SKELETON TECHNOLOGIES

ULTRAKONDENSATOREN ALS EFFIZIENTE LEISTUNGSSPEICHER IN DER ELEKTROMOBILITÄT

Energy Saxony Summit, Innovationsforum Intelligente Mobilität, 18.09.2017, Katharina Maurer

ULTRACAPACITORS: HIGH POWER ENERGY STORAGE

WHAT IS AN ULTRACAPACITOR?

SKELETON TECHNOLOGIES

SLOW

Li-ion Batteries and fuel cells use a chemical reaction to store energy

+ Chemical storage of energy
+ Good energy density
+ Limited power capabilities
+ Limited cycle life (<1,000-2,000)
+ Limited safety

UNTAPPED OPPORTUNITY IN HYBRID ENERGY STORAGE SYSTEMS!

FAST

Ultracapacitors use an electric field to store energy

+ Physical storage of energy
+ High power density
+ Limited energy density
+ Extreme cycle life (>1 million)
+ Inherently safe

ULTRACAPACITORS ARE MOST ECONOMICAL

FOR HIGH POWER APPLICATIONS BETWEEN 10ms-60s

SKELETON TECHNOLOGIES

CAPACITORS	ULTRACAPACITORS	BATTERIES
→ 10 ms	10 ms – 60 s	60 s →

ULTRACAPACITORS OFFER:

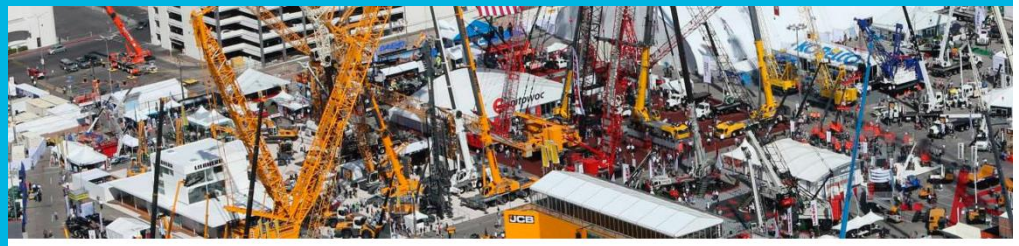
+ POWER FROM 1KW TO 10's OF MW's
+ VOLTAGE FROM UNDER 12V TO 1500V (standard modules and systems, custom systems up to 10kV)

Ultracapacitor applications

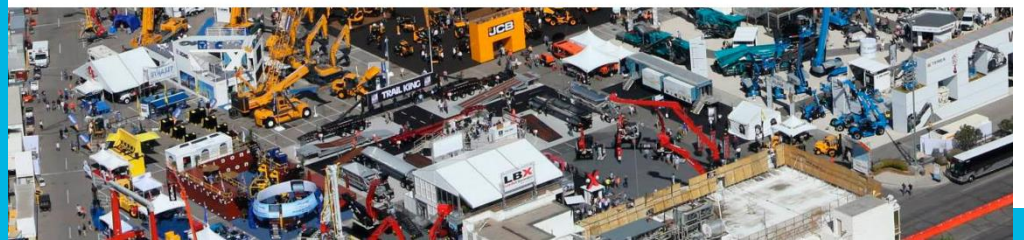
Automotive

Grid & Renewables

ULTRACAPACITOR SYSTEMS FOR KERS



INDUSTRIAL EQUIPMENT



SKELETON: EUROPE'S LEADING MANUFACTURER OF ULTRACAPACITORS

LEADING EUROPEAN MANUFACTURER
FULL VALUE CHAIN PRODUCTION IN EUROPE

SKELE+ON TECHNOLOGIES

Großröhrsdorf, Germany Skeleton Technologies GmbH

- Industrial scale manufacturing facility
- Electrode centre of excellence

Viimsi, Estonia Skeleton Technologies OÜ

- Assembly facility
- Research and Engineering
- Module & System Development

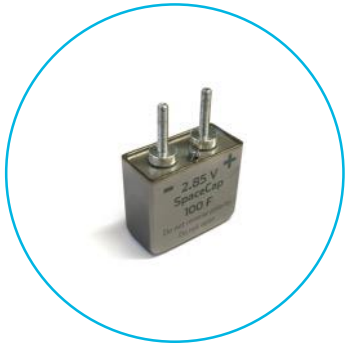
ONLY ULTRACAP MANUFACTURER WITH A COMPLETE VALUE CHAIN

MATERIALS

Curved Graphene
OUR PATENTED
RAW MATERIAL

SINGLE CELLS

SkelCap SCA series
INDUSTRIAL ULTRACAPACITORS



SpaceCap
CUSTOM ULTRACAPACITORS

SOLUTIONS

SkelMod 51V
ULTRACAPACITOR MODULE

SkelMod 170V
ULTRACAPACITOR MODULE

SkelStart Engine Start Module
ULTRACAPACITOR MODULE

SkelGrid
ULTRACAPACITOR-BASED
ENERGY STORAGE SYSTEM

Skeleton's Cells are applied all over Europe

SKELE+ON TECHNOLOGIES

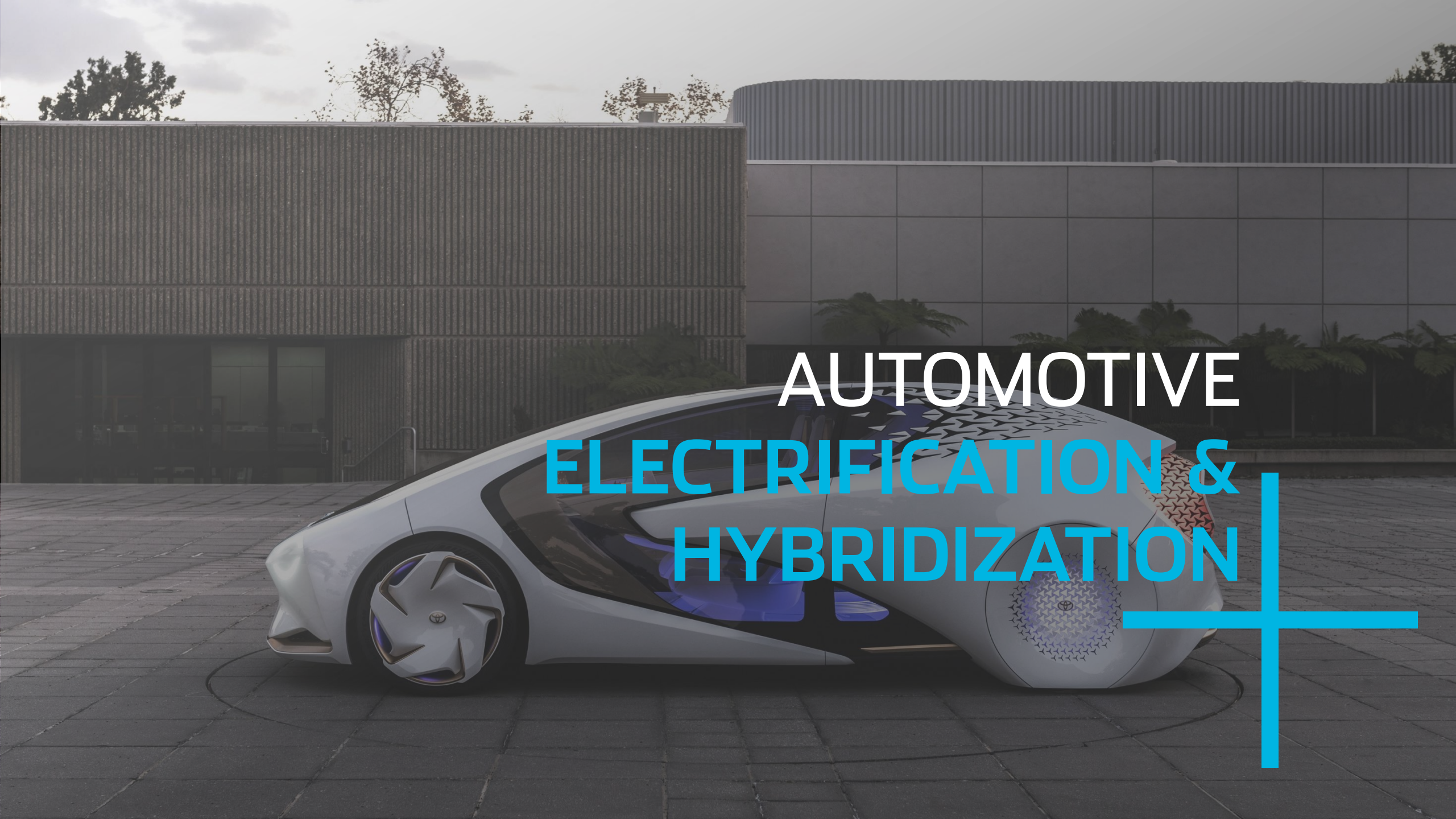
SINCE 2009 WE HAVE BUILT A STRONG CUSTOMER BASE IN CELLS AND MODULES

IN 2016 ENERGY STORAGE SYSTEMS FOR HEAVY TRANSPORTATION AND INDUSTRIAL GRID WERE ADDED TO THE PRODUCT PORTFOLIO

SAINSBURY'S
(HYBRID TRUCK SOLUTIONS)
30% reduced fuel consumption

PORT OF MUUGA
(RTG CRANES)
40% reduced energy consumption

LEADING SCANDINAVIAN ENERGY COMPANY (INDUSTRIAL GRID)
Peak power grid stabilization

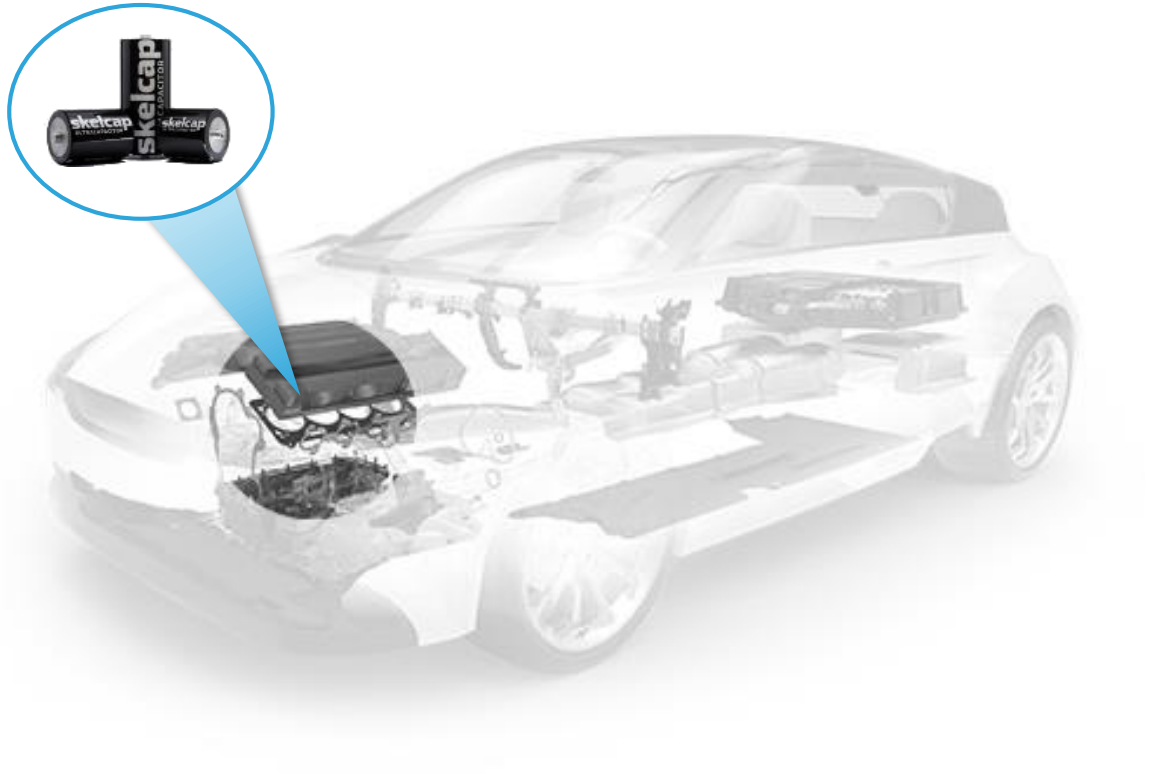

AUTOMOTIVE
ELECTRIFICATION &
HYBRIDIZATION

Automotive applications

Why Ultracapacitors?

SKELETON TECHNOLOGIES

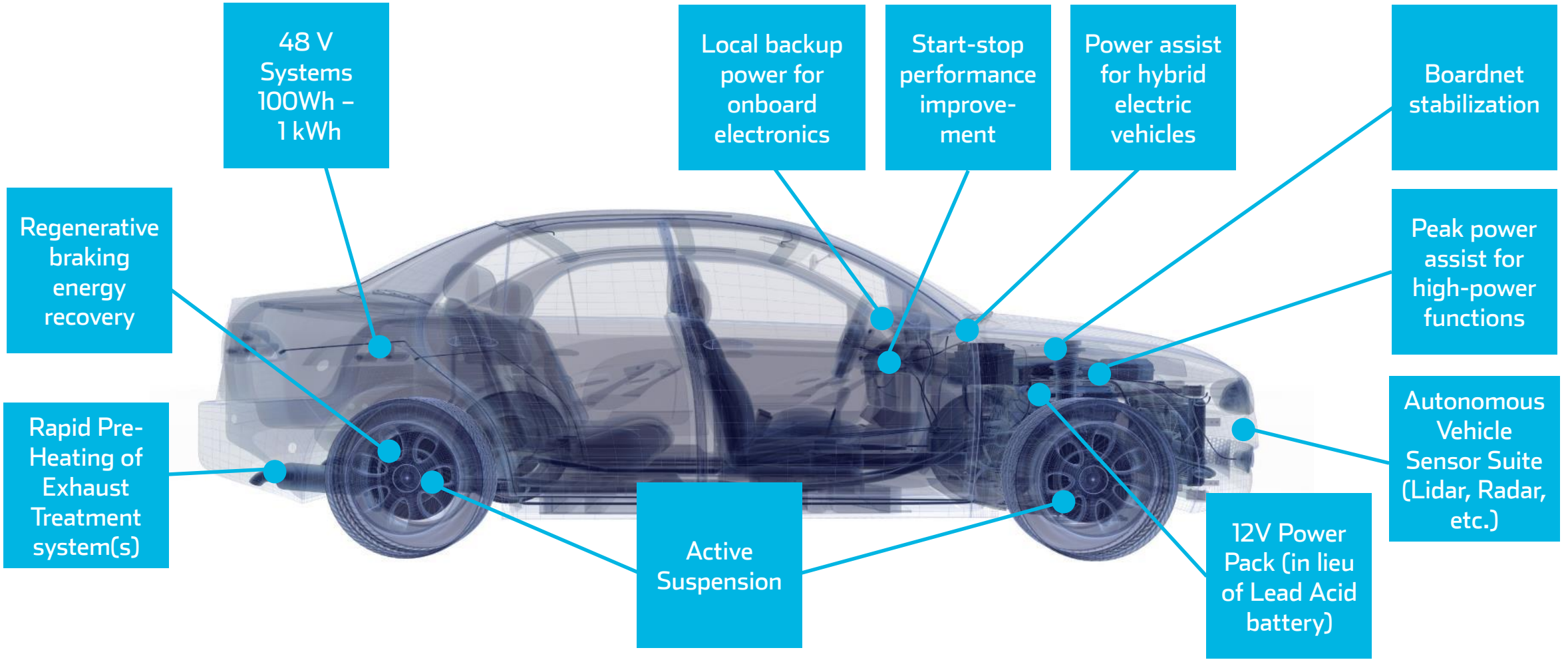
Best Price per kW	Lifetime of 15+ years
Large operating temperature window -40°C to 65°C	Super fast charge-discharge (<10s)
High cycle number lifetime (>1,000,000)	
Fast power response	High efficiency



Automotive applications

Ultracapacitors in vehicles

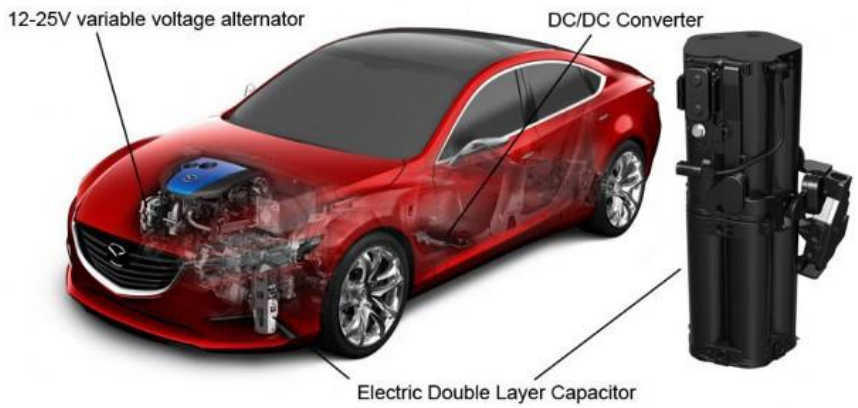
SKELETON TECHNOLOGIES

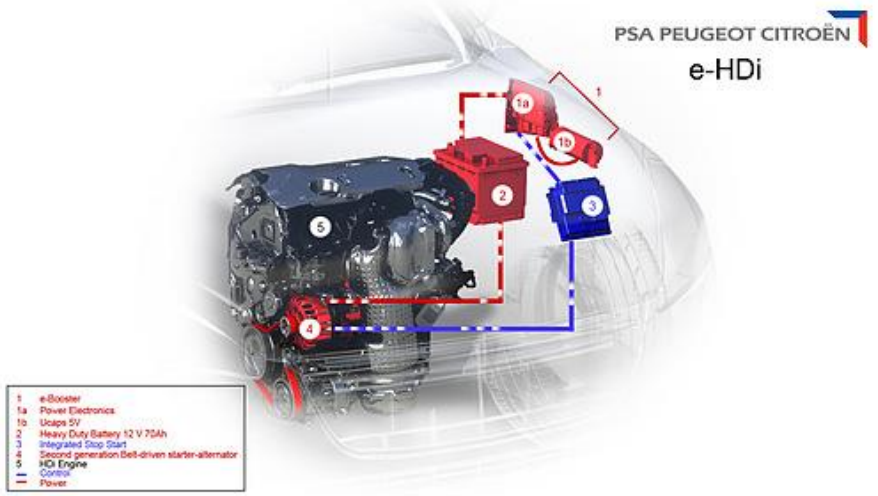


ULTRACAPACITORS ARE ALREADY PRESENT - IN MILLIONS OF VEHICLES

SKELETON TECHNOLOGIES

- In use for more than 20 years
- Large cells used in 4+ million cars (PSA Group, Mazda, etc.)
  - Not a single malfunction
- Several applications require 8600 hours/year –
  for a minimum of 10 years
- Approx. 20bn passengers use them per year





KEY APPLICATIONS IN MOBILITY – FUEL CELL VEHICLES

+ Long range

+ Fast refuelling

+ High energy density

- No kinetic energy recuperation

- Low power density

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+ High power density (>50 kW/L)h

+ Perfect for kinetic energy recuperation

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+ Long range

+ Fast refuelling

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Hybrid Energy Storage System (HESS)
+ Long range
+ Fast refueling
+ KERS
+ fast acceleration

- Low energy density

+ High power density (>50 kW/L)h

+ Perfect for kinetic energy recuperation

SKELETON TECHNOLOGIES

ADVANTAGE IN POWER

1200 F Cells: Comparison

Power density (IEC62391 Standard)

SKELETON TECHNOLOGIES

IEC62391 Method	Skeleton SCA1200		Maxwell BCAP1200 P270 K05		Ls Mtron LSUC 2.7V 1200F	
	Internal resistance (mΩ)	**Power density (kW/L)**	Internal resistance (mΩ)	**Power density (kW/L)**	Internal resistance (mΩ)	**Power density (kW/L)**
1A: class 2	0.17	**66.1**	0.58	**14.7**	0.31	**27.6**
1A: class 3	0.17	**66.8**	0.59	**14.7**	0.35	**24.6**
1B: classes 3, 4 and 5	0.16	**71.0**	0.60	**14.4**	0.34	**24.8**

4x

POWER DENSITY vs COMPETITION

As measured by IEC 62391 industry standard

WE ARE

SKELE+ON TECHNOLOGIES

WE HELP TO SAVE ENERGY