BENNING
World Class Charging Systems

Excellent Technology, Efficiency and Quality

New energy for the future

LIONIC®

Lithium-ion energy systems
for the materials handling industry

LIONIC® reduces the total cost of ownership (TCO) of your industrial truck operations

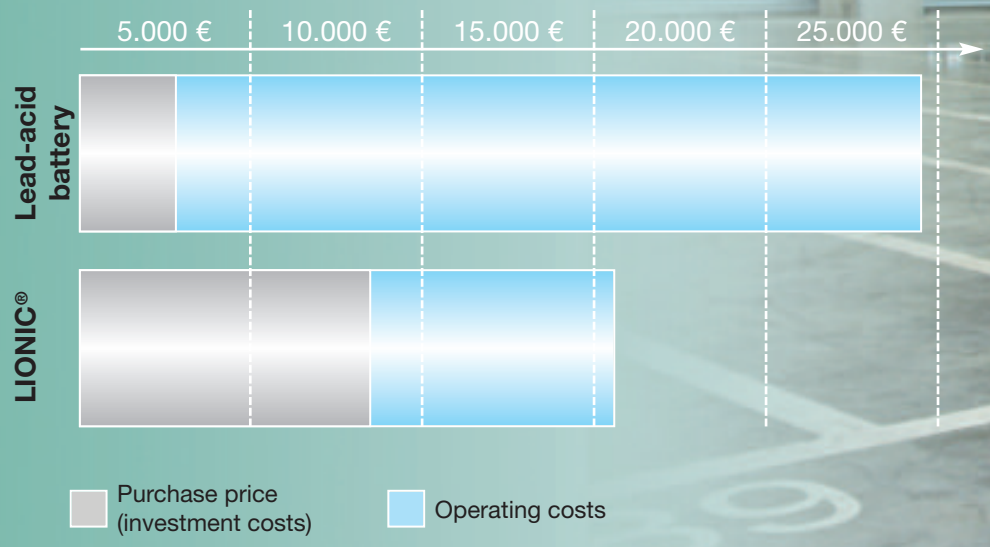


Fig. 1: Cost comparison 375 Ah lead-acid batteries vs. LIONIC® 240 Ah energy system based on 2-shift operation over a period of 5 years. (investment and operating costs)

LIONIC® – the highly efficient energy system for the materials handling industry

- Fast charging
- Opportunity charging
- Maintenance-free, no topping up with water
- Low operating costs
- Long life
  > 3000 cycles
- Reliable operation

Fig. 2: LIONIC® energy system 48 V / 18 kWh (360 Ah)

More energy and lower costs thanks to opportunity charging

Make better use of equipment, increase cost efficiency

- No need for a replacement battery
- Opportunity charging possible at any time (25 % charge in 20 min)
- 100 % charge in 2.0 h

LIONIC® energy systems are capable of fast charging and can also be opportunity charged. Charging is carried out at constant current.
In 2-shift operation, a replacement battery is not required if opportunity charging is carried out during breaks (1x15 min and 1x30 min per shift).
As an example, Fig. 3 shows the capacity curve of a LIONIC® 24 V / 9 kWh (360 Ah) energy system for 2-shift operation with intermediate charging.

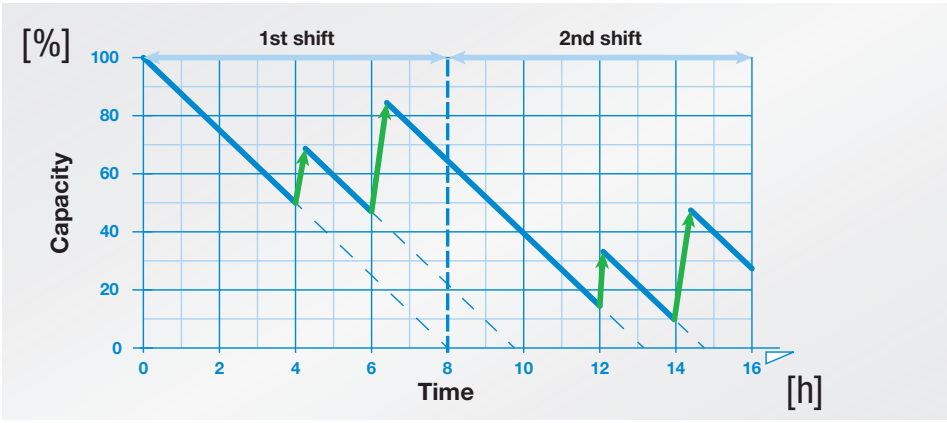


Fig. 3: Capacity curve of a LIONIC® 24 V / 9 kWh (360 Ah) energy system for 2-shift operation with opportunity charging

LIONIC® energy systems provide up to 30 % higher energy efficiency

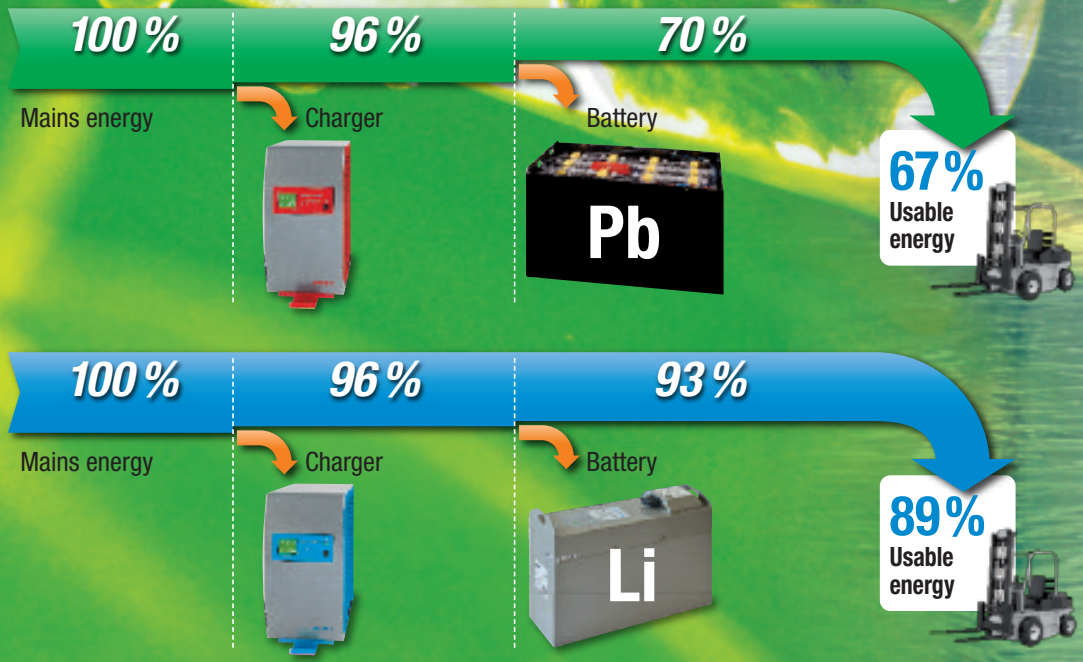


Fig. 4: Comparison of usable energy for lead-acid and lithium batteries

LIONIC® – Lower energy consumption, less CO_2

Economic and environmental advantages:

- Reduced energy costs
- High efficiency
- Emission-free
- Low self-discharge
- Energy recovery system e.g. during braking
- Stand-by mode
- Environmentally friendly
- Recyclable

Fig. 5: LIONIC® energy system 24 V / 6 kWh (240 Ah)

LIONIC® – Higher energy efficiency reduces your costs and protects the environment!

As Fig. 4 shows, the electrochemical conversion of the electrical energy in the lead-acid battery takes place with an efficiency of only 70 %.

The losses arise due to the charge factor, the large voltage swing between charge and discharge, and the temperature rise in the battery during the charging/discharging process.

Only 67 % of the full mains energy is available for the operation of electric vehicles powered by lead-acid batteries.

If LIONIC® energy systems are used instead of lead-acid batteries, the usable energy for the electric vehicle increases significantly to 89 %. This is because the efficiency of LIONIC® energy systems is approx. 93 % and therefore substantially higher than with lead-acid batteries.

This high efficiency is the result of a reduced charge factor, lower voltage swing and lower temperature rise when charging and discharging.

This gives rise to significantly better energy efficiency with LIONIC® energy systems.

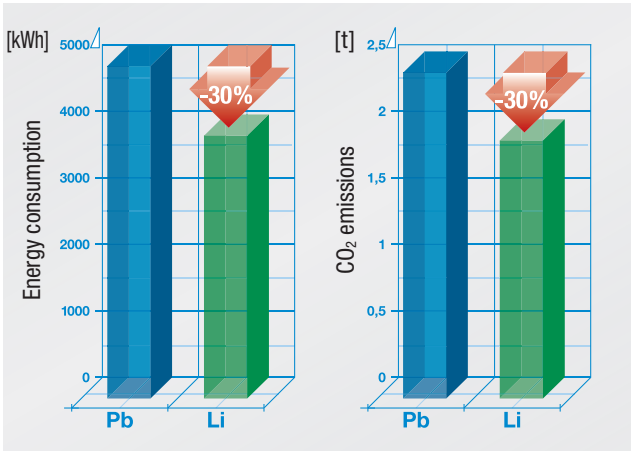


Fig. 6: Annual energy consumption and CO_2 emissions for charging traction batteries - lead-acid battery (Pb)/lithium-ion battery (Li)

Compared with lead-acid batteries, 30 % less electrical energy is required for every charging operation.
The costs for electrical energy and the figures for the relevant CO_2 emissions reduce equally as a result of using LIONIC® energy systems.

Lithium vs. lead-acid battery – saving in operating costs of a LIONIC® 24 V / 6 kWh (240 Ah) energy system

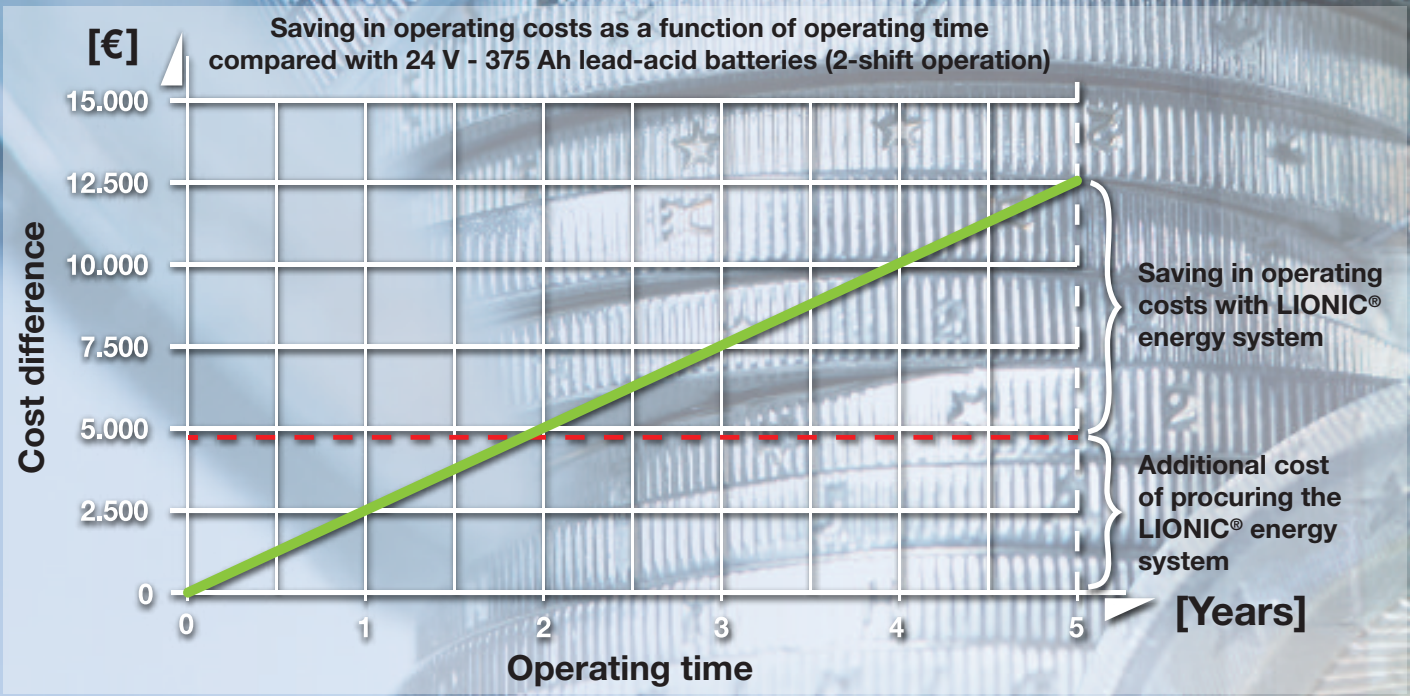


Fig. 7: The additional cost of investing in a LIONIC® energy system is compensated for by the savings in operating costs after just 2 years.

LIONIC® – The efficient energy system with the following cost advantages

- Approx. 30 % reduced energy costs
- Approx. 75 % lower maintenance costs
- Approx. 60 % lower battery handling costs

Fig. 8: LIONIC® energy system 24 V / 6 kWh (240 Ah), fitted in a conventional battery tray with counterweight

The diagrams (Fig. 7 and 9) show the large difference in maintenance and battery-handling costs for lead-acid and lithium-ion batteries. The cost comparison is based on 2-shift operation with two lead-acid batteries compared with one lithium-ion battery.

With lead-acid batteries, maintenance in the form of topping up the water is carried out once a week; with the LIONIC® energy system, inspection only has to be carried out once a year.

With lead-acid batteries, costs are incurred at every battery changeover due to the 2-shift operation (7 battery changes/week). With the LIONIC® energy system, short-term opportunity charging eliminates the costs for changing batteries.
(see also Fig. 3, Page 3)

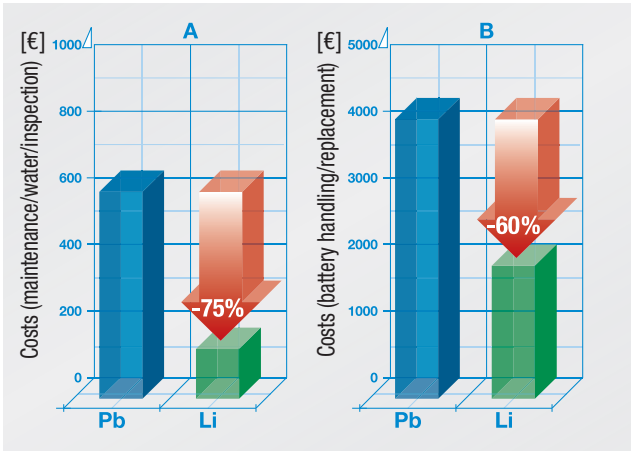


Fig. 9: Lead-acid battery (Pb) vs. LIONIC® energy system (Li), annual cost comparison for:
A) Maintenance and water or inspection (for 2-shift operation)
B) Battery handling/battery changeover or charging (for 2-shift operation)

LIONIC® – operationally reliable and emission-free ideal for the food trade and refrigerated warehouses

LIONIC® energy system – no need to invest in central battery rooms

Charging is carried out on site

- No central charging station
- No need for battery changing equipment
- No ventilation and extraction systems
- No central water filling
- Short distances to charging point

LIONIC® energy systems can be charged at decentralised charging points. As no gassing occurs during charging and LIONIC® energy systems do not contain liquid electrolyte, the special regulations for central battery charging stations (e.g. DIN 50272-3, BGHW, ZVEI datasheet) do not apply in many respects to the charging of LIONIC® energy systems.

Investment costs for setting up these charging points are significantly reduced, as no special ventilation or acid-resistant floor material is required.
In many cases, working time is increased due to the reduced distance travelled to reach the decentralised charging station.

Fig. 10: In the future the investment in central battery charging rooms with costly extraction and handling systems can be dispensed with

E/PzS lead-acid batteries vs. $LiFePO_4$ lithium-ion batteries

Lead-acid batteries	Characteristics	Lithium-ion batteries
40 Wh/kg	Energy density	95 – 140 Wh/kg
Up to 70 %	Charging efficiency [%]	Up to 95 %
1200 cycles	Charge/discharge cycles	> 3000 cycles
Gassing and water loss occurs when charging	Emissions	Emission-free (zero gassing)
Required	Maintenance	Not required
Charging: 50 % in approx. 3 h, 90 % in approx. 6 – 7 h	Fast charging capability	Charging: 90 % in approx. 1.5 - 2 h
Negative effect on service life	Opportunity charging	No negative effect on service life

Fig. 11: Comparison of main characteristics

Comparison of the main characteristics of lead-acid and lithium-ion batteries

From the point of view of the user of battery-powered industrial trucks, the current method of propulsion with lead-acid batteries has several significant disadvantages, in spite of good reliability overall. With today's knowledge, no satisfactory solutions to these problems are likely to be available in the future.

Significant improvements can be achieved here by the use of lithium-ion batteries, e.g. higher energy efficiency (lower operating costs), very short charging times (effective opportunity charging), freedom from maintenance, emission-free recharging, lower weight and volume and longer service life.
(See Fig. 11)

Lithium iron phosphate ($LiFePO_4$) traction batteries have been used in various parts of the materials handling industry for some time.

Previous experience has confirmed that lithium iron phosphate ($LiFePO_4$) batteries possess superior system-specific properties to lead accumulators.

These energy systems are very robust and are distinguished by an extremely long service life.

From current results, a service life of more than 3000 charge/discharge cycles can be expected. This is at least 2.5 times the average life of E/PzS batteries.

As a pioneer of these new energy systems, the BENNING LIONIC® range now offers energy systems with capacities of 120 Ah, 240 Ah, 360 Ah and 480 Ah to replace the E/PzS lead-acid batteries previously used in 24 V and 48 V industrial trucks.

Buy or lease:
choose the most cost-effective option for you

Fig. 12: The BENNING leasing model offers a comprehensive array of services to suit your Li energy package requirements

Flexibility and maximised availability at a fixed monthly price

Perfectly aligned with the specific operational processes of a company, leasing models for capital goods have now become a common feature of cost-efficient business management. They give the owner visibility to plan and allow it to benefit from the very latest products.

The BENNING leasing model for Li energy packages is aimed at both the trade sector and at businesses which operate ground conveyors. It offers the opportunity to experience the benefits of lithium ion technology in practical use without any risk.

A service plan from BENNING is provided for choosing individual leasing lengths for the LIONIC energy package, ranging from 12 to 60 months. It does away with high initial investment costs, as well as incalculable expenditure for servicing, maintenance or replacement. The leasing rates remain stable. This results in a marked reduction in operating costs, as well as continuous availability of the ground conveyor fleet.

After the end of the leasing period, the customer has the option to buy the Li energy package.

Cost-efficiency

- Respond flexibly to different order situations
- Planning reliability
- Calculable expenditure
- Capital is not tied up
- Quick availability thanks to direct links to the manufacturer

LIONIC® energy systems achieve 2.5 to 3 times more charge cycles

Fig. 13: External charge state and status indicator

Fig. 14: Charge state indicator for LIONIC® energy systems

Fig. 15: LIONIC® energy systems with different capacities

Fig. 16: Housing WT 60

LIONIC® energy systems

BENNING LIONIC® energy systems consist of 8 or 16 lithium iron phosphate ($LiFePO_4$) cells arranged in series and are available for capacity ranges of 120 Ah, 240 Ah, 360 Ah and 480 Ah. The LIONIC® energy systems cover a very large proportion of the needs for electrically operated ground conveyors.

LIONIC® energy systems are about 50 % lighter and about 30 % smaller than comparable lead-acid batteries.
Every energy system is fitted in a robust housing together with a Battery Management System (BMS) and can be integrated into standard battery trays.

The Battery Management System (BMS) ensures that voltage and temperature limits are maintained during the charging/discharging process. The individual cells are also monitored and are equalised in the event of potential deviations.

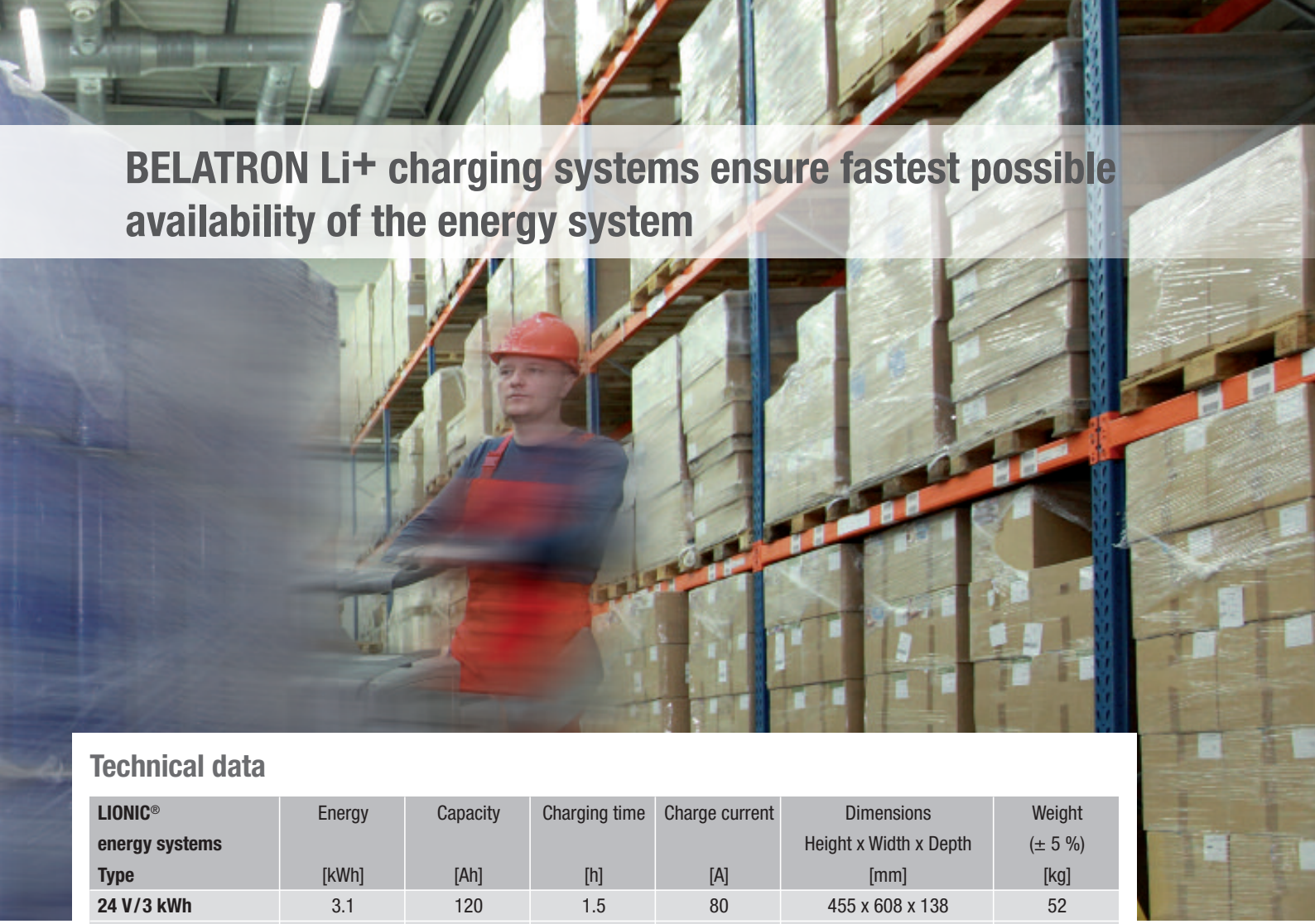
BELATRON Li+ charger

BELATRON Li+ units are highly efficient charging systems with an efficiency of up to 96 % and have been specially developed for charging LIONIC® energy systems.

The charging process follows an IU-characteristic and is monitored and controlled by the Battery Management System (BMS) incorporated in the LIONIC® energy system.

With high-efficiency chargers, the electrical energy consumed when charging LIONIC® energy systems is approx. 30 % less than when charging E/PzS lead-acid batteries.

30 % less electrical energy means 30 % lower energy costs and 30 % lower CO_2 emissions.



BELATRON Li+ charging systems ensure fastest possible availability of the energy system

Technical data

LIONIC® energy systems Type	Energy [kWh]	Capacity [Ah]	Charging time [h]	Charge current [A]	Dimensions Height x Width x Depth [mm]	Weight (± 5 %) [kg]
24 V/3 kWh	3.1	120	1.5	80	455 x 608 x 138	52
24 V/6 kWh	6.1	240	2	160	455 x 608 x 202	86
24 V/6 kWh long	6.1	240	2	160	455 x 772 x 160	86
24 V/9 kWh	9.2	360	2	250	455 x 608 x 296	125
24 V/9 kWh long	9.2	360	2	250	455 x 765 x 252	125
24 V/12 kWh	12.3	480	2	300	455 x 776 x 314	165
48 V/12 kWh	12	240	2	120	470 x 775 x 315	175
48 V/18 kWh	18	360	2	180	470 x 784 x 466	258
48 V/18 kWh long	18	360	2	180	470 x 1210 x 308	260
48 V/25 kWh	25	480	2	240	470 x 784 x 614	330
48 V/25 kWh long	25	480	2	240	470 x 1210 x 408	330

Protection class: IP54

BELATRON Li+ charger Type	Rated current [A]	Mains voltage [V]	Mains current [A]	Dimensions Height x Width x Depth [mm]	Weight [kg]	Housing
24 V/80 A	80	1 x 230	11.2	405 x 564 x 318	27	WT 30
24 V/100 A	100	1 x 230	14	405 x 564 x 318	27	WT 30
24 V/120 A	120	3 x 400	6.7	405 x 564 x 318	30	WT 30
24 V/180 A	180	3 x 400	9.8	405 x 564 x 318	38	WT 60
24 V/240 A	240	3 x 400	13.4	405 x 564 x 318	38	WT 60
48 V/120 A	120	3 x 400	10.1	405 x 564 x 318	30	WT 60
48 V/200 A	200	3 x 400	17.8	405 x 564 x 318	38	WT 60
48 V/240 A	240	3 x 400	21.1	905 x 564 x 392	70	WT 120
48 V/300 A	300	3 x 400	26.7	905 x 564 x 392	70	WT 120

LIONIC® energy systems – easily integrated into your industrial trucks

LIONIC® – No additional investments in vehicle technology

- Using the existing battery trays
- No need to modify the vehicle
- Requisite counterweights are integrated into the battery tray

Fig. 17: Integral metal plates are used as a counterweight for use in counterbalance trucks.

Fig. 18: Examples of LIONIC® energy systems in conventional battery trays

Easy opportunity charging using externally accessible plug-in charging connector

Fig. 19: An externally accessible plug-in charging connector enables fast opportunity charging without lifting the battery cover. (Option)

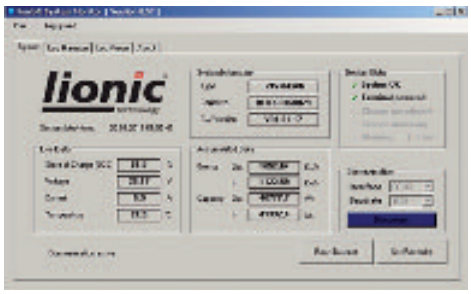


Fig. 20: System overview

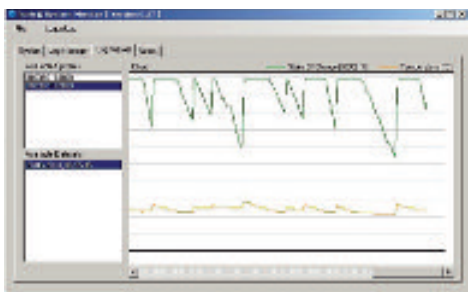
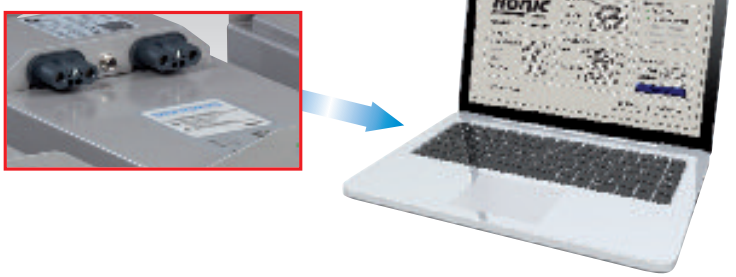


Fig. 21: Opportunity charging overview

LIONIC® Monitoring Software

- Data transmission to laptop using infrared interface
- Current measuring data
- Long-term measuring data



These days, it is essential for battery-powered industrial trucks to have a high availability and to operate reliably and efficiently. The control of the charging/discharging process for the traction batteries and the monitoring of battery temperatures are important measures for ensuring the maximum availability of the truck fleet at all times.

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