





Guidelines for designing the right battery system for any applications



Agenda

✓ Who is easyLi?

- ✓ What is a Lithium-ion Battery System?
- ✓ Practical Guidelines for Designing a Battery System
- ✓ Cycle Life Management
- ✓ Your Questions

Design and manufacturing of battery systems for e-mobility and home energy storage European leader of custom « battery swapping » solutions

A full-service offer covering the entire battery cycle life from initial design to reconditioning and second life

What is a Lithium-ion Battery System?

© All rights reserved - easyLi – April 2022

Three battery cell form factors

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Typical Lithium-ion battery system architecture

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Two main technologies available on the market NMCA and LFP

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

	Lead Acid	Nickel-Cadmium	Nickel-Metal Hydride	Lithium-ion
Cell Voltage	2,0 V	1,2 V	1,2 V	3,6 to 3,7 V 3.2 V (LFP)
Specific Energy	25-50 Wh/kg	30-60 Wh/kg	50-90 Wh/kg	100-230 Wh/kg
Cycling	200-500	1000-1500	1000	500-3000
Temperature Range	0°C to 50°C	-30°C to 50°C	-20°C to 50°C	-20°C to 50°C
Self discharge	~5% / month	~15% / month	~25% / month	~2% / month
Calendar Life Span	5 years	10 years	5-10 years	5-15 years
Price / kWh (base 100 Pb)	100	300	400	250 to 500
Standard charge Time	10 hrs	5 hrs	3-5 hrs	3 hrs
				Source : easvL

Two main ageing factors: Depth of Discharge (DoD) and temperature

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

DOD / 2 = Nb of cycles x 4

Impact of cell balancing on battery performance and lifespan

1. Who is easyLi?

- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Cell unbalancing \rightarrow Loss of usable capacity

- + « weaker » cells constantly sollicited \rightarrow unbalancing increase
- + accelerated ageing

Above simple battery packs made of a limited number of cells, efficient balancing is mandatory to deliver expected performance and lifespan

Thermal runaway vs. battery technology

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Higher sensitivity to abuse conditions of NMC vs. LFP

Battery performance and durability: Combination of two key parameters

- 1. Who is easyLi?
- 2. What is a Lithiumion battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

 Electrode redox reactions on charge: Cathode oxidation : LiCoO₂ → Li_{1-x}CoO₂ + xLi⁺ + xe⁻ Anode reduction : xLi⁺ + xe⁻ + C₆ → LiC₆
discharge is the opposite

High quality electrochemistry

High performance ECU (BMS)

Practical Guidelines for Designing a Battery System

Battery System Dimensioning Guidelines

LFP: 7 – 12 l/kWh

NMCA : 5 – 9 l/kWh

1. Who is easyLi?

- 2. What is a Lithium-ion Battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

What is the available space?

Take care of the battery form factor: Design and industrialization rules, type of selected battery cell, thermal management... are limiting factors to designers' creativity

KG

LFP : 9 – 12 kg/kWh NMCA : 6 – 9 kg/kWh

Challenge the acceptable vs. ideal runtime: « Perfect is the enemy of good » Avoid over-specifying, functional mocks-up can be desirable

Think battery downsizing: higher voltage, opportunity charging, shorter charge duration

Fast chargers are expensive, inductive charging even more

Other possible options: removable batteries, modular architecture

Define your market pricing strategy and share the information with your battery supplier: You will save a lot of time and shorten your time-to-market

Regulatory requirements: Don't over-specify, but fully comply to essentials

- ✓ CE marking
 - **Declarative but your liability is engaged**: the product is built in reference to a quality system, is compliant with regulations and non hazardous
 - EU directives: 2006/66/CE 2014/30/CE
 - Some common standards applicable to batteries:
 - Battery standard: IEC 62133
 - Specifics related to your equipment (not exhaustive): IEC 15194 (ebike) / IEC 62040 (stationary) / IEC 61000 (EMC) etc.
- ✓ Lithium-ion battery transportation: UN3480 (hazardous goods)
 - Battery systems and battery cells must comply with UN38.3 + specific packaging
 - Exceptions:
 - Small quantities (<100 units)
 - Battery packs < 100 Wh compliant to UN38.3 and packed in accordance with UN3480 are not considered as hazardous goods
- $\checkmark\,$ Accreditation of category M and N vehicles
 - Electric safety: R100 rev2 regulations

- Who is easyLi? What is a Lithium-ion
- 2. What is a Lithium-i Battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Cycle Life Management

- 1. Who is easyLi?
- 2. What is a Lithium-ion Battery system?
- 3. Battery system practical designing guidelines
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

Sustainable batteries for a circular and climate neutral economy

- ✓ Since 2006, battery end-of-life management has been regulated by 2006/66/EC battery directive
- This directive is under complete review with first applications expected as soon as 2022. Topics under discussion include:
 - **Carbon footprint declaration** and mandatory minimum thresholds
 - Electronic passport to ensure traceability all along the battery life
 - **Performance and lifespan** minimum thresholds
 - **Ecodesign approach** to ensure that batteries are easily repairable, removable, reusable and repurposed for second life
 - Higher collection and recycling thresholds

To know more: <u>https://rechargebatteries.org/eu-batteries-legislation/batteries-</u> regulation/

Your questions?

© All rights reserved - easyLi – April 2022

To pursue the discussion, don't hesitate to visit us at our booth A21

- 1. Who is easyLi?
- 2. What is a Lithium-ion Battery system?
- 3. Practical guidelines for designing a battery system
- 4. Battery cycle life management
- 5. Your questions
- 6. Contact us

+33 5 86 16 10 00 / +39 02 87187406

contact@easylibatteries.com

easyLi France 1, avenue des temps modernes F - 86360 Chasseneuil-du-Poitou

easyLi Italia Via Leone XIII, 14 20145 Milano (MI)