skeleton

Mission-Critical Power for MW-Scale Grid Stability

SkelGrid 2.0 - Supercapacitor energy storage system for high power applications



SkelGrid 2.0 is a versatile and scalable energy storage cabinet, designed for short-term peak power and MW-scale grid stability.

It includes energy storage modules, electrical protections and management software, all optimized to have the easiest integration process for our customers. Compatible with all busbar systems and containerized solutions.

Modular

Cabinets can host 1-10 energy storage modules to match application voltage ranging 0-1500V.

Thanks to the standardized dimensions, several SkelGrid cabinets can be connected in parallel to reach the power demands.

Plug & Play

SkelGrid 2.0 includes all the auxiliaries required for safe operation and monitoring.

Temperature, single cell voltage, module State of Health, State of Charge and more, are all accessible with a single CAN bus communication port.

3MW in a single cabinet

Capable of up to 2700A per module, a fully stacked and charged SkelGrid cabinet can provide extremely high power for a short time (up to 3MW/300ms) or lower power for a longer duration.

Applications

- Virtual inertia
- Frequency regulation
- Peak shaving
- Generator ramp up support
- DC bus stability
- Microgrid Stability
- Fuel cell Hybrid
- Uninterruptible Power Supply (UPS)

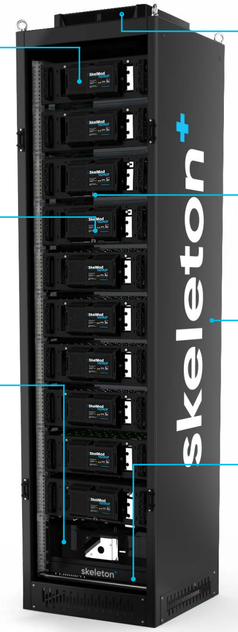


SkelGrid 2.0
Components Overview

1-10 Supercapacitor modules
With its new modular design, SkelGrid can be configured with several different layouts based on customer needs, ranging from 1 to 3 parallel modules and a max of 10 modules in series (10s1p, 5s2p, and many other configurations).

New PE concept
With the new SkelMod 162V module design, having no metal parts in the casing, there is no need to connect the module casings to protective earth. This reduces maintenance, simplifies assembly, and improves system reliability.

Modular Switchgear
SkelGrid includes a set of electrical protection devices (fuses, contactors etc.) efficiently packaged in a low footprint unit, which takes the space of not more than four rack units. The switchgear communicates its status with the master controller, which can control it and ensure that protections are active and healthy. Finally, two terminals are available to connect a pre-charge (or discharge) unit.



Fan cooling
Based on the application requirements, SkelGrid can come together with a centralised fan cooling system. Thanks to the presence of multiple temperature sensors in the cabinet, the fan is controlled from the master controller to optimize its usage to the lowest power consumption and maximum component lifetime.

The most reliable communications network
SkelGrid features the most reliable communications network architecture designed by Skeleton Technologies. All modules communicate with a ring bus, hosting CAN and I/Os fault lines for the highest reliability.

Mechanical Enclosure
Custom design from Skeleton Technologies, optimized for the SkelMod 162V module, while being compatible with 19“ rack-mountable devices. IP20 rating to allow optimal cooling, while ensuring protection from high voltage parts. Dimensions: 600x600x2200mm

Master Controller
The brains of SkelGrid, carries out several important tasks. The Master Controller includes the hardware and software to perform cell balancing at both module and rack level. Calculates SoH (State of Health) for each cell, and is the heart where all the logic regarding rack management is calculated. A single CAN port allows customers to interact with and access all this important information.



SkelMod 162V 62F
Supercapacitor module

The SkelMod 162V supercapacitor module is a powerful and compact solution for a variety of applications. It is based on the patented SkelCap supercapacitor cells that provide the highest power and energy density on the market.

Modular
design for optimized scalability, with parallel configu-ration possible in the same cabinet

19“ rack-mountable
designed for the easiest installation in cabinets and containers

High Energy
54 cells in 19“ rack footprint translates into up to 2.3kWh in one cabinet package

1500V
maximum series voltage, in a single cabinet footprint

Robust cell
The latest design from Skeleton, with maximum reliability in harsh condition, both in high RMS and pulsed current

Polymer Casing
without compromising endurance, no need for protective earth

Enhanced Cooling
designed for forced air and natural convection, also available with liquid cooling

State of Health
estimation thanks to cutting-edge algorithm and current sensor

SkelMod 162V 62F
Specifications

Cells per module	54 (54s1p)
Maximum voltage	162 V
Rated Capacitance	62 F
ESR 10ms	10.9 mΩ
ESR 1s	13.0 mΩ
Maximum stored energy	225 Wh
Cycle life @RT	1M cycles
CMS	Individual cell monitoring with centralized Master Controller
Weight	35 kg
Number of rack units	10x SkelMod 162V modules
Dimensions	483x172x540 mm

SkelGrid
With included switchgear

- Very compact and cost effective
- Lightweight
- Plug & play, easy to use

Switchgear functions

+ Protection from high current fault events
+ Load breaking in case of overheating
+ Pre-charge/discharge contactors and external terminals
+ handle in the front to actuate main switch
+ Steel enclosure
+ Fault detection for fuses





SkelGrid 2.0

with the most advanced capacitor management system (CMS) on the market

Setting the bar higher, our advanced CMS in SkelGrid 2.0 redefines control, efficiency, and reliability.

	Skeleton CMS	Competitor CMS
Controlled balancing	✔	✘
State of Health	✔	✘
Temperature sensors	7	1
Single cell voltage reading	✔	✘
CAN bus	✔	✘
Fault lines	✔	✔
Failure detection	✔	✘
Redundant ring loop for communication (ISO SPI)	✔	✘

Balancing

Microcontroller-based controlled resistive balancing, implemented with automotive grade hardware components

SoH

Model-based algorithm, estimation for every cell and the entire module. Prediction of remaining useful life (RUL)

Failure detection

Software capable of identifying faulty cells and providing information for maintenance planning

Fault lines

As a redundant monitoring, IOs are present to detect overvoltage and overtemperature

Architecture

ISO SPI ring network to wire the modules together, utlizing ethernet connectors for maximum reliability

Temperature sensors

20 thermistors provide real time temperature measurements in the most important locations among cells, electronics and current sensor

CANbus

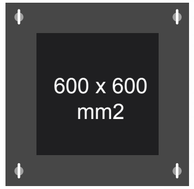
Standardized CAN bus 2.0B protocol J1939, which allows to read all valuable parameters with 1 single connection to master controller. Other communication protocols available via gateway.

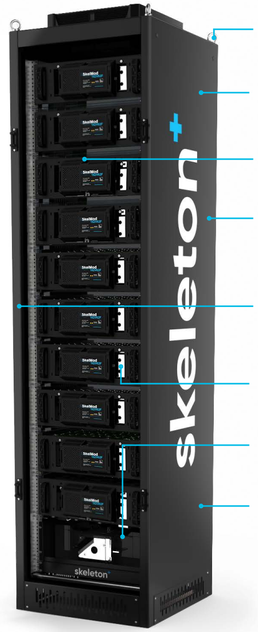
SkelGrid

Interfaces

Seamless monitoring through CAN bus Phoenix connector, DC line control with the use of a manual handle for the main switch, and maximum safety while ensuring optimal cooling through the IP20 enclosure.

SkelGrid's innovative design unlocks new applications and possibilities.

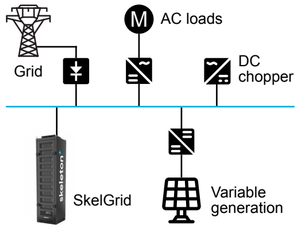




- Easy hoisting points
- Weight: 550 kg (with 10 modules)
- CAN bus Phoenix connector
- IP20 enclosure for safe operation and optimal cooling
- Cooling air input from openings in the front door
- Busbar terminals
- DC line switch manual handle
- Height: 2200 mm

SkelGrid
Example architectures

Direct DC bus connection



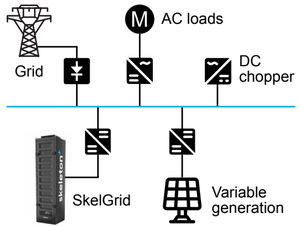
Skelgrid directly connected to DC bus systems or VSD DC link

Pros: simplest installation, highest system reliability

Cons: narrow voltage range = low utilization of nominal energy

Example Applications: Variable Speed Drive backup, voltage stability, short circuit current

DCDC converter integration



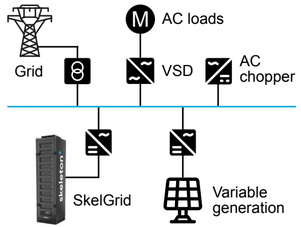
Skelgrid connected to DC bus systems through DCDC converter

Pros: maximum utilization of energy content, optimal control of power flow

Cons: more complex and higher CAPEX

Example Applications: energy recovery, peak shaving, power management

DCAC converter integration



Skelgrid connected to AC bus systems through DCAC Inverter

Pros: possibility of coupling with existing AC grids

Cons: ES needs to stay at higher voltage and can't fully discharge

Example Applications: hybrid AC grids, frequency regulation, UPS and power quality

SkelGrid Specifications
One cabinet – many possibilities up to containerized solutions

Skelgrid can be configured in many different layouts, aiming for the maximum voltage or the maximum current. Depending on your needs, Skeleton Technologies' Application Engineers can suggest the most suitable option.

Configuration	Modules in series	Modules in parallel	Max V	Cap [F]	10ms ESR [mΩ]	1s ESR [mΩ]	Power 1s [kW]	Power 10s [kW]	Max energy[1] [Wh]	Max current for 1s [A]	Short Circuit current [kA]
10s1p[2]	10	1	1500	6,2	108,3	129,9	2265	460	1938	2576	13,9
9s1p	9	1	1458	6,9	97,5	116,9	2376	481,5	2034	2782	15,0
8s1p	8	1	1296	7,8	86,6	103,9	2112	428	1808	2782	15,0
5s2p	5	2	810	24,8	27,1	32,5	2640	535	2260	5563	29,9
3s2p	3	2	486	41,3	16,2	19,5	1584	321	1356	5563	29,9

Containerized solutions

Skeleton Technologies works with established integration partners to offer fully equipped containerized energy storage solutions.

Skeleton's scope

- Supercapacitor-based Energy Storage System (SESS)
- Supercapacitor Management System
- CAN communication

Shared offering with integration partners

- Power Conversion System (PCS) for grid connection to 3-phase AC
- Heat, ventilation, and air conditioning (HVAC)
- Energy Management System (EMS)
- Internal lighting and power system. DC panels.
- Fire suppression system.
- FAT and SAT included.



1. This performance refers to Begin of Life conditions. Please contact Skeleton Technologies Sales team for better understanding of End of Life performance and optimal design. Power is calculated for a discharge pulse using the window Vrated-Vrated/2, for optimal lifetime and depending on the use case, lower voltage can be preferred.
2. Due to max voltage 1500V, the energy is not maximized, however lifetime is drastically improved

The Largest SkelGrid System
Superior Efficiency and Power

With an impressive power output of 75 MW, used in a renewable energy production application, this SkelGrid system stands as the largest and most powerful installation up to date.

75 MW

United States
In operation since 2022

SkelGrid
Example Systems in the Field

With over 100+ megawatts (MW) of grid and industrial installations across the globe, Skeleton's cutting-edge energy storage technologies are enabling efficient and reliable energy supply while reducing carbon emissions.



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

Installations in operation globally since 2017



Globally operating wind energy company
Application: Energy buffer, 1MW for 5 seconds.
In operation since 2019.



European grid operator
Application: Grid peak power booster, 56 MW for 300 ms.
In operation since 2019.



European automation solution provider
Application: Passenger car simulation peak power, 2.7 to 10 MW.
In operation since 2018.



European power electronics and control systems provider
Application: Fast Frequency Response
In operation since 2020.

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Skeleton Technologies is a Global Cleantech 100 company and a technology leader in high power, fast charging for transportation, grid, automotive, and industrial applications.

For us, developing and producing the best energy storage solutions is a means to an end: helping companies to reduce CO2 emissions and save energy.

We work with some of the largest companies in the world - from European automotive companies, industrial equipment OEMs to truck fleet operators and aerospace prime contractors. Our products decrease CO2 emissions and fuel consumption, improve power quality, and empower wider electrification of the biggest industries globally to fight climate change.

Our supercapacitor and SuperBattery energy storage technologies, based on patented curved graphene, represent the biggest technological advancement in the industry in the last 20 years and the use of this innovative material provides our products with an unparalleled advantage in power and energy density.

www.skeletontech.com