



The battery of the future

- Universally applicable
- Modularly scalable
- Robust
- Reliable
- Secure
- Connected
- Reasonably priced



The necessity for a scalable & replaceable modular battery

Electric transportation infrastructure which meets international traffic requirements.



The quest for different applications for “**modular multi use batteries**”
From innovative companies in the VDMA*.
*largest and most important industrial association in Europe



Forum Elektromobilität



The battery market today



- Each application needs time for development and testing
- Batteries are designed for primary use (first life)
- Batteries cannot be swapped to other applications
- Charger and battery need to fit to each other
- The weakest cell determines the capacity of the battery pack
- Opening and refurbishing of the battery is difficult
- Batteries with a capacities > 100 Wh are dangerous goods
- No competition between producer and supplier
- No communication to the application → lack of intelligence
- No data analysis of real scenarios
- The user finances the battery pack and bears the risk



Major problem: There is no standardized battery development

Johannes Dörndorfer history and know-how of the founder and CTO

1995 development and patenting of a power assisted wheelchair

With this development the previous knowledge for power-supporting systems, hub motors, engine management and battery systems were combined into a serial product.

2002 concept, hardware development and performance of a battery-field test with the Deutsche Post with the set goal: **to develop parameters for a standard battery => Outcome: knowledge of communication, plug-in connectors and safety standards** as a basis for future battery systems. Establishment of the EnergyBus and BATSO

2007 Development of a **modular battery system**, based on the currently developed EnergyBus protocol for bomb disposal robot from Cobham/Telerob. That knowledge brought the ability to combine several different battery chemicals, package sizes and charge conditions together with a full cell according to military technology policy for the first time.

2010 Development of **the first vehicle based on EnergyBus for mass production** with a customized modular battery- and charging system.



1995



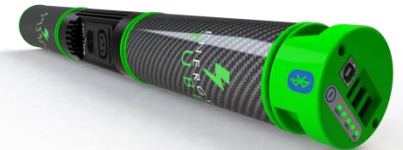
2002



2007



2010



2012

Johannes Dörndorfer battery safety and communication standards



ExtraEnergy is the leading organisation for technical regulation von LEVs (Light Electric Vehicles) for more than 20 years.

Occupation: founding member, technical expert and leader of the battery field test with the Deutsche Post and Initiator of EnergyBus und BATSO



EnergyBus is an open communication standard for all electrical DC components, with the goal to improve the compatibility and safety. Through the collected knowledge, connector series and respective communication protocols are developed.

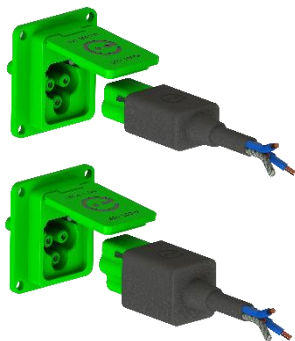
Occupation: founding member, initiator and leader in the development of the standard, and technical consultant for the progression



BATSO is an independent platform whose aims are battery safety and the development of associated test procedures and making them more transparent.

Occupation: founding member and technical consultant for the development of test procedures and test environments

EnergyLock and EnergyTube in the field of standardization



IEC 62196-4:

Plugs, socket-outlets, vehicle connectors and vehicle inlets – conductive charging of electric vehicles

Part 4: Dimensional compatibility and interchangeability requirements for AC, DC and AC/DC vehicle couplers for Class II or Class III light electric vehicles (LEV)



IEC 61851-3-3:

Electric vehicle conductive power supply system

Part 3-3: General requirements for light electric vehicles battery swap system

	2015												2016											
IEC	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
62196-4	CD						DTS			TS														
61851-3-3	WD						CD						DTS			TS								

WD: Working Draft
CD: Committee Draft

DTS: Draft Technical Specification
TS: Technical Specification

EnergyTube

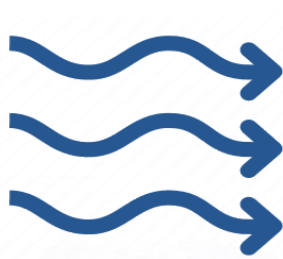


100 Wh capacity
no dangerous good
Equivalent to a notebook battery

70 mm diameter
180 mm length
ca. 800 g weight, dependent on cell type

Output voltage to the application is configured by the adapter.

EnergyTube Advantages of the cylindrical modular structure



Distance prevents **overheating and flammability**

Large surface for **thermal dissipation**

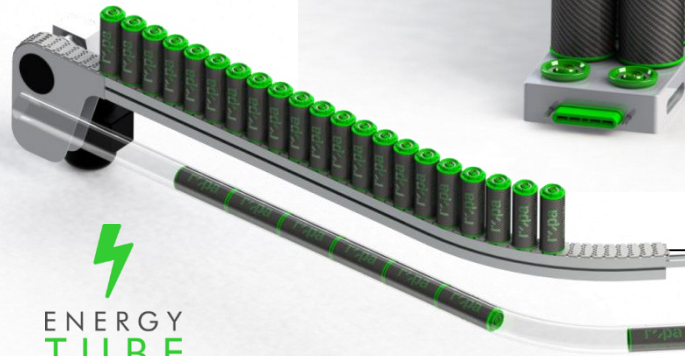
Space for active and passive **air conditioning**

Crash behaviour:

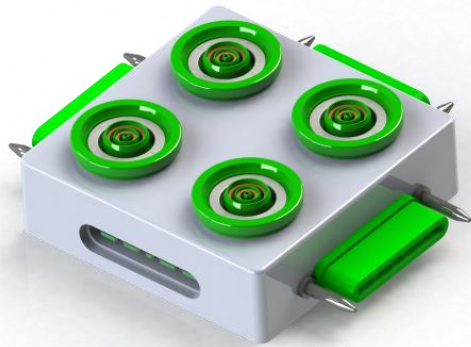
- Crumbles into single parts
- Individual modules are mechanically stable

Transport systems and handling systems

- Pneumatic delivery and conveyer
- Systems of the beverage industry



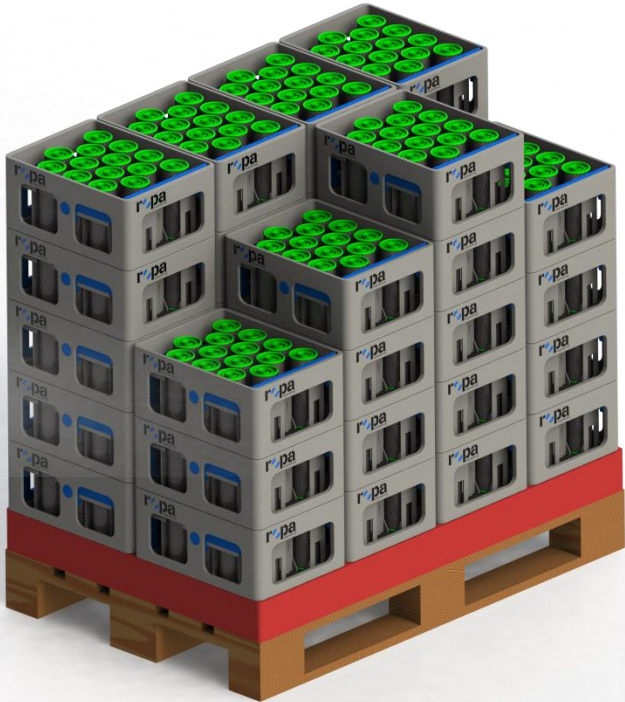
EnergyTube organic scaling in 3 dimensions



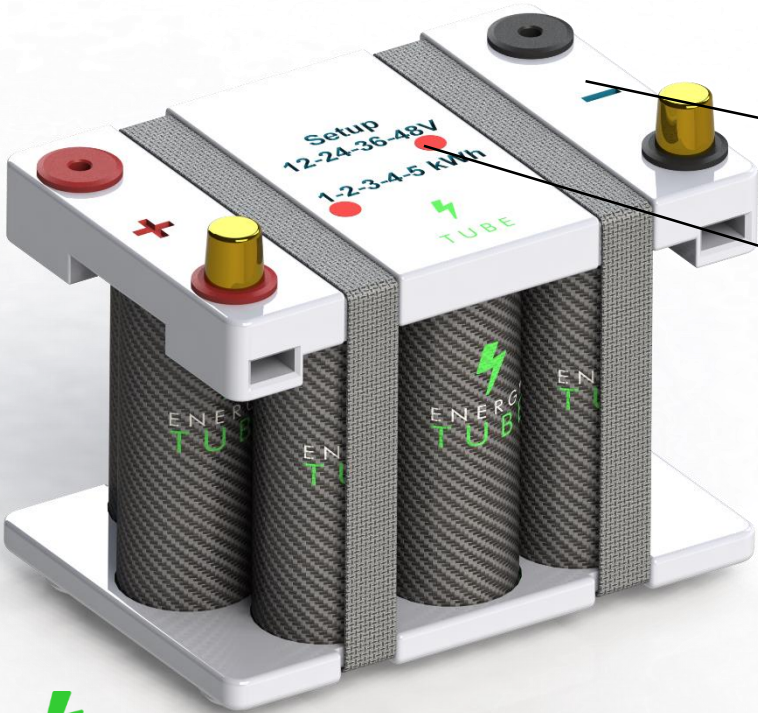
EnergyTube Transport and handling systems



EnergyTube Transport and handling systems



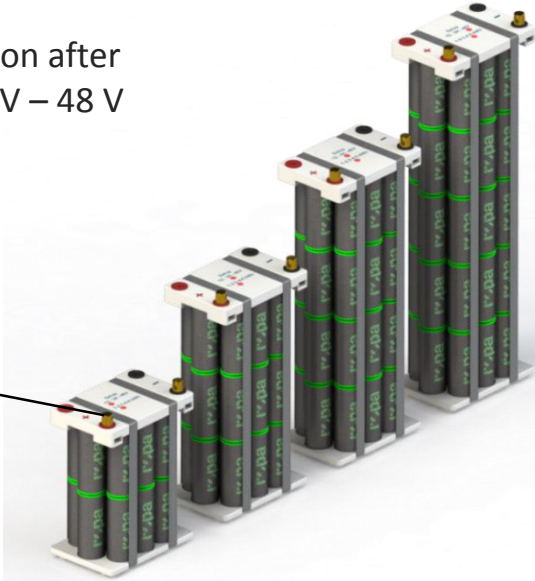
EnergyTube different packaging for compatibility with lead-acid batteries



Electrical reaction of lead-acid-batteries is simulated

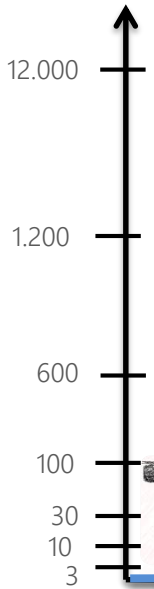
Free voltage selection after software setup: 12 V – 48 V

Construction height determines capacity 1-10 kWh



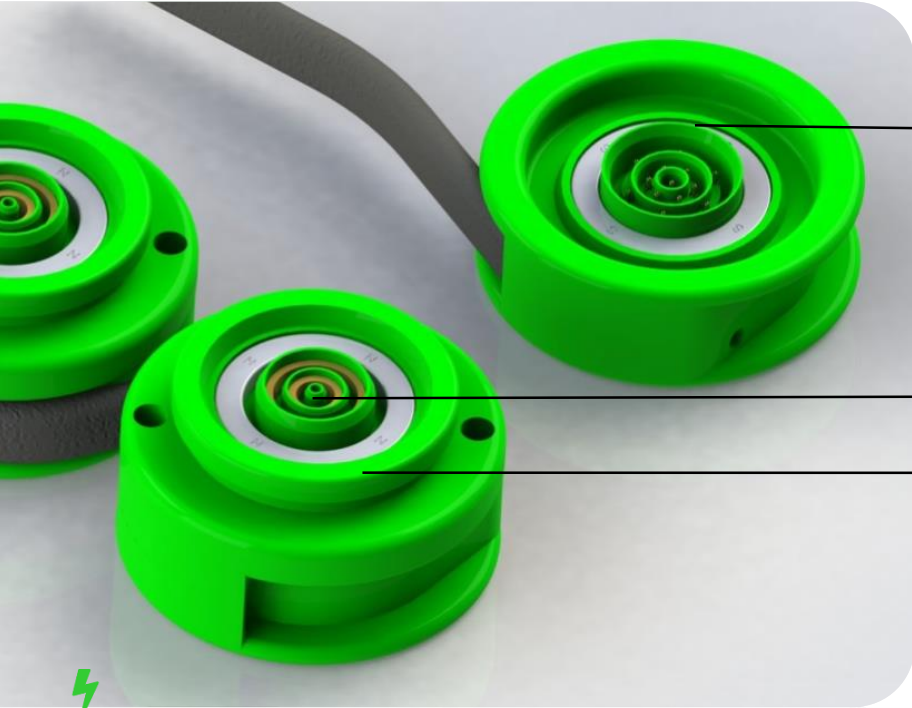
EnergyTube applications

Quantity



100Wh 400Wh 1kWh 1,6kWh 4,2 kWh 24kWh 50kWh 1,2MWh

EnergyTube The connector



Data interface for application and to the **EnergyTube Cloud Service:**

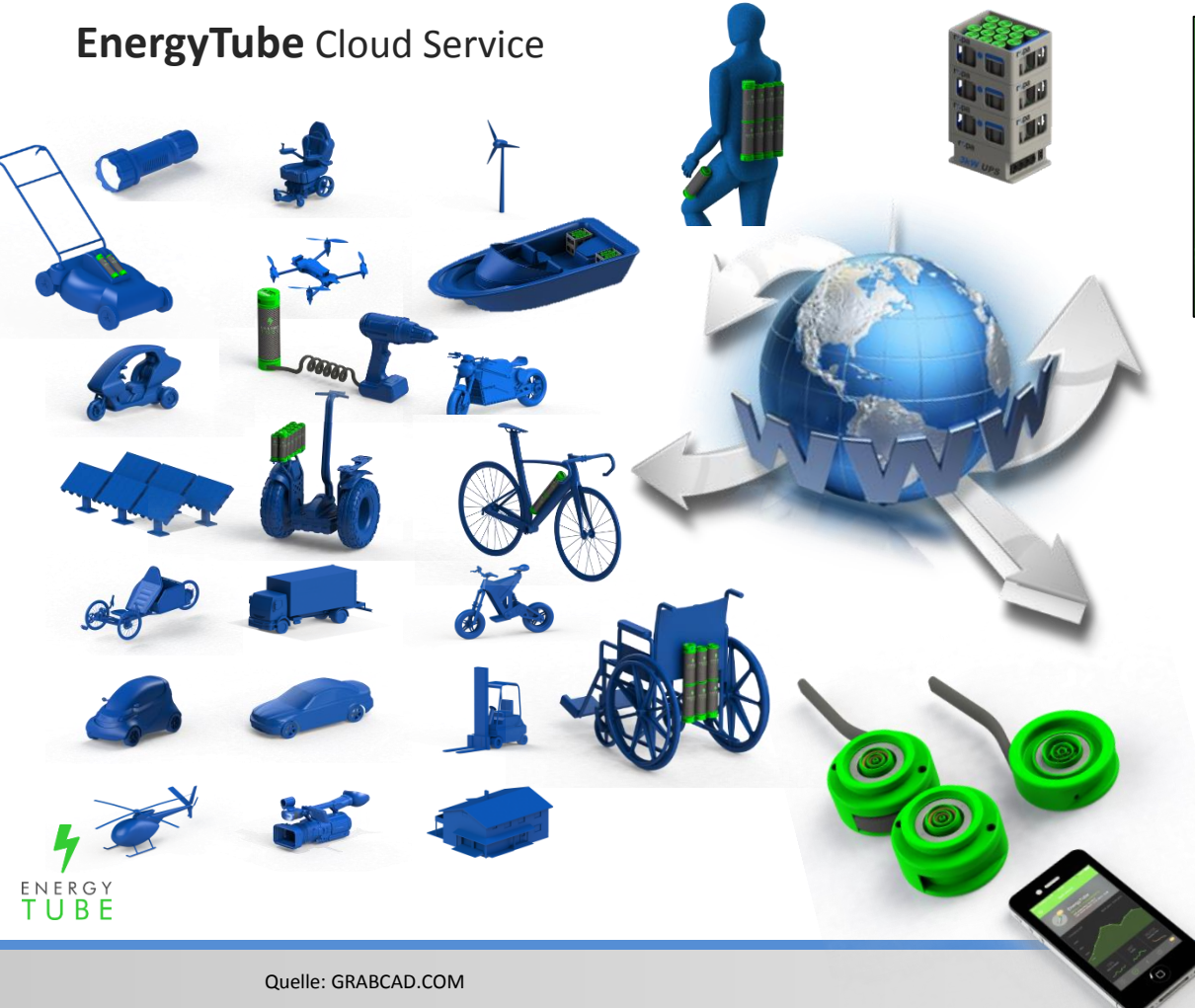
- EnergyBus
- Smart Grid
- Industry 4.0
- IoT (Internet of Things)



3 contact points (+48V | GND | AUX)

- **NFC** (Near Field Communication) for data transfer
- **Unique ID**
- **Electronics, sensors, and software**

EnergyTube Cloud Service



- Documentation of relevant SOH parameter (State Of Health)
- Determination of the statistical residual value
- Warrantee control
- Statistics about utilization
- Quality assurance
- Basis for further development
- Basis for rental systems

EnergyTube Pedelects



EnergyTube Cargo-Pedelecs



EnergyTube eScooter



EnergyTube industrial usage



EJE 112i



12 tubes
12 x 0,1 kWh → 1,2 kWh



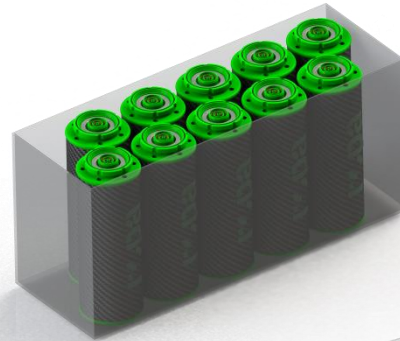
1,0 kWh

EnergyTube industrial usage

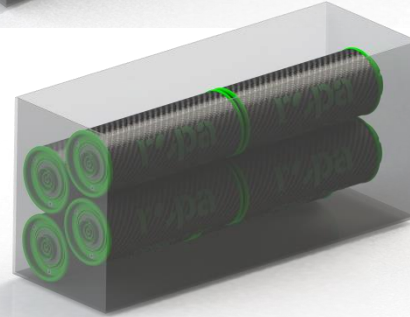
Hako
Clean ahead



**ENERGY
TUBE**



10 tubes
10 x 0,1 kWh → 1,0 kWh
10 kg



8 tubes
8x 0,1 kWh → 0,8 kWh
8 kg

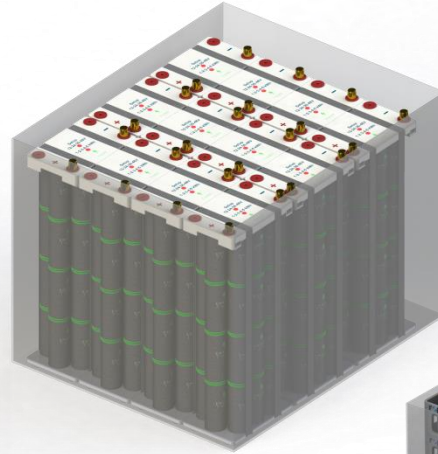


24 V, 25 Ah
0,6 kWh
22 kg

EnergyTube industrial usage



EFG 540k/540/545k/545/550/S40/S50
Battery dimensions: L/W/H 1028x855x784 mm



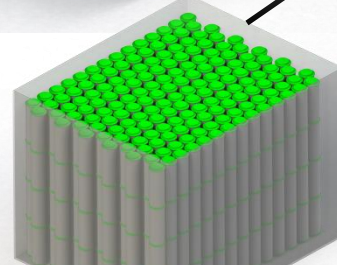
480 pieces
48 kWh
480 kg



24 boxes
33,6 kWh
336 kg



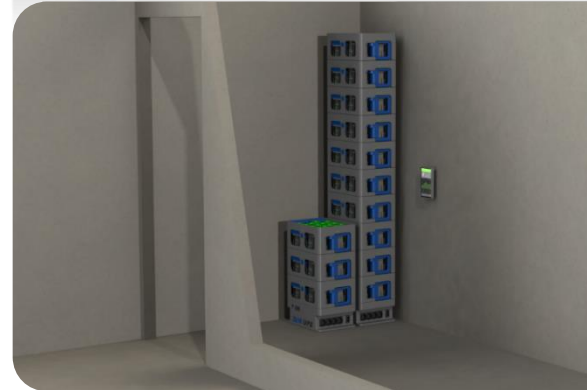
62 kWh
1.9 t



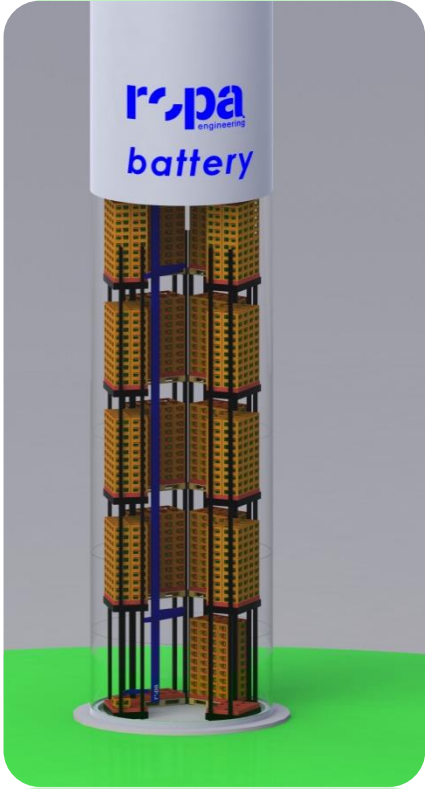
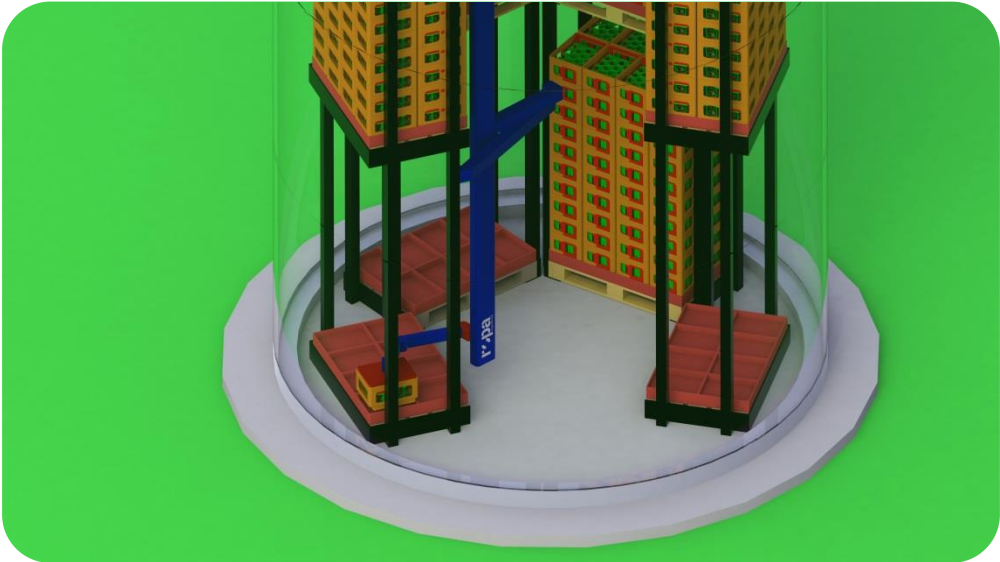
672 tubes
67,2 kWh
670 kg



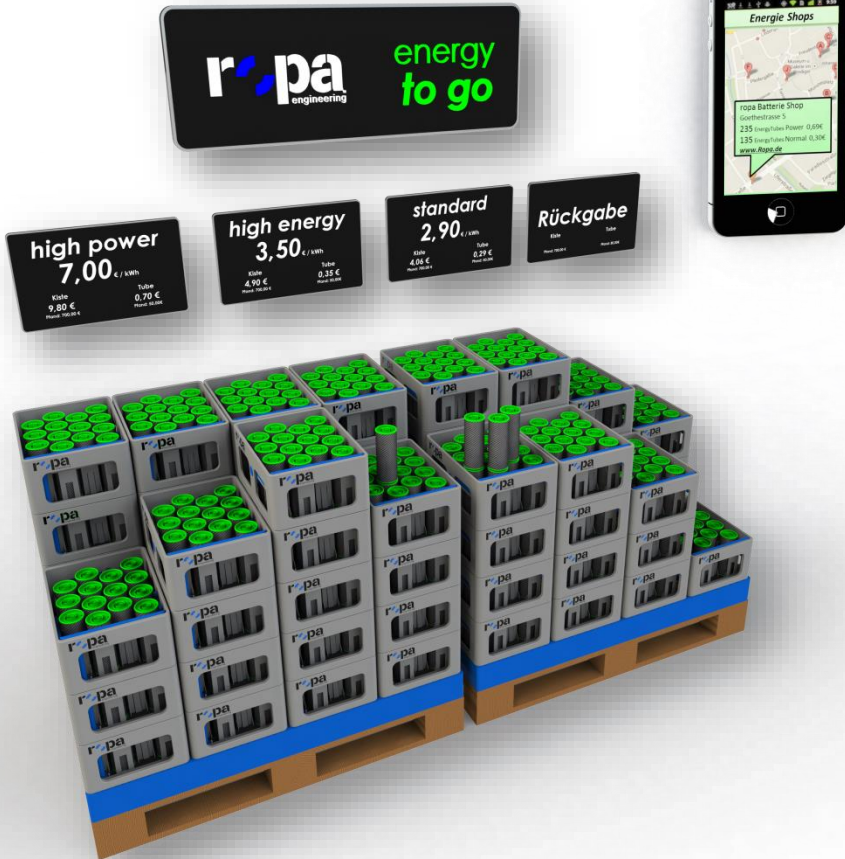
EnergyTube Charging, storage, swapping, energy supply



EnergyTube wind power / storage for hybrid systems



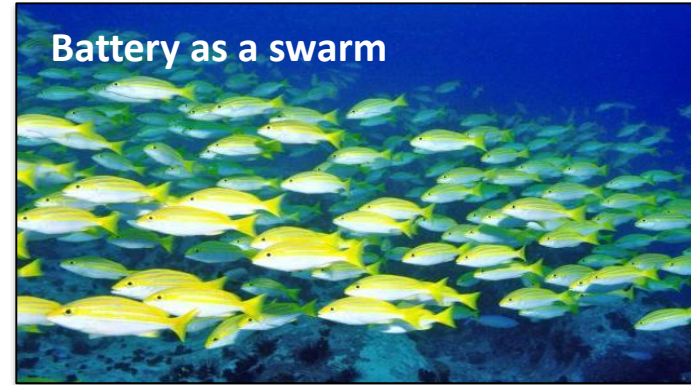
EnergyTube changing



EnergyTube current battery technology compared to swarm technology



- Exact dimensioning
- Low number of components
- Simple communication



- Fast integration into new applications
- Quantity determines size and power
- Lower risk in case of failure of individual modules
- Superior crash and fire protection
- Natural thermal reaction
- Intelligent and social power capabilities
- Allows the combination of old, young, high or low power, etc.

EnergyTube construction details

Fully equipped with **18650 cells**, which is the most common cell standard with its typical advantages (equal to **TESLA**):

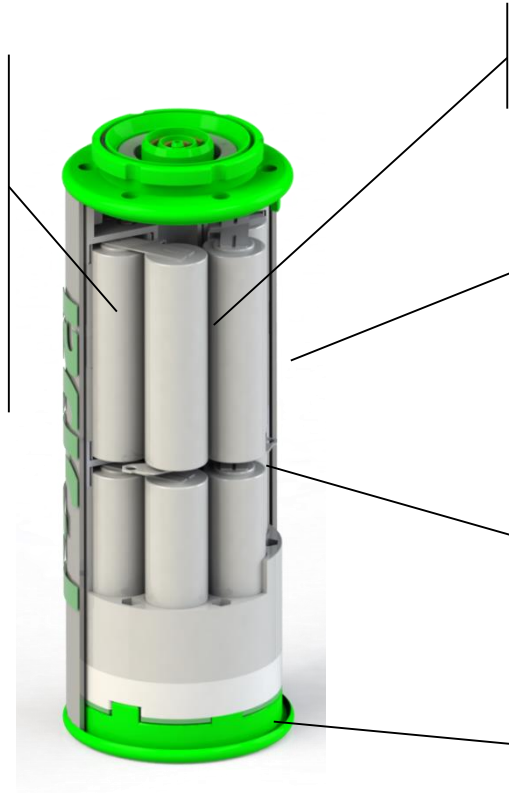
- Different types of chemicals
- Different manufacturers
- Various qualities
- Different usage optimizations
- Best price-performance ratio

Why 18650?

Used in power tools and notebooks



It's secure!



Cell distance > 1 mm

In case of burning this distance will ensure that other cells won't burn.

Casing

The casing is mechanically stable. In case of destruction of an EnergyTube pack, it will crumble into sole EnergyTubes.

Simple cylindrical setup

Enables EnergyTube to be produced fully-automatic in mass production. Repairing or refurbishing is easy.

Material

By using thermoconductive fiber-reinforced plastics the heat is delivered over the big outer surface.

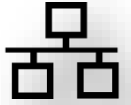
EnergyTube multifunctional possibility for contact and communication


ENERGY
TUBE

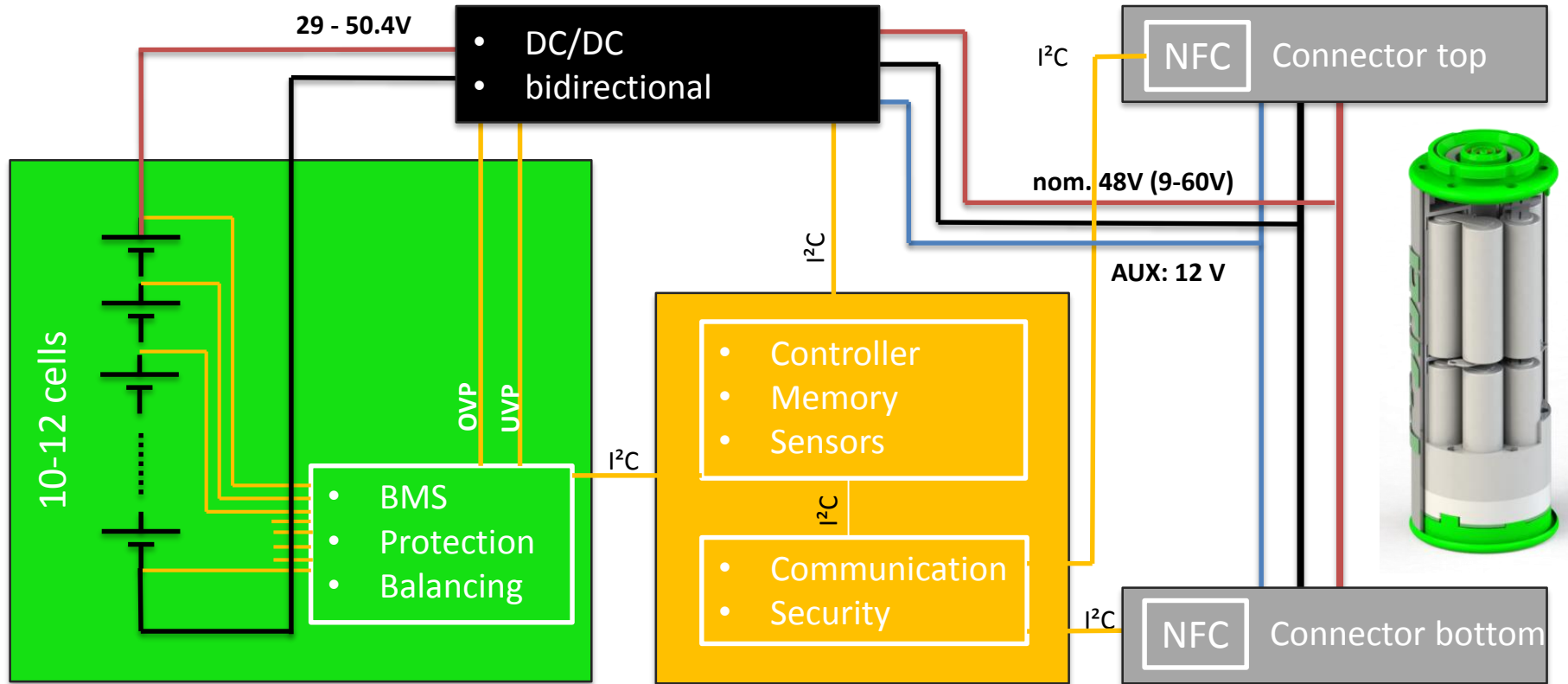



EnergyBus

12V
DC
SAE J563



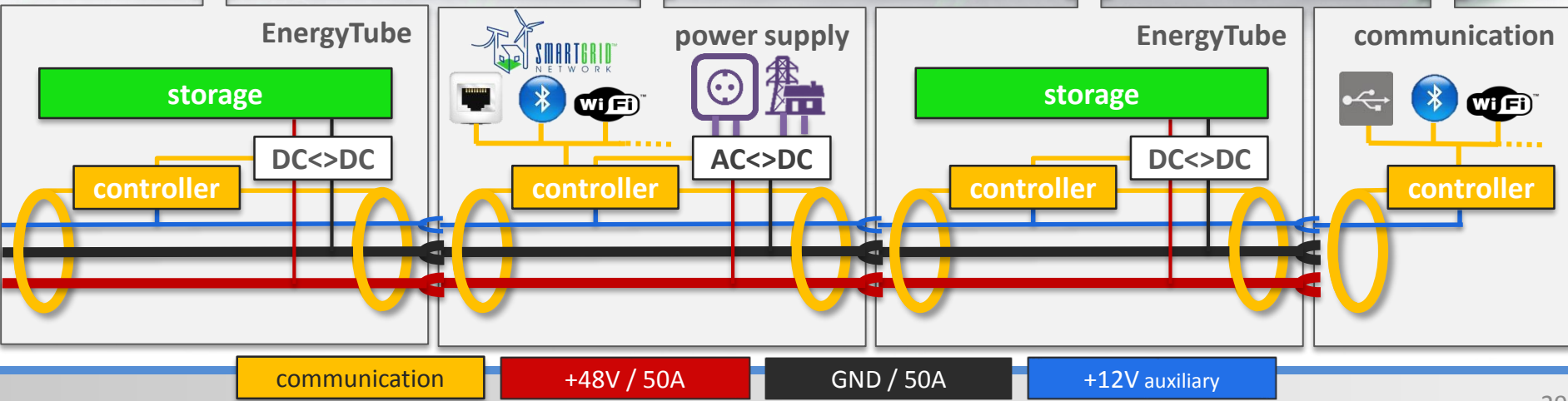
EnergyTube Electrical structure



EnergyMesh energy grid as the basis for swarm intelligence

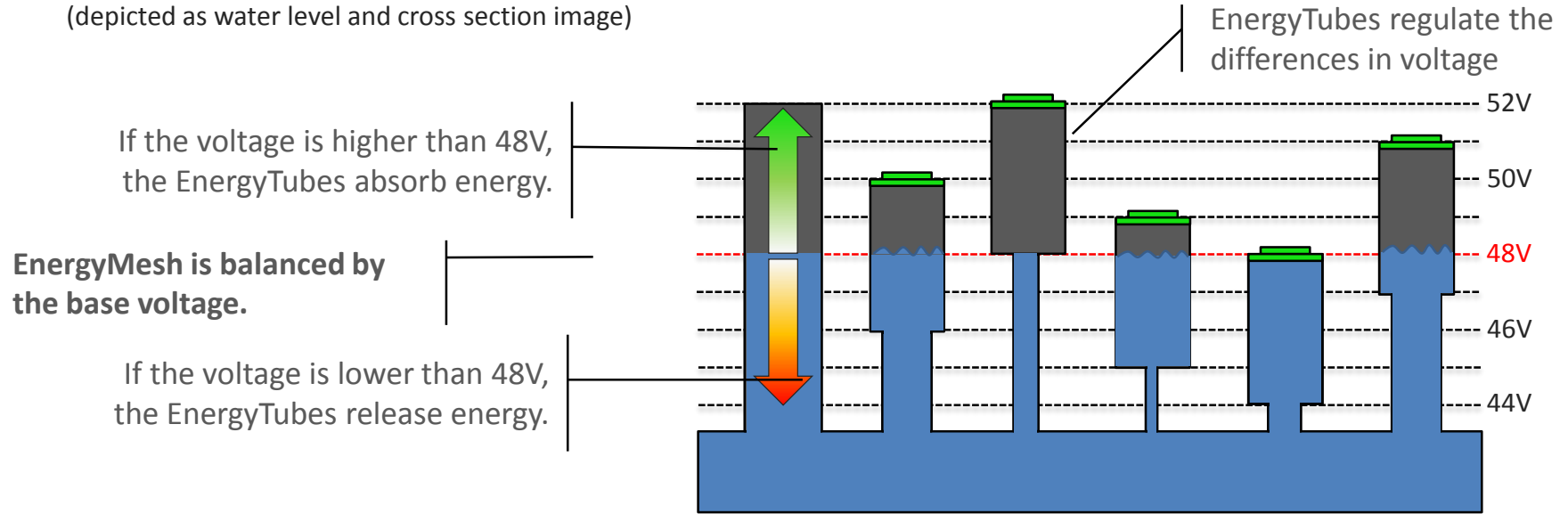
bi-directional power supply with communication interface to the **EnergyTube Cloud Service**

communication gateway and USB charging adapter with variable interfaces



EnergyMesh charging management system

(depicted as water level and cross section image)



Via the bi-directional voltage converter (DC <> DC), the network participants regulate into the grid.

The adjustment of the voltage regulates the absorption or release of energy.

An adjustable internal resistance in the EnergyTube regulates the flow of power.

The regulation of the voltage and the resistance controls the current flow.

EnergyTube distinctive features

flexible

scalable without limits starting from 100Wh
selection of the dimensions by the user → plug and play



secure

compensation in case of an error through distribution into multiple small cells, no dangerous good < 100 Wh! No high-voltage 48 V!

reliable

individual tubes can be turned on and off and repaired, combination of old and new batteries and different chemicals can be used



optimum price

automated mass production
price structure: 80 % battery cells / 20 % packing and intelligence

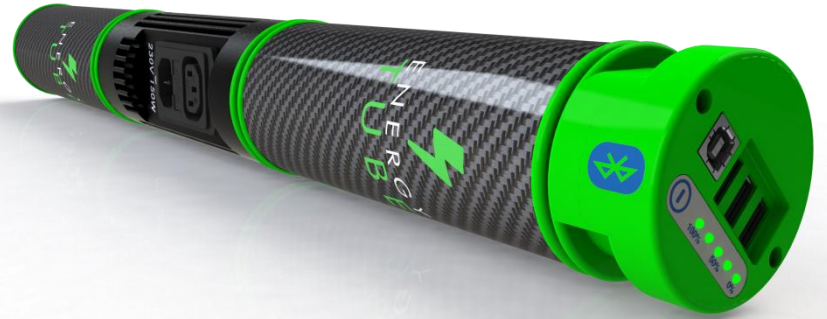
standardized

one standard for many applications,
suitable for a big part of the battery market

connected

The EnergyTube CloudService allows:
Swapping and rental systems, remote diagnostics,
measurable database, energy management, user
management





We are looking for development partners and personnel.

Prototype phase: since October 2014

First demonstrative applications in operation: end of 2015

www.energytube.de



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