

Reimagining battery waste: direct restoration of high-value cathode components

Marta Rodrigo, María Fernanda Gazulla, Laura Montañes, Jéssica Gilabert

11th September 2025

ICBR 2025

Project funded by:



AGENDA

01

Introduction



02

Experimental



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Results



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Conclusions



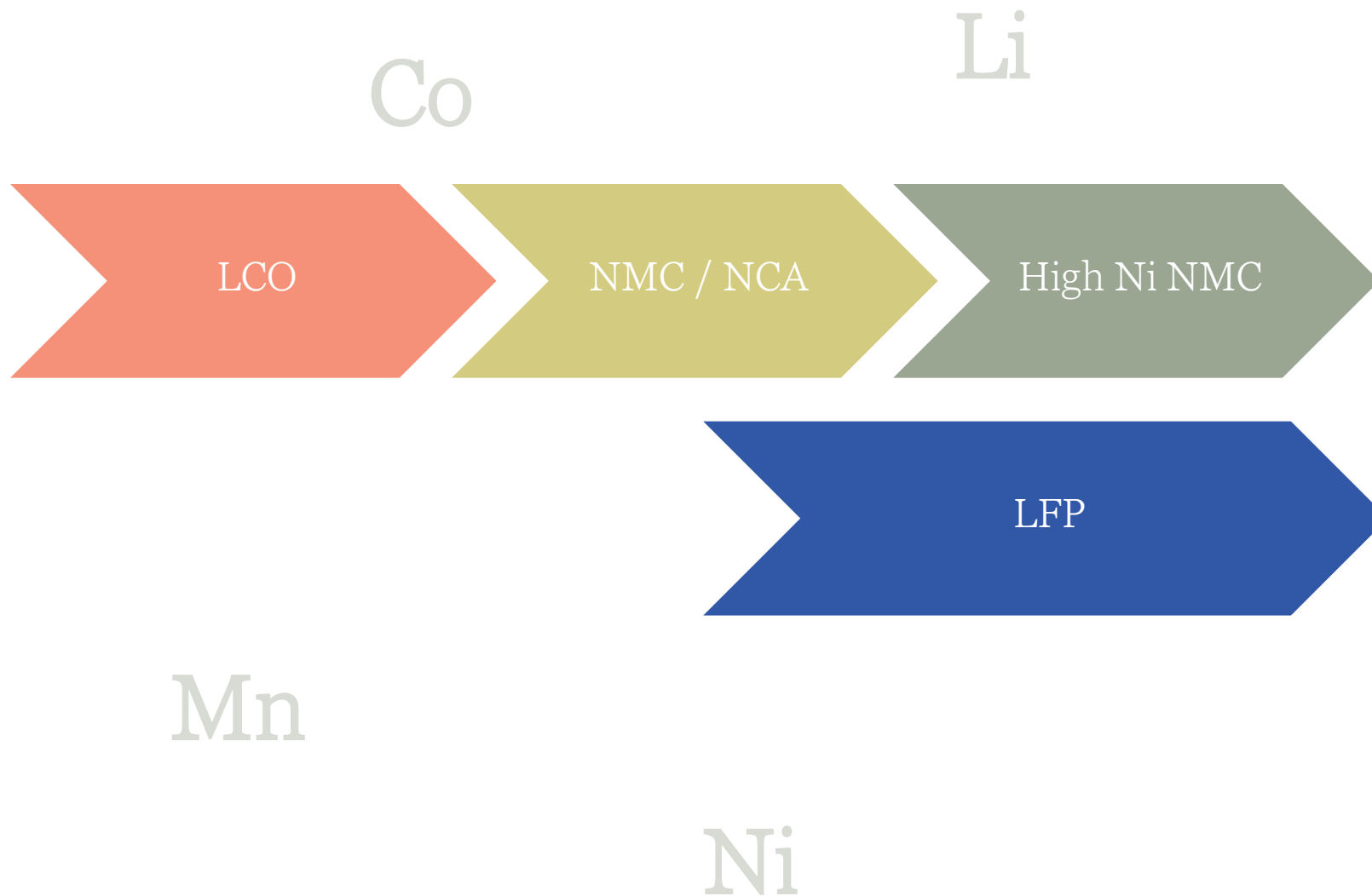
Conclusions

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Evolution of cathode battery chemistries



Conclusions

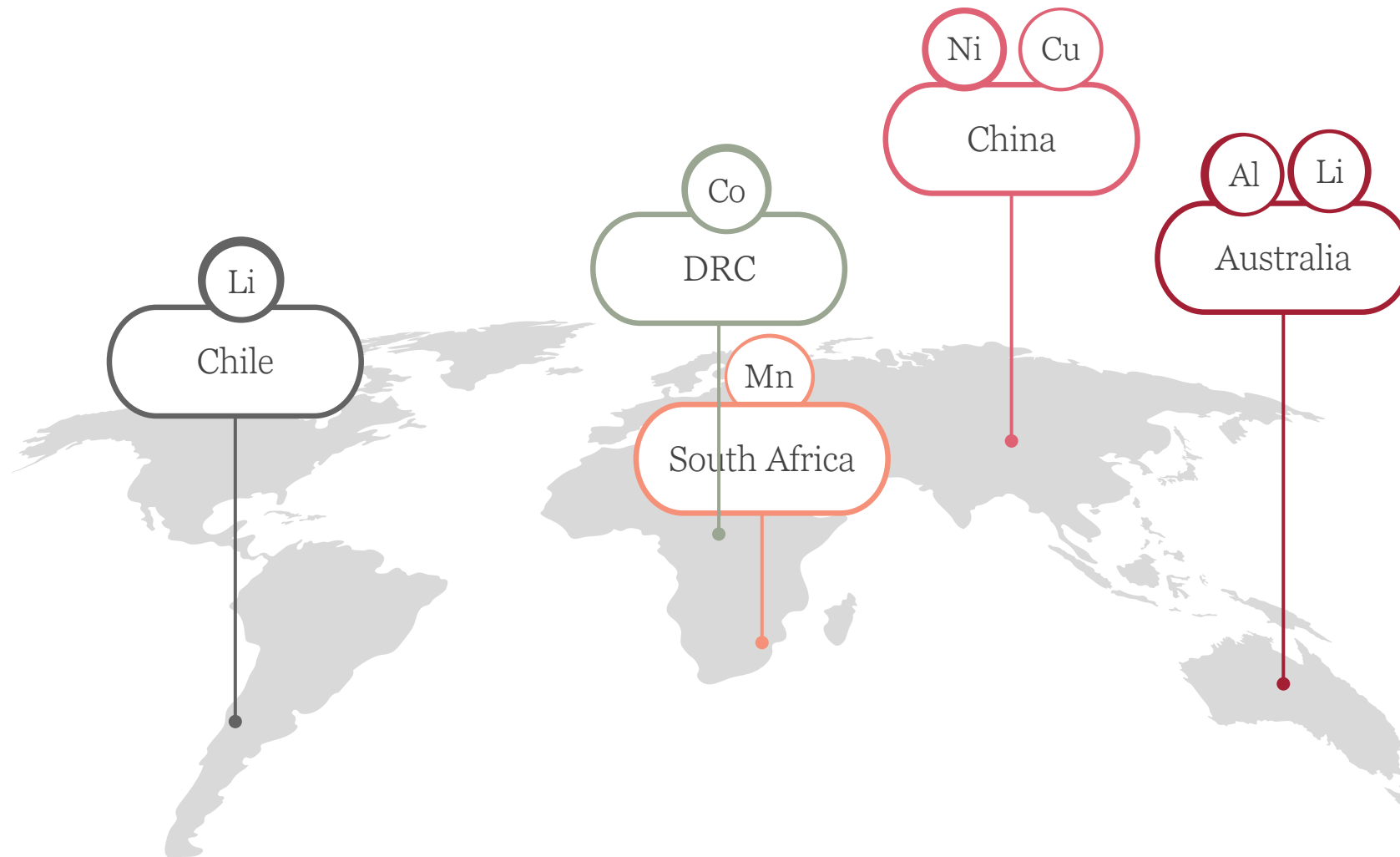
Results

Experimental



Introduction

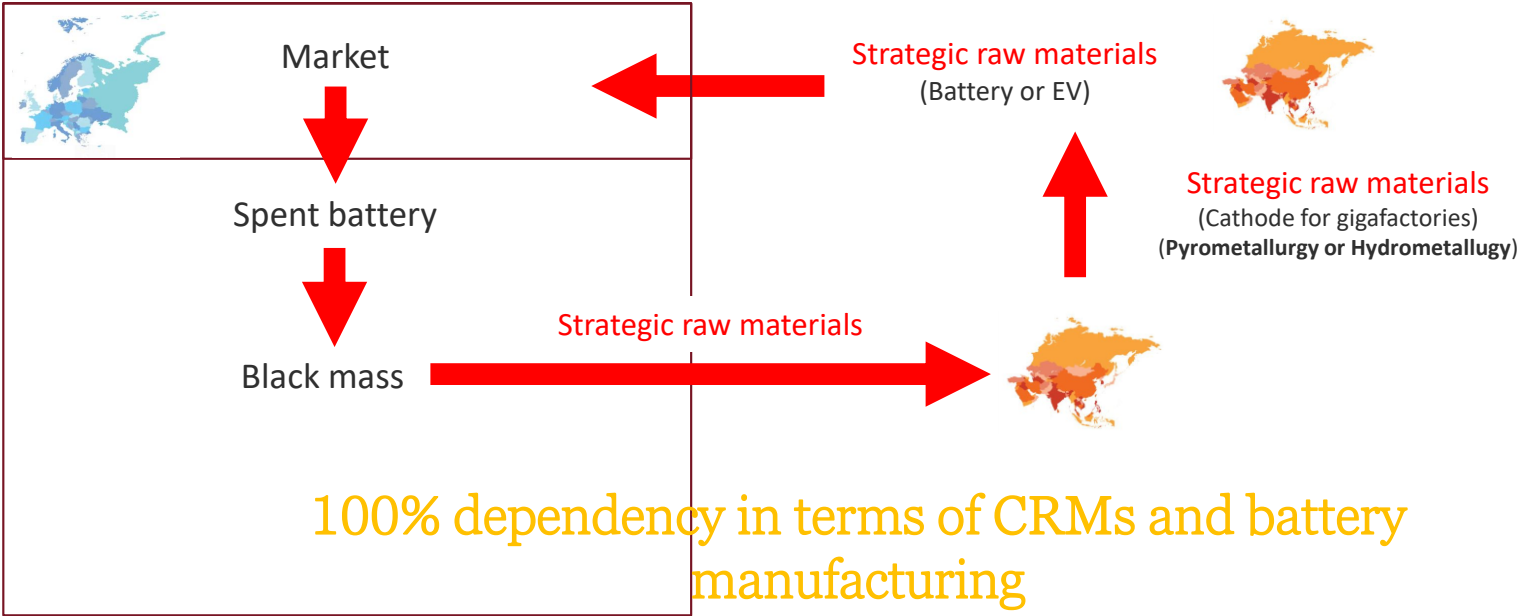
Need for Critical Raw Materials (CRMs)



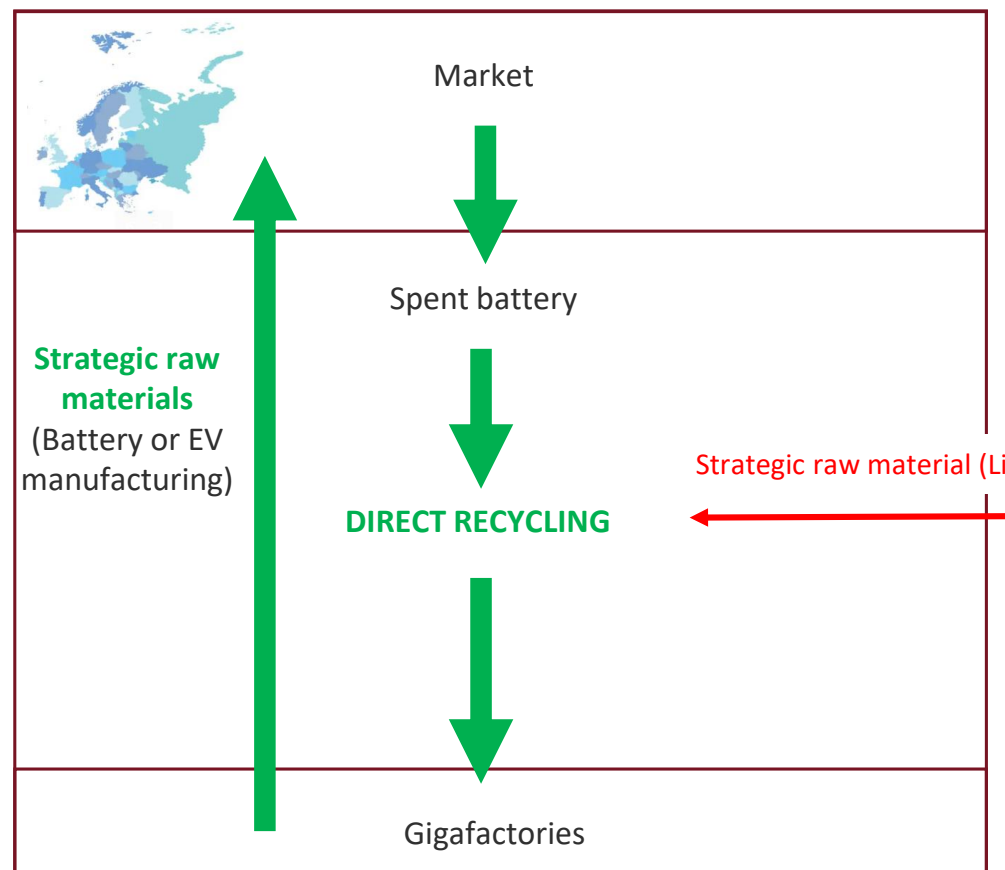
European Battery Regulation 2023/1542

Li-based batteries	By 2031	By 2036
Minimum % share of recycled material	Co = 16 % Ni = 6 % Li = 6 %	Co = 26 % Ni = 15 % Li = 12 %

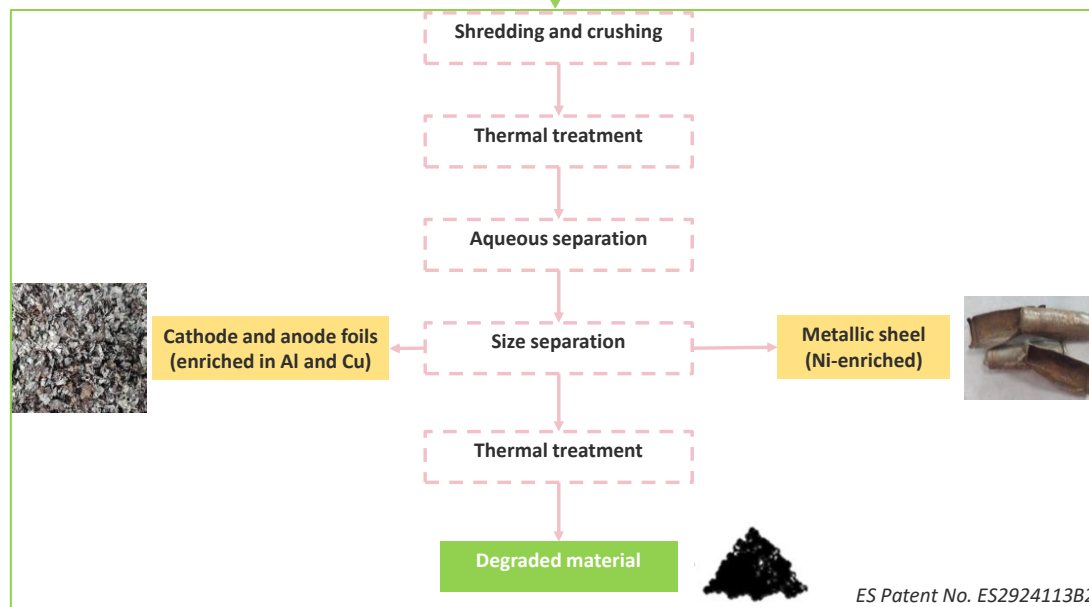
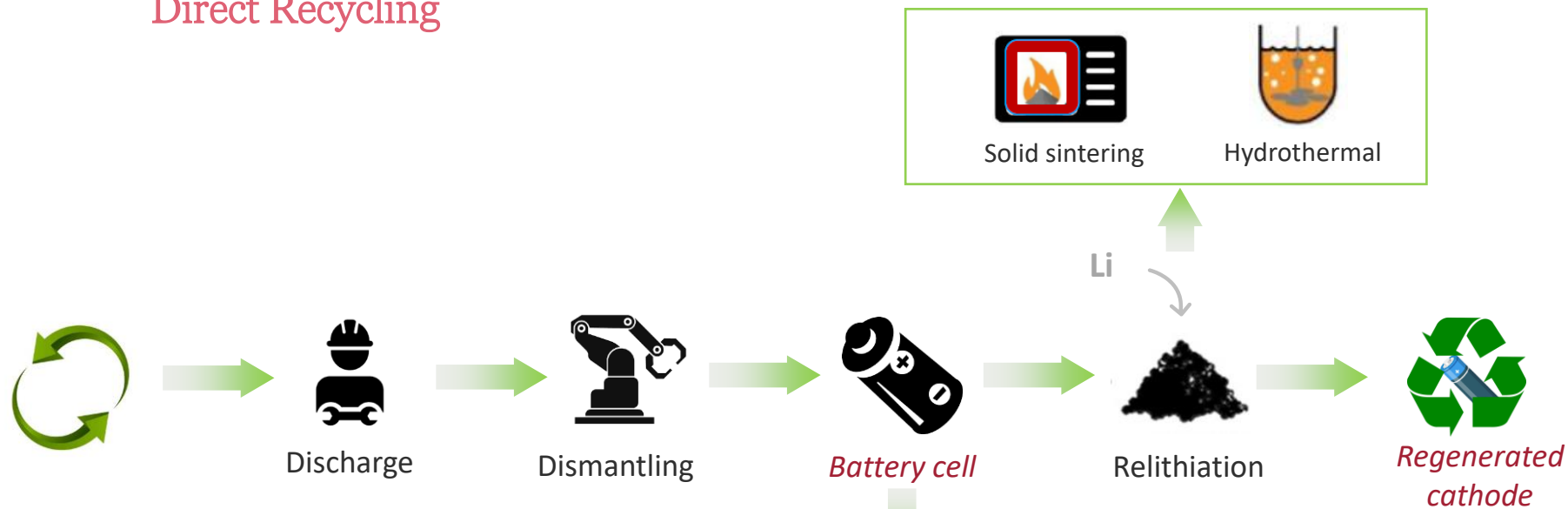
Current European situation



Future Europe Scenario



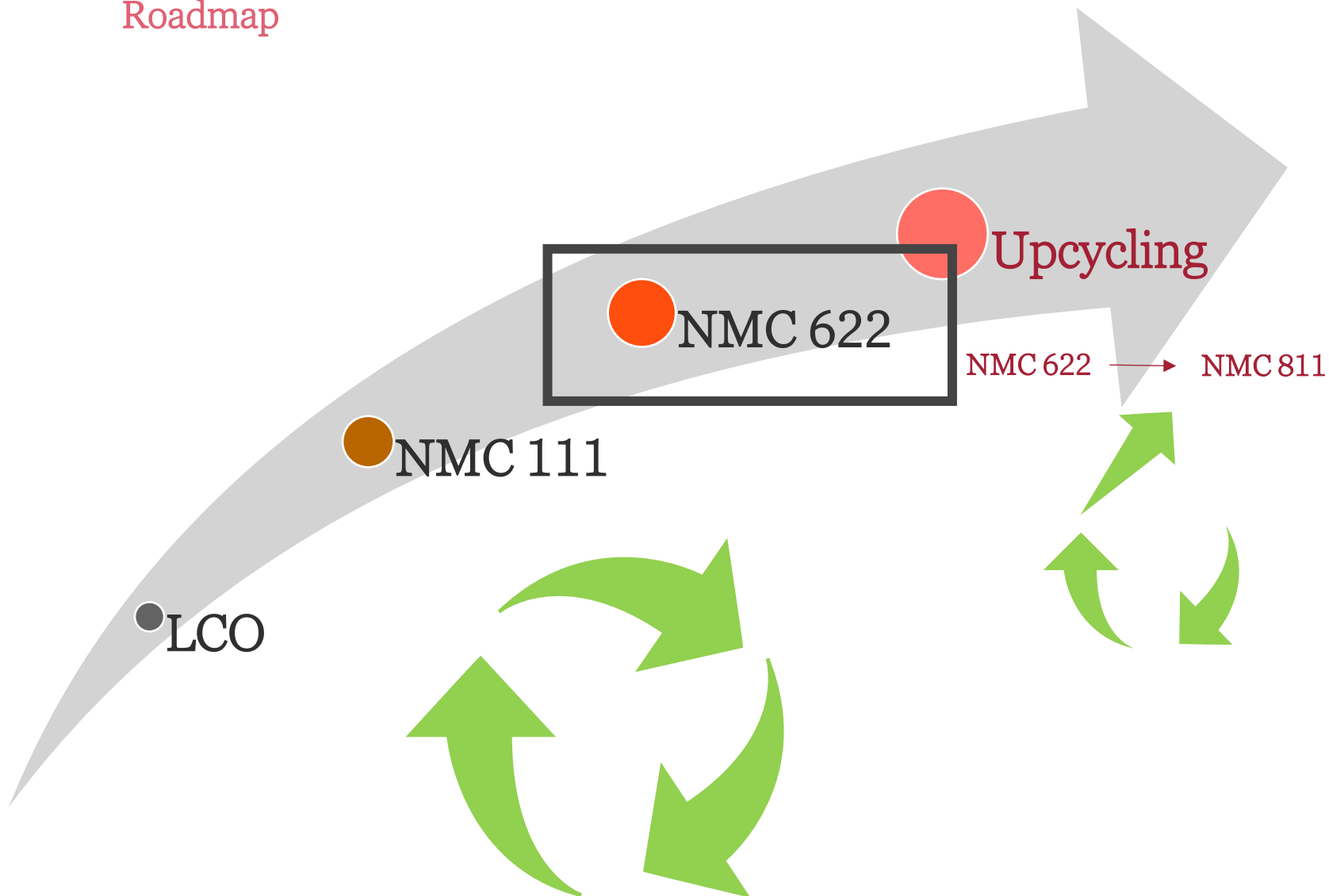
Direct Recycling



ES Patent No. ES2924113B2



Roadmap



NMC 622 - Restoration



Hybrid Ford Kuga 14.4 kWh

Separation process



ES Patent No. ES2924113B2



Optimization of the
annealing process



Regeneration process – Hydrothermal method



01

ICP-OES

Determination
of Li



02

XRD

Identification of
the crystalline
structure



03

Electrochemistry

Determination
of the
electrochemical
properties

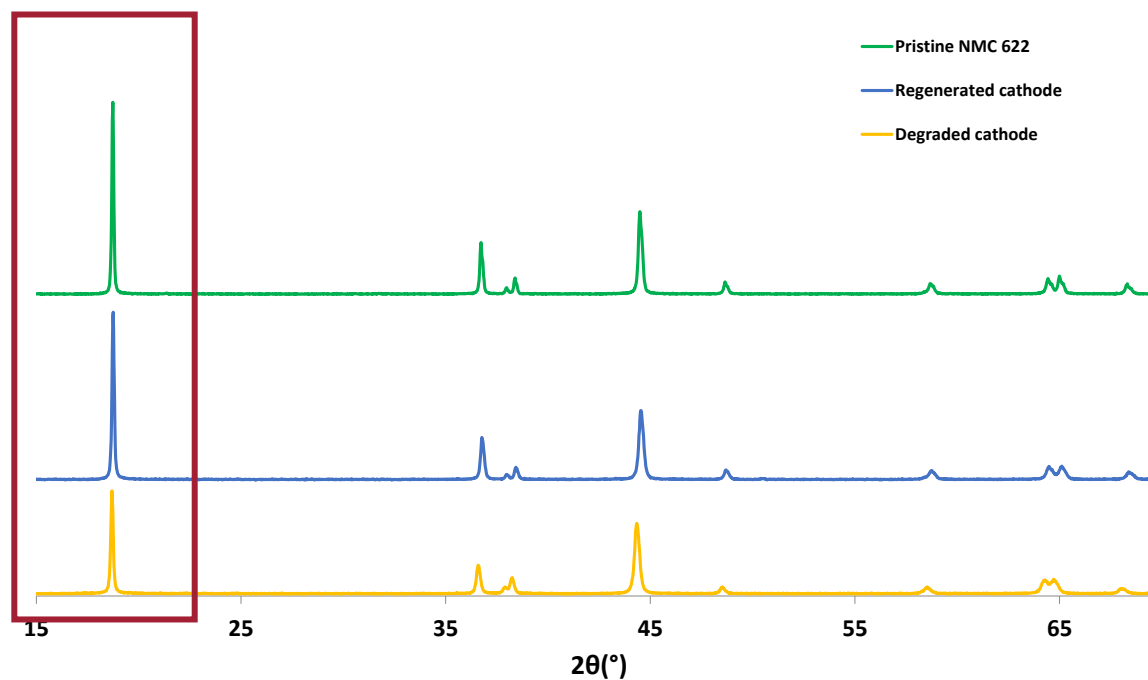


Regenerated NMC 622 – Physicochemical characterisation

- *Determination of lithium*

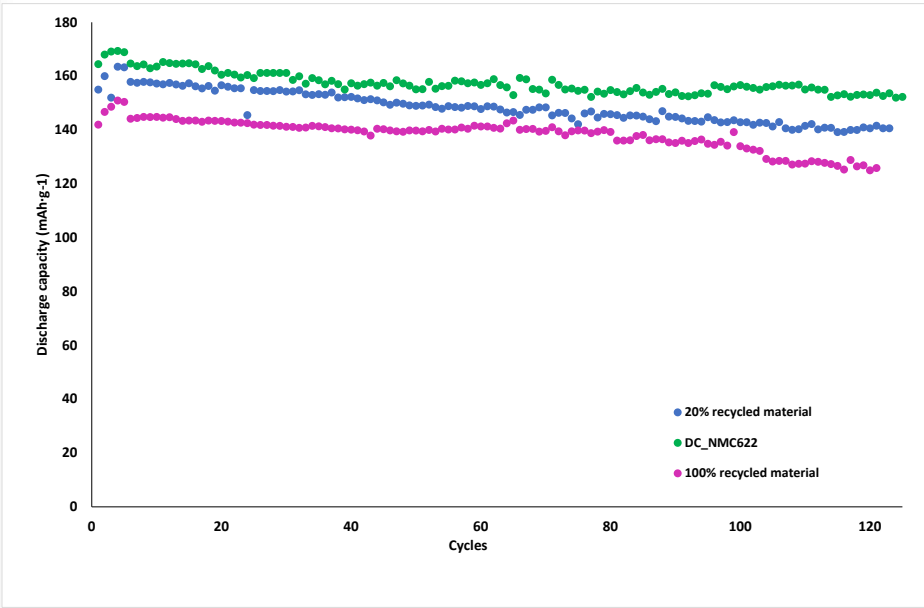
Degraded cathode	Regenerated cathode
6.6 %	7.1 %

- *X-ray diffraction*

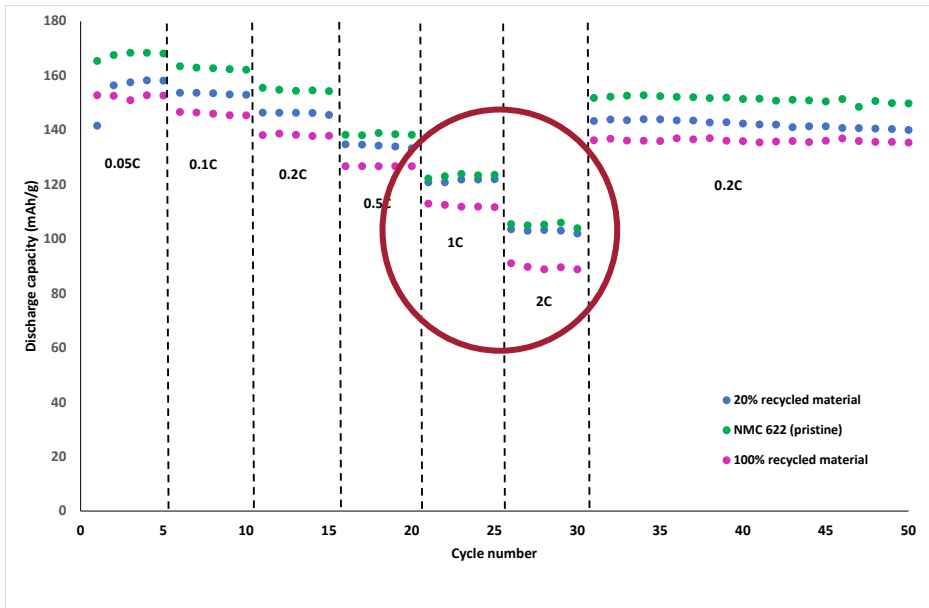


Regenerated NMC 622 – Electrochemical properties

Cycle life



Rate performance



Compliance with Regulation 2023/1542

2031	Recycled material (%)	
	20 % regenerated material	
	Co	2.3 / 1.8
	Ni	7.3 / 2.2
	Li	1.4 / 0.4

2036	Recycled material (%)	
	20 % regenerated material	
	Co	2.3 / 2.9
	Ni	7.3 / 5.5
	Li	1.4 / 0.9

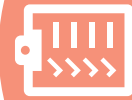
The regeneration of NMC 622 cathode material recovered from an EOL-LIB used in an EV and its viability in the manufacturing of new batteries was assessed

The manufacturing of new batteries with 20% of recycled material complies with the battery regulation requirements for 2031

The establishment of direct recycling plants in Europe will enable strategic raw materials to remain in Europe

This reduction in the dependence on the supply of certain raw materials will facilitate the implementation of gigafactories in Europe

Future research will be focused on increasing the percentage of recycled material to meet the requirements for 2036



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Thank you

Marta Rodrigo Edo

Head of the Electrochemical Laboratory
Battery Recycling



marta.rodrigo@itc.uji.es

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