skeleton

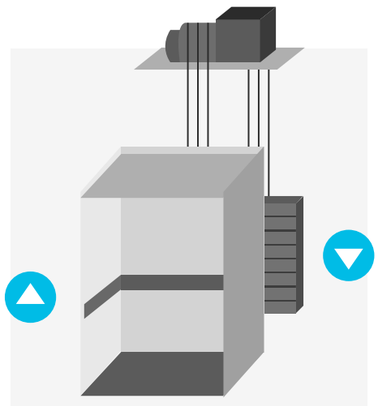
Case study

Energy savings of up to 70% with **ElevatorKERS**

Kinetic Energy Recuperation System for elevators

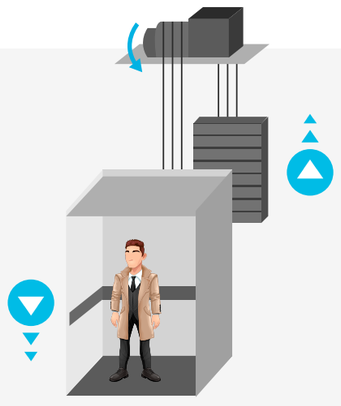
Energy-intelligent elevators reduce **energy consumption by up to 70%** by storing and re-using energy generated during operation.

Skeleton Technologies' industry-leading supercapacitors power ElevatorKERS (Kinetic Energy Recuperation System). The system is used to capture energy created by electric traction elevators and to re-use it to power the elevator, offering a simple, efficient, and practically maintenance-free way to cut down the energy consumption of elevators by up to 70%.

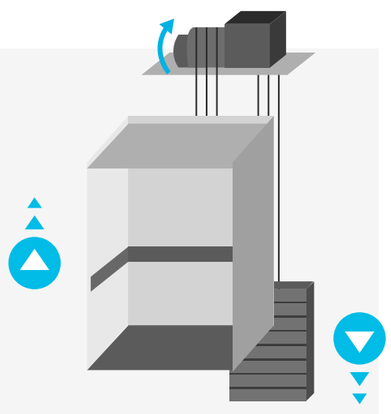


In a typical elevator, the cabin is counter-weighted.

When the counterweight goes down, the cabin goes up and vice versa.



When the cabin goes down loaded, it weighs more than the counterweight of the cabin, and goes down by effect of gravity. The elevator motor acts as a brake, generating energy.



The principle is reversed when the cabin goes up unloaded; in that case the counterweight is heavier than the cabin, which is pulled up. The elevator motor again generates energy in the same ways as a dynamo.

In electric traction elevators that include inverters, the generated energy is wasted as heat via the braking resistors. The ElevatorKERS stores the energy in Skeleton Technologies' supercapacitors until it is needed again to help power the elevator and decrease the use of energy from the grid.

The ElevatorKERS also includes an option to connect solar panels to the system, further reducing the need for energy from the mains. This is not the case with regenerative drives, with which the elevator consumes the same and then returns to the grid. The amount of saved energy can be measured and communicated via CAN bus communications.

ElevatorKERS enables energy savings of up to 70% with a simple two-wire connection to any drive. No harmonic distortion and no added stand-by consumption.

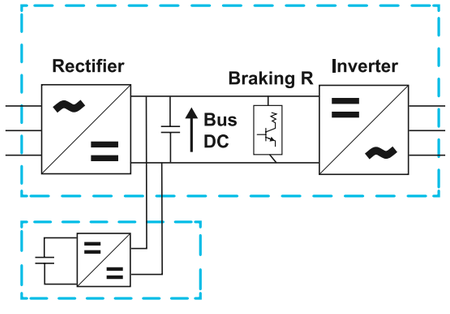
ElevatorKERS - the best option for energy savings

Electric traction elevators equipped with inverters, also known in the industry as VVVF (variable voltage variable frequency) drives, produce energy while moving up and down in an elevator shaft. The generated energy can be dealt with in three different ways:

1 The most common solution is to simply let the energy be wasted as heat in a braking resistor. The resistors are activated by the drive and protect the drive from internal overvoltage by removing excess energy from the system.

2 Another option is to return the energy back to the grid. This is done via a regenerative drive. A normal unidirectional drive is replaced with a bi-directional (regenerative) drive that returns the excess energy into the AC grid. However, this energy must be used by other energy-consuming systems in the building as the energy is being generated.
In this type of a drive, the elevator energy consumption is actually increased compared to the first option due to the higher standby consumption of regenerative drives.
The upside is the energy injected into the building for other systems to use. However, regenerative drives require special filters to ensure the energy created complies with the required standards.

3 The ElevatorKERS stores the braking energy in supercapacitors, enabling the elevator itself to re-use this energy. The bi-directional energy storage process is carried out in DC (direct current), avoiding additional filtering requirements. The implementation and installation of ElevatorKERS does not require any changes in existing elevators that already have a drive, nor is there any need for the system to interact with the elevator control.



Simple & **Efficient**

+ Bi-direction, high-efficiency DC/DC converter with an integrated supercapacitor energy storage module.
+ A simple connection to any VVVF drive is enough to make the elevator regenerate energy.
+ Only a DC link connection needed for the system to automatically store the energy in an supercapacitor pack.
+ Simple integration into new or existing elevators.

Advantages of **ElevatorKERS**

+ Recovers and stores the energy generated by the elevator to return it in the next consumption trip or to support the drive's standby.
+ No regeneration to the grid. No harmonic problems. energy
+ Improves the energy efficiency classification of the lift.
+ Elevator actually consumes less energy from mains.
+ Very simple two-wire connection to any drive, new or existing.

How does the **ElevatorKERS** work?

Every VVVF drive rectifies the three-phase main grid and transforms the 50Hz AC grid into DC (about 560 VDC) to then again transform this DC voltage into an AC that is variable in voltage and in frequency in order to manage the synchronous motor properly.

Supercapacitors are low-voltage energy storage elements, so an intermediate element is needed to transform voltages in the range of 600V to lower voltage values. This is achieved with a bi-directional DC/DC converter. To make it functional and practical for the application, the converter needs to be:

Very efficient

As the energy goes back and forth, any losses in the process happen twice. Electrical efficiencies of more than 98% are required, otherwise ROI decreases substantially.

Easy to connect

with plug-and-play functionality. It automatically detects when the motor is generating and stores the energy before it goes to the braking resistors and returns the energy before the drive takes it from the network. If the supercapacitors are already full, the energy will still go to the braking resistors, and when the supercapacitor pack is depleted of energy, the elevator draws the required energy fully from the grid. The system also needs to automatically (and smoothly) pre-charge the supercapacitors when rebooted.

Compact

The module includes supercapacitors and power electronics all-in-one for simplicity.

Multibrand

No need for adjustments regardless of the VVVF or elevator manufacturer.

Flexible and sizable

Not all elevators are the same in terms of power consumed and generated and in terms of the energy needed for an average trip. Therefore, a basic system is designed to transfer a certain power in kW and store a certain energy in kJ but it can easily be parallelized to double the power or the energy. Parallelization in DC is very simple and only requires a connection - no need of additional cabling or communications.

Energy Savings in Real-Life Use Cases

The data in the graphs below shows the energy consumption of elevators before and after the installation of ElevatorKERS. The power need from the mains is much lower after the installations, because the elevators can re-use the energy recuperated from braking instead of having to rely solely on grid power.

Case Study 1

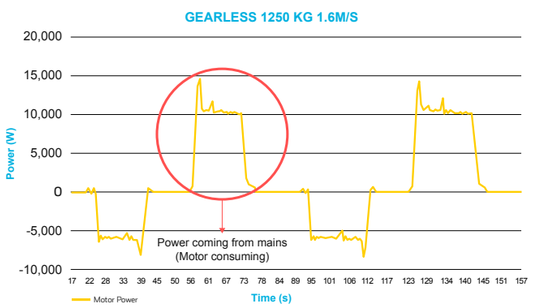
ELEVATOR DATA

Motor	**Gearless**
Load	**1250 kg**
Speed	**1.6 m/s**

System operation with
1 ElevatorKERS and **2** ElevatorKERS in parallel

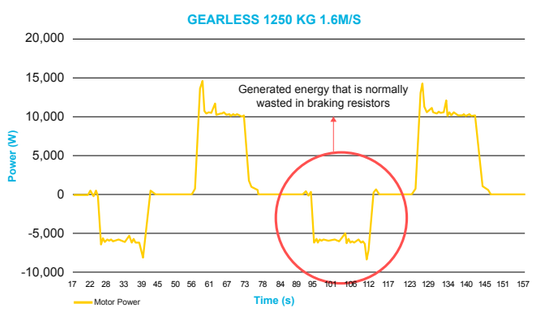
Consumption trips

Elevator going up fully loaded or down empty



Generation trips

Elevator going down fully loaded or up empty

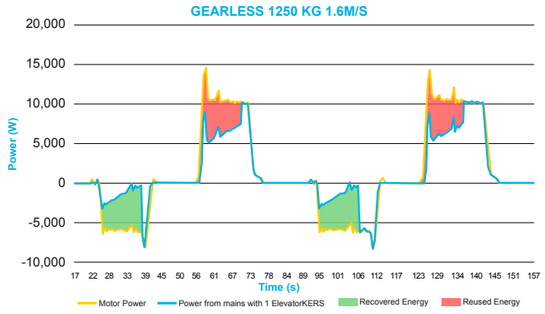


ElevatorKERS system

to save and reuse the energy generated by the motor

Operation & Savings

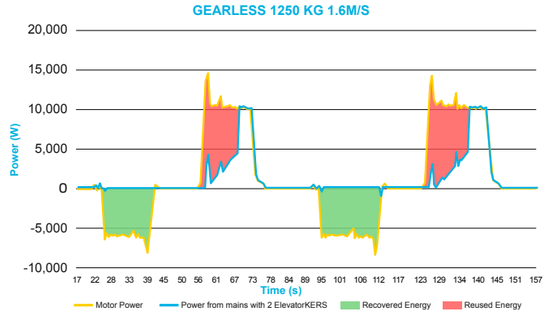
Difference in power consumed before and after installing **1 ElevatorKERS**



Energy savings of 34%

The area marked in green shows the energy saved by 1 system. The area marked in red shows the energy reused.

Difference in power consumed before and after installing **2 ElevatorKERS in parallel**



Energy savings of 54%

The area marked in green shows the energy saved by 2 systems. The area marked in red shows the energy reused.

Case Study 2

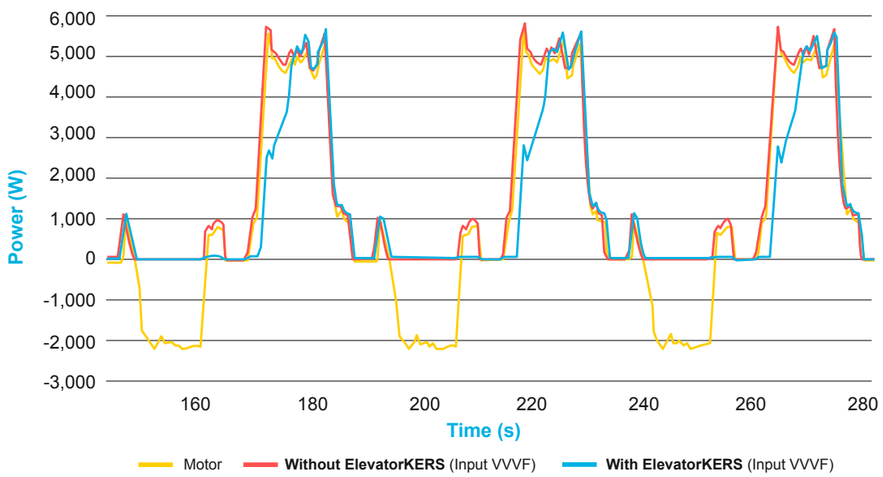
ELEVATOR DATA

Installation	**Germany**
Motor	**Gearless**
Load	**8 pax**
Speed	**1 m/s**

MOTOR POWER

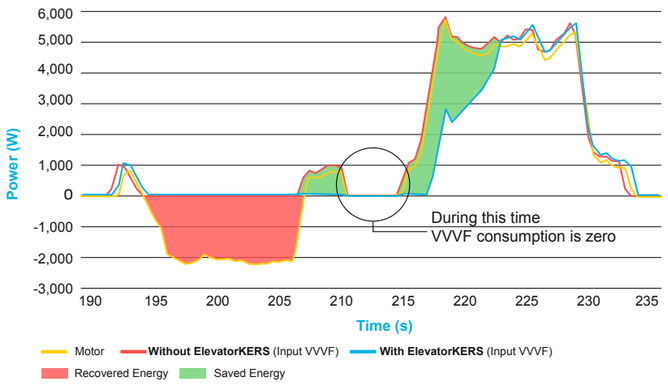
Max peak power	**5.708,9 W**
Min peak power	**-2.203,9 W**
Generated energy	**5.84Wh**
Shaft efficiency	**62.13%**

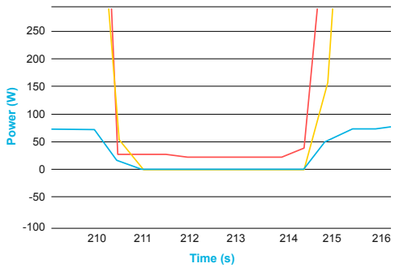
Three cycles up & down



One cycle up & down

Elevator VVVF consumes **22.32% less with ElevatorKERS System**

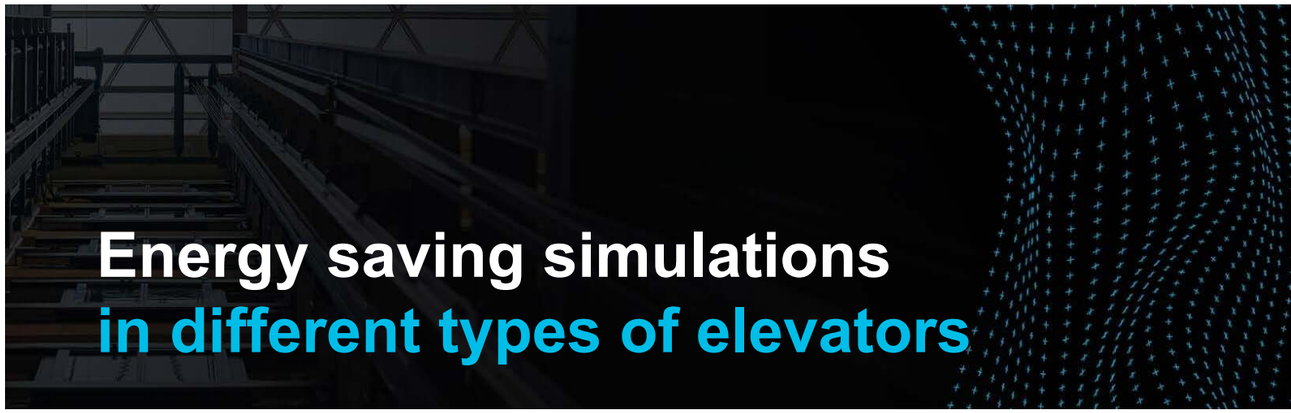




Elevator VVVF efficiency: η **94.7%**

ElevatorKERS efficiency:
η **KERS=95.13%**

Energy generated by motor	**5.84 Wh**
Energy consumed by motor	**18.87 Wh**
Energy consumed by VVVF without ElevatorKERS	**21.23 Wh**
Energy consumed by VVVF with ElevatorKERS	**16.49 Wh**
Energy saved with ElevatorKERS	**4.74 Wh**



Energy saving simulations in different types of elevators

Different elevators are simulated below to obtain estimations of the power requirements and energy savings that can be achieved. The first thing that needs to be considered when choosing an energy saving solution for an elevator is the efficiency.

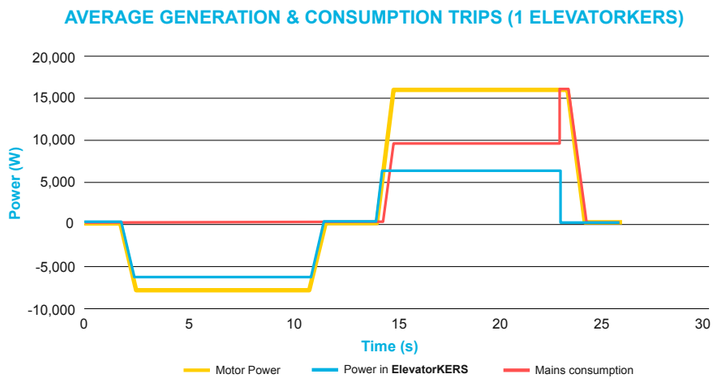
Case 1

Passenger elevator of **1200 kg** moving at **1.6 m/s**.
15 stops and **45 m** height.
Max power demand (no load going down or full load going up) = **15 kW**

Maximum load	**1200 kg**
Number of stops	**15**
Total height	**45 m**
Type of building	**Very large office**
Speed	**1.6 m/s**
Mechanical efficiency	**0.7**

Savings results with ElevatorKERS: **45,13%**

Annual savings:
2809,76 kWh
Annual consumption with Elevator KERS:
3416,00 kWh



Results **without** Elevator KERS

Annual elevator consumption: **6225,76 kWh**

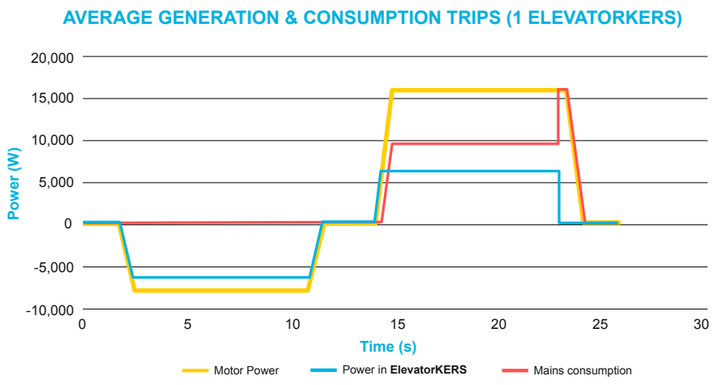
Case 2

Passenger elevator of **1600 kg** moving at **1.6 m/s**.
15 stops and **45 m** height.
Max power demand (no load going down or full load going up) = **18 kW**

Maximum load	**1600 kg**
Number of stops	**15**
Total height	**45 m**
Type of building	**Very large office**
Speed	**1.6 m/s**

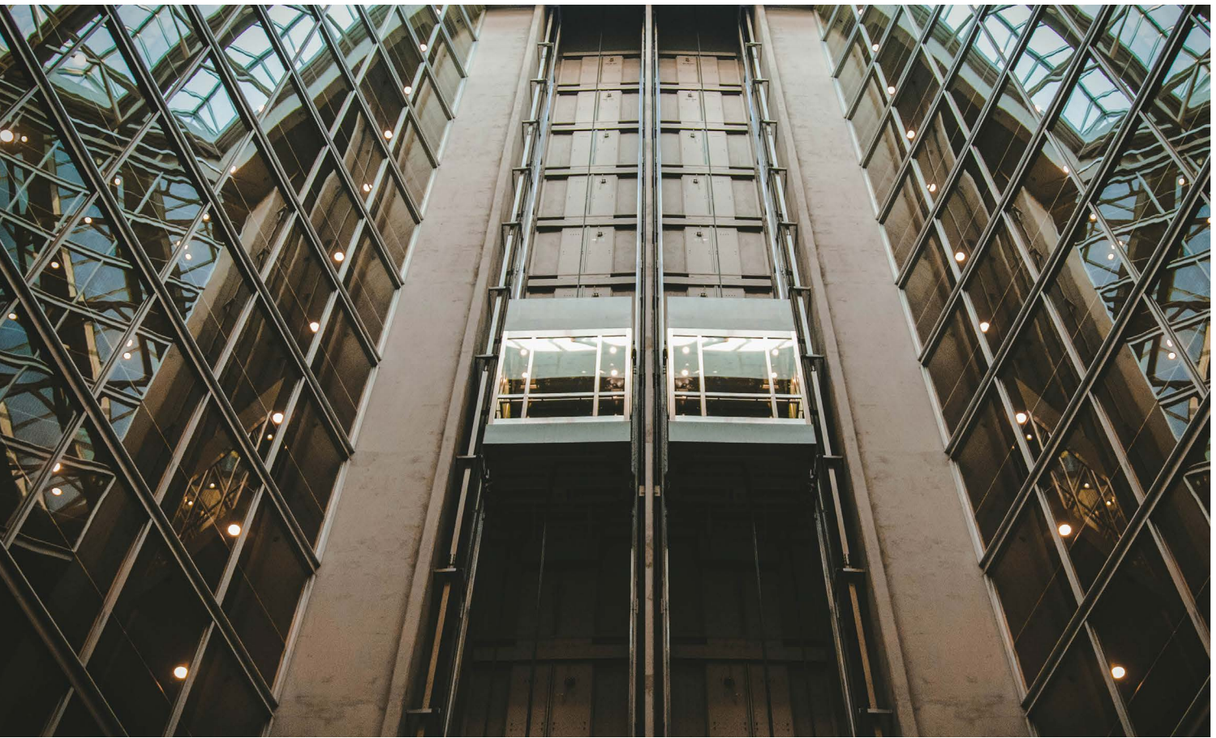
Savings results with ElevatorKERS: **37,18%**

Annual savings:
3333,09 kWh
Annual consumption with Elevator KERS:
5632,32 kWh



Results **without** Elevator KERS

Annual elevator consumption: **8965,42 kWh**



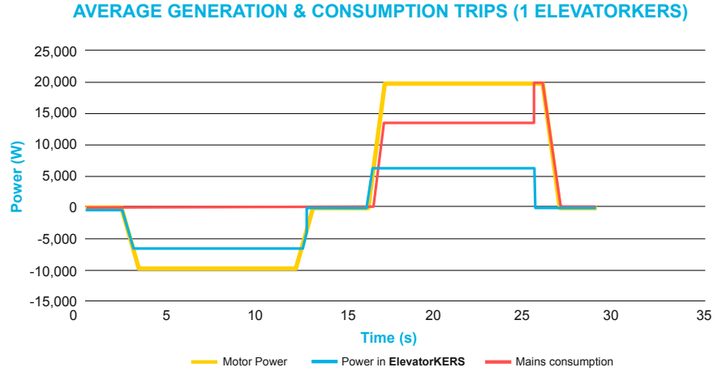
Case 3

Passenger elevator of **1600 kg** moving at **2 m/s**.
20 stops and **60 m** height.
Max power demand (no load going down or full load going up) = **22 kW**

Maximum load	**1600 kg**
Number of stops	**20**
Total height	**60 m**
Type of building	**Very large office**
Speed	**2 m/s**
Mechanical efficiency	**0.7**

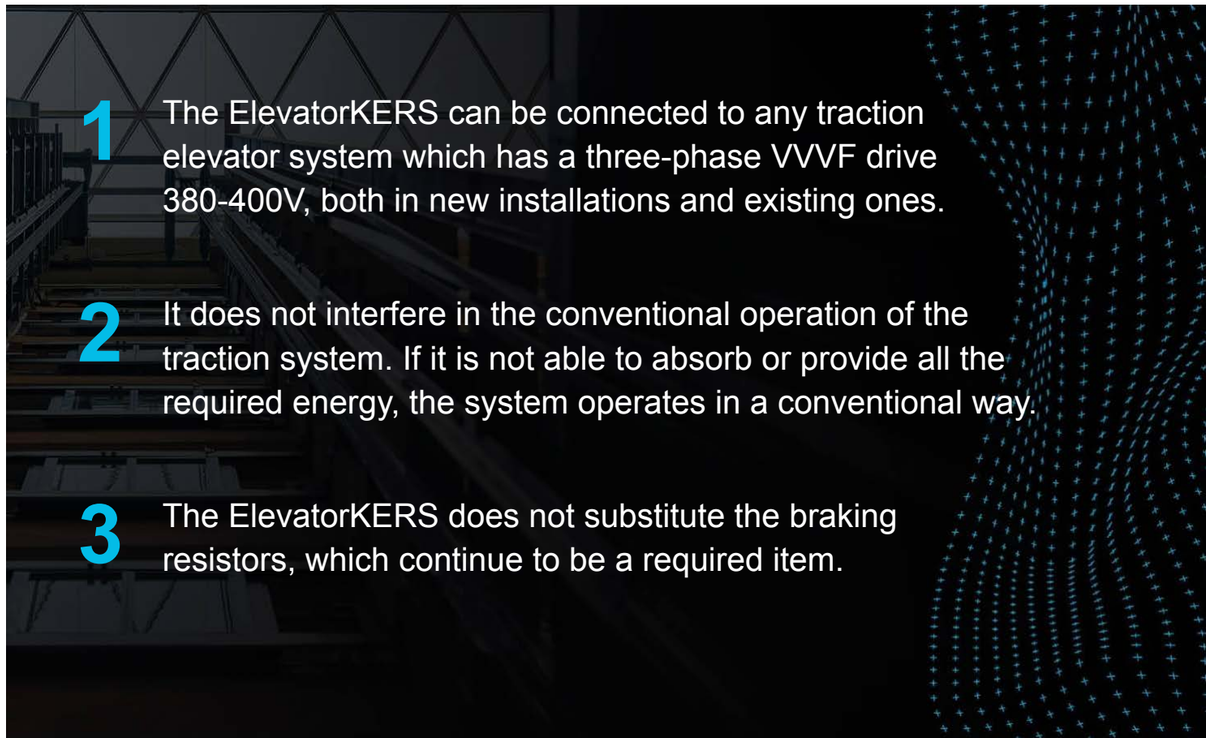
Savings results with ElevatorKERS: **29,92%**

Annual savings:
3577,00 kWh
Annual consumption with Elevator KERS:
8376,89 kWh



Results **without** Elevator KERS

Annual elevator consumption: **11953,89 kWh**



ElevatorKERS
Technical Features

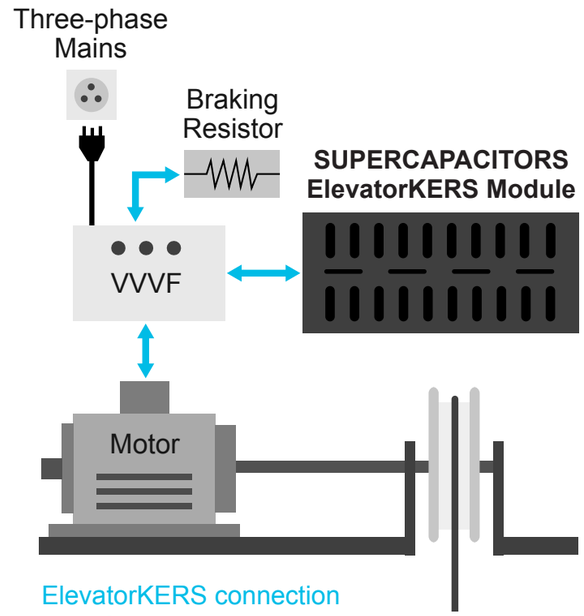
A suitable solution for all types of loads and travel distances:

+ Easy upgrade of any elevator into a regenerative one
+ Saves up to 70% of the energy consumed by the motor
+ Can be installed in new elevators or retrofitted into existing ones
+ Improves the energy classification of the elevator
+ Possibility to connect with solar panel installation

	ElevatorKERS	ElevatorKERS x n (can be installed in parallel)
Optimal power	**Up to 15 kW**	**Up to 15 kW x n**
Stored energy	**60,000 Ws**	**60,000 Ws x n**
Nominal power	**6,300 W**	**6,300 W x n**
Efficiency	**Up to 98%**	
Standby	**< 2 W**	
Solar energy	**Available with solar panel input**	

The ElevatorKERS is a single module that has inside both the power converter and the energy storage. This module has a height of 414 mm, a depth of 166mm and a width of 266mm. Thanks to these dimensions, it can be easily located in almost any machine room with lift installation.

ElevatorKERS's fundamental feature is that the connection with the drive is very simple and it's only made through three wires (positive, negative and ground), with no need for any kind of adaptation or preparation.



ElevatorKERS connection
to a lift traction system

Why Supercapacitors instead of Batteries?

Ultracapacitors are an energy storage technology that is often compared to batteries, but the two technologies have quite different features and ideal applications. The benefits of ultracapacitors are well-established: long lifetime of about 15 years or more than 1,000,000 charge-discharge cycles, the ability to charge and discharge in seconds, high power density, and high reliability, lowering maintenance and replacement costs significantly.

KERS is in many ways an ideal application for ultracapacitors, because fast charging and discharging, and the high number of charging cycles are what supercapacitors excel in.

Advantages of Supercapacitors

High power density (50 kW/kg)
Long calendar and cycle-life (over a million cycles)
High temperature tolerance - operates efficiently at -40°C to 70°C
Low internal resistance - quick reaction time
Maintenance-free
Charge and discharge in seconds (C-rate of 3000)
Safe - can be short-circuited without danger and contains no harmful metals or toxic liquids

skeleton+

Rebuilding industry for a net-zero future.

Skeleton Technologies is a Global Cleantech 100 company and a global technology leader in supercapacitor energy storage for automotive, transportation, grid, and industrial applications.

Our patented curved graphene raw material represents the biggest technological advancement in the industry in the last 20 years and enables the development of superior solutions over the entire energy storage market, from high-power supercapacitors to high-energy solid-state batteries.

Established in 2009

280+ employees

33 granted/pending patent families

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

GLOBAL REACH FROM THE HEART OF EUROPE

Combining Estonian IT and German Engineering

The largest and most modern supercapacitor factory in Europe

Großröhrsdorf, Germany

Industrial scale, highly automated production facility
Supercapacitor research & development center
Main production location from cells to systems

Tallinn, Estonia

Software development
Electronics engineering
Module & system development

Bitterfeld-Wolfen, Germany

Curved Graphene synthesis and production
Material pilot & development plant
Solid-state material research

Berlin, Germany

Sales & application engineering
Grant & IP management
Solid-state battery development

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