

Emanuele Michelini

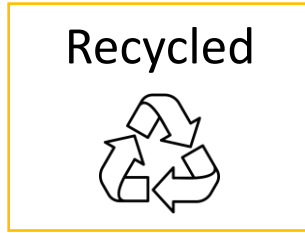
Monday, 24 April 2023

Second-Life Battery

Graz University of Technology – Vehicle Safety Institute



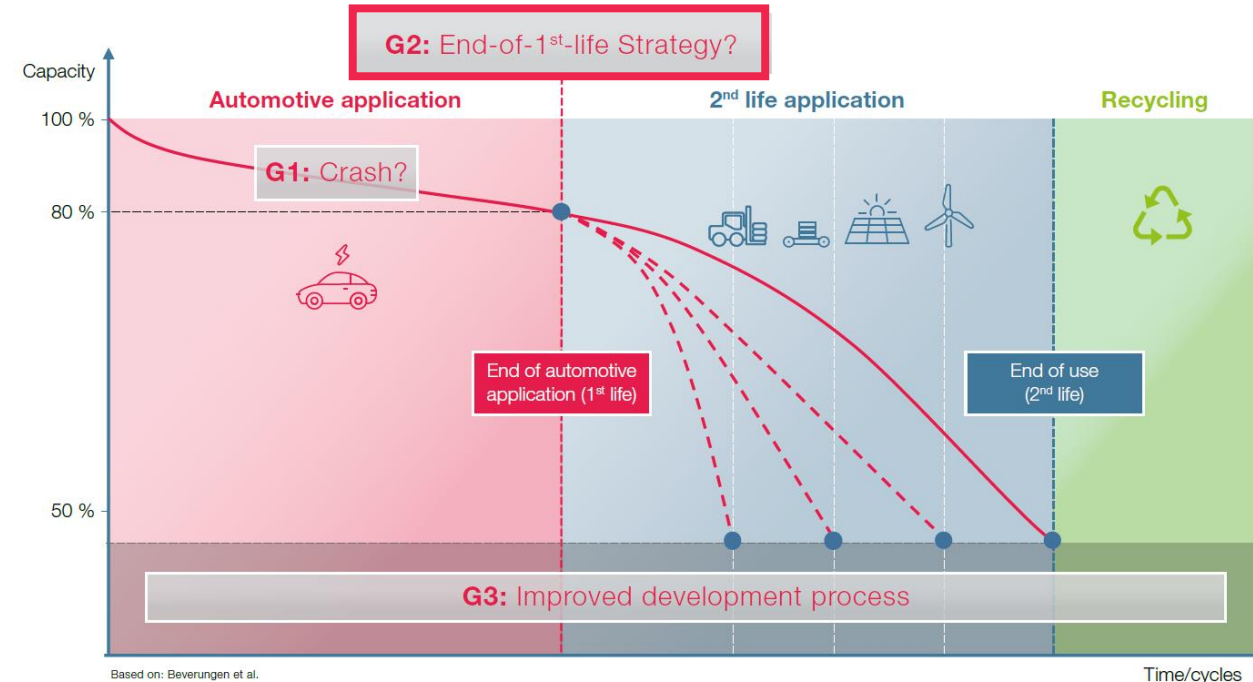
What happens to batteries once they are removed from an electric vehicle?



→ Batteries extracted from an EV can be used in a new application giving them a “second life”

Why “second-life batteries”?

- Prolonged battery life
- Reduced environmental impact
- Increased sustainability
- Increased economic efficiency
- Emergence of new markets and business models



Challenges

- Unknown aging history
- Unknown effect of aging on the cell
- **Unknown safety!**

End of first life

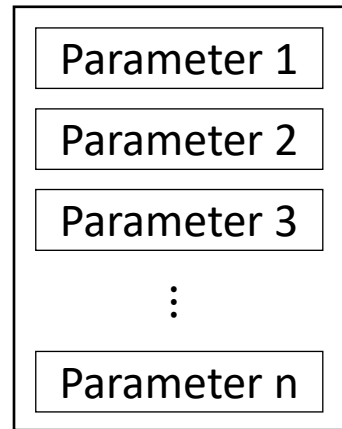
Battery qualification

Second-life


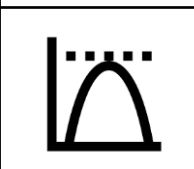
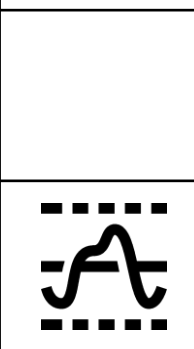


Aged battery




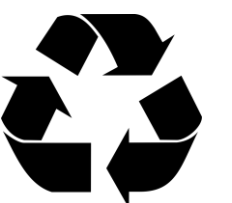
Is the battery safe for a second-life application?



What parameters are aging and safety sensitive?

Param 1	
Param 2	
⋮	
Param n	

What are the parameters safety margins?

High demanding load profile	
Medium demanding load profile	
Low demanding load profile	
Recycle	

What is the optimal load case for the investigated battery?

What are potential second-life batteries applications?

Potential second-life applications

41 mobile applications
(e.g. short-range EVs, industrial vehicles, micro-mobility, consumer electronics)



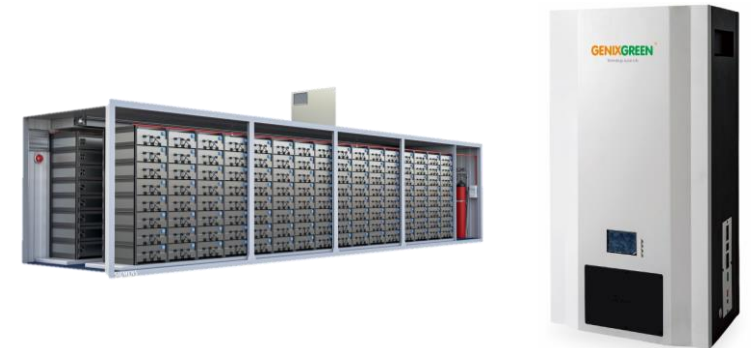
SOURCE: International cargo bike festival

7 semi-stationary applications
(e.g. power-stations, power generators, mobile chargers)



SOURCE: Instabooost SOURCE: FreeWire Technologies

17 stationary applications
(e.g. residential, commercial and industrial energy storage systems (ESS))



SOURCE: Siemens

SOURCE: GenixGreen

Highlights

- ➔ There is a wide variety of potential second-life applications
- ➔ Potential second-life batteries are not only stationary but also mobile

What are the most promising second-life applications?

Most promising second-life applications

Most promising second-life applications

APPLICATION	EVALUATION CRITERIA								SCORE
	Max discharge	Max charge	Required capacity	Mobility degree	Temp. range	Business model	Legal knockout		
AGV	++	++	++	+	0	0	0	7	
Forklift	+	++	++	+	-	0	0	5	
Pallet truck	+	-	++	+	0	0	0	3	
Golf cart	X	++	++	+	-	0	0	X	
Renewable firming industrial ESS	++	++	-	++	+	+	0	7	
Peak shaving commercial ESS	0	+	0	++	+	+	0	5	
Peak shaving industrial ESS	0	+	0	++	+	+	0	5	
Buffer storage at charging station	-	+	+	++	X	+	0	X	



Highlights

- ➔ The applications' assessment was conducted considering technical, economic and legal aspects
- ➔ Two applications, with different degrees of mobility, were found to be the most promising

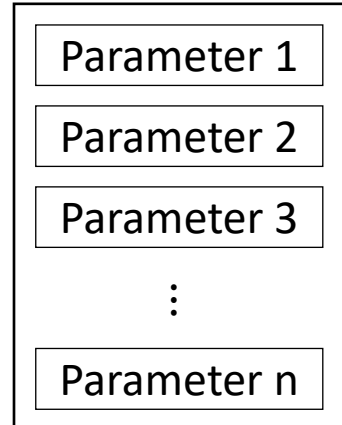
End of first life

Battery qualification

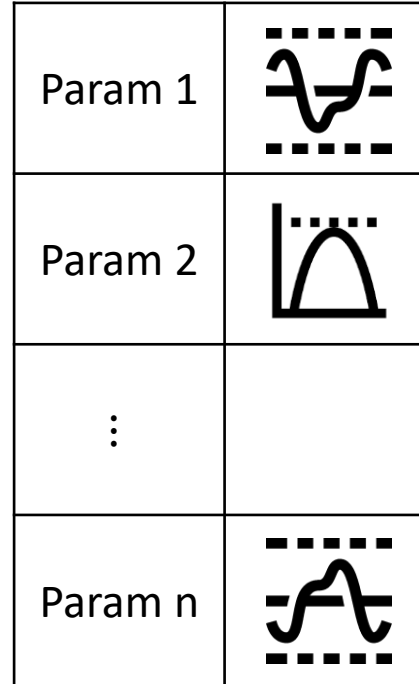
Second-life



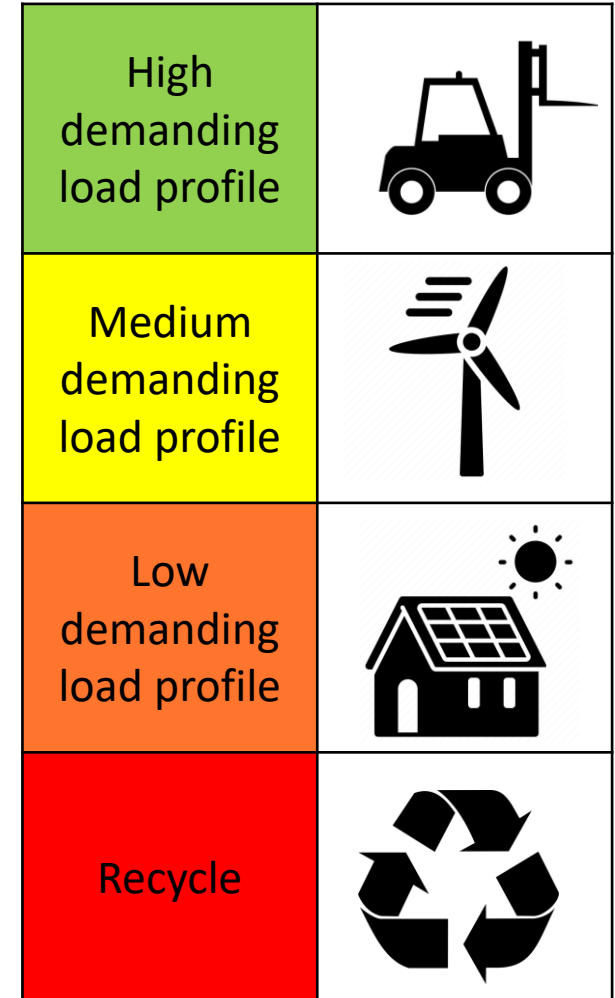
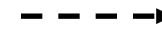
Aged battery
Is the battery safe for a second-life application?



What parameters are aging and safety sensitive?



What are the parameters safety margins?



What is the optimal load case for the investigated battery?

Partners



Das COMET-Projekt SafeLIB wird im Rahmen von COMET – Competence Centers for Excellent Technologies durch BMK, BMDW, das Land Oberösterreich, das Land Steiermark sowie die SFG gefördert. Das Programm COMET wird durch die FFG abgewickelt.

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