HELIOS : High Energy Lithium-Ion Storage Solutions

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EVS 2013 - Barcelona

HELIOS : High Energy Lithium-Ion Storage Solutions

FP7 Program – Sustainable Surface Transport (SST) -2008-RTD-1

Call identifier : SST.2008.1.1.2 Electric – hybrid powertrains

Grant Agreement nº 233 765

Duration : 48 months , Starting date : 01/11/2009

Coordinator : Renault
Home page : http://www.helios-eu.org/

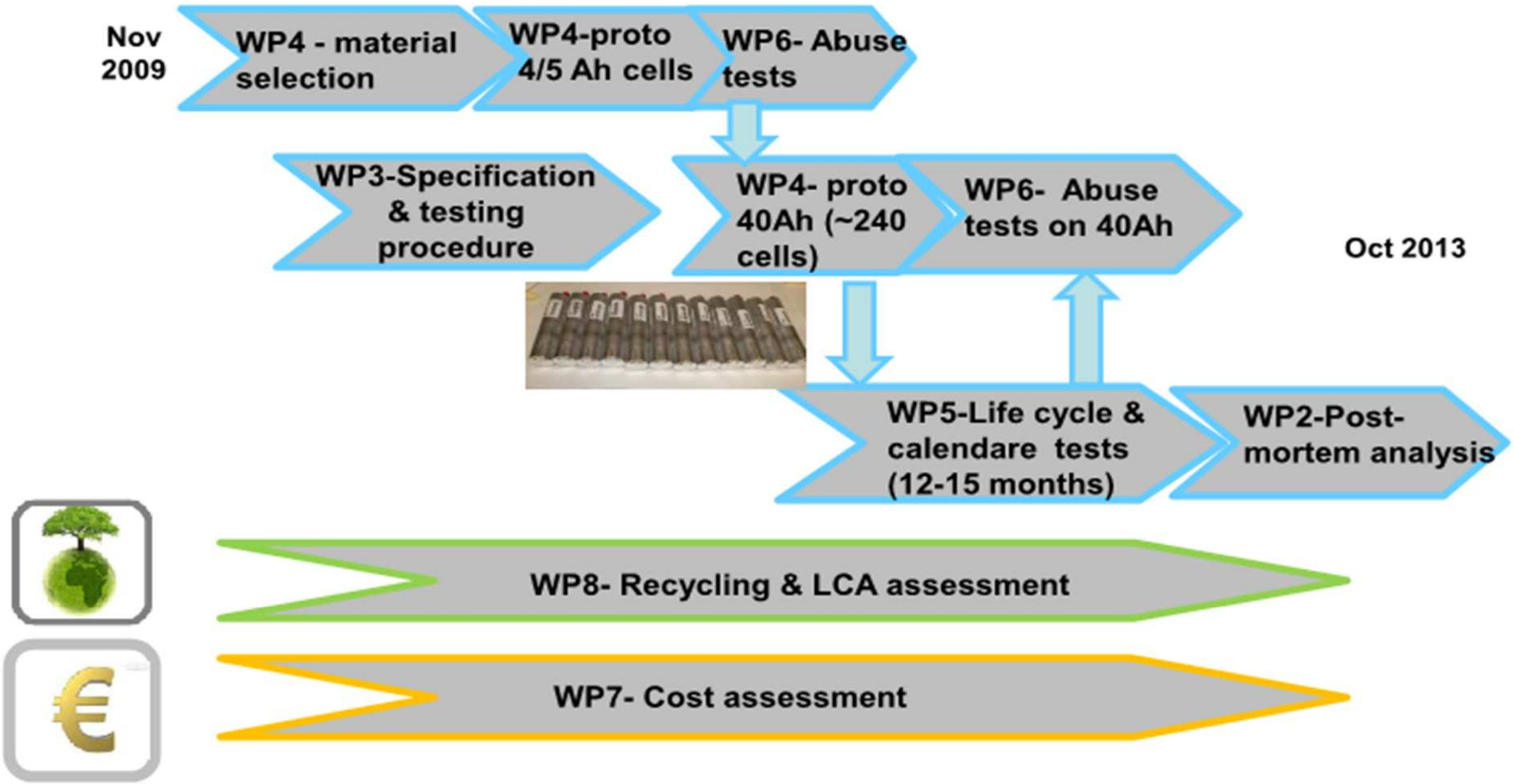
Total Budget : 4,28 M € , EC contribution : 2,77 €

HELIOS consortium : 18 partners from 6 member states

6 OEM	CRF
	Adam Opel AG
	Ford
	Volvo
	Renault
	PSA
4 Industries	EDF
	SAFT
	Umicore
	JCHaR
6 Research Institutes	AIT
	ZSW
	CNRS - LRCS
	INERIS
	CEA
	ENEA
2 Universities	RWTH-ISEA & IME
	UU

Objectives - technical approach

The main objective is to evaluate the performances of 4 positive electrode (**NCA, LMO-NCA blend, LFP & NMC**) on **performance, life, cost, recycling and safety** points of view.



High Energy Applications

1. EV (Electric Vehicles)
2. PHEV (Plug-in Hybrid Electric Vehicle)
3. HEV-APU (Auxiliary Power Unit of Hybrid Truck)

Main results : WP3
(Cell specification and test procedures)

Public reports

- Target specification for a high energy cell for EV and PHEV/HEV-APU applications (one set was chosen for the full size cells to be built in WP4 and tested in WP5 & WP6)
- Performance, ageing and cycling test specification completed
- Safety test procedures (mechanical, electrical and thermal abuse conditions)

Main results : WP4
(High energy cell manufacture)

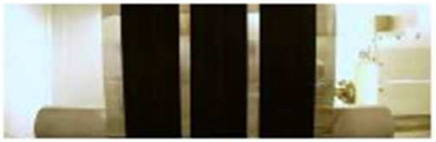
- Material selection for NMC, LFP, LMO (NCA= reference material used in SAFT's commercial cells)
- Manufacturing of small sample cells (4/5 A),for pre-investigation (12 cells per chemistry)

- Manufacturing of large cells to test institutes

	NCA	NMC	LMO-NCA	LFP
Capacity (Ah)	41	38	28	35

Electrode Manufacturing

Coating

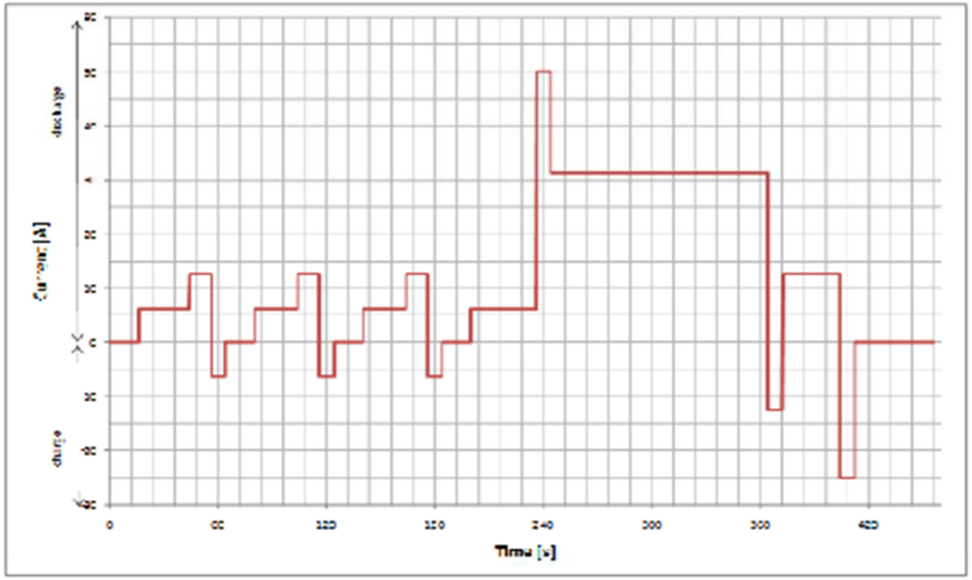


Calandering

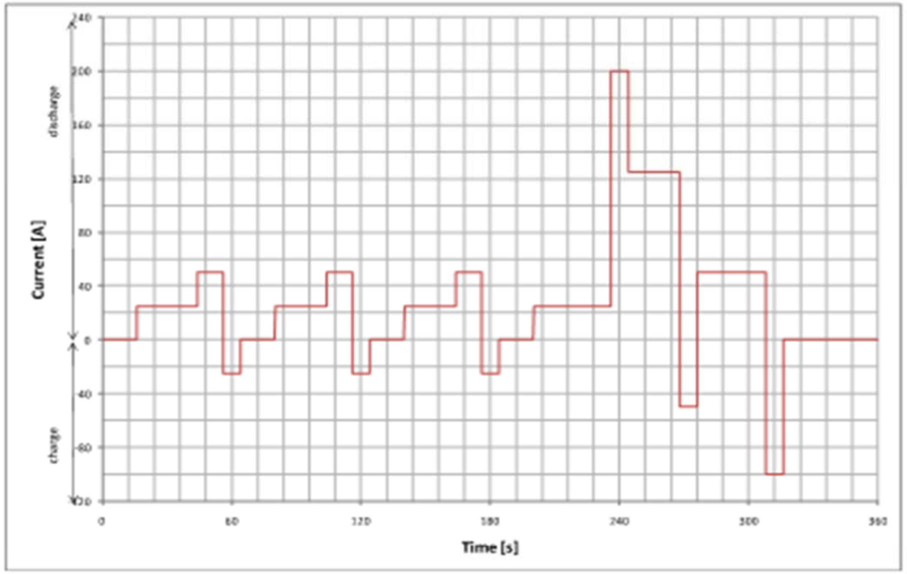
Slitting

Main results : WP5
(Electrical performance testing : cycling and storage)

- Cycling tests :
  - EV type profile : SOC 100% - 20%
  Imax ~1.25C (50A) @30 – 45°C

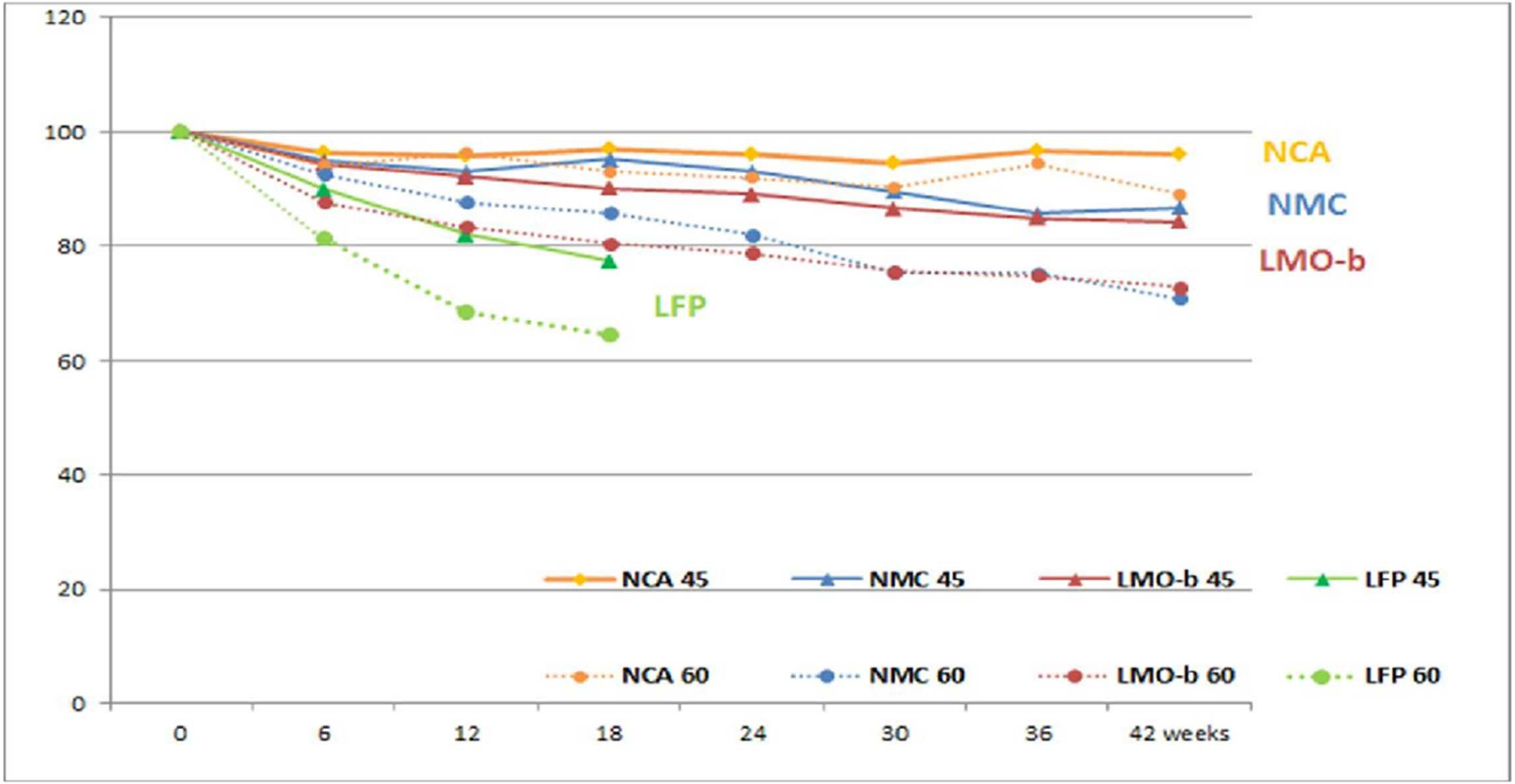


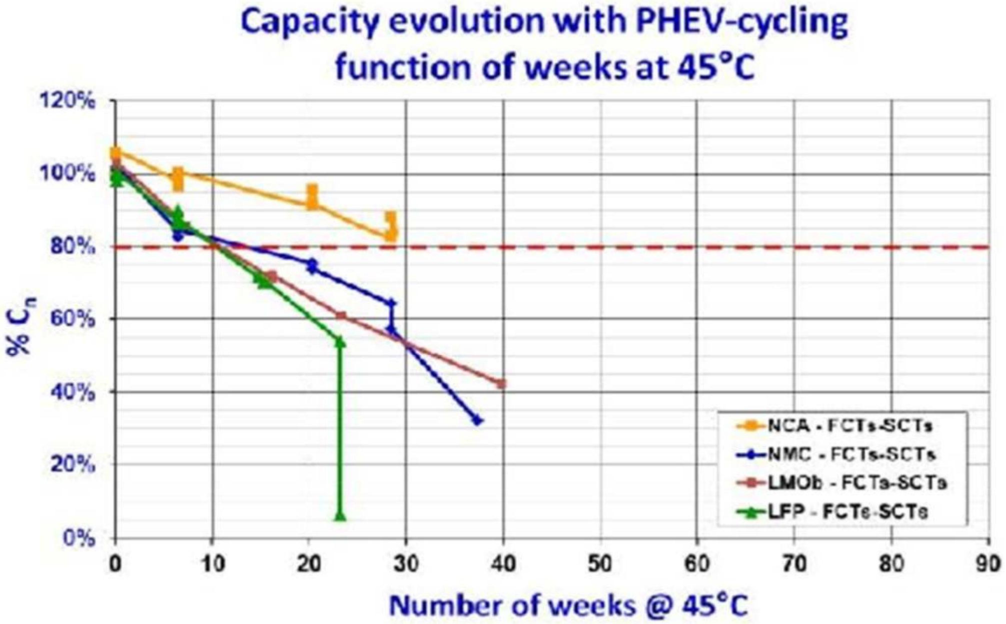
- Cycling tests :
  - PHEV type profile : SOC 95-25%
    Imax ~ 5C (200A) @ 30-45°C
    P_{rms}~195W

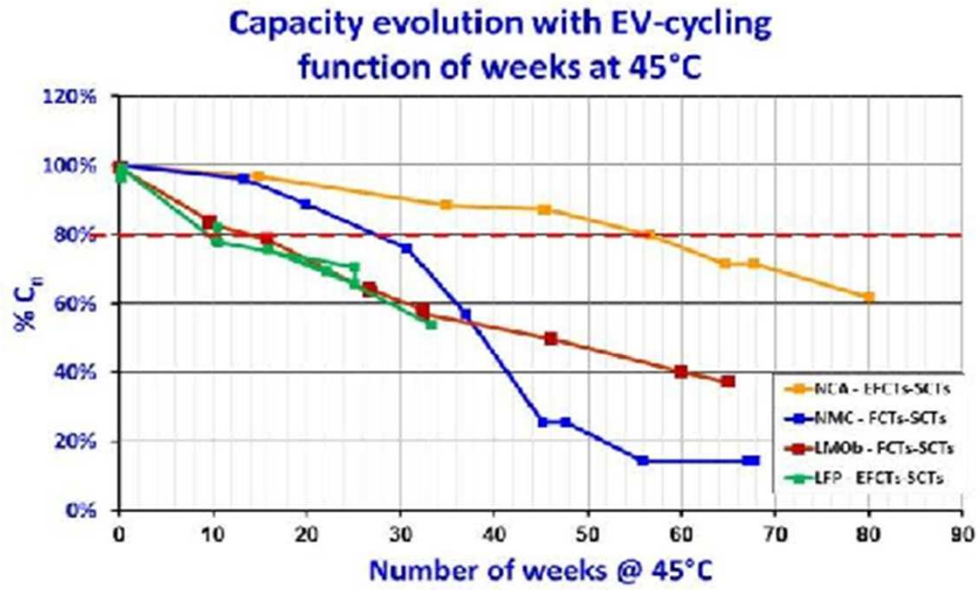


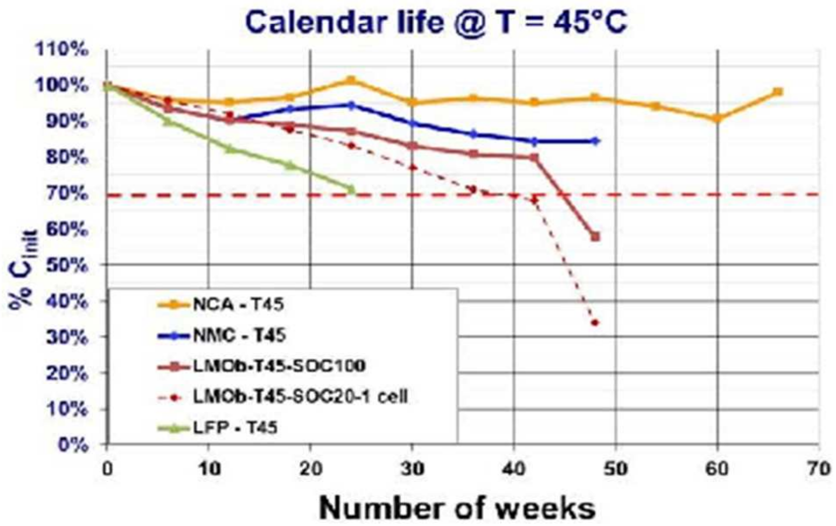
- Calendar tests : storage at 45 – 60°C, 100%SOC

Calendar tests: ageing higher at 60°C than 45°C







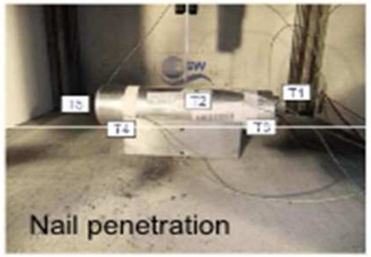


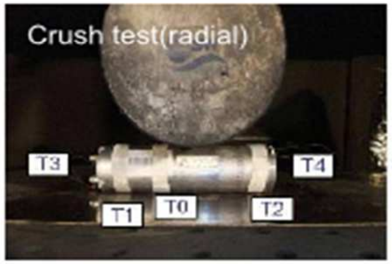
- At 45°C : PHEV cycling is the most constraining test > EV cycling > calendar
- NCA (commercial ref) > NMC >LMO-NCA > LFP

Main results : WP6
(Safety and abuse testing)

Public report

- Bibliographical study of thermal 'runaway' mechanisms in lithium battery systems
- Thermal stability tests on 0.5 Ah cells
- Safety tests on 40 Ah cells
    - Controlled crush (Radial and axial)
    - Penetration (nail)
    - Thermal stability (ARC)
    - Simulated Fuel Fire (Beginning of Life)
    - Elevated temperature Storage (2 months)
    - Rapid charge / discharge
    - Thermal Shock Cycling (from -40°C / + 75 ° C)
    - Overcharge
    - Short circuit
    - Over discharge





Crush test(radial)

EVS 27 – Nov 2013

Main results : WP6
(classification)

Hazard Levels	Description	Classification Criteria and Effect
0	No effect	No effect. No loss of functionality
1	Passive protection activated	No defect ; no leakage ; no venting, fire or flame ; no rupture ; no explosion ; no exothermic reaction or thermal runaway. Cell reversibly damaged. Repair of protection needed.
2	Irreversible damage	No leakage; no venting, fire or flame; no rupture ; no explosion ; no exothermic reaction or thermal runaway. Cell irreversibly damaged. Repair needed.
3	Leakage	No venting, fire or flame; no rupture ; no explosion. Weight loss < 50 % of electrolyte weight.
4	Venting	No fire or flame ; no rupture ; no explosion. Weight loss ≥ 50 % of electrolyte weight.
5	Fire or flame	No rupture, no explosion
6	Rupture	No explosion, rupture without violent projections
7	Explosion	Total disintegration of the cell, violent projections

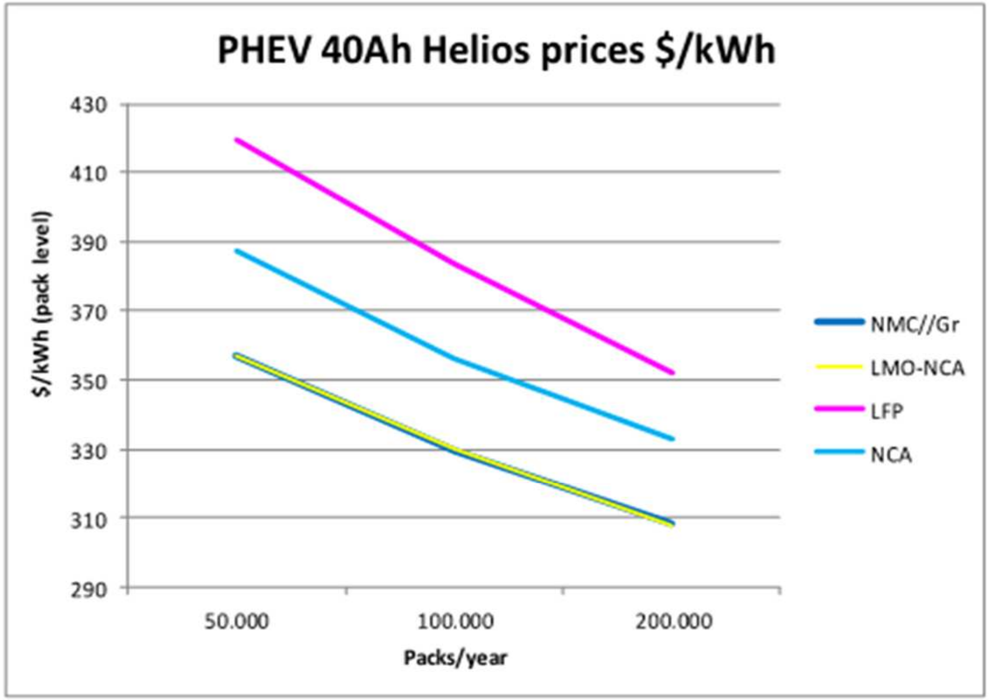
Main results : WP6

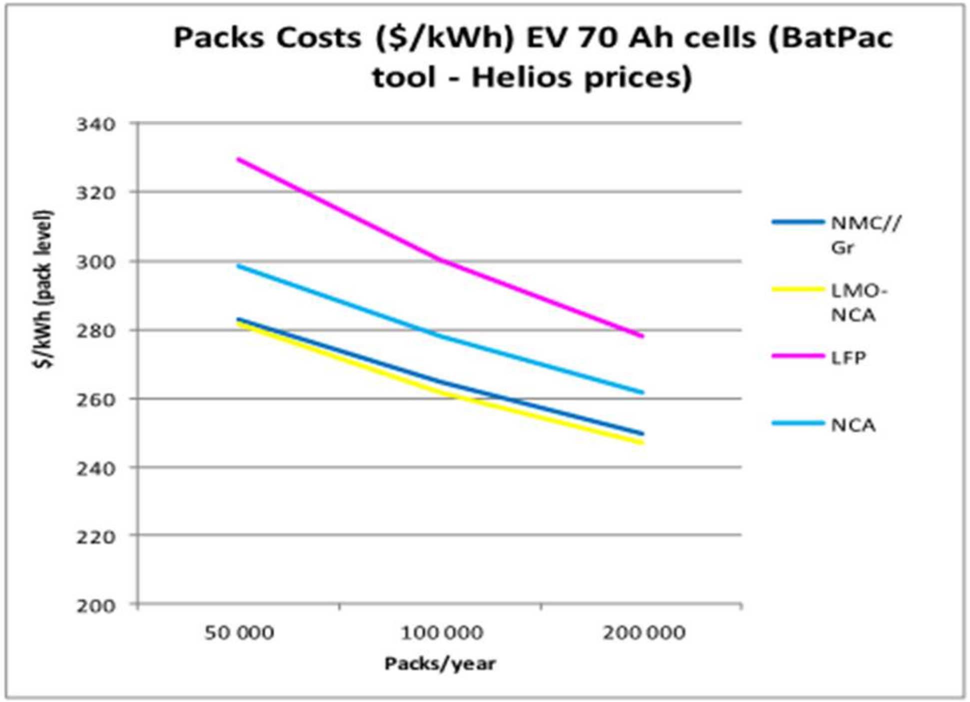
Abuse tests	Level acceptability	Cells tested (ZSW/INERIS)			
	HELIOS	LMO-NCA	NMC	NCA	LFP
Overcharge	**3**	**4**	**5**	**5 → 7**	**4**
Rapid charge/discharge	**2**	0	0	0	0
Short circuit	**2**	0	**4**	**5**	**4**
Overdischarge	**2**	2	2	2	2
Thermal Shock Cycling	**2**	0	0	0	0
Nail penetration	**4**	4	**5 → 6**	**5**	4
Nail penetration on pre-stored	**4**	**4**	**4**	**5**	4
Nail penetration on cycled	**4**	**5**	**4**	**5**	No test
Crush test (Radial)	**3**	**4**	**6**	**5 → 6**	**6**
Crush test (Axial)	**3**	3 → 4	3 → 4	**6**	3 → 4
Simulated Fuel Fire	**5**	0	0	0	0
Elevated Temperature storage	**2**	0	0	0	0
Thermal Stability	**4**	**5**	**5**	**5**	3 → 4
Thermal stability on pre-stored	**4**	**6** 4	4 4	**6** **6**	4 4

LMO_NCA technology cannot be compared to the others technologies (only 28 Ah capacity)

WP7 (Economical assessment)

Cost assessment at pack level (based on Bat Pac model*) :





- Decrease of ~13-15 % between 50 000 and 200 000 systems
- PHEV pack (in $/kWh) is ~ 25% more expansive than EV pack
- **LMO-blend ~NMC < NCA << LFP**

WP8 - Recycling
part of the clean mobility global picture

Choice of transport mode

Clean vehicles

Exhaust control

Electrification

Vehicle and battery recycling

EV-Batteries: a complex mixture of chemical elements: H, Li, C, O, F, Al, (Si), P, (Ti), Mn, Fe, Co, Ni, Cu, (Sn)

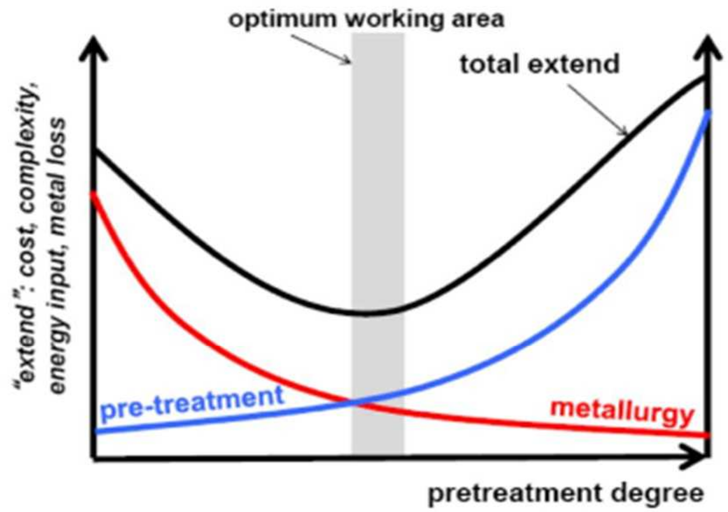
Clean energy

Helios

SEVENTH FRAMEWORK PROGRAMME

WP8-Battery recycling concepts

- EV battery recycling is a combination of 'pre-treatment' (disassembling, shredding, pyrolysis) and metallurgical processes (pyro or hydro)



- Low volume of EV batteries today and the uncertainty of the ultimate cell chemistry, make it difficult to fully assess the cost / benefit ratio of EV battery recycling.

- There is a broad range of battery chemistries and the diversification is still going on. Therefore, an EV-battery recycling process has to be robust, in order to cope with this variety.

Contacts

- Public website : http://www.helios-eu.org/

- Project coordinator :

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