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# Energy Storage for High-Power Applications

Curved Graphene-based supercapacitors and SuperBatteries

# A Pan-European Company

European value chain, European energy storage innovation

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### Tallinn, Estonia

- Software development
- Electronics engineering
- Module & system development

### Großröhrsdorf, Germany

- SuperBattery R&D
  Supercapacitor research & development center
- Main production location from cells to systems

### Markranstädt, Germany

- The largest and most modern supercapacitor factory in the world
- Start of production in 2025

### Bitterfeld-Wolfen, Germany

- Curved Graphene synthesis and production
- Material pilot & development plant

### Berlin, Germany

- Sales & application engineering
- Grant & IP management

### Varkaus, Finland

- SuperBattery pilot production
- Electrode manufacturing

### Toulouse, France

- SuperBattery R&D laboratory

# Led by a World-class Management Team of Industry Veterans

Energy storage experts, entrepreneurs, and experienced leaders

## Oliver Ahlberg

Chairman of the Board

- Co-Founder of Skeleton Technologies
- Successful exits in e-commerce and digital marketing

## Taavi Madiberk

CEO

- Co-Founder of Skeleton Technologies
- Member of the board in the European Innovation Council
- Former Chairman of the Supervisory Board of Estonian Railways

## Dr. Linus Froböse

CTO

- PhD in solid-state batteries from Technische Universität Braunschweig
- Previously Head of operations at Vitesco Technologies, and Head of Manufacturing Technology Battery and Electric Engines at Continental

## Tobias Hüppe

COO

- Long experience in the automotive and battery manufacturing industries
- Formerly Senior Director of Manufacturing at Northvolt, Plant Manager at Faurecia Interior Systems

## Grischa Sauerberg

CCO

- 23 years at Shell, most recently as VP of Sectoral Decarbonization & Innovation, driving the decarbonization of the mining sector, new sector development, and Shell's innovation roadmap.
- As General Manager Customer Operations at Shell, Grischa lead ca. 1000 staff across Europe, Russia, and Africa in sales & marketing

## Tero Järveläinen

CPO

- Previously R&D Director at Danfoss Power Solutions, leading R&D activities in Danfoss' eMobility division; CTO at Visedo, a smart hybrid and electric drive train manufacturer; Research Engineer and Team Lead at Robert Bosch

## Timo Koljonen

VP Curved Graphene Scale-Up

- Over two decades of operation and manufacturing leadership in complex production environments
- Formerly Director of Operations at Danfoss Power Solutions, Chief Operating Officer at Visedo, and VP Operations at ElFys, Inc.

## David Arsenault

SVP Business Development

- 15+ years of experience with supercapacitors and heavy-duty vehicle hybridization and electrification as founder of Effenco, acquired by Martinrea
- PhD in Mechanical Engineering from École de Technologie Supérieure in Montréal, Canada

## Arnaud Castaignet

VP Government Affairs & Strategic Partnerships

- Previously Director of Political outreach of DIGITALEUROPE, the leading tech lobby in Brussels, and Communication Officer for the French President François Hollande.
- French Foreign Trade Advisor, appointed by the French Prime Minister

# Key Enabling Technology to Power Electrification Across Industries

A qualified supplier & system provider to industry leaders

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- Peak shaving for AI data centers
- BBU (Battery Backup Unit) energy storage for data centers


- 12V boardnet stabilization & backup power solutions
- 48V active suspension
- Engine starting
- High power storage for alternative drivetrains


- Virtual inertia / Grid forming in E-STATCOMs
- Grid power back-up and quality


- Peak load shaving to cover short-term peak power demands
- Industrial UPS solutions
- High-power support for electric arc furnaces

GE · Hitachi Energy · ŠKODA · CAF Power & Automation · Danfoss · Honda Racing HRD · esa · MITSUBISHI · MEDCOM · ATTABOTICS · Brush Traction

# Technological Advantage Through Superior Carbon Raw Material

Backed by the largest R&D team in the industry

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## Li-ion Batteries

use a chemical reaction to store energy

Slow

- Limited power density (0.5 kW/kg)
- **High energy density** (250 Wh/kg)
- Limited cycle life (<6000)
- Slow charge rate (3 C)
- Safety concerns
- Utilizes critical raw materials (Li, Graphite, Co)


## Supercapacitors

use an electric field to store energy

Fast

- **High power density** (up to 60 kW/kg)
- Limited energy density (up to 16 Wh/kg)
- Extreme cycle life (>1 million)
- Extremely fast charge rate (2000 C)
- High inherent safety
- No rare metals


## SuperBattery

Based on supercapacitor technology

Fast

- High power density (4 kW/kg)
- **Increased energy density** (65 Wh/kg)
- Long cycle life (50,000)
- Fast charge (<60s)
- Extreme power (20 C continuous, 100C peak)
- High inherent safety
- High recyclability and sustainability
- No Graphite, no Co, <5% Li

# Technology Advantage Throughout the Entire Energy Storage Industry

Highest performance and quality for every energy storage application, powered by Curved Graphene


**SkelCap supercapacitors (Gen 1)**

- 4x power density compared to competitors
- High power (up to 60x compared to batteries)
- 1,000,000+ lifecycles
- Ultrafast charging times (<1 s)

**Graphene supercapacitors (Gen 2)**

- +72% increase in energy (16 Wh/L), while maintaining high power
- 1,000,000+ lifecycles
- Ultrafast charging times (<1 s)
- Increased efficiency & lower footprint

**SuperBatteries**

- High energy density (65 Wh/kg)
- 50,000+ lifecycles
- Fast charging (60s)
- Extremely competitive cost-base compared to similar energy storage technologies

# Addressable Energy Storage Application Space

High power from sub-second to up to 15 minutes duration

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Skeleton products provide **high power energy storage** for applications with **<5-minute charge / <15-minute discharge** cycle durations

**Lower cost** compared to **Li-ion batteries** in this application space

**Supercapacitors**


**SuperBatteries**


**Lithium-Ion batteries**

Fast charging

<1s to 60s | 1-5 min | 1-15 min | >15 min

# Independent 3rd Party Verified Advantage

Superior power and energy densities in energy storage

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"Your cells have very low resistance so are truly high-power devices. I think **they are the best in the world of the carbon/carbon type.**"

Dr. Andrew F. Burke

UCDAVIS UNIVERSITY OF CALIFORNIA

"One property **that stands out is the ESR of the Skeleton capacitor**, which is significantly less than the others."

*C. N. Nybeck, D. A. Dodson, D. A. Wetz and J. M. Heinzel, "Characterization of Ultracapacitors for Transient Load Applications," in IEEE Transactions on Plasma Science, vol. 47, no. 5, pp. 2493-2499, May 2019*

## Supercapacitors

**4X** power density vs competitors

64.3 kW/L skeleton

15.6 kW/L UCAP Maxwell TECHNOLOGIES

## SuperBattery

Uniquely fast charge times with high energy density

60 sec skeleton

Charge time of 10 min *Competition*

# From Single Cells to Full Energy Storage Systems

The only full value-chain manufacturer on the market




## Raw Material

**Curved Graphene**

## Single Cells

**300-5000F**

Industrial supercapacitors

## Industrial Modules

**From low to high voltage needs**

Supercapacitor modules with smart balancing and management systems

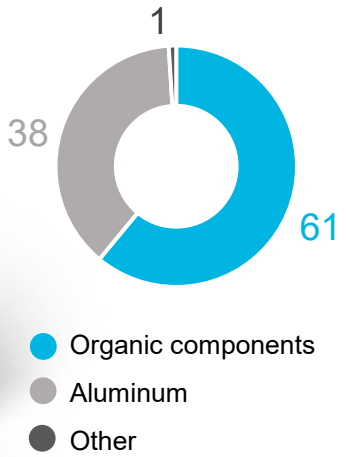
## Systems

**MWs of immediate power**

Modular, supercapacitor-based energy storage systems

# Increased Safety Compared to Lithium-ion Batteries

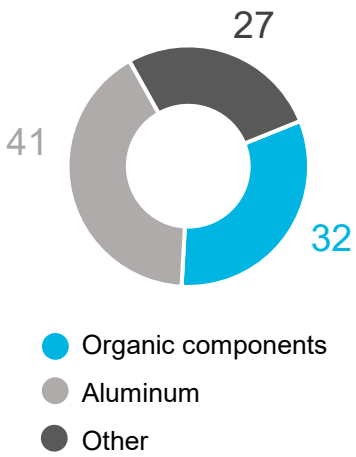
Lower cost due to Curved Graphene and abundance of other raw materials


## Supercapacitor

Composition

- Mostly carbon and aluminum – easy to recycle
- Contains no heavy metals


## SuperBattery

Composition

- Safer to handle than Li-Ion batteries (no lithiated graphite)
- Contains lower cost elements compared to Li-Ion

## Curved Graphene

- Proprietary carbon, produced without any rare earth materials
- Synthesis byproducts re-usable – zero waste created

# Sustainable Products And Production Process

From supercapacitors to SuperBatteries

### Little to no rare earth metals used

- ✓ The only metal content in supercapacitors is aluminum
- ✓ SuperBattery uses no graphite, nickel or cobalt, and very little lithium (<5% of weight)

### Easy and affordable to recycle

- ✓ Carbon and aluminum are easy to recycle
- ✓ Products use lower cost elements than in Li-ion

### Sustainable production and processing

- ✓ Skeleton uses water-based process for coating and recycling
- ✓ Products are safer to handle than li-ion batteries due to no lithiated graphite or lithium plating

# High Performance Energy Storage - Made in Europe

Fully integrated production – control over the entire manufacturing chain

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# Leipzig Superfactory

State-of-the-art supercapacitor production

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## Building the **largest supercapacitor factory** in the world

(Markranstädt, Germany)

# Varkaus Factory

SuperBattery manufacturing

## First industrialization of SuperBattery

(Varkaus, Finland)

Mass production facility for SuperBattery to be built near Toulouse, France (SOP 2028)

# Skeleton Materials

Curved Graphene production facility in Bitterfeld, Germany

## **Skeleton Materials** is Skeleton's material development arm, situated at the Bitterfeld-Wolfen Chemical Park in Saxony, Germany.

Led by world-class material scientists and researchers, Skeleton Materials is already the global leader in synthesizing capacity and scaling up Curved Graphene material production to industrial levels to meet the demand for Skeleton's GEN 2 supercapacitors, SuperBatteries, and solid-state batteries.

# German Quality, Certified According to the Highest Standards

Qualified supplier to some of the largest OEMs in the world

**Linus Froböse**
CTO

"**Quality is the bedrock of Skeleton's success** and something we have put an enormous amount of work in – to produce the most robust and long-lasting products for our customers."

Certified

ISO 9001:2015

ISO 14001:2015

IATF 16949

Compliance and selected product certifications

# A Qualified Supplier & System Provider to Industry Leaders

To automotive, grid, transportation, and industrial companies, OEMs & Tier 1s

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ŠKODA

mjr Power & Automation

MAJA

German automotive OEM

Hitachi Energy

North-American Truck OEM

Honda Racing HPD

CAF Power & Automation

GE

MITSUBISHI

Danfoss

esa

# Enabling Higher Penetration of Renewable Energy & Stabilizing Power Grids

MWs not, kWh business – 50 MW solution delivered


**50% FEWER**

**supercapacitors needed for power quality applications compared to competition**

Hitachi Energy

"Most competitive supercapacitor-based ESS for grid applications."
(Virtual Inertia)

# Supercapacitors Electrifying Trams Across Europe

Kinetic energy recovery reduces costs and protects infrastructure


ŠKODA

"Skeleton Technologies brings the necessary quality mindset to critical applications. **The highest power density and efficiency in the industry provides us with a very clear competitive advantage**."

Stanislaw Wizur
Škoda Electric

CAF Power & Automation

**"Skeleton's cells are a perfect fit to the rail and tram industry.** Adding them to our energy storage systems will greatly benefit our existing and future customers, **allowing to maximize energy efficiency at an unprecedented level**."

CAF Power & Automation

# Supercapacitors Kickstarting Fusion Reactors

Enabling technology to create clean energy


Supercapacitors are used to provide **20 MW of power for each gram of hydrogen to be heated in less than 1 second.** Skeleton is supplying a **global leader in fusion energy**.

# Key Benefits

To working with us

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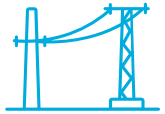
IATF-certified & the **largest supercapacitor factory** in Europe



**100+ MWs** of grid & industrial installations, **10 000+** systems & modules in the field

Unique technology & product roadmap with **Curved Graphene**, protected by more than 11 patent families

World-class team of **350+ professionals** with vast experience in energy storage development & production

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# Thank you!

For more information contact us:

www.skeletontech.com


Certified

9001:2015 14001:2015 IATF 16949

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