
I-STATE TECHNOLOGY
E-MOBILITY FREEDOM
FOR ALL
AT BATTERY SHOW
MAY 23RD, 2023
THE FIRST EUROPEAN
FULL CELL BATTERY
CHEMISTRY INNOVATOR
POWERED BY I-STATE
INNOLITH

OVERVIEW

INNOLITH

01

INTRODUCTION TO INNOLITH

KEY FACTS ABOUT US: I-STATE TECHNOLOGY PIONEER

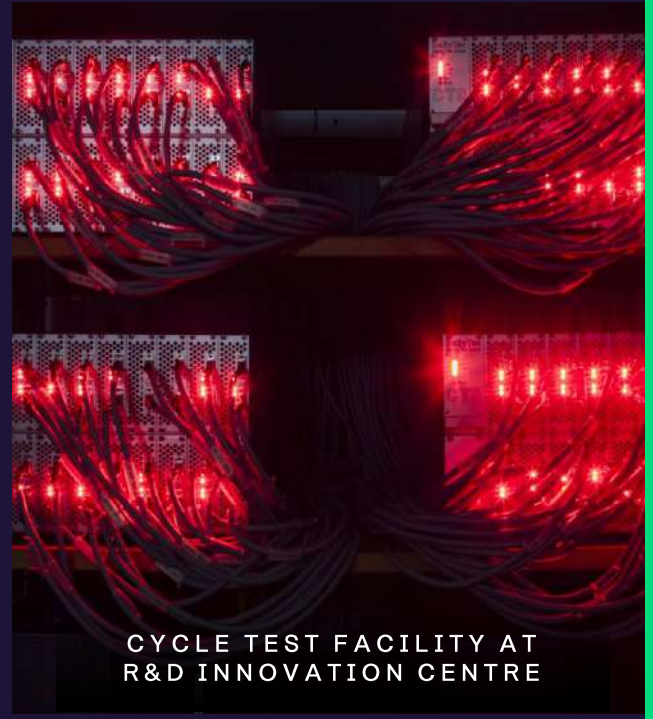
A WORLD-CLASS TEAM THAT'S CHARGING THE FUTURE

Founded in 2018 with an expert battery cell team

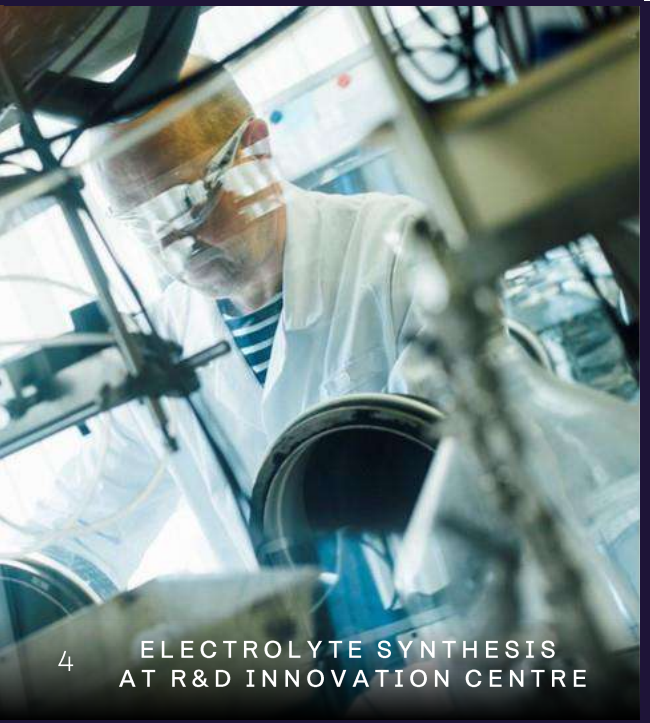
- ~80 employees across 3 locations: HQ in Basel, CH; R&D Innovation centre in Bruchsal, DE; China office
- 20+ years of R&D research by the core team behind this technology

$120M OF COMMITTED CAPITAL

- $100M invested in R&D to date
- Lab Line commissioned end of 2021 for full samples manufacturing and R&D



CYCLE TEST FACILITY AT R&D INNOVATION CENTRE



ELECTROLYTE SYNTHESIS AT R&D INNOVATION CENTRE

BETTER PERFORMANCE. UNLOCKED

- Breakthrough discovery of a new liquid electrolyte in 2019
- Invention of inorganic electrolyte formula unlocks I-STATE benefits.
- Best cost, highest energy density, best temperature range, improved safety and recyclability – to name a few.

R&D INNOVATION CENTRE

FULLY PROTECTED IP

- 100% own IP – > 325 granted patents
- > 70 pending patents and extensive trade secrets

INNOLITH

E-MOBILITY NEEDS TO BE FREED FROM 6 KEY BARRIERS.

WE ARE DETERMINED TO BRING THIS FREEDOM

LOWER COST BATTERIES

HIGHER ENERGY DENSITY

WIDER TEMPERATURE RANGE

FASTER CHARGE

IMPROVED SAFETY SPECIALLY FIRE

IMPROVED RECYCLABILITY

INNOLITH

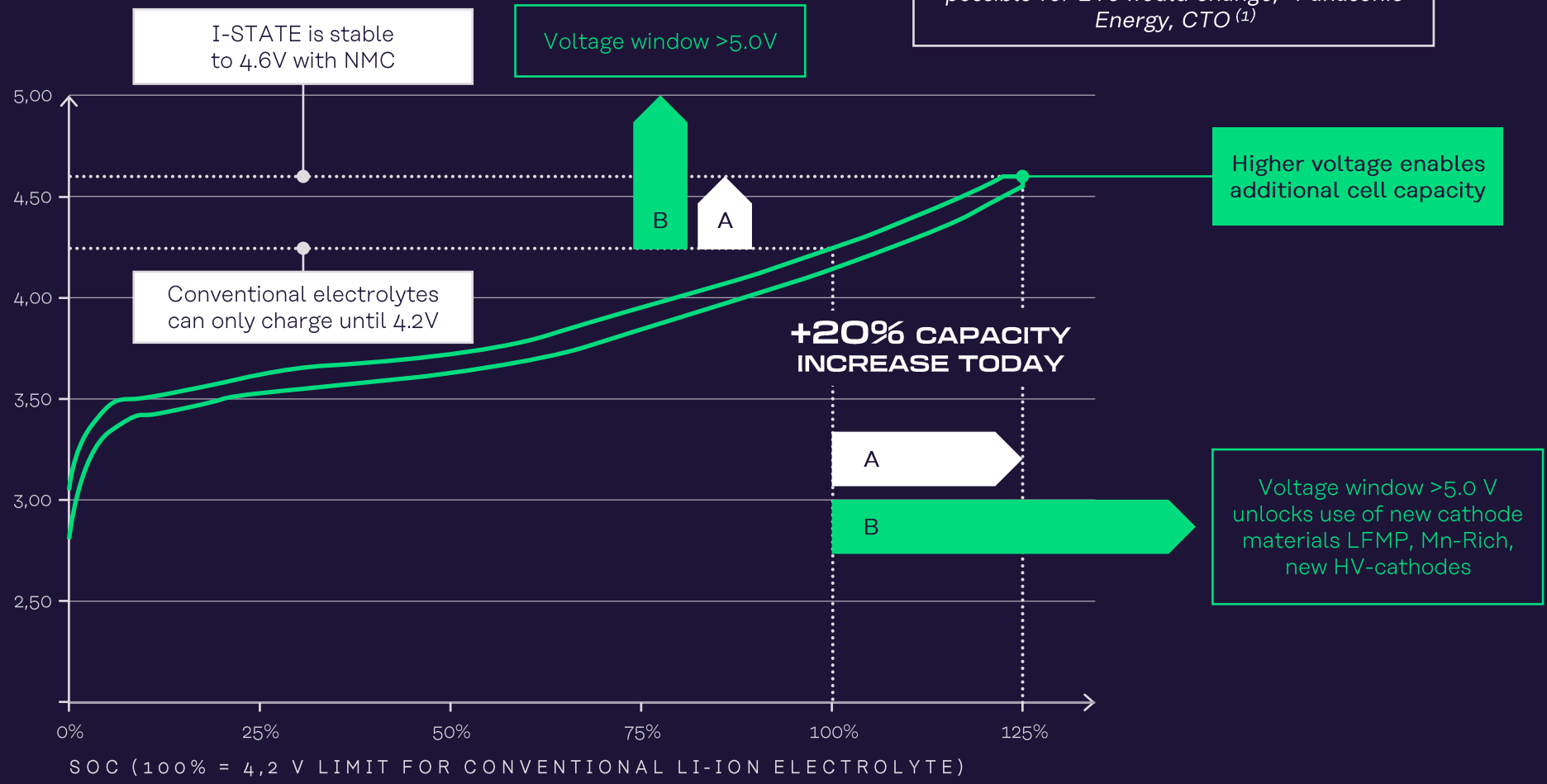
02

HOW INNOLITH'S ELECTROLYTE WORKS

I-STATE UNLOCKS APPLICATION OF THE NEW MATERIALS (LFMP, MN-RICH AND NEW HV-CATHODES)

"If we can get that to 4.5 or 4.6 volts, I think the whole world view in terms of what's possible for EVs would change," Panasonic Energy, CTO (1)

TEST WITH NMC AND GRAPHITE CYCLED FROM 2.8-4.6 VOLTS



Source: ZSW; University of Ulm
Note: SOC (State of Charge) level of charge of an electric battery relative to its capacity
(1) https://www.reuters.com/business/autos-transportation/exclusive-tesla-supplier-panasonic-eyes-20-jump-battery-density-by-2030-2022-07-13/

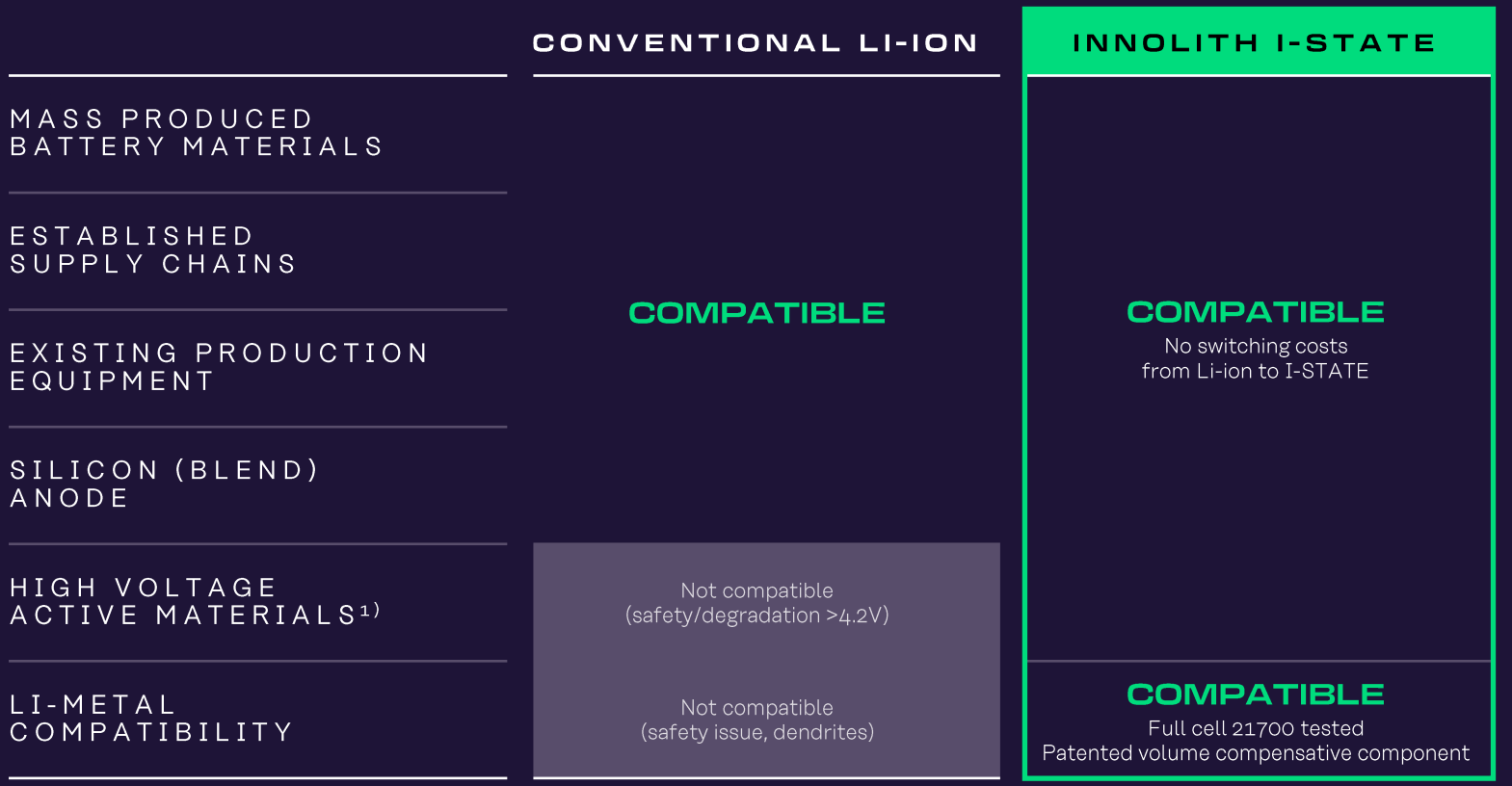
INNOLITH

BESIDES HIGH VOLTAGE STABILITY INNOLITH'S ELECTROLYTE HAS SUPERIOR PROPERTIES ON ALL METRICS, WHICH LEADS TO PERFORMANCE IMPROVEMENT

ELECTROLYTE PROPERTIES	IMPLICATION FOR BATTERY CELL	CONVENTIONAL ORGANIC ELECTROLYTE	INNOLITH I-STATE ELECTROLYTE	COMMENT
Voltage stability window	Increase in energy density	0.0 – 4.2 V	0.0 – +5.0 V	Values apply for electrolyte only
Conductivity	Increase in power capability	6 – 12 mS / cm *)	> 42 mS / cm	Measured at room temperature
Low temperature limit	Less heating required	-20°C	-60°C	At -40°C Innolith cells can be discharged with > 70% capacity
Flash point	Increase in safety	Starts at +15°C	No flash point	Depending on used solvents
Active material compatibility	Performance improvement	Commercially available materials	Commercially available & advanced materials	Positive test results for selected commercial materials NMC, NCA, LFMP, Gr, Gr/Si

*) Source: Dahn et al., Journal of The Electrochemical Society, 165 (2) A21-A30 (2018)

A UNIQUE ELECTRIC FUTURE WHERE EVERYONE CAN JOIN THE PARTY



Source: Automotive OEM disclosure and commentary; Innolith analysis
Note: 1) Innolith with positive test results for selected commercial materials NMC, NCA, LMP, Gr, Gr/Si

INNOLITH

03

INNOLITH'S CELL PERFORMANCE TEST RESULTS

INNOLITH

FROM THE I-STATE ELECTROLYTE TO FULL CELLS, SETTING NEW BENCHMARK FOR NMC-GRAPHITE CELL

I-STATE electrolyte is leading the way to new cell design and cell features:

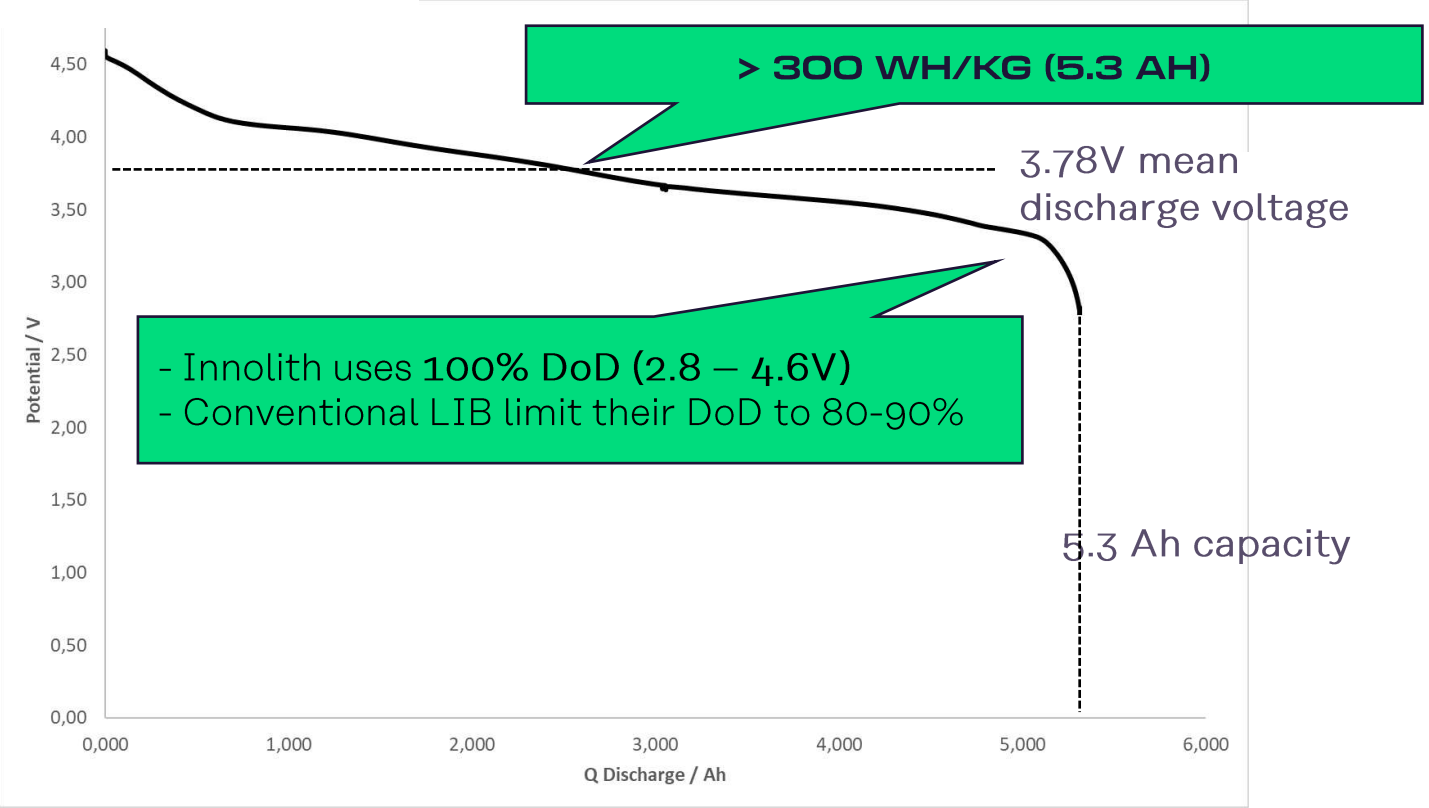
- **Voltage stability** is the starting point to improve cathodes and energy density.
- **Low freezing temperature** leads to improved performance at low temperatures
- **Voltage > 4,2V** is not affecting stability even at higher C-Rate

The first 21700 cells from Innolith use these opportunities to set new levels for NMC-Graphite cells

OUR BASIC SAMPLE ALREADY ACHIEVED
300 WH/KG WITH NMC-GRAPHITE

TEST RESULT

4.6V charge cut-off voltage



SAMPLE FROM OUR SMALL PRODUCTION LINE: 5,3 Ah and 20 Wh

TEST SETUP

CELL IN 21700 FORMAT WITH FOLLOWING SPECIFICATIONS

- Cathode: NMC 811
- Anode: Graphite

BATTERY CELL CYCLED REACH 300 Wh/kg

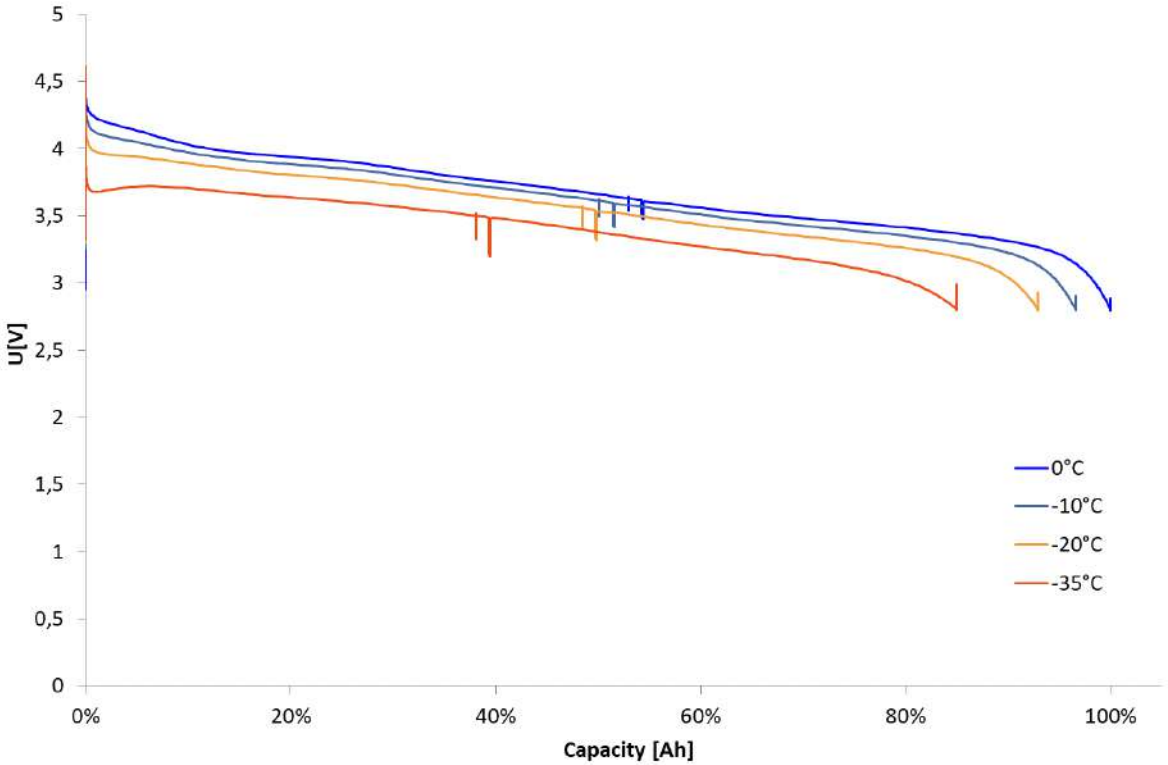
- 5.3 Ah capacity
- 3.78 V mean discharge voltage
- 20.0 Wh (Conventional cells: 17.3 Wh)
- 300 Wh/kg and 830 Wh/l

Note: DoD (Depth of discharge) is the fraction of battery capacity that can be used from the battery and will be specified by the manufacturer; LIB (Lithium-Ion Battery); Conventional LIB limit their DoD to ensure cycle life (2.9 – 4.1V instead of 2.8 – 4.2V)

INNOLITH

CELL CAN BE DISCHARGED AT TEMPERATURES DOWN TO -35°C WITH C/3 CURRENT RATING

TEST RESULT



	Discharged Capacity in % of cap @ RT
0°C	94,1%
-10°C	91,4%
-20°C	88,2%
-35°C	81,8%

IT IS POSSIBLE TO DISCHARGE AT -35°C WITH C/3 AND GET > 80 % CAPACITY compared to room temperature

TEST SETUP

CELL WITH FOLLOWING SPECIFICATIONS

- Cathode: NMC 811
- Anode: Graphite

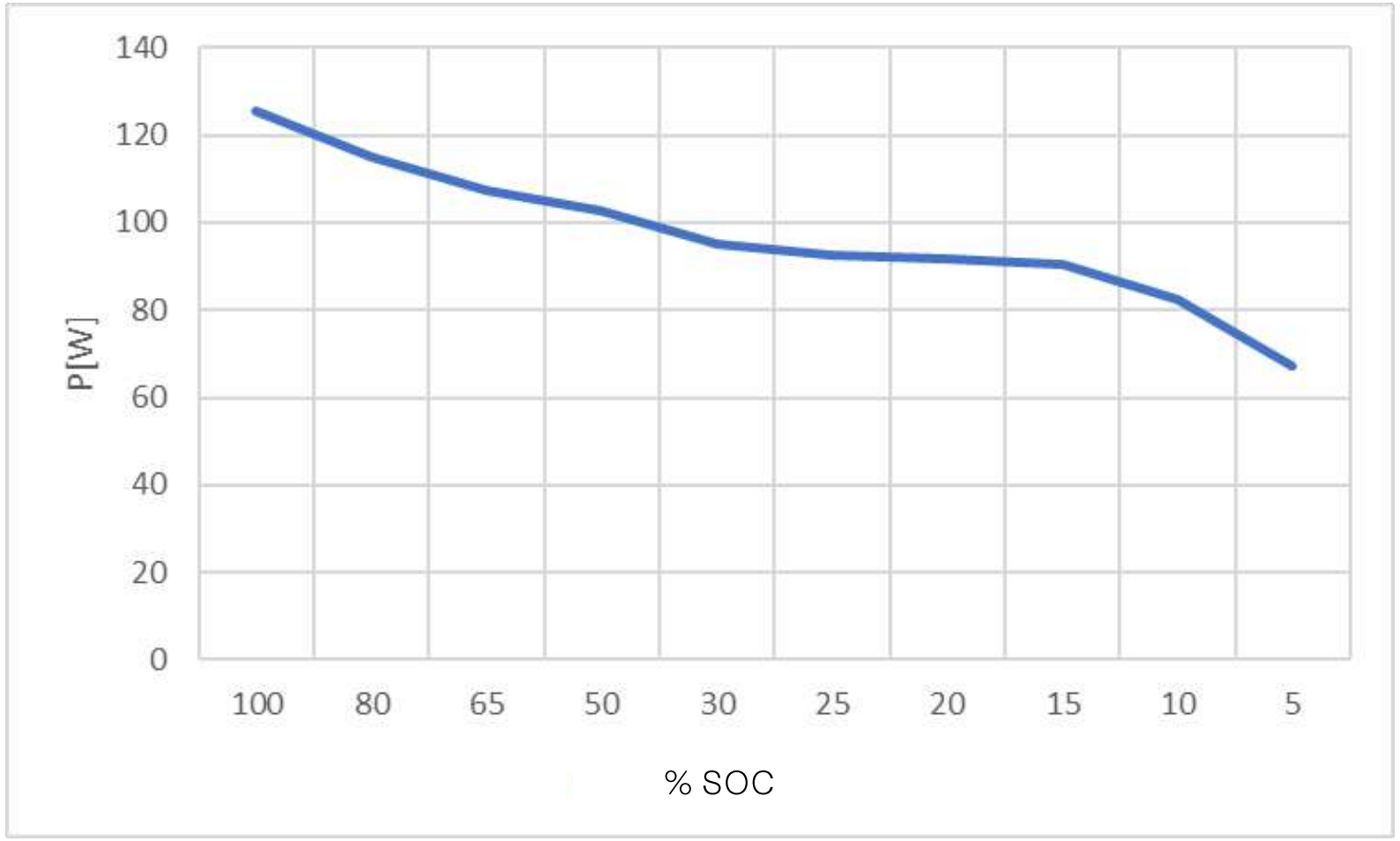
TEST CONDITIONS:

- Charge cells at room temperature
- Keep cells for 6 h at relevant temperature
- Discharge at relevant temperature
- Current rating C/3 up to 4.6V CCCV
- Discharge CC C/3 at [0,-10,-20, -35]°C

INNOLITH

MORE THAN 80 W @ 15% SOC, EXCELLENT POWER OVER WIDE SOC-RANGE

TEST RESULT



TEST SETUP

Cell in 21700 format with following specifications

- Cathode: NMC 811
- Anode: Graphite

Pulse discharge:

- Pulse length: 30s
- Current: 35A (7C)

More than 400 kW (for a 98 kWh battery) would be available, even when battery is almost discharged (15% SoC)

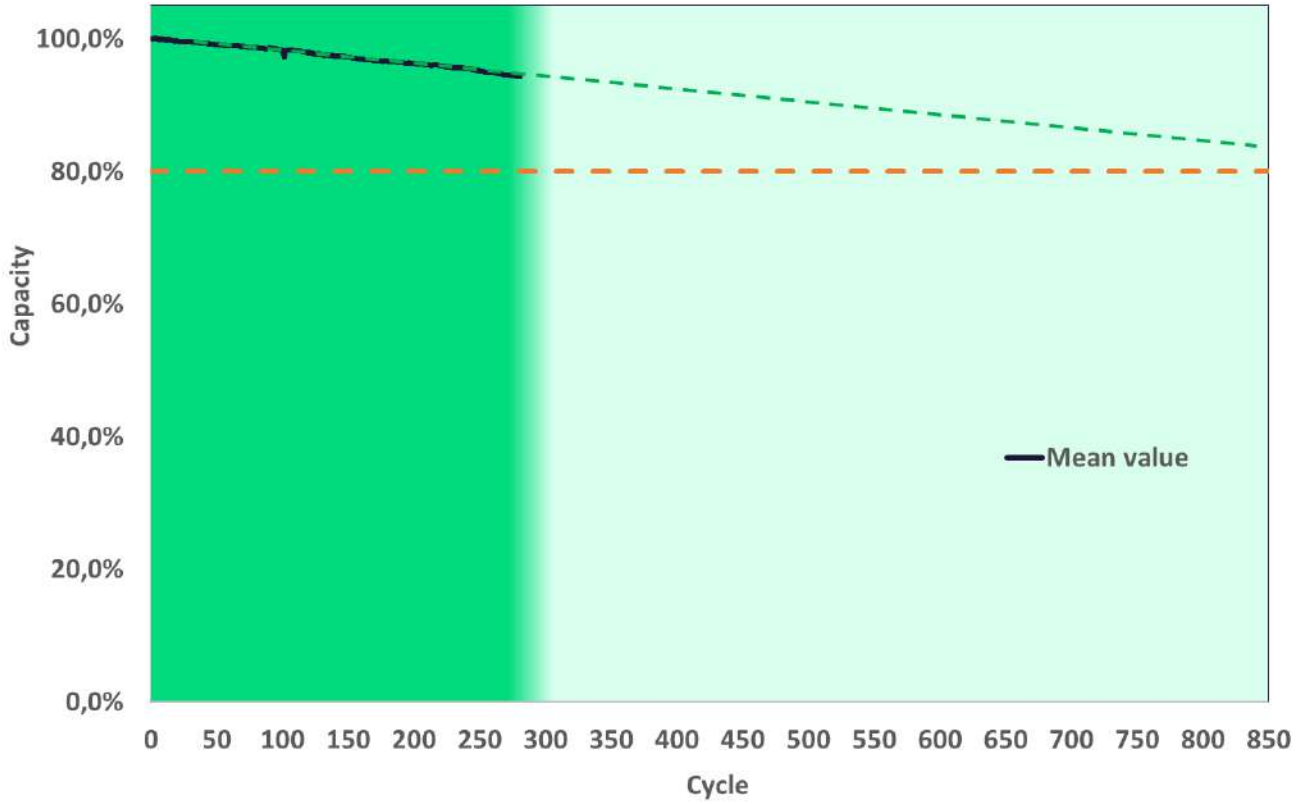
INNOLITH

CYCLING TESTS – CAN NMC BE CYCLED ABOVE 4,2 V? YES WITH I-STATE TECHNOLOGY!

TEST RESULT

Innolith cells are designed for high energy density but performance and specially cycle life is also important for us.

- Cells are cycling at **C/2-C in the voltage range between 2,8V and 4,6V**
- Cells are fully charged and discharged during each cycle.



We can show that cycling NMC above 4.2 V is not affecting cell performance with I-State technology.

INNOLITH

INNOLITH'S 1ST GENERATION 21700 CELL

	21700 High Energy	NMC811 & Graphite
Energy density	300 Wh / kg 825 Wh / L	
Energy per cell	~ 20 Wh	
Min - max cell voltage	2.8 – 4.6 V	
Abs. min voltage	2.5 V @ max current	
Nom. cell voltage	3.75 V @ C/5 discharge	
Nom. cell resistance	25 mΩ @ 50% SoC	
Nom. cell capacity	5.2 Ah @ C/5	
Max constant current	CH: 2.5 A, DC: 5.0 A	
Peak discharge current	35A for 10s; 25A for 60s	
Peak charge current	8.4 A @ 10-80% SoC	
Cycle life	1100 @ C/3 & D/3, 600 @ C/2 & 1D	
Calendar life	10 years	
Temp. range charge/discharge	-20°C – 60°C / -40°C – 60 °C	
Storage temperature	-40°C – 75°C	
Optimal storage/operating temp.	0°C - 40°C	

Lab Line manufactured FULL CELL samples are available since December 2021 and distributed for testing by various partners and customers.

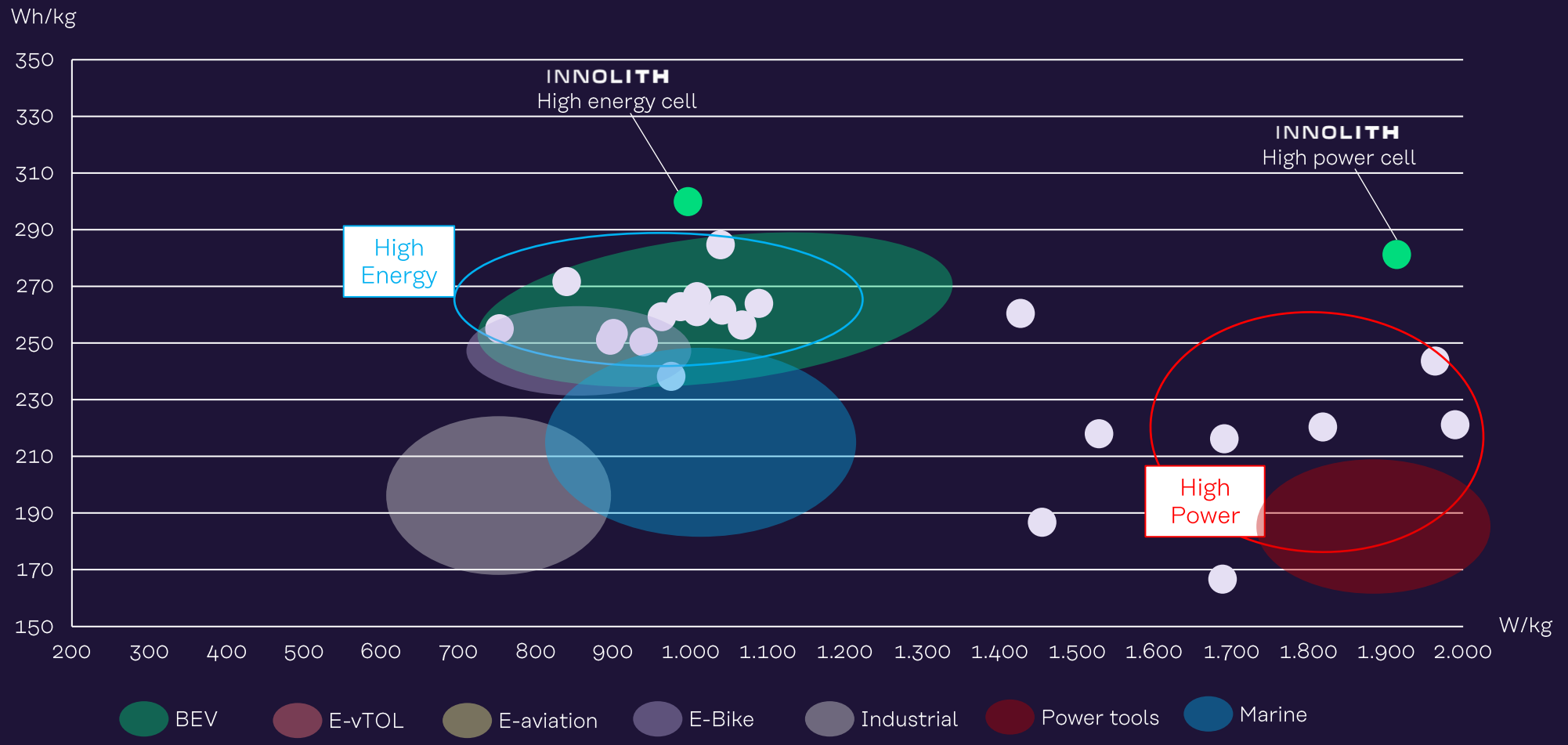
04

TECHNOLOGY ROADMAP AND SUMMARY

INNOLITH

6 UNIQUELY POSITIONED VS COMPETITION

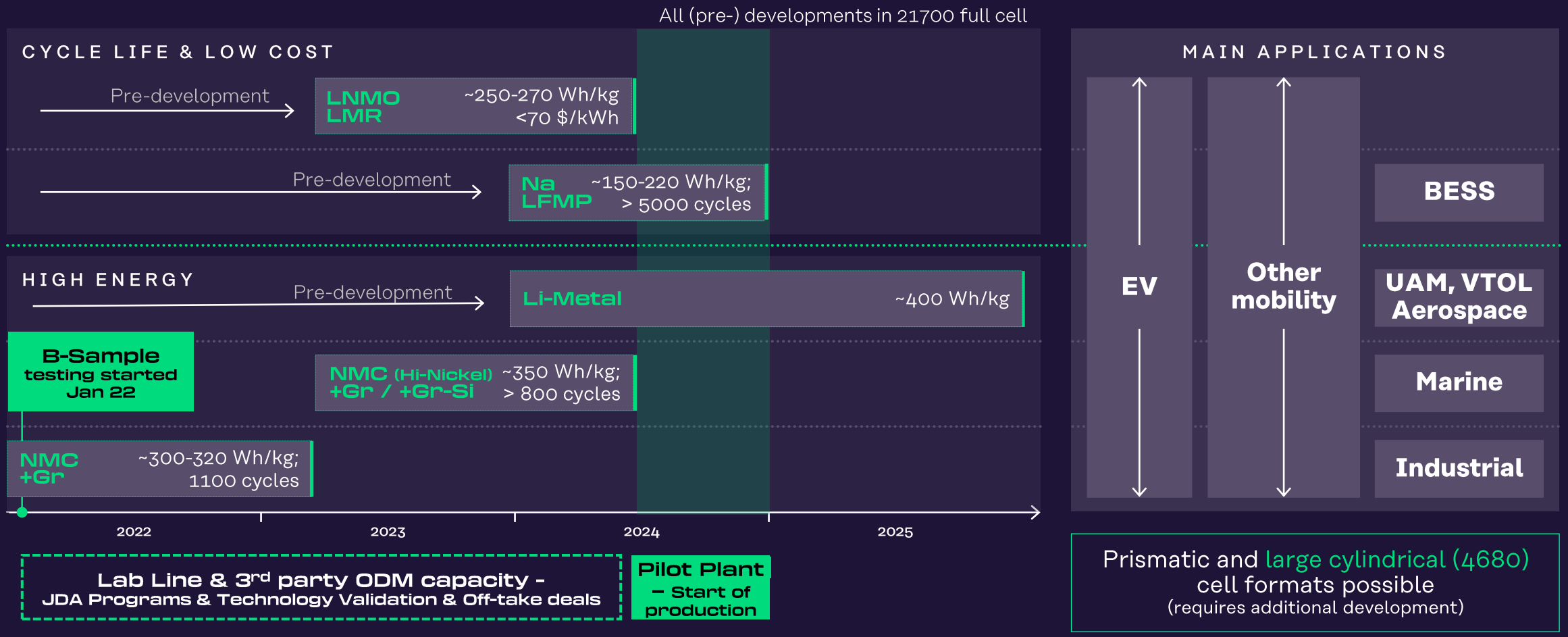
ENERGY AND POWER DENSITY BENCHMARKING VS COMPETITION



Source: Innolith calculations, www.batemo.de (Energy density based on C/10, Power density based on peak power during 5min discharge)

INNOLITH

SET TO SCALE-UP: TECHNOLOGY ROADMAP ENABLED BY I-STATE



Source: Innolith
Note: TIMELINE SHOWS TECHNOLOGY FROM INITIAL A-SAMPLE TO BEING READY FOR PILOT PLANT.
Innolith energy density corresponds to A-Sample;
Hi-Nickel NMC, NMC+Gr-Si, LFMP, Na, LNMO, LMR, Li-metal timelines can be adapted depending on prioritization of resources.
Pilot plant SOP – Q3/Q4 2024 depending on a location

INNOLITH

E-MOBILITY FREEDOM BATTERY TECHNOLOGY. DELIVERED

EV READY

LOWER COST —

-20%

less cathode material per kWh

Intrinsic cost advantage independent of raw material price

HIGHEST ENERGY DENSITY—

300Wh/kg

with 100% depth of discharge.

extra capacity available for when you need it.

BEST TEMPERATURE RANGE —

-40°C

to +60°C discharge

Charge at -20°C+ 60°C
Less heating; longer range

TOP-END C-RATE CHARGING —

15min

10% to 80%

And we are not stopping there.

SAFETY ABOVE ALL —

-40%

less heat produced in case of thermal runaway

non-flammable electrolyte, no combustible gasses or fire propagation.

FULLY RECYCLABLE —

100%

The world's first recyclable electrolyte salt and solvent.

INNOLITH

WELL, THERE IS NO TIME LIKE PRESENT.

CONTACT:

Markus Borck
markus.borck@innolith.com

INNOLITH