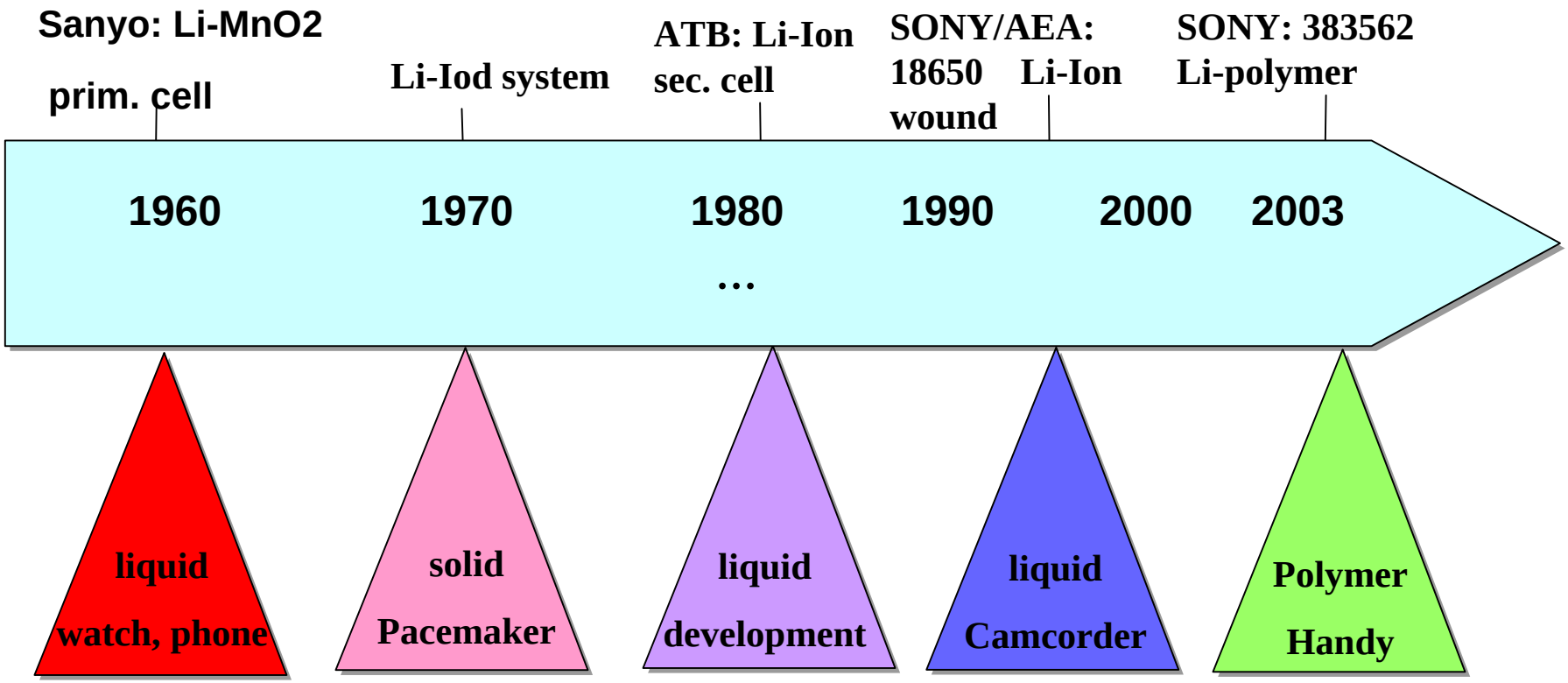
Batterietechnologie: Trends, Entwicklungen, Anwendungen

Tim Schäfer – Li-Tec Battery Kamenz/Sachsen

3. Expertentreffen Energiemetropole Leipzig
„Eine Region unter Strom - Konzepte im Wettbewerb"
07.12.2009 von 9.00 - 18.00 Uhr im Mediencampus Leipzig
www.energiemetropole-leipzig.de

li-Tec®
endless power.

History Lithium Cells



History: NIFE -Cell

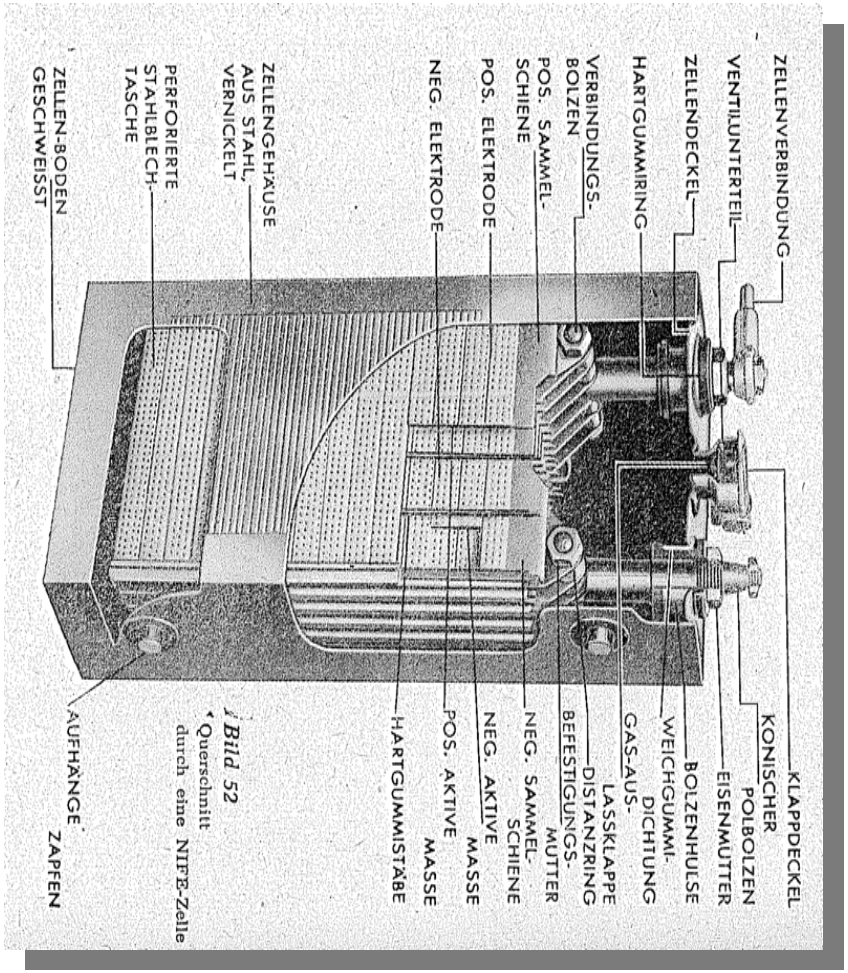


Bild 52
Querschnitt durch eine NIFE-Zelle

Source: Elektrochemie mit Einführung in die anorganische Chemie, Schmitt Fachbuchverlag Leipzig 1952, S. 172

Cylindric cell

Coffee bag (pouch) cell

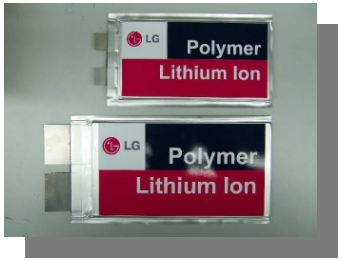
Prismatic cell

Button (Coin) cell

Performance Improvement

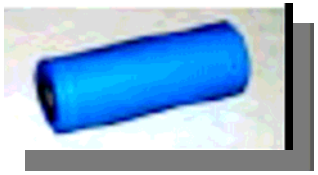
Power

Energy



Safety

Cycle Life



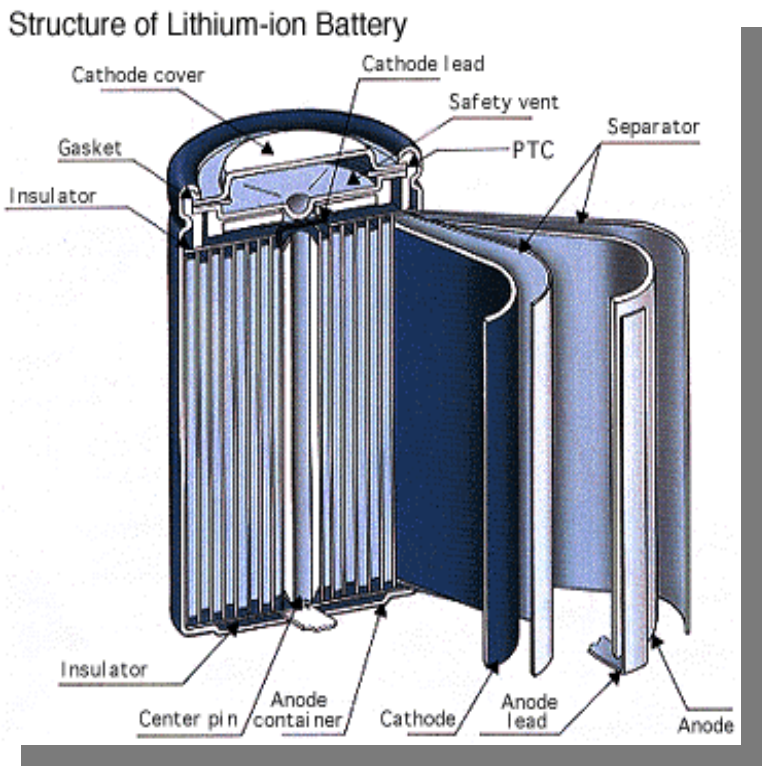
Cost

Source: ITRI Taiwan R.o.C

li-Tec®
endless power.

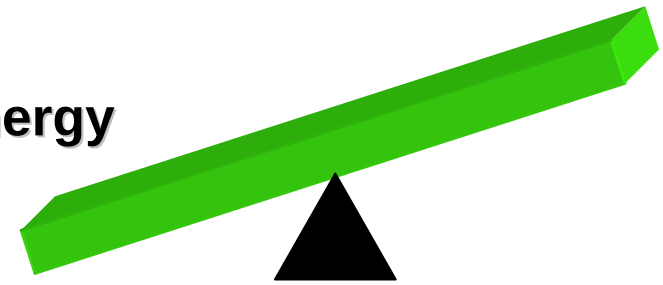
Market : derived from Multimedia Age

- Cylindrical: Power Tool & Laptop PC application (40 % of the market)
- Prismatic: Growth of Mobile phone market slowing down
- Polymer: Growing steadily (Mp3,PND,PMP,Bluetooth)
- ... Others
- New LEV/ EV application: Prismatic & Polymer!

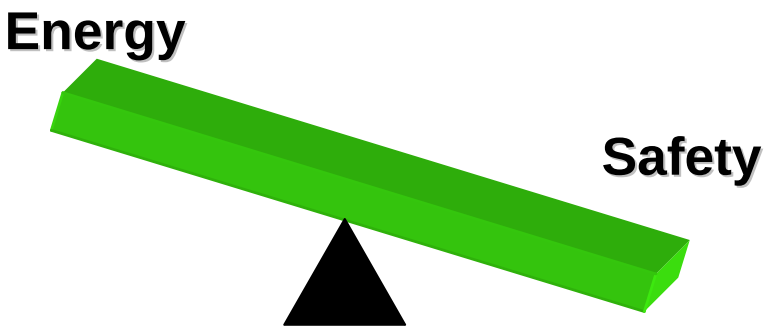


Challenge of Li-ion Battery in EV 1991-

in 1991, 0.7Ah



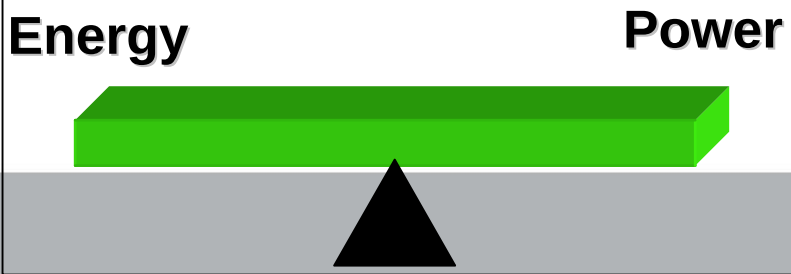
in 2006, 2.6Ah…3.xAh



Safety > 20 Ah

Cycle life

Cost

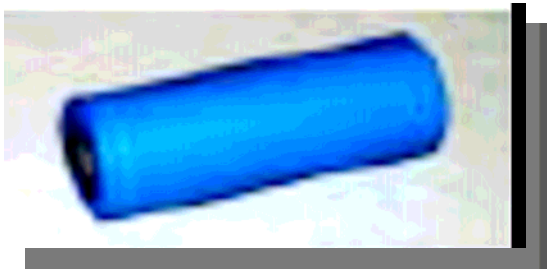


Source: ITRI Taiwan R.o.C

li-Tec
endless power.

Multimedia Age - Cyclindric Cell

Standard cell: 18650
diameter in millimeters: 18 mm
length in millimeters: 65 mm
About 2000 mAh – 3x00 mAh today



26650 cell ca. 3200 mAh – 3600 mAh today

Advantages:
- long time production experiences
- high life time
- pressure stable (40 bar)
- > 40 bar: burst disk
- reliable tightness

Disadvantages:
- bulky size => battery has air cavities
  => lower spec. energy
- complex cooling

.

li-Tec®
endless power.

External requirements drive new mobility concepts

	Micro	Mild	Full	PHEV	EV
Fuel savings	3-5%	10-20%	20-40%	20-60%	100%
CO_2 Savings potential	3-5%	10-20%	30-35%	>40%	100%
Range (Zero Emission)	0	5-10 km	10-30 km	60-100 km	150-250 km
Energy content		1-2 kWh		10-25 kWh	

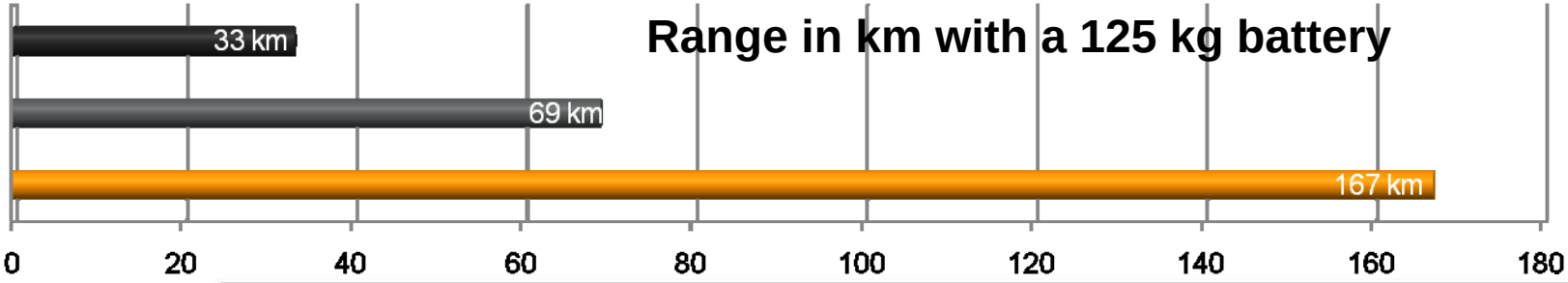
li-Tec® endless power.

Requirements for large scale LIB for automotive applications

Energy	High energy content needed for long range. Important for EV and PHEV.
Power	High power important to achieve high torque and acceleration. Important for HEV.
Costs	Battery costs contribute considerably to vehicle costs , especially for EV and PHEV.
Lifetime	Minimum lifetime of 10 years demanded for all vehicle concepts: EV, PHEV, HEV.
Safety	Must be provided and assured by cells with maximum inherent safety and secondary measures on battery level.

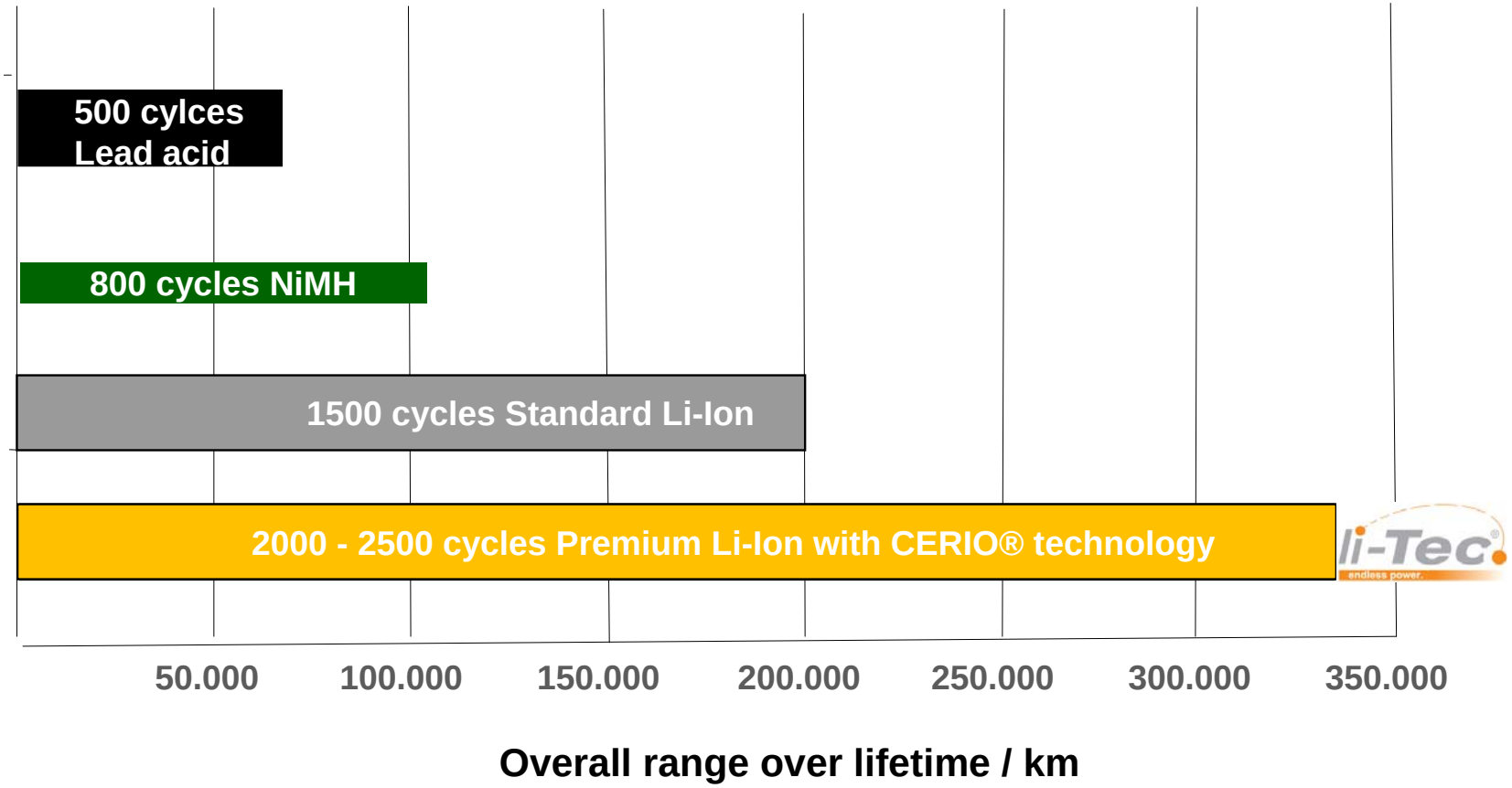
How much energy is stored in modern storage systems?

Lead Acid	Nickel Metal Hydride	Lithium-Ion
ca. 5 kWh	ca. 10 kWh	ca. 25 kWh
0,5 L Diesel	1,0 L Diesel	2,5 L Diesel



Equals consumption of 1,5 L Diesel on 100 km!

Cycle stability determines range over lifetime



Li-Tec – JV of Evonik and Daimler

li-Tec®
endless power.

Li-Tec – JV of Evonik and Daimler

Technology basis out of 10 years experience in Evonik R+D Center

2005 Foundation of Li-Tec Battery

2008 new shareholder structure Evonik(50.1) /Daimler (49.9)

One of the most advanced infrastructure for Li-Ion production in Europe

- 10.000 m^2 plant area, 200 employees
- Current capacity 300.000 Cells p.a.
- Future capacity more than 15 Mio Cells p.a. (Daimler and others)
- ISO 9001:2008 Certified
- TS 16949 Certification ongoing 2009/2010

Vision and Mission: Li-Tec Battery

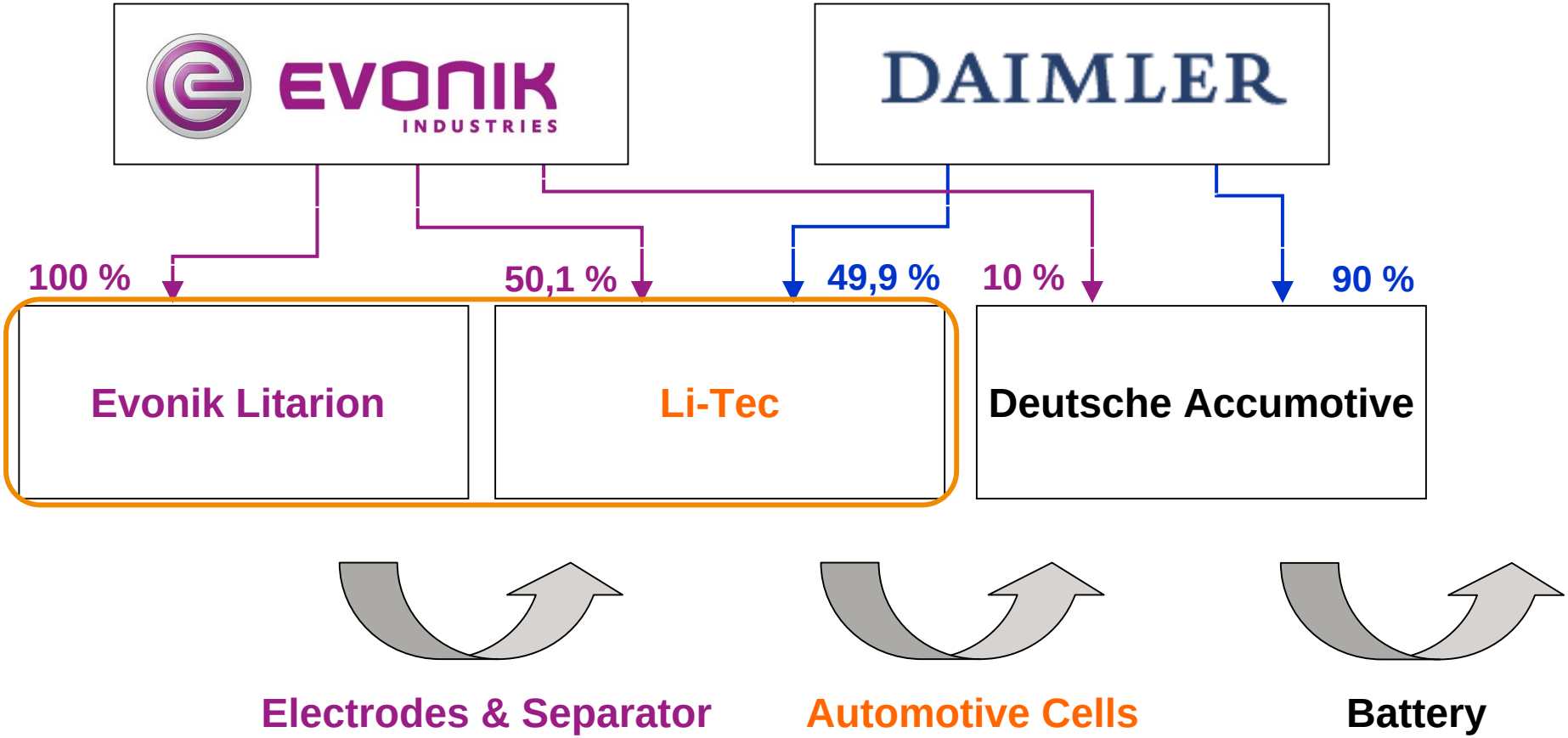
Leading manufacturer of large Li-Ion cells and industrial batteries in Europe

Customized business models

Focus on vehicles and industrial applications

Your preferred partner

Evonik & Daimler – non exclusive alliance along the value chain



Cells for automotive and batteries for industrial applications

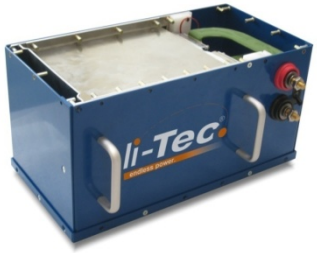
Automotive – Application in road going vehicles :

E-Smart04.jpg

Standard Cells and Custom Design

Industrial – Stationary and mobile applications:

Batteries, Services

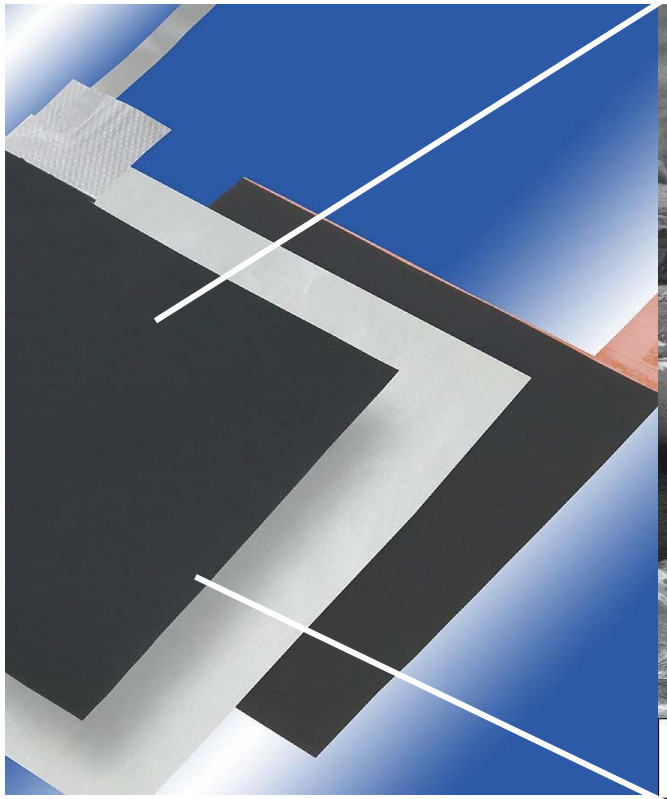


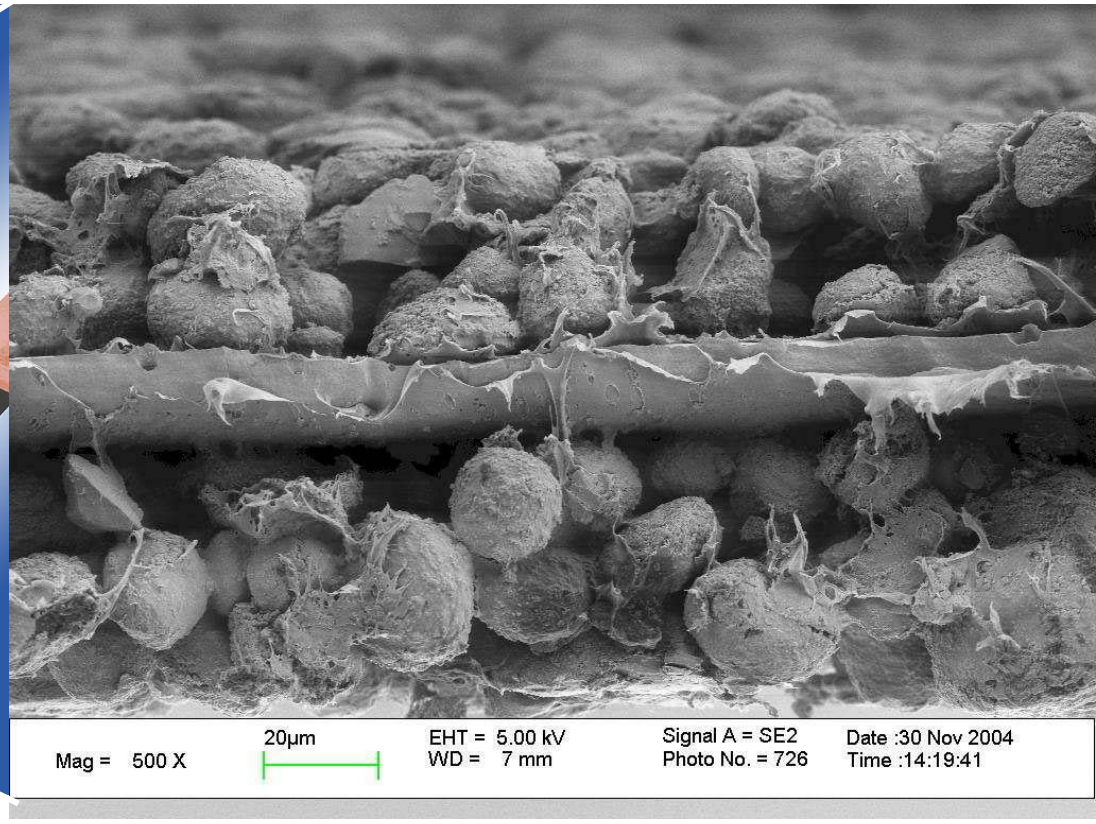
All our businesses are non exclusive, except for custom designed products

CERIO®technology paving the way to e-mobility

li-Tec®
endless power.

CERIO®: Ceramic materials and high-molecular ion conductors



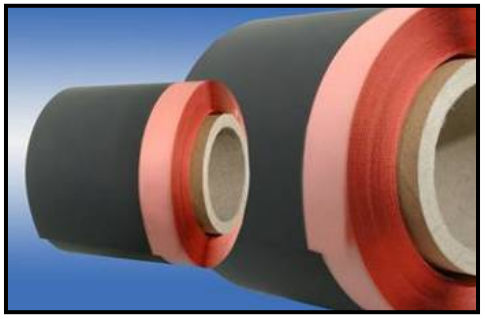


Li-Tec CERIO® battery system

Anode

Active Material:
Graphite

Collector: Cu
(LITARION®)



Electrolyte

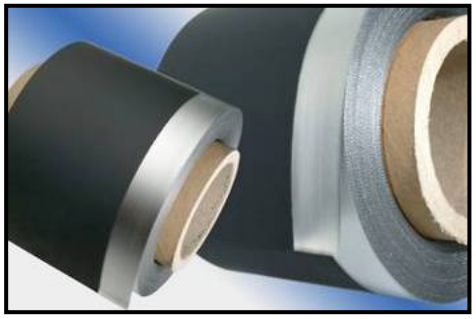
Organic Carbonates
Salt: $LiPF_6$

Separator: ceramic
(SEPARION®)

Cathode

Active Material:
$LiNiMnCoO_2$

Collector: Al
(LITARION®)



Our unique CERIO® technology - the basis of all our products

Originally developed for Formular One Racing Applications
Combination of ceramic materials and high-molecular ion conductors
Including Evonik´s ceramic separator SEPARION®

World benchmark in cycle stability, rated power and safety
Compact design for high energy density and high power at low weight

Three CERIO® product lines:

- **CERIO®motive:** **Cells for automotive applications**
- **CERIO®station:** **Battery systems for stationary energy storage and use of renewable energies**
- **CERIO®serve:** **Battery systems for transport, logistics and mobile work machines**

Abuse Test: 40 Ah CERIO®motive High Energy cell

Products portfolio for mobile and stationary applications

40 Ah High Energy cell
EV & Plug-In

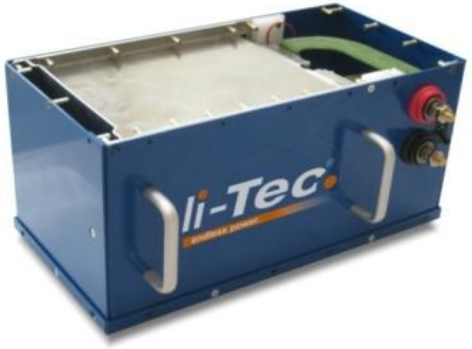
10 Ah High Energy cell
LEV

6 Ah High Power cell
HEV

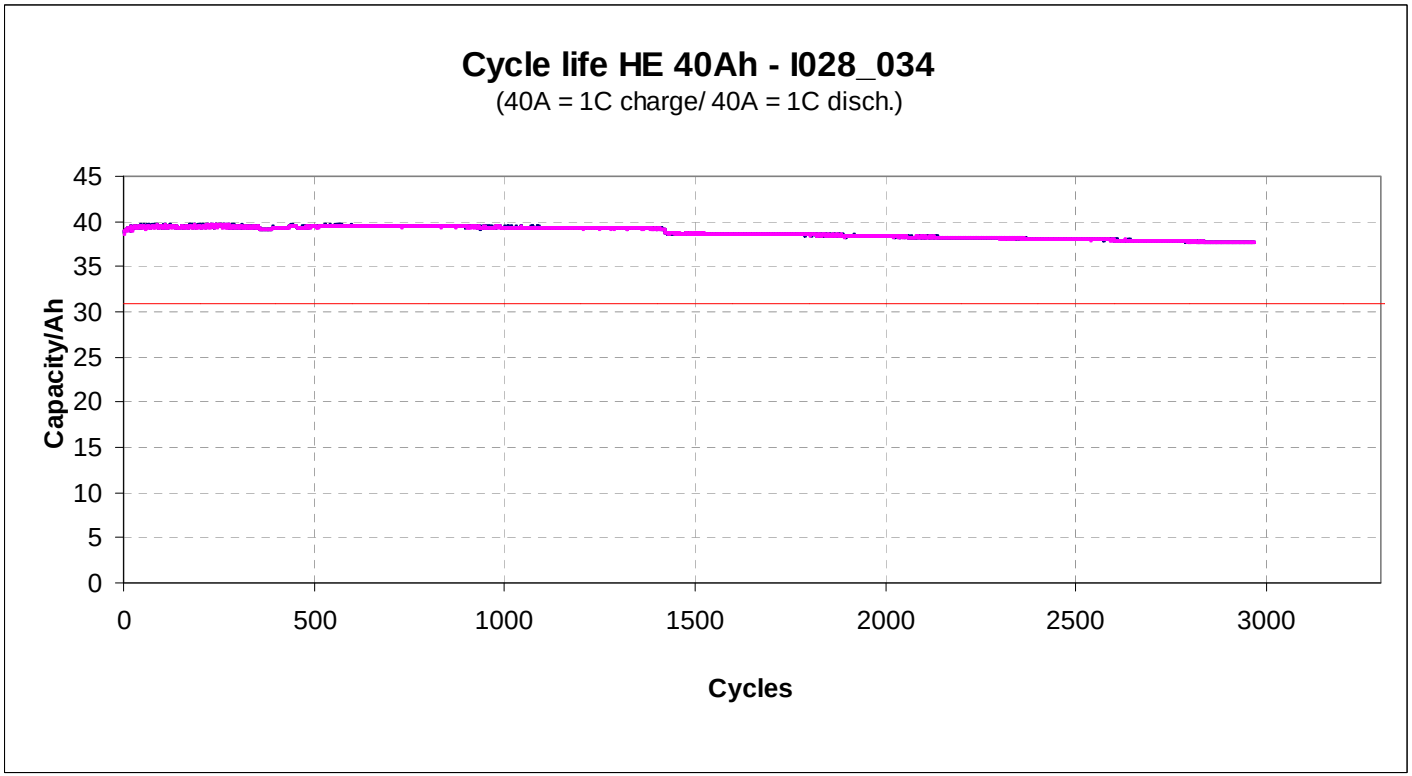
3 Ah Super High Power cell
Special HEV

Full Battery Packs Solution
Stationary and Industrial

Specific custom designed products

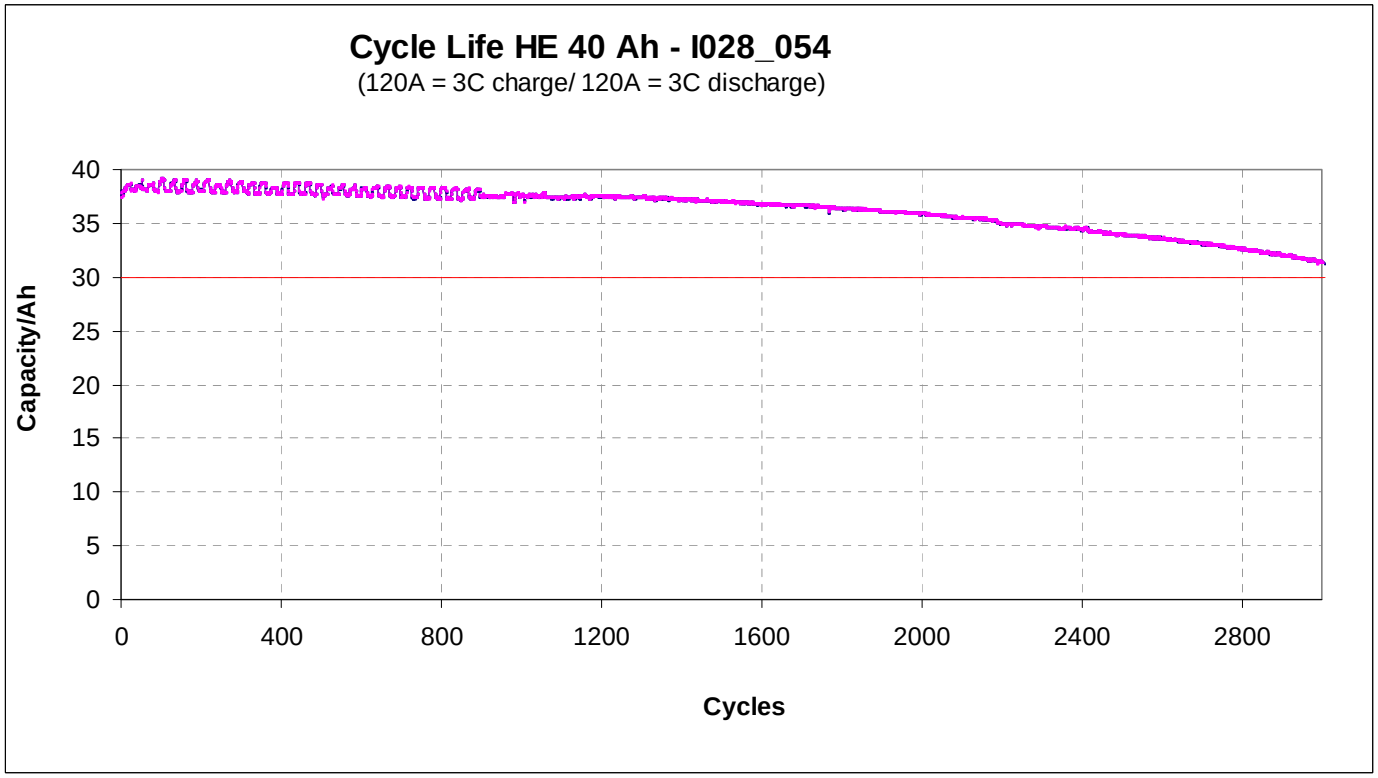


Full EV and Plug In: Cycle Life Test at 1C/1C



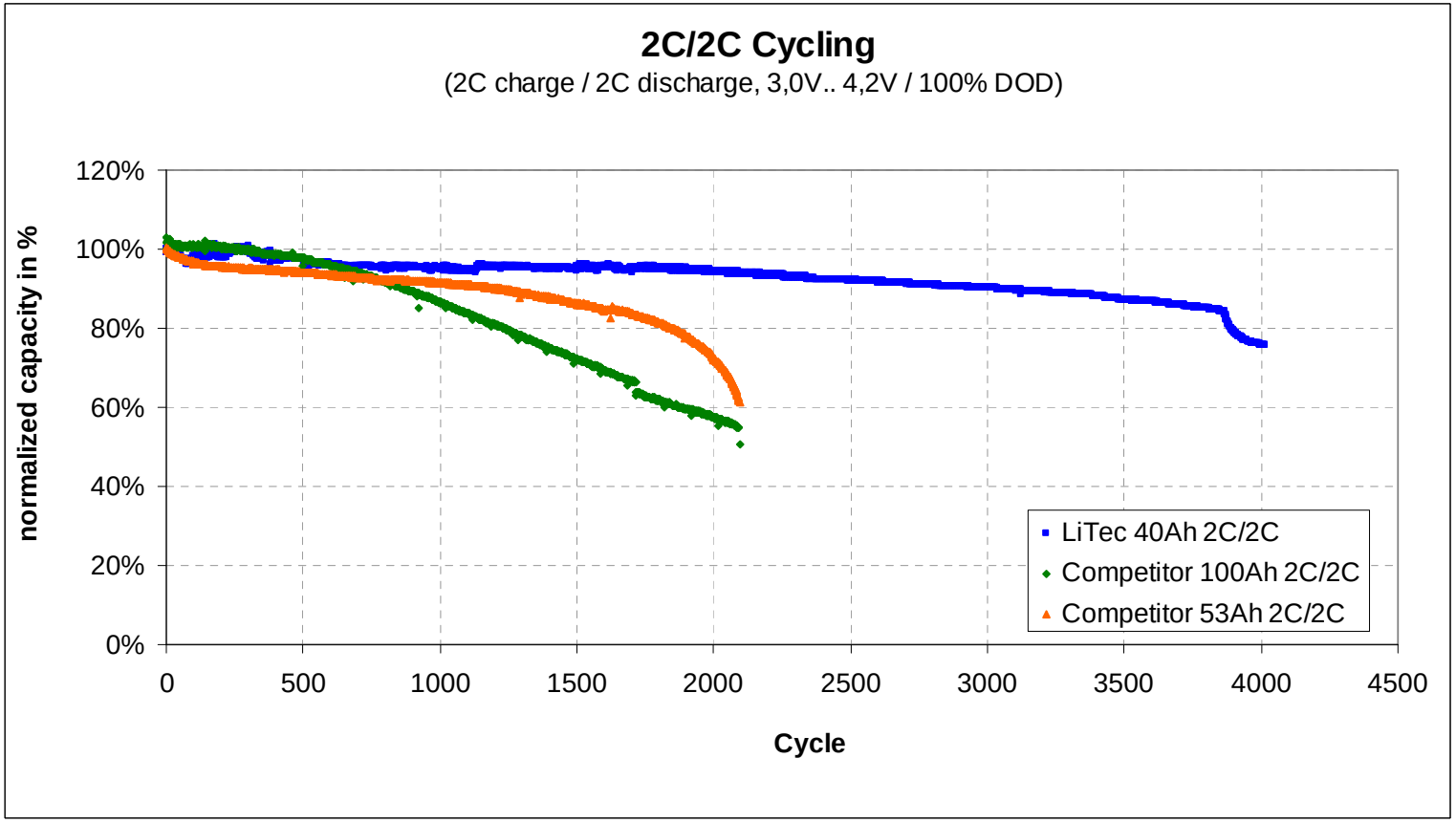
1 hour full discharge and 1.1 hour full charge

Full EV and Plug-In: Cycle Life Test Cell at 3C/3C



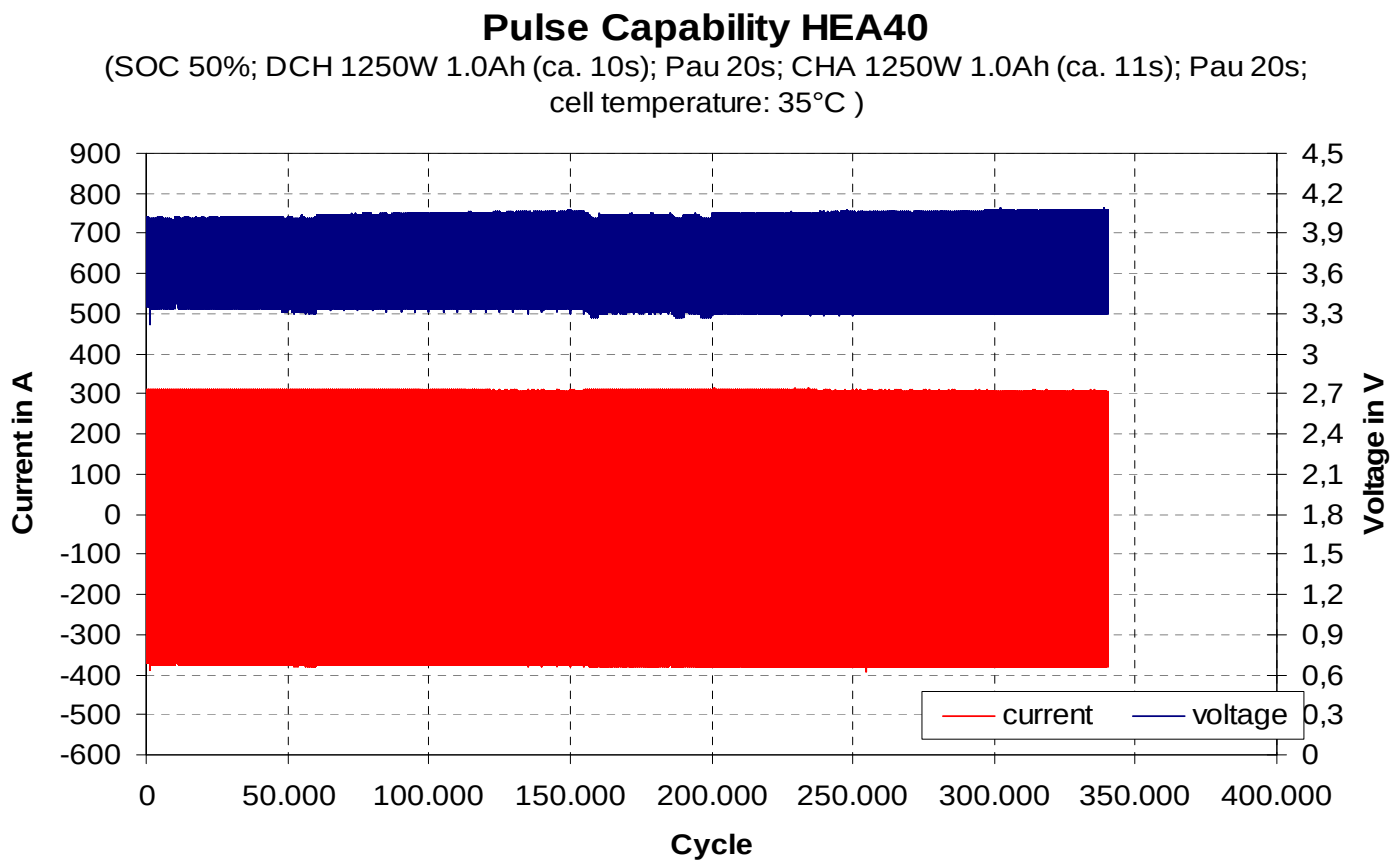
20 minutes full discharge and 25 minutes full charge

Full Ev and Plug-In: Comparison to Asian Competitors



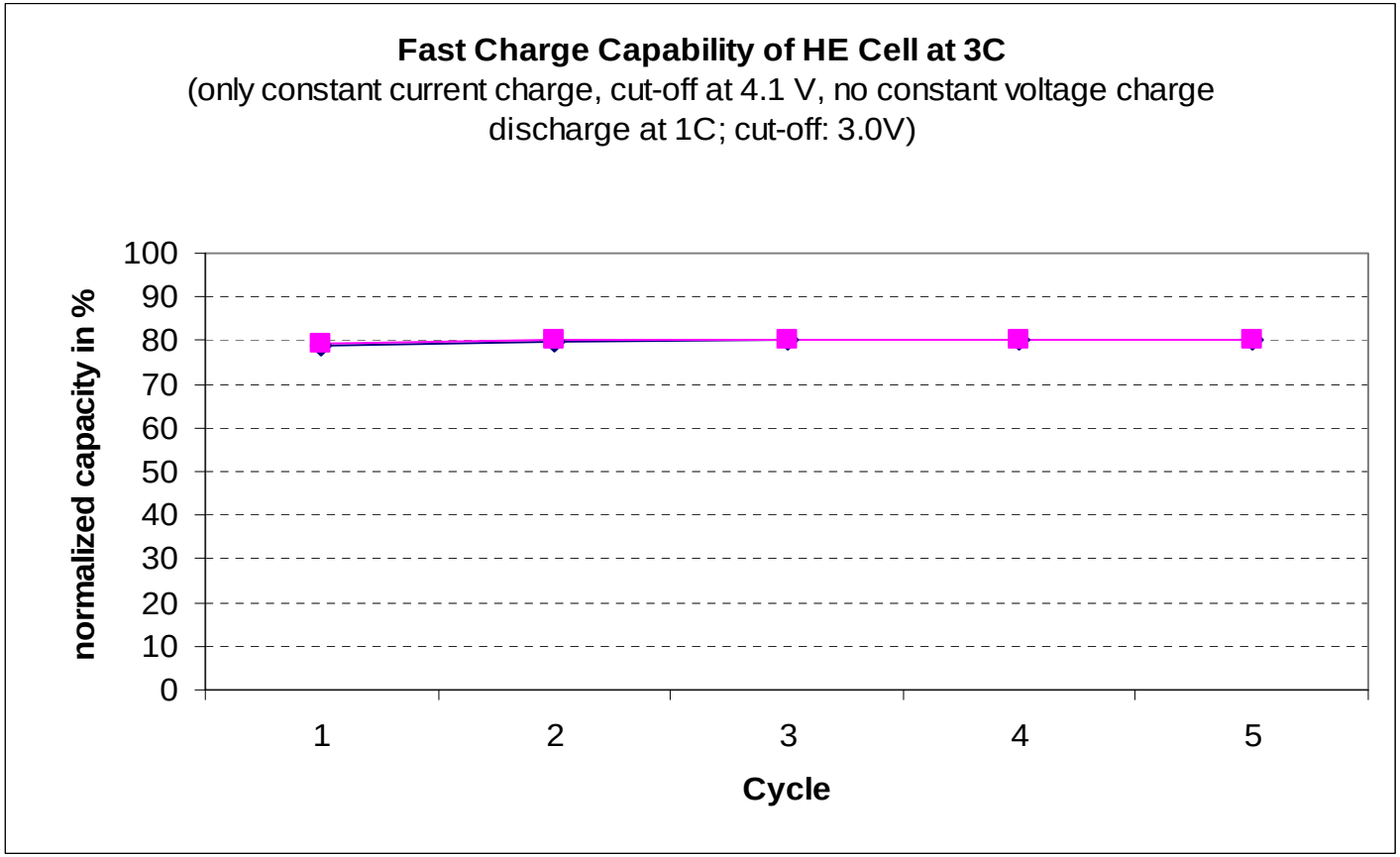
30 minutes full discharge and 35 minutes full charge

40 Ah CERIO®motive: 380 A Pulse Power Plug-In Simulation



Battery of 100 kg allows 80 km electric range and 100 kW peak power

Full EV fast charge capability of 40 Ah CERIO®motive cell



20 minutes are enough for 80% recharging

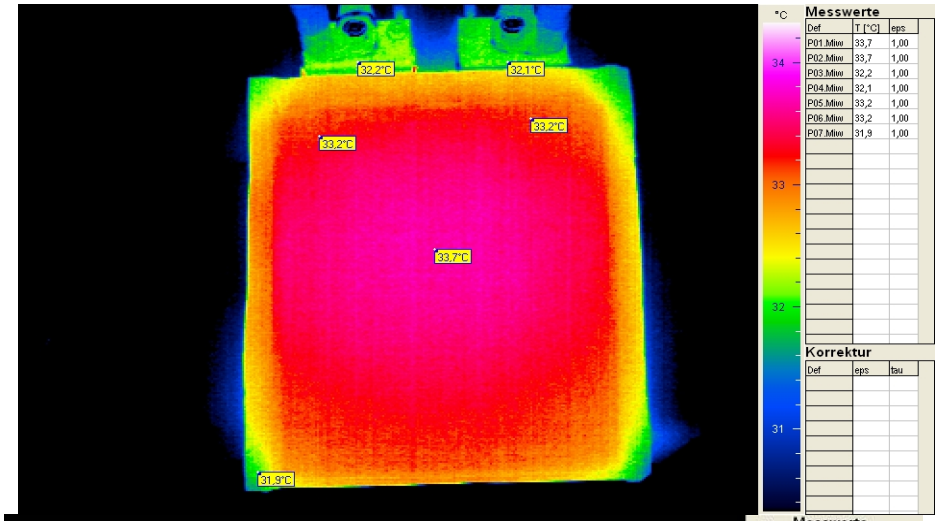
Systems integration is key to overall performance

Requirements

- Fixation
- Protection
- Insulation
- Cooling
- Shock absorption
- Housing

- Measures
  - Geometric fixation of cells and electronics
    - Cell connection
    - BMS
    - LV, HV
  - Protection against external influences
    - Dust
    - Water
  - Electrical isolation of the battery
  - Thermal management
    - Air venting
    - Liquid
  - Vibration damping
  - Metal, plastics, carbon/kevlar housing
  - Sensors and feedback
  - BMS custom design
  - Testing, qualification

Thermal management measures depend on application

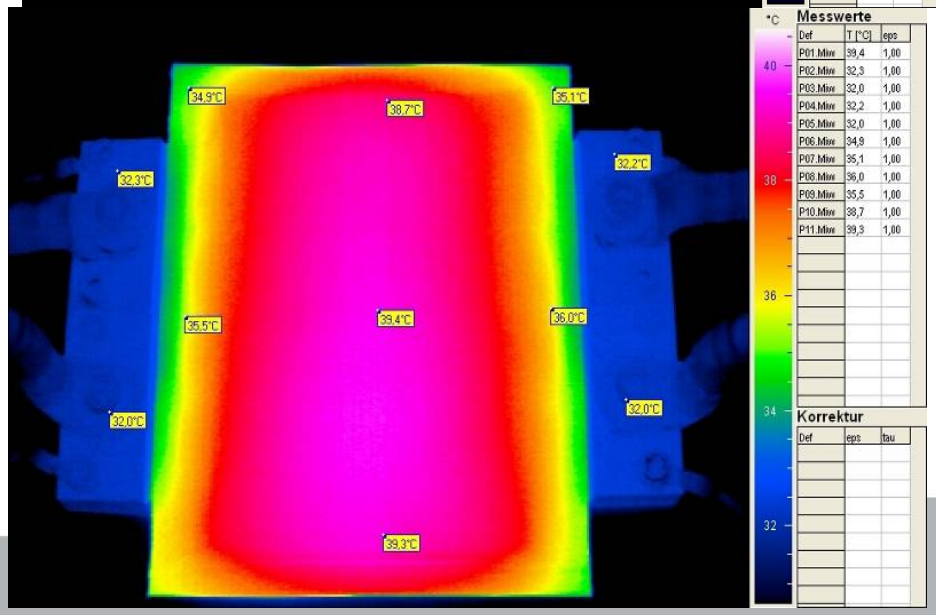


CERIO® HEA 40 cell

2 C Continuous

ΔT cell surface ca. 1 K

ΔT cell to tab ca. 1.5 K



CERIO® HPA 6 cell

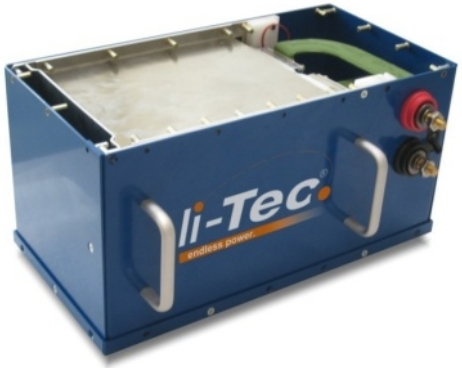
20 C Pulse / 10s with 5s Pause

ΔT cell surface < 4 K

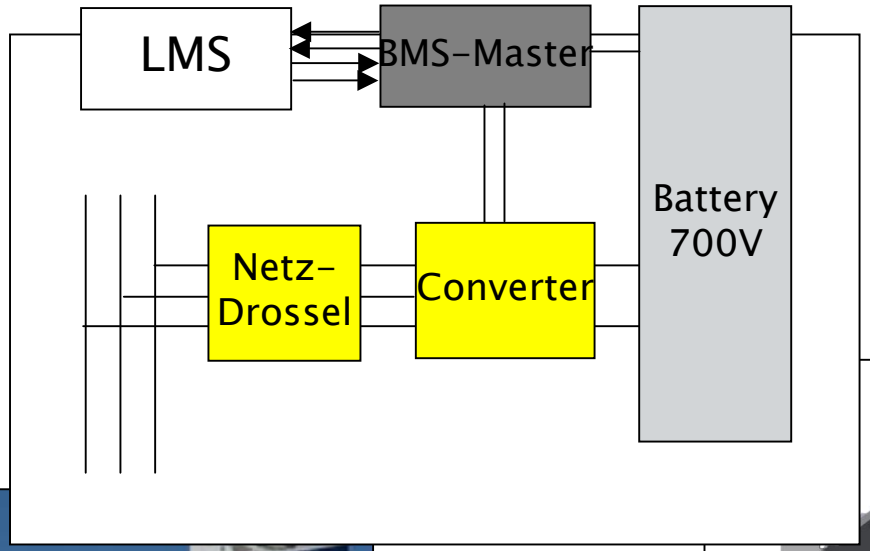
ΔT cell to tab ca. 7 K

First prototype batteries for industrial applications realized

Standardized solutions of module type batteries for e.g. telecommunication applications

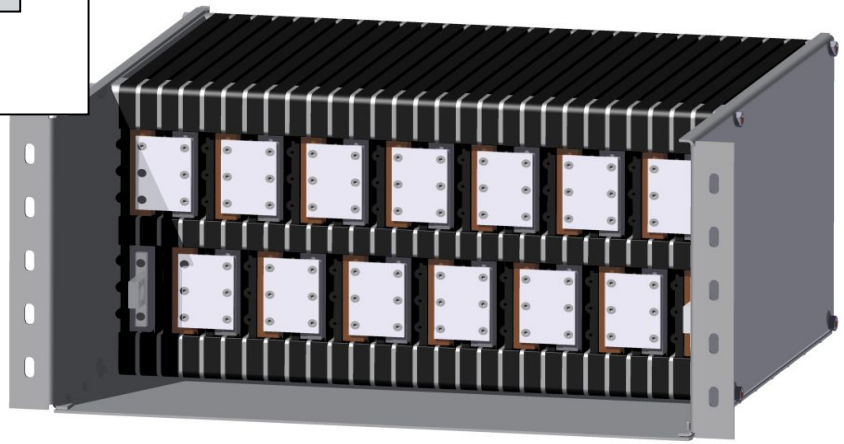


Vehicle-to-Grid or Stationary Power Management



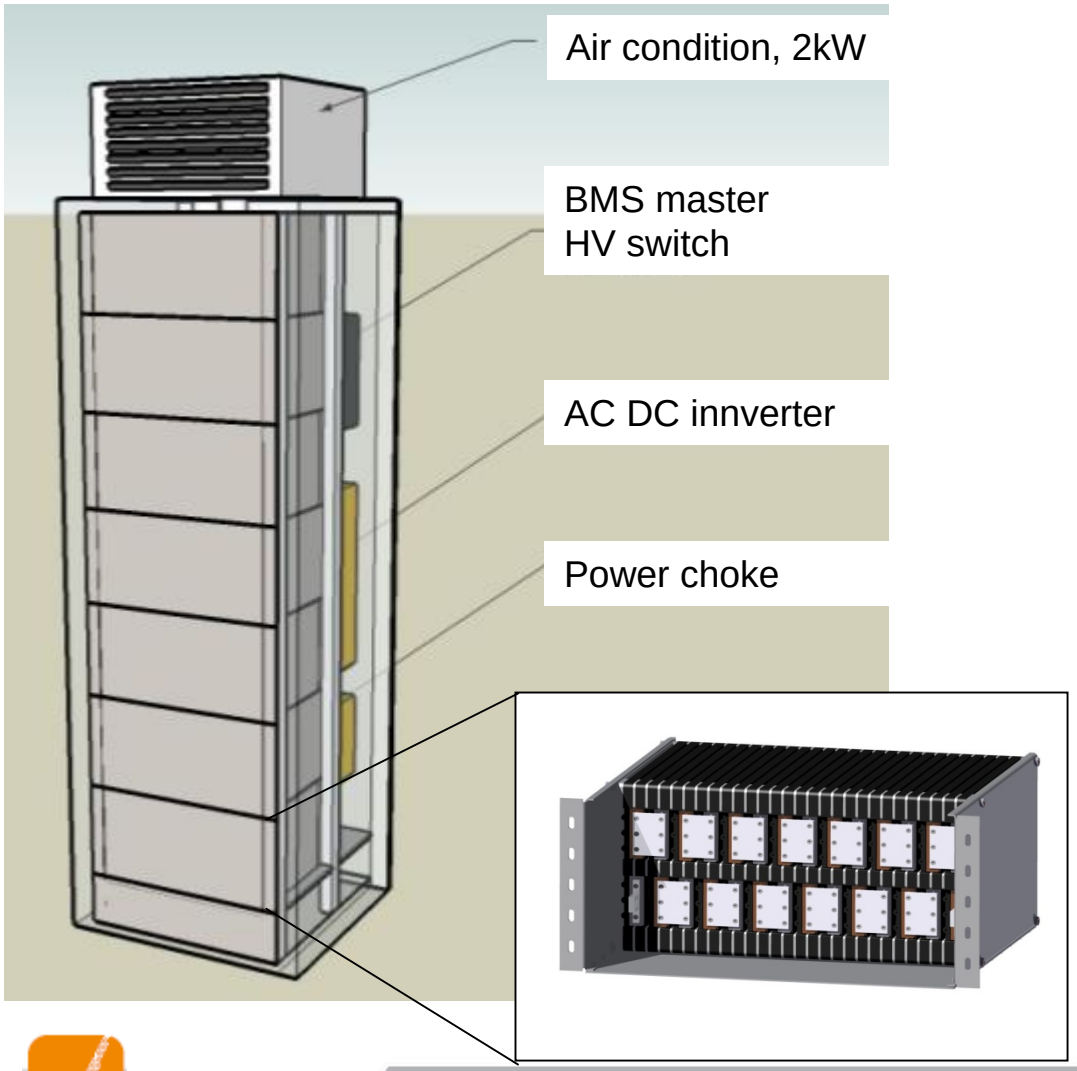
100 kW Peak stationary
Power Management Unit

AC/DC Converter
DC/AC Converter



Submodule of a stationary
Power Management Unit

100kW demonstrator for on site power management



196 cells in series: 700V, 28kWh

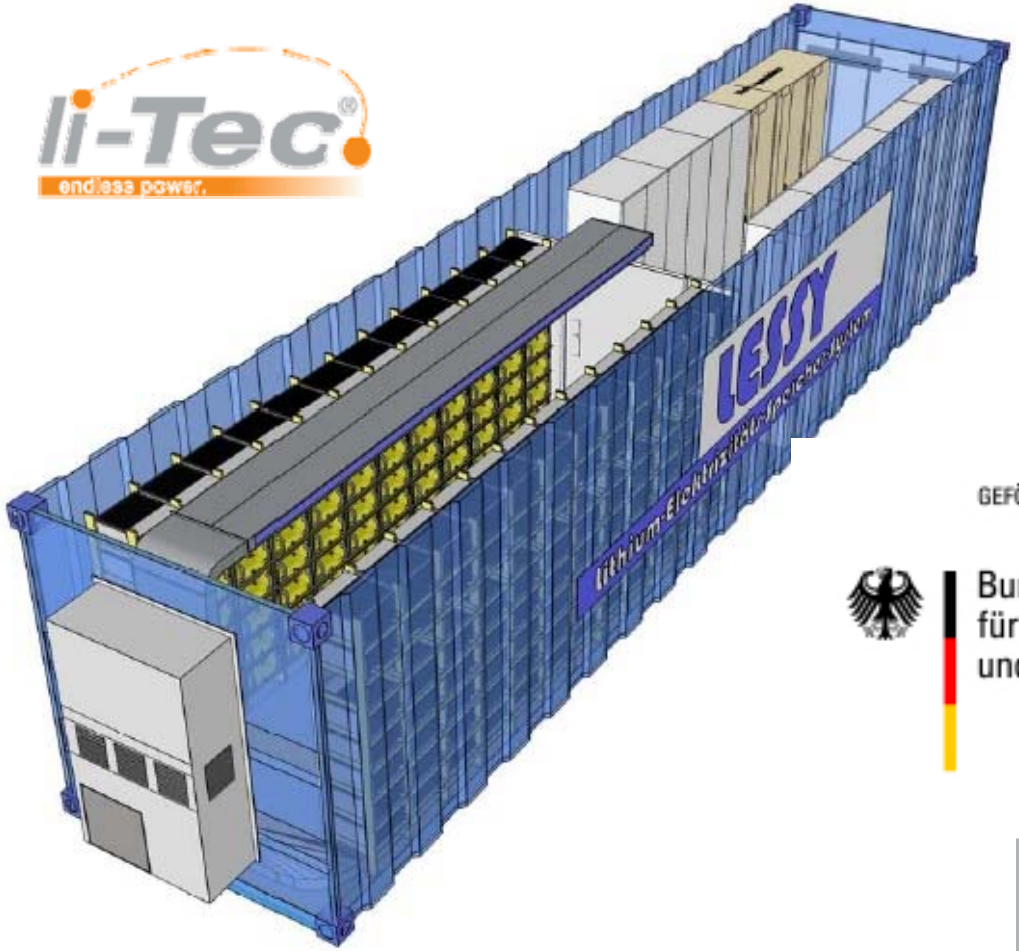
LESSY: Lithium-Electricity-Storage-SYstem

Digatron firing circuits

POWER ENGS

EVONIK INDUSTRIES

li-Tec endless power.



Westfälische Wilhelms-Universität Münster

NEXT ENERGY
EWE-Forschungszentrum für
ologie e.V.

GEFÖRDERT VOM

Bundesministerium
für Bildung
und Forschung

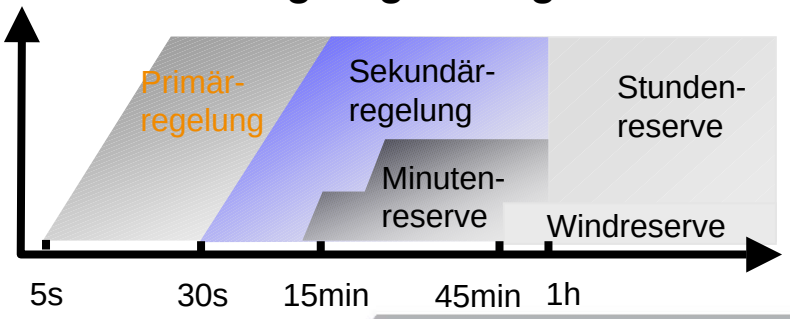
LESSY – Überblick

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Ziel:
Nachweis der technischen und wirtschaftlichen Machbarkeit von großformatigen stationären Elektrizitätsspeichern auf Basis der Lithium-Ionen Technologie am Beispiel der Anwendung „Primärregelenergie“

Kraftwerk Fenne (Evonik Power Saar)

Bereitstellung Regelenergie



Projektlaufzeit: 01.02.2009 – 31.01.2012

Leistung: +/- 1 MW

Speicherkapazität: ca. 700 kWh

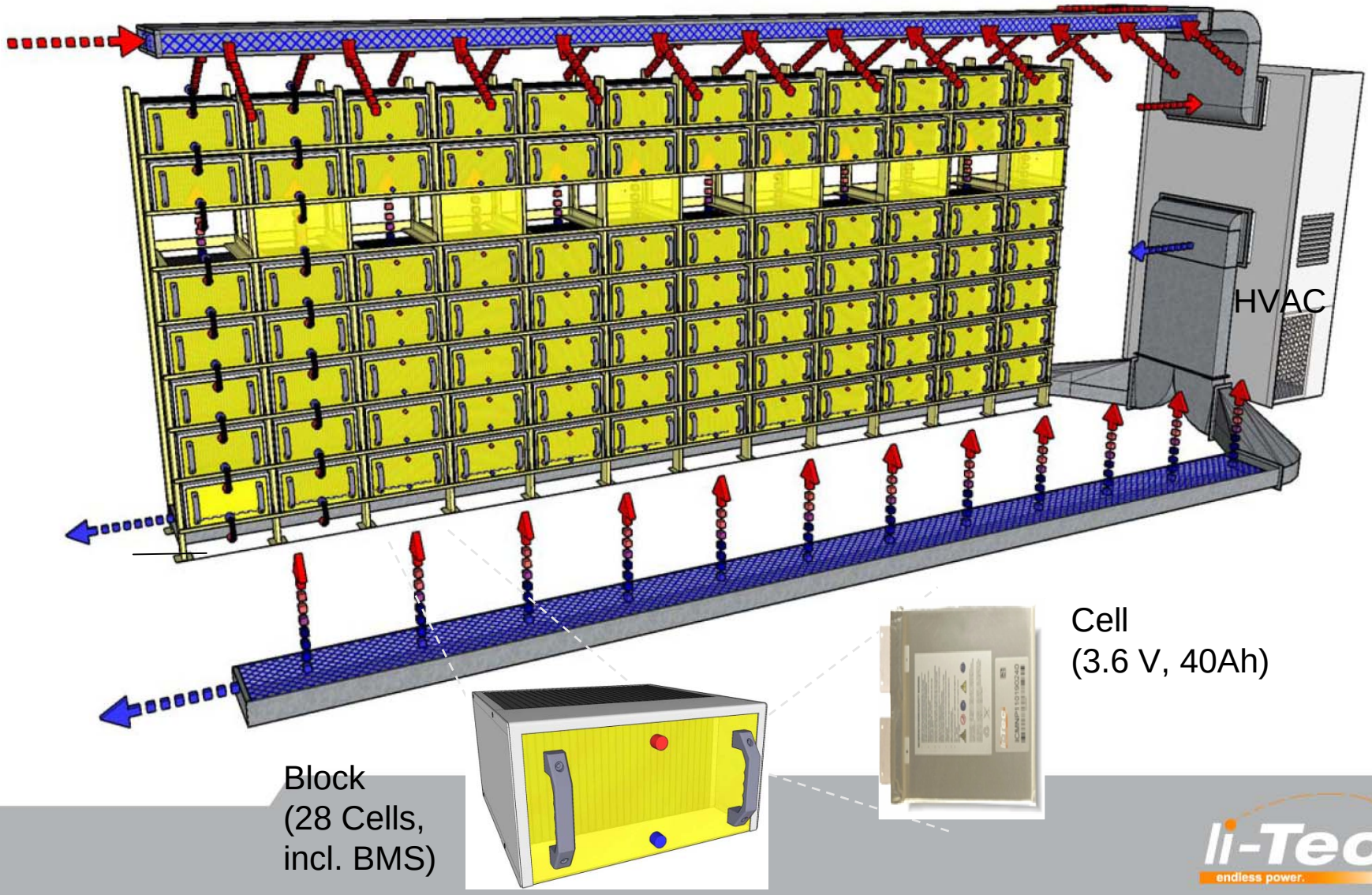
Förderaufwand: ca. 5 Mio. €

li-Tec endless power.

LESSY: The Modular Storage Battery

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

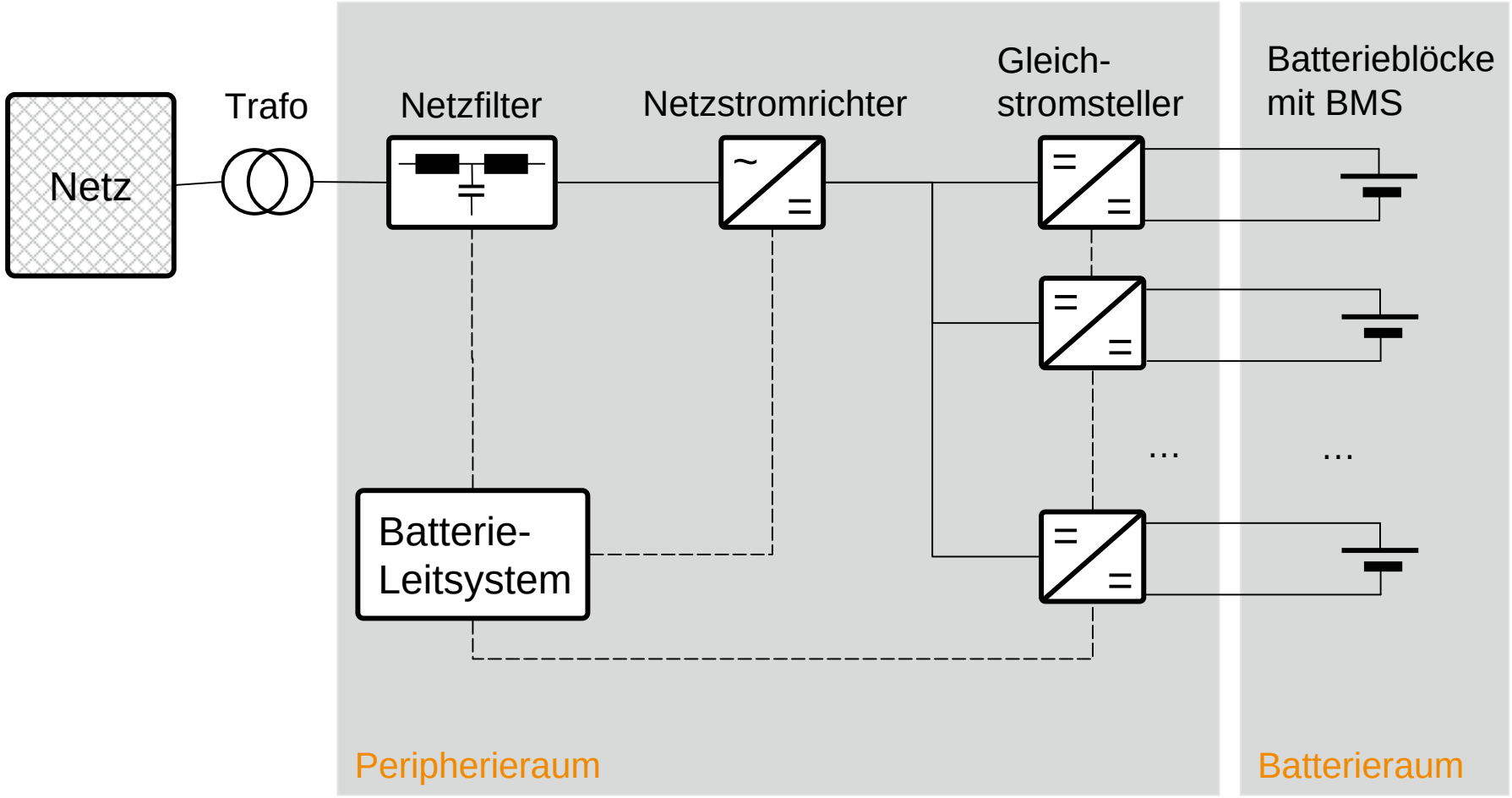
12 strings à 14 blocks à 28 cells: about 4700 cells



li-Tec endless power.

LESSY: Stromrichterkonzept (Prinzip)

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung



CERIO® motive

CERIO®motive applications on the street

li-Tec® endless power.

EVs are not new …

CERIO® motive

Edison, 1889

Davenport, 1834

E-Taxis, 1898, New York

li-Tec® endless power.

- Full EV racing car: E-Wolf e1
  - Ultra Light Weight Construction, Mass < 600 kg
  - Max Speed 250 km/h, Max Power 110 kW
  - Electric Range 300 km
  - **Li-Tec Cerio® Battery 16 kWh**

- Full EV „eRUF Porsche 911“ and „Dakara“
  - Basis Porsche 911, Porsche Cayenne
  - Max Power > 200 kW, Max Speed 250 km/h
  - **Li-Tec Cerio® Battery 36 kWh, 45 kWh**

- Full EV Truck „Multicar eFumo“
  - Multipurpose City Truck, Mass 2,9 t + 2,5 t Load
  - Max Power > 100 kW, Electric Range > 100 km
  - **Li-Tec Cerio® Battery 45 kWh**

- Full EV Opel Corsa Demonstrator
  - Retrofit in Cooperation with Evonik and Lotus Engineering
  - Electric Range 100 miles
  - **Li-Tec Cerio® Battery 24 kWh**

IAA 2009

End of 2009

eCar Tech 2009

2009

Series project with Deutsche Accumotive

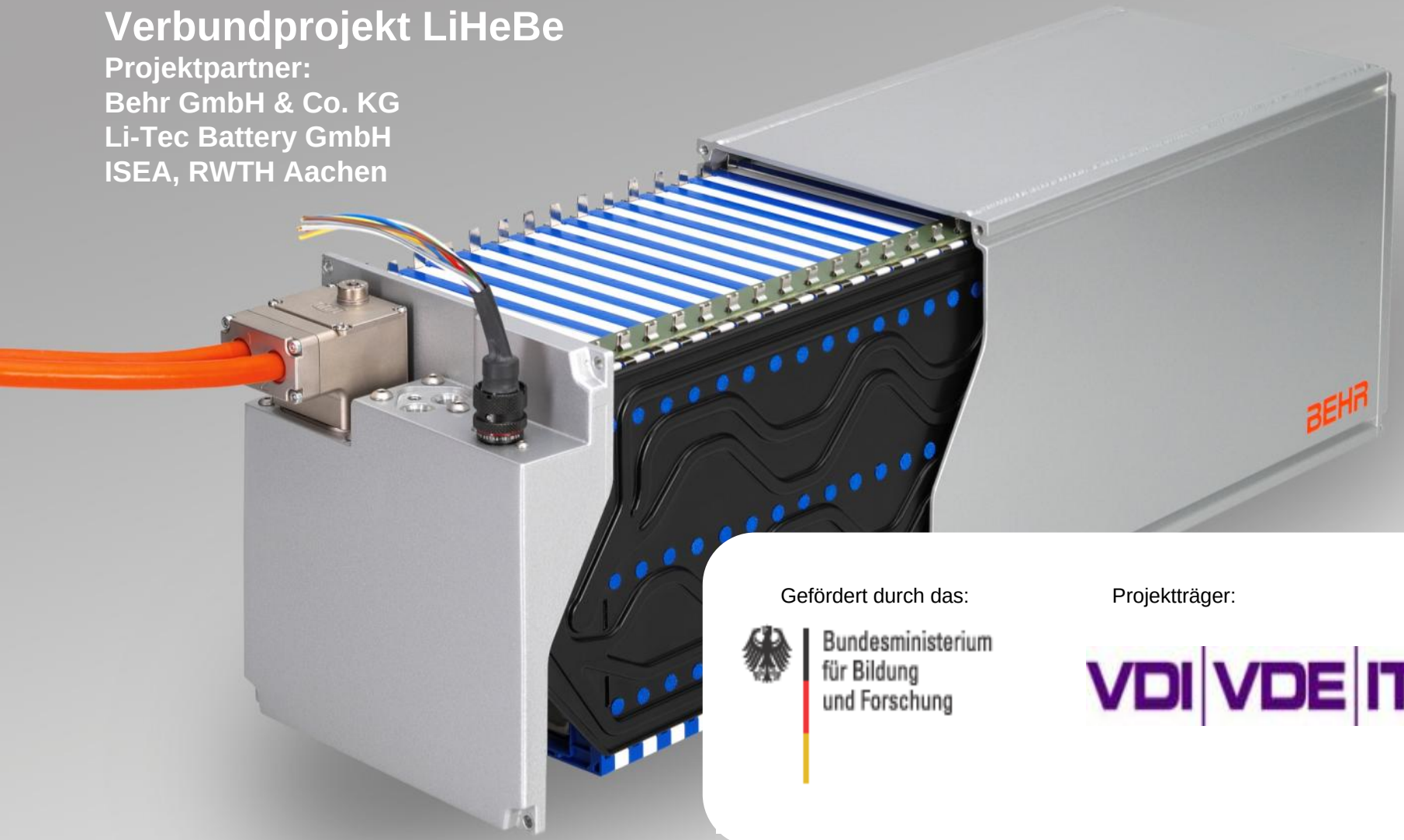
Full EV City car: E-Smart

- Electric Range 100 miles
- **Li-Tec Cells Cerio®motive**

Li-Ionen Batteriemodul für On- und Off-Highway Anwendungen

Verbundprojekt LiHeBe

Projektpartner:
Behr GmbH & Co. KG
Li-Tec Battery GmbH
ISEA, RWTH Aachen



Gefördert durch das:

Bundesministerium für Bildung und Forschung

Projektträger:

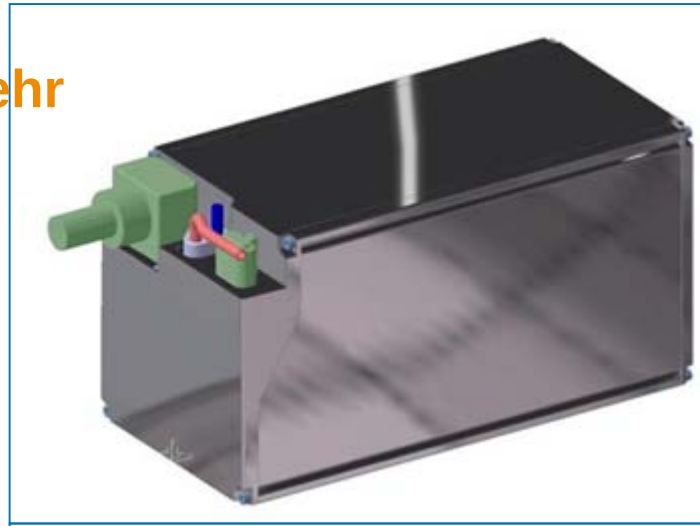
VDI | VDE | IT

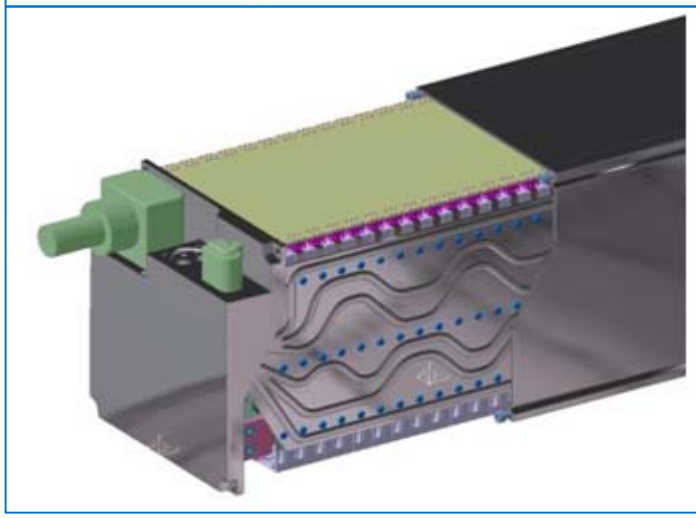
Heat up. Cool down.

BEHR

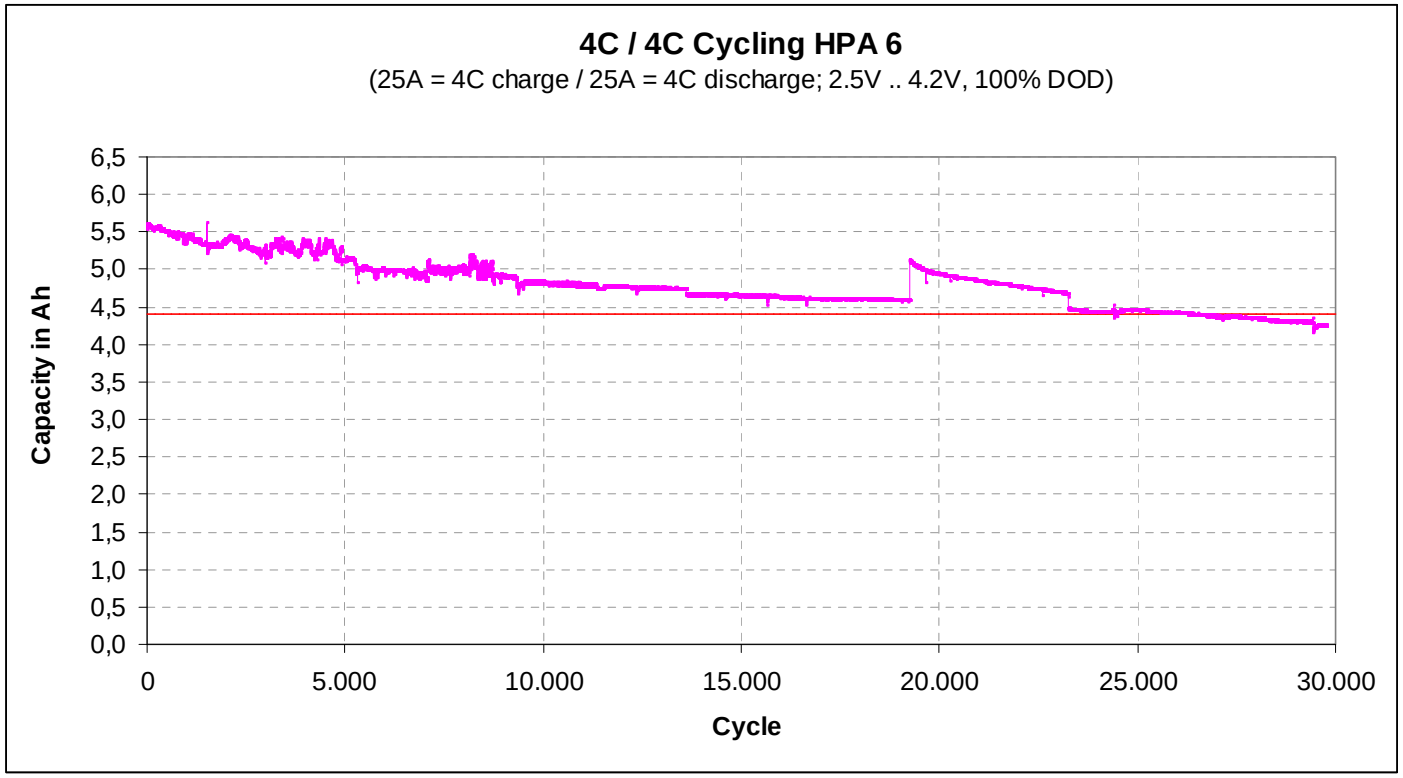
HEV H8 Hybrid Battery Concept Li-Tec/Behr

Daten:	
Zielmarkt	Hybridfahrzeuge (mild hybrid)
Gehäuse	353 x 175 x 190 mm³ (H8)
BMS	integriert
Zelltyp	High Power Zelle
Anzahl Zellen	38
Kapazität pro Zelle	6 Ah
Spannungslage	3,6 V pro Zelle ⇨ 136,8 V
Gesamtkapazität	0,9 kWh (@20C ⇨ 18kW)
Lade-/Entladerate	>20 C
Kühlung	Kältemittel (R134a)

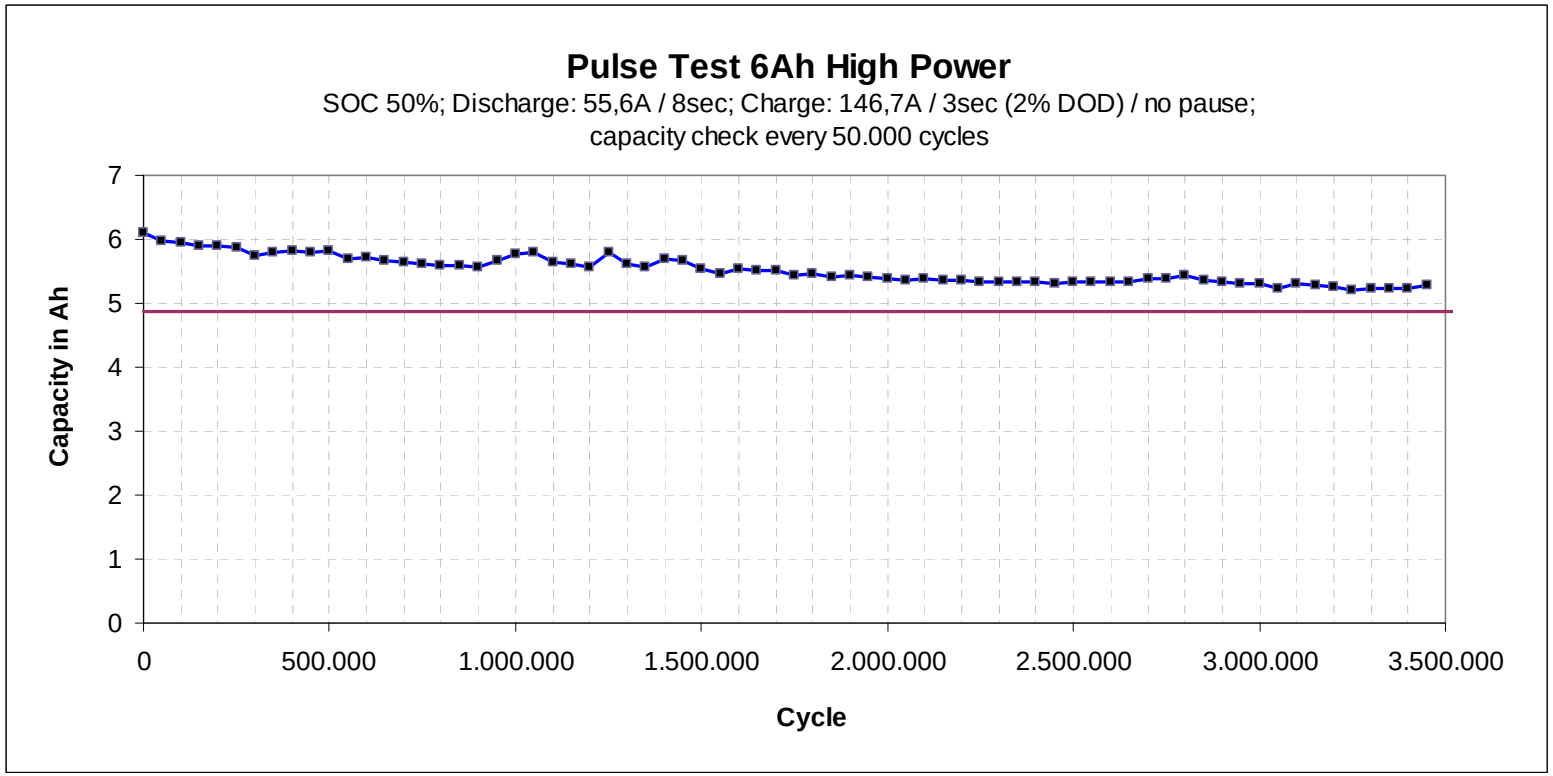




Cycle life test of 6 Ah High Power cell at 4C/4C



Cycle life test of 6 Ah High Power cell at $10C_{DCH}$ / $25C_{CHA}$ (2% DOD)



Products portfolio for mobile and stationary applications

Super	Hybrid	PHEV	EV	Station
Power density				
7-9 kW/kg	1.3-3 kW/kg	1-1.4 kW/kg		0.25-0.7 kW/kg
Energy content				
0.5-2 kWh	1-5 kWh		10-25 kWh	kWh-MWh

3 Ah Super High Power cell

6 Ah High Power cell

40 Ah High Energy cell

Full Battery Packs Solution & Specific custom designed products

Li-Tec systems solution approach

Li-Tec offers a solution designed to your needs based on Li-Tec advanced CERIO® battery technology.

CERIO®.strong.safe.sustainable.

- A special combination of ceramic materials and high-molecular ion conductors
- Developed for Formula One and therefore especially powerful
- Based on the innovative ceramic SEPARION® separator

Li-Tec CERIO® technology is covered by 133 patents and patent applications.

Li-Tec is ISO 9001 certified; ISO 14000 certification planned for 01/2010, TS16949 certification will be achieved in 2010.

The strategic partnership with Evonik and Daimler will ensure investment and growth aligned with market needs and guarantee a sustainably competitive business and market position – to the benefit of our customers.

Our business philosophy and mission

Safety comes first. All our lithium ion cells and batteries are „Made in Germany“ and meet highest safety standards.

Quality is our core competence. We produce lithium ion cells and batteries for industrial customers in technical high-class applications. We make no compromises when it comes to quality.

Reliability is central. We convince not only with high performance products but also by adherence to schedules and promises.

The customer is our focus. With sustainable technical solutions and business models we aim for long-term cooperative partnerships with our customers.