RSE
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Battery second life application: how to enable it?

International Workshop on Supercapacitors and Energy Storage

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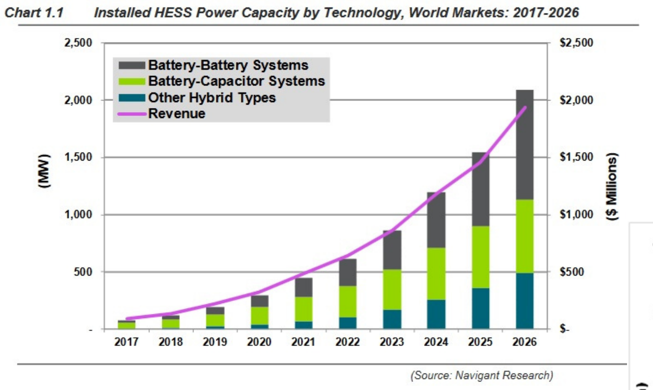
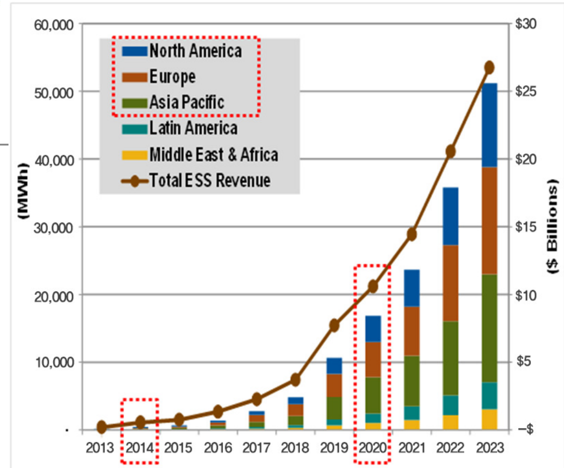
Energy Storage System market

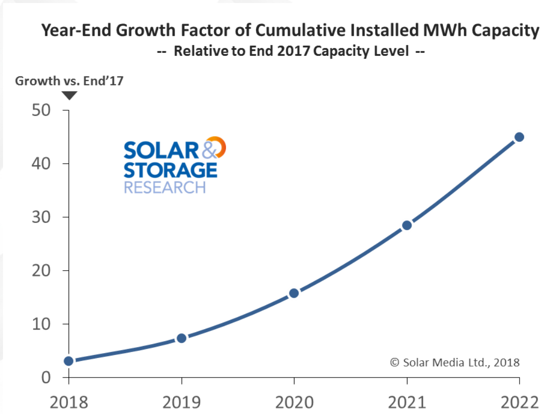
How will the ESS market change in the future?

Many scenarios have been considered with quite different results

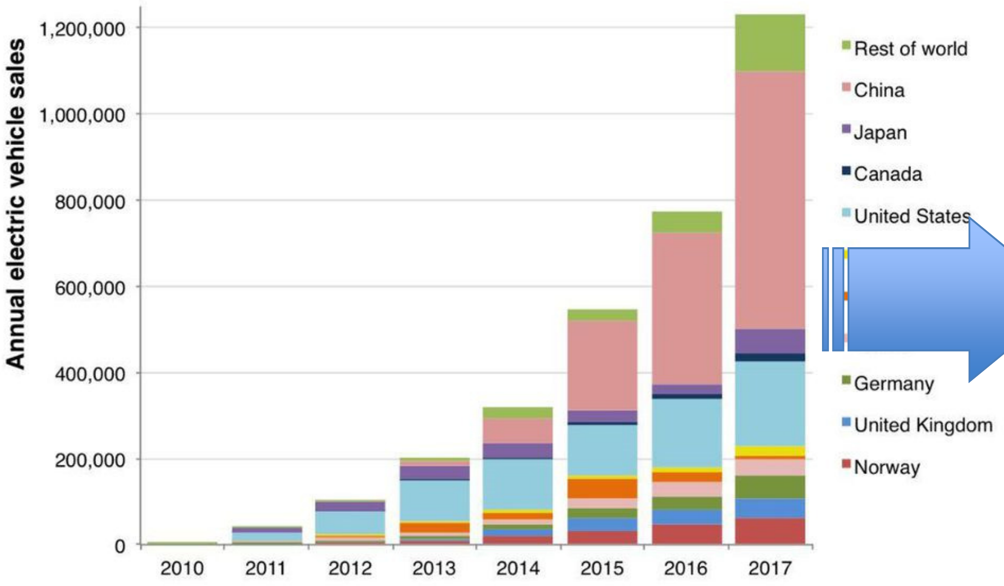
A common agreement is that the ESS market for stationary applications will be growing.

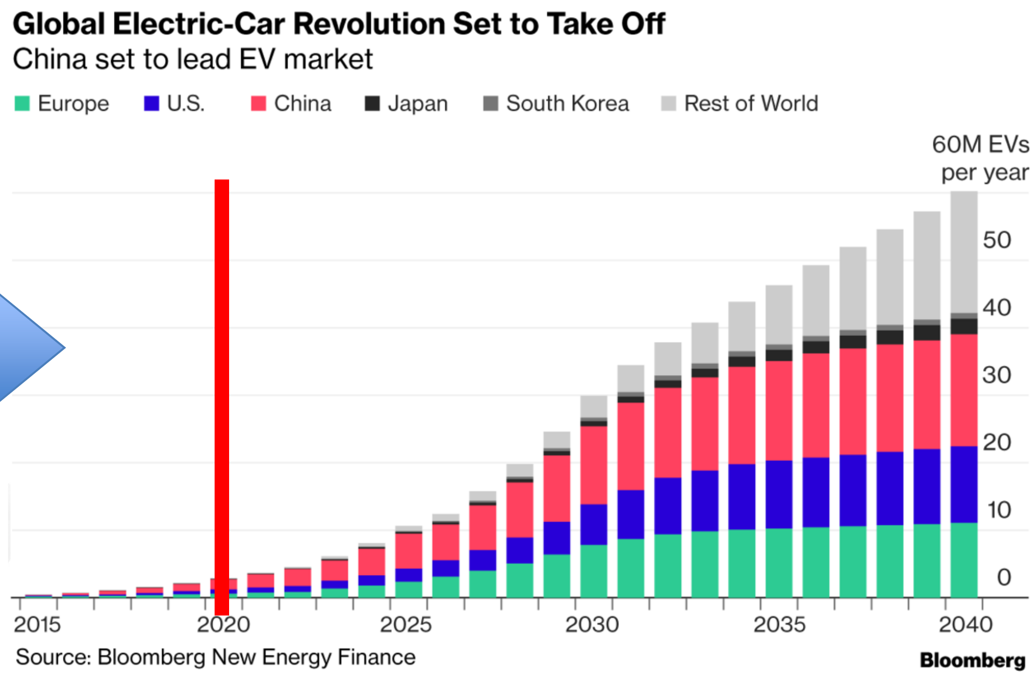






EV market

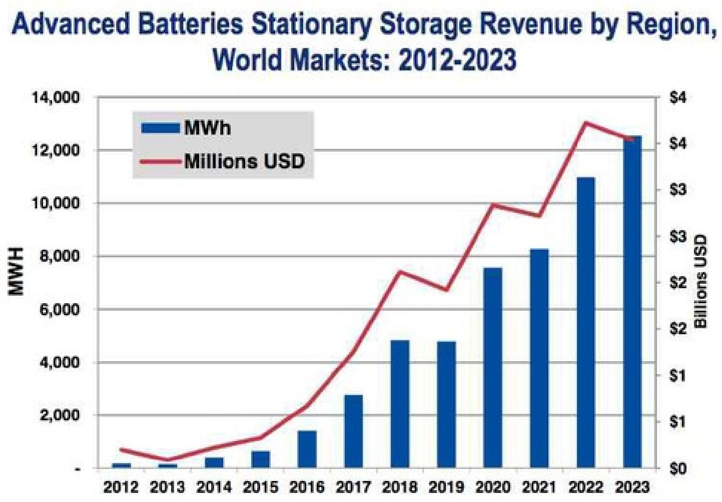


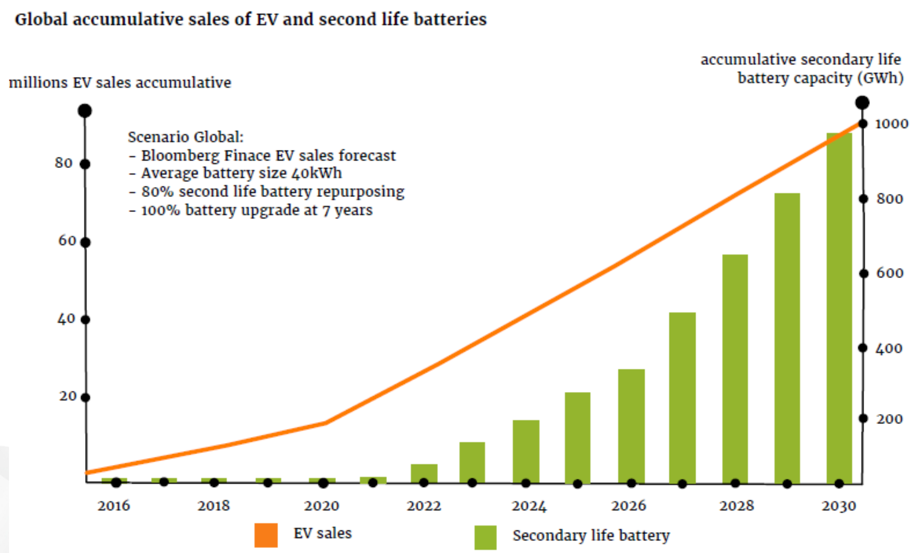


In the last years the EV market is growing all around the world and also the forecast shows a growing.

In 2020 2M of EV (with about 40kWh of battery each one) → **more than 80 GWh of potential 2nd life batteries in future**

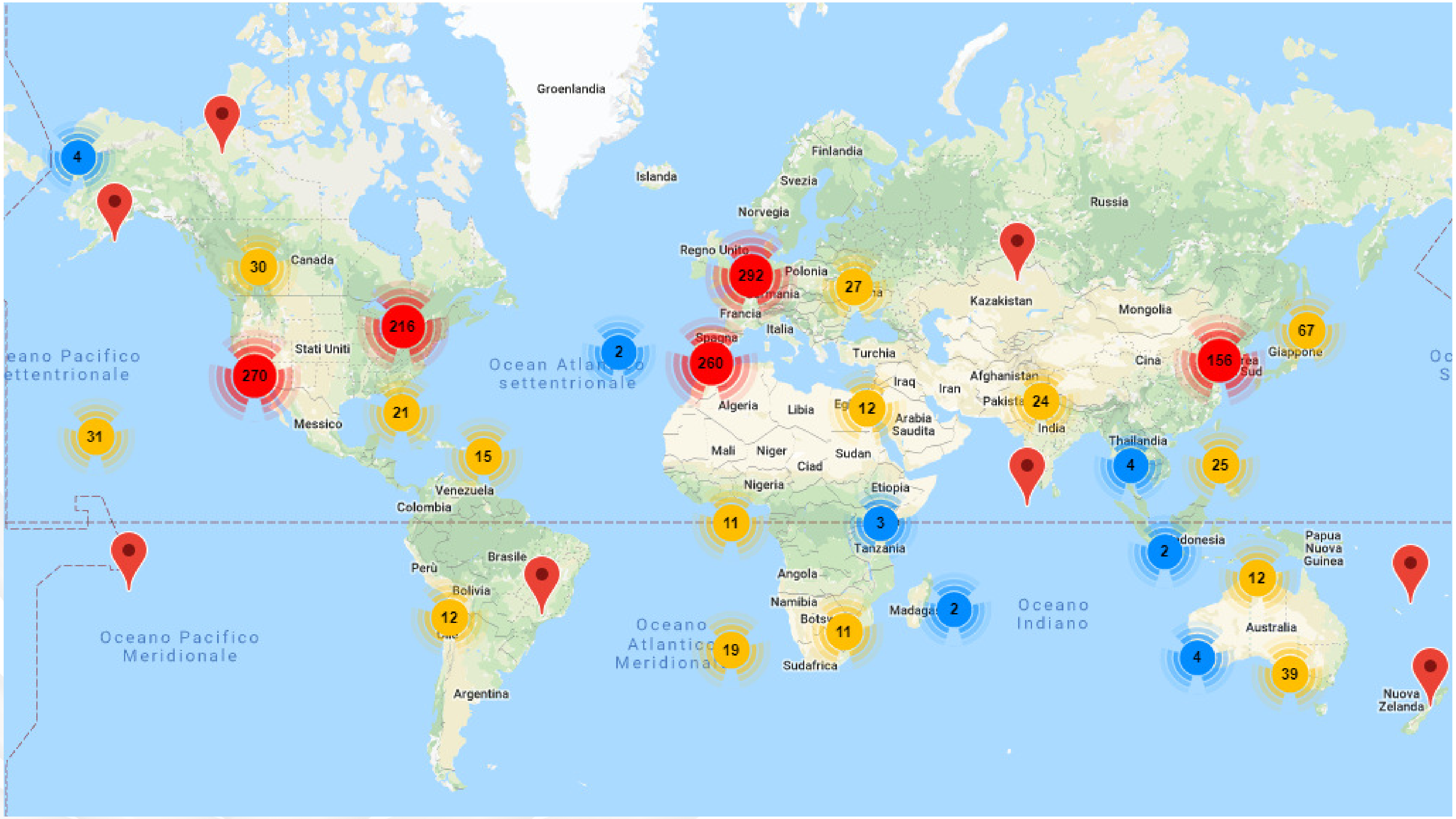
Stationary ESS market





"Second Life-Batteries As Flexible Storage For Renewables Energies"

In 2023 many GWh of stationary ESS will be connected to the grid.
This value will increase over the time and the EV market will support this market.

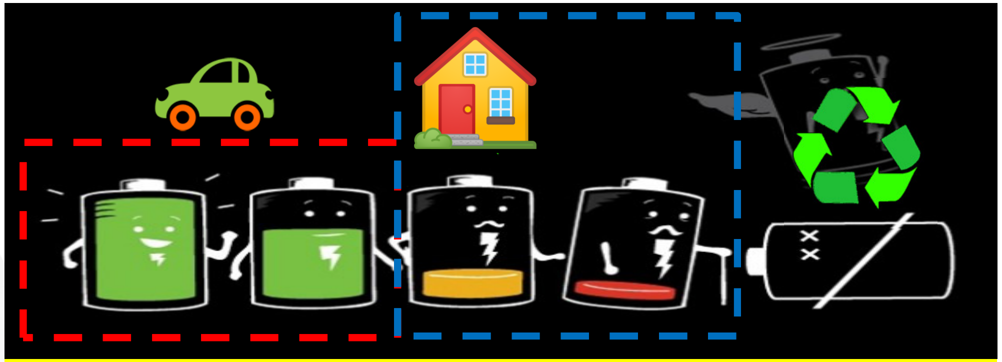


https://www.energystorageexchange.org/projects

EV and stationary ESS requirements

Requirements	EV	2nd life	Stationary ESS
Energy density [kWh/l]	High	**Increasing Volume**	Low
Power density [kW/l]	High	**Setting new (nominal) energy and power**	Low
End of life [%]	-20% Energy +100% Resistance		-20% Energy +100% Resistance
Cost [€/kWh]	< 300 €/kWh	**Decrease the cost**	~~< 1000 – 500 €/kWh~~ < 300 €/kWh

Challenges



"As batteries from the first electric cars reach their useful life automotive companies will be confronted with the decision to recycle or find them another use. One alternative to <u>recycling</u> those batteries is to recondition them and <u>reuse</u> them in less strenuous applications such as stationary applications. Where batteries are generally charged and discharged at small rates and operate in a controlled environment and secured working space."

<u>*Recycling*</u>

- How?

<u>*Reuse*</u>

- Diagnostic on aged ESS
- Battery Inhomogeneity

Recycling

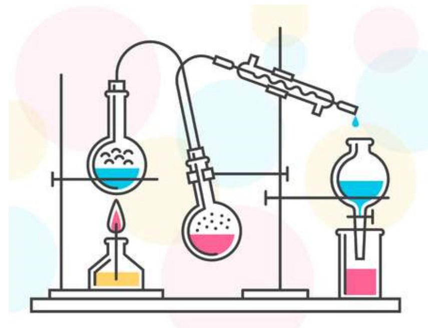
Lithium-ion batteries often contain among other useful metals high-grade copper and aluminium in addition to transition metals as well as rare earths

Deactivation

Disassembly

Mechanical processes

Chemical processes



Diagnostic on aged ESS

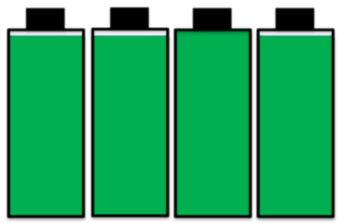
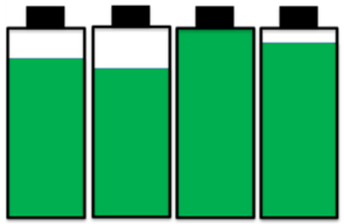
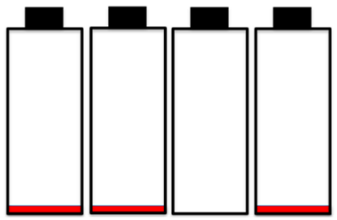
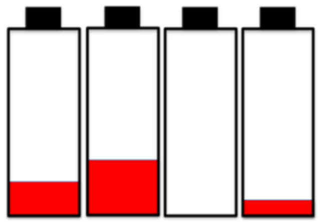
Nowadays the diagnostic tools are usually based on offline test.

In order to have a reliable ESS with 2^{nd} life batteries, some characterization tests have to be done on the batteries before to use them in stationary ESS.

RESIDUAL CAPACITY **CELLS INHOMOGENEITY** **AGING TREND**

SLAVE BMS BEHAVIOUR **MECHANICAL RESISTANCE**

Battery Inhomogeneity

	New battery	Aged battery
Battery fully charged		
Battery fully discharged		

How to fix these issues?

Standard

New active BMS

New diagnostic algorithm

Standard

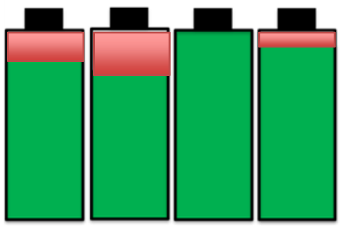
- Standard on battery measurements and recording during the first and second life
- Standard at national and international level on battery pack for EVs:
- Standard on characterization test for 2nd life batteries
  - IEC TS 62933-2-2 ED1 Electric Energy Storage Systems; Part 2-2: Unit parameters and testing methods – Applications and Performance testing
  - IEC 62660-1 Secondary lithium-ion cells for the propulsion of electric road vehicles –Part 1: Performance testing
  - ISO 12405-4 Electrically propelled road vehicles --Test specification for lithium-ion traction battery packs and systems -- Part 4: Performance testing
- Criteria for dismissing

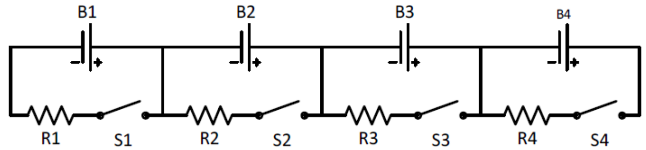
New active BMS

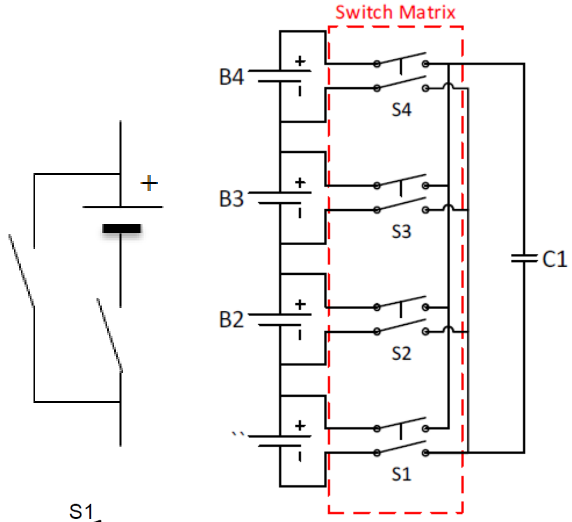
The BMSs on the market are usually passive

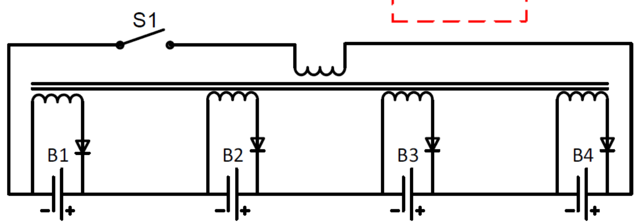
New kind of BMSs with advanced control strategies should be developed in order to manage the 2nd life batteries exploiting their potential:

- BMS able to manage the cells inhomogeneity ensuring the <u>safety</u>
- BMS able to <u>maximize the available energy</u>
- BMS with high <u>robustness</u>





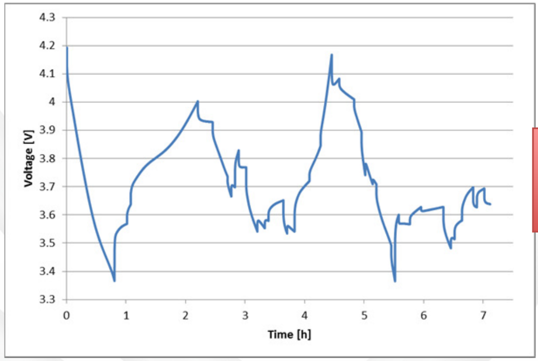




New diagnostic algorithm

New diagnostic tools based <u>on on-line battery parameter identification</u>

Data acquisition system



Data processing and parameters identification → Update parameters → ESS model for diagnostic tool

Conclusion

2nd life is a sustainable application that extends the lifetime of a battery. This will reduce the greenhouse gas emission (due to the recycling and manufacturing phase).

2nd life could contribute to reduce the cost of the EV.

Some challenges have to be faced to fully enable the 2nd life battery.

Thank you for your attention!

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