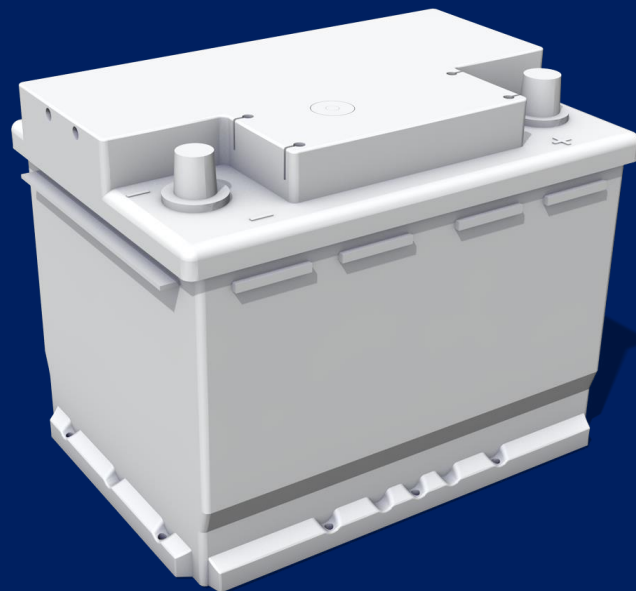
- system and functional development
- BMS, CMC, BJB, and interfaces
- safety analysis, ISO 26262
- IAV BMS (automotive, flexible)



Validation

- supplier management, -qualification
- test specification, -management
- prototype manufacturing
- vehicle integration and test

12V starter battery



Customer focus points:

- Price
- Lifetime
- Reliability in cold temperatures regardless battery condition
- What about Environment impact ?

Disadvantages of Lead-Acid Batteries:

- **Toxicity:** Lead exposure, even in minimal amounts, poses severe health risks therefore it can be banned soon
- **Environmental Impact:** Facilities involved in the production, recycling, and storage of lead-acid batteries pose a potential risk of contaminating both water and soil
- **Performance:** significant degradation of performance in low temperatures

What if there is an alternative ?



Customer focus points:

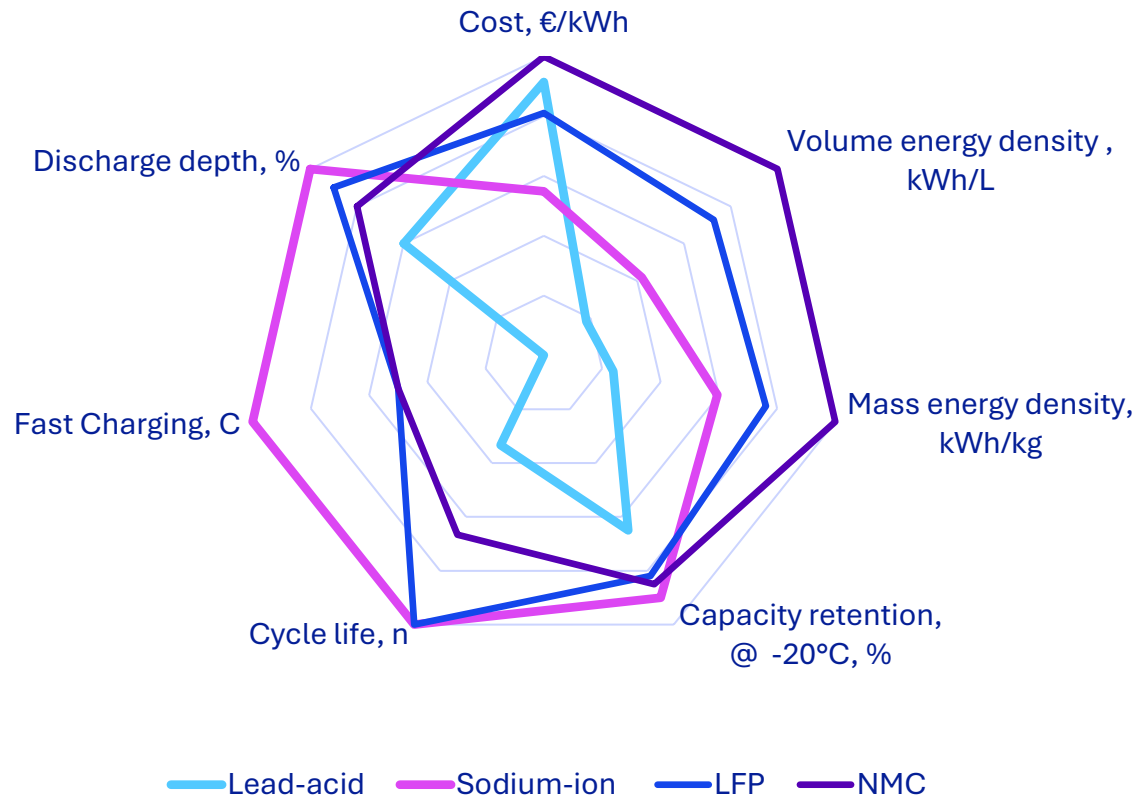
- Price
- Lifetime
- Reliability in cold temperatures regardless battery condition
- What about Environment impact ?

Advantages of Sodium ion Batteries:

- + **Safe:** Lower toxicity with high level of safety
- + **Enhanced Performance:** Superior cold-cranking capabilities
- + **Durability:** Tolerant to complete discharge without damage.
- + **Longevity:** Extended operational lifespan
- + **Weight Reduction:** Lighter weight improves vehicle efficiency and performance

Why Sodium ion?

Comparison of different Cell chemistries



High resources reserves: 6th abundant element in Earth's Crust

Discharge depth: up to 0V

Discharge temperature: up to -40°C

Charging temperature: up to -20 °C

High discharge rate: up to 10C

Gravimetric energy density: up to 150 Wh/kg

More cost-effective – no need of lithium, cobalt and copper (both current collectors – aluminium)

Electrolytes: Often using less flammable solvents than LIB

https://www.isi.fraunhofer.de/content/dam/isi/dokumente/cct/2023/Fraunhofer-ISI_LIB-Roadmap-2023.pdf

<http://ijmmm.ustb.edu.cn/article/doi/10.1007/s12613-022-2541-1>

https://www.researchgate.net/figure/Electrochemical-performance-of-NMC811graphite-full-cells-a-Cycling-performance-at-05C_fig3_368363445

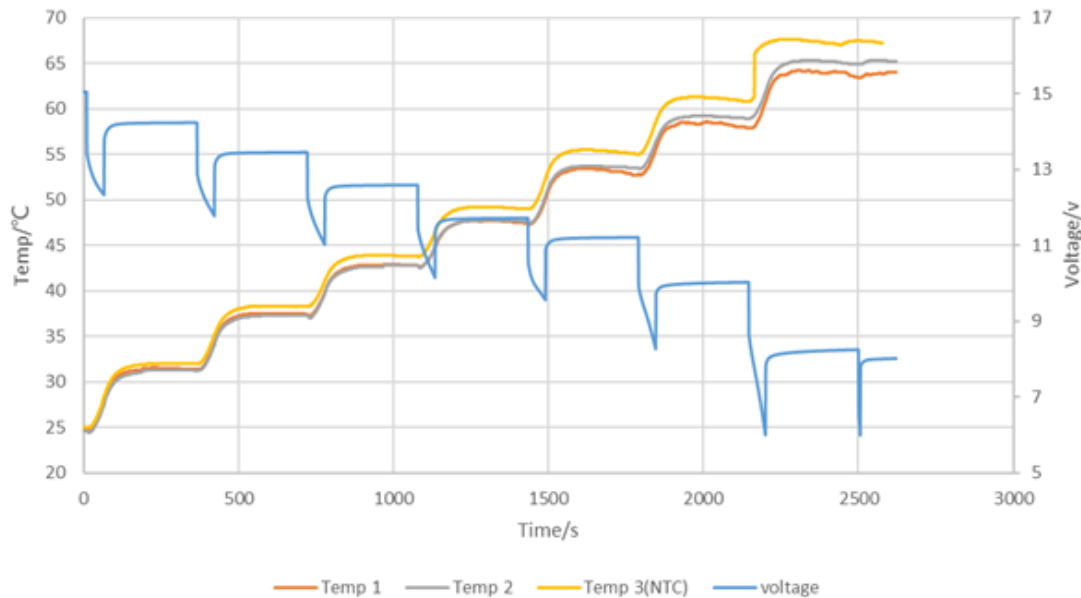
<https://www.woodmac.com/news/opinion/sodium-ion-batteries-disrupt/>

12V SiB Proof of Concept

Target vehicle	C segment
Configuration	4S7P
Nominal voltage (V)	12
Minimum capacity (Ah)	70
Weight (kg)	9.9
Volume * (L)	5.2
Max discharge current BOL (A) for 30s at 25°C	945
Max discharge current BOL (A) for 30s at - 20°C	565



600A discharge-Temperature voltage curve



High current cycling
600A/56s -> 300s pause until V<6

Results

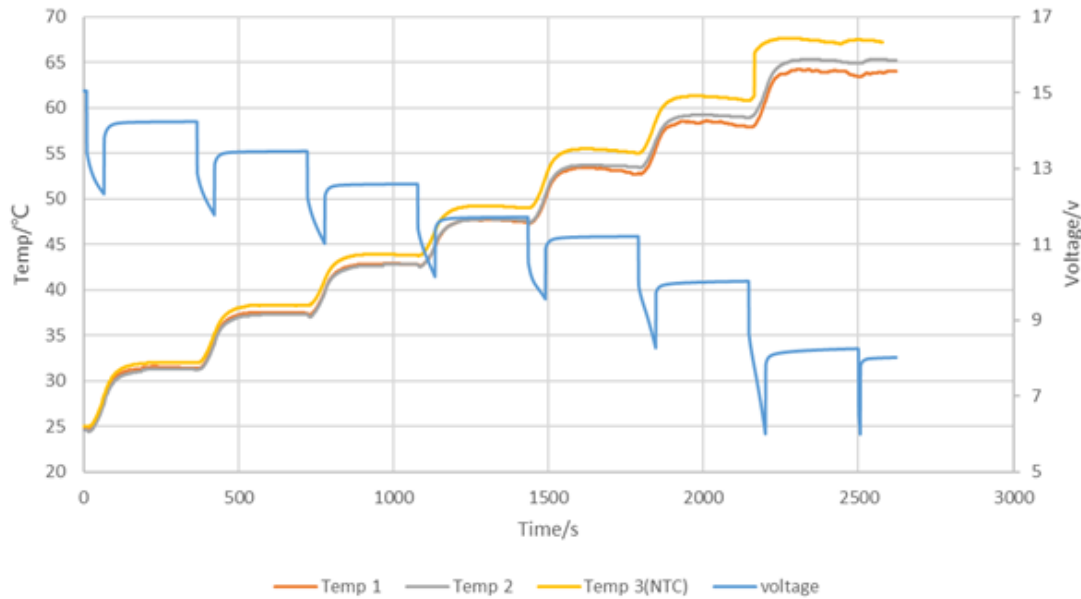
- 50% less weight
- 20% less volume
- Stable voltage and temperature
- Robust and safe solution although stressful testing

12V SiB Proof of Concept

Target vehicle	C Segment
Configuration	4S7P
Nominal voltage (V)	12
Minimum capacity (Ah)	70
Weight (kg)	9.9
Volume * (L)	5.2
Max discharge current BOL (A) for 30s at 25°C	945
Max discharge current BOL (A) for 30s at - 20°C	565



600A discharge-Temperature voltage curve



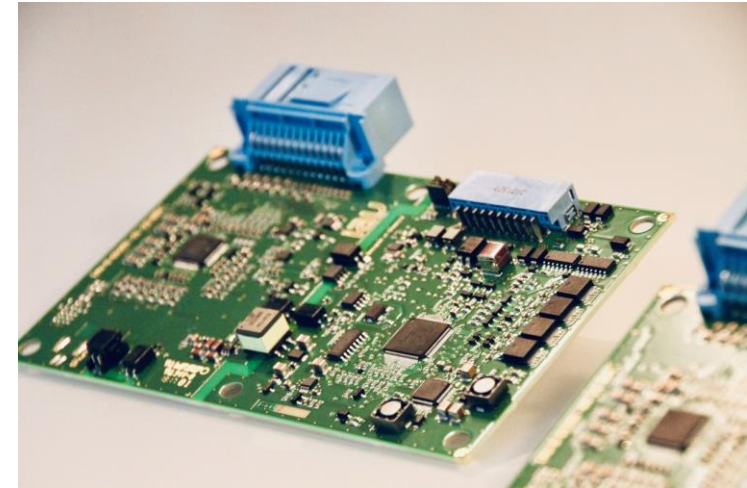
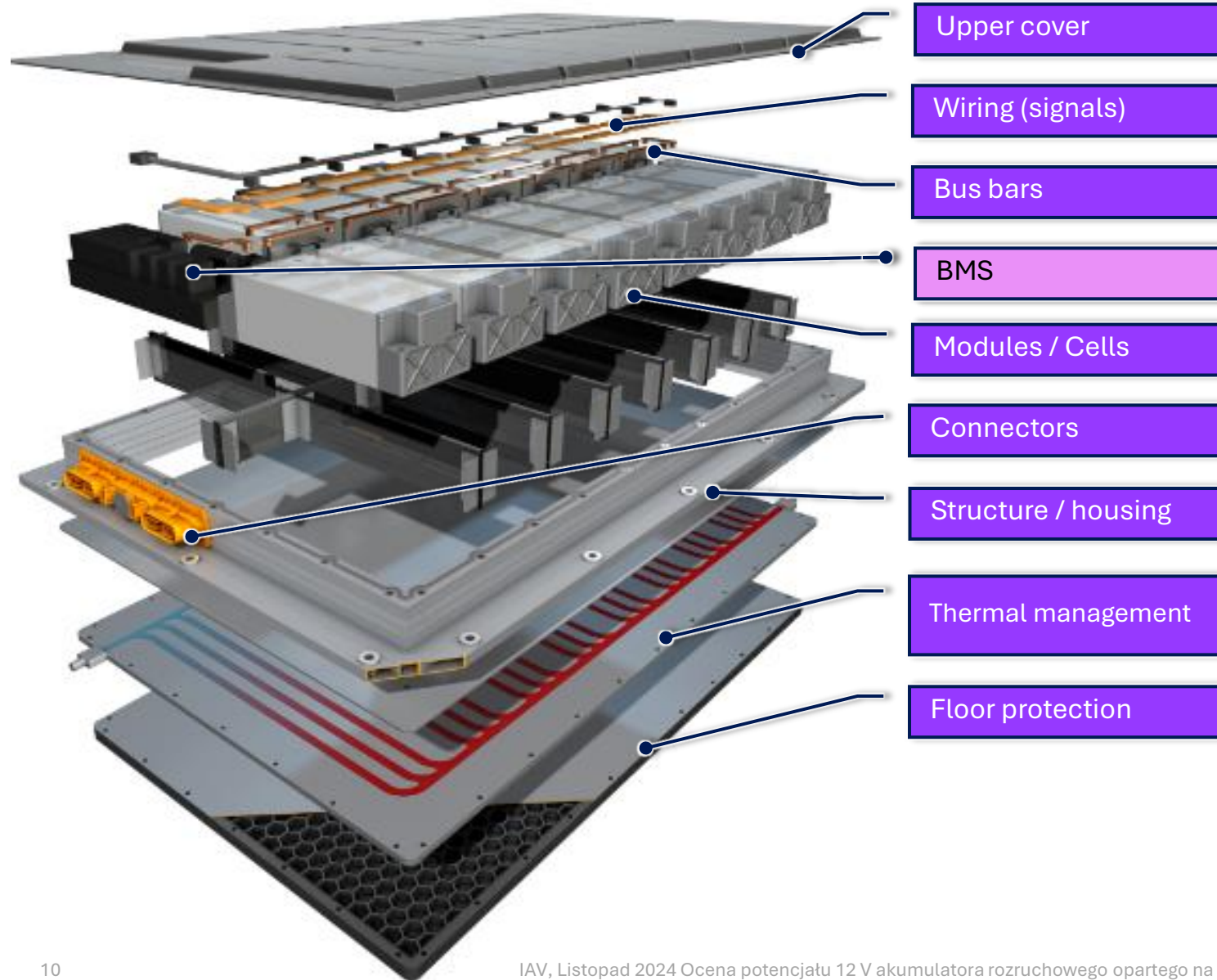
High current cycling

600A/56s -> 300s pause until V<6

Next Steps

- Target vehicle – Premium OEM
- L5 Housing – Automotive Standard
- 100Ah – 4S10P – Cold Cranking Amp @-18°C 850A
- Battery Development

IAV Battery development



Scalable high-voltage BMS including AI and cloud applications

- **Flexible:** Different battery configurations (series, parallel and combined interconnections)
- **Wide range of applications:** Different cell chemistries, system voltage from 12 V to 1000 V, system current up to 4000 A, system power up to 4 MW.
- **Safety:** according to automotive standards
- **Markets:** Automotive, Off highway, BESS

Conclusions & Outlook

- Lead is a banned material in automotive application, with the lead-acid battery being the last one still in use
- Phasing out lead – acid battery aligns with global regulatory trends and standards aimed at reducing hazardous substances, ensuring compliance and promoting sustainable practices in the industry
- OEMs are planning to shift their 12V batteries from lead-acid to other technology
- Various chemistries are being investigated in academia and industry
- Sodium ion Batteries shows a great potential to substitute 12V lead-acid batteries showing a promising cold temperature performance, extended lifetime and safety
- IAV, as a provider of solutions tailored to customer needs, is developing a drop-in 12V Sodium ion starter battery for both mid-class and premium OEMs

Acknowledgements for the support to:

IAV France Team

IAV Automotive Engineering Team

HiNa Battery

Thank you for listening!

Let's discuss the future of electrification!

Justyna Indrychowska

Jan Wierzba

www.iav.com

