Beyond lithium ion workshop, October 2nd 2018, Acropolis, Nice, France

ALISE | Advanced Lithium Sulphur battery for xEV

Christophe AUCHER (LEITAT)

ALISE

This project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 666157.
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ALISE European Li-S value chain

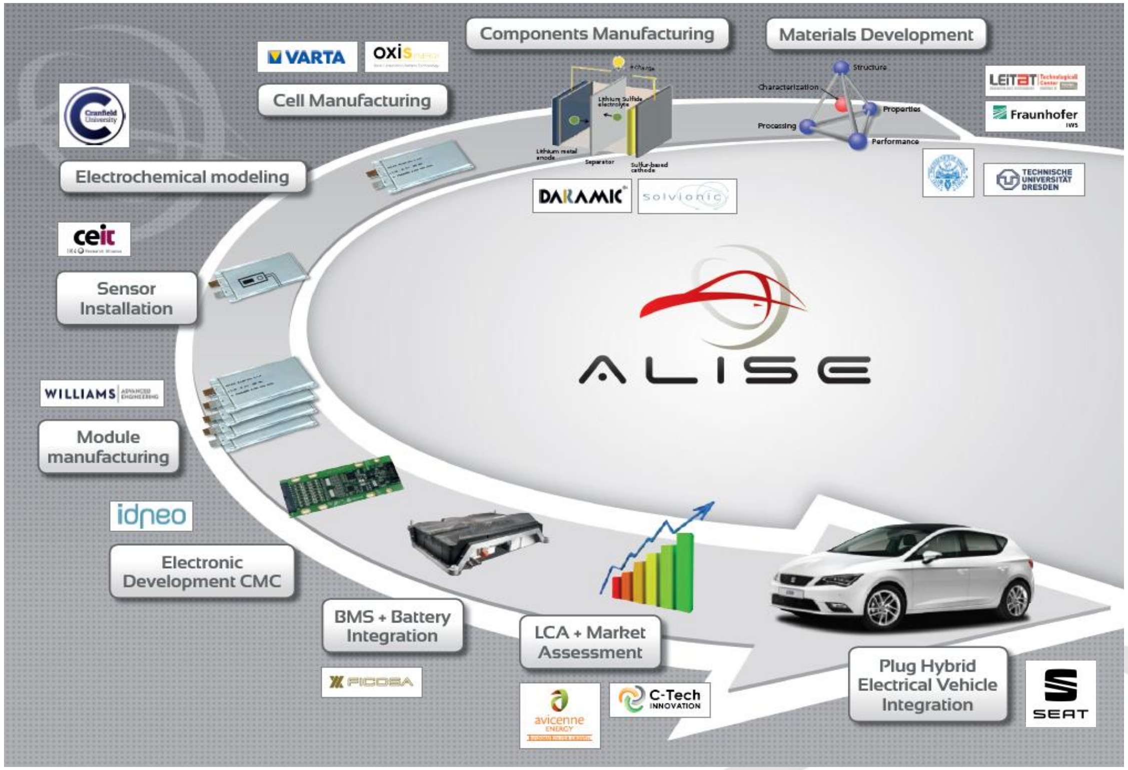
http://www.aliseproject.com/

Video

Leaflet

Poster

H2020-NMP-GV-2014
Grant agreement n° 666157.
EU contribution: 6,899,233 €
Duration : June 2015 – May 2019
Activities expected to focus on TRL4



1. LEITAT (Coordinator)
2. AVICENNE ENERGY
3. Centro de Estudios e Investigaciones Técnicas
4. Fico Triad
5. IWS Fraunhofer
6. OXIS Energy Ltd.
7. SEAT
8. Solvionic
9. TUD Dresden University
10. VARTA Micro Battery
11. Politecnio di Torino (POLITO)
12. C-Tech Innovation
13. Daramic
14. Cranfield University
15. Williams Advanced Engineering

1. R&D Vehicle Systems Ltd (Terminated)
2. Vayon Group (Terminated)
3. IDNEO (Activities absorbed by Fico Triad)

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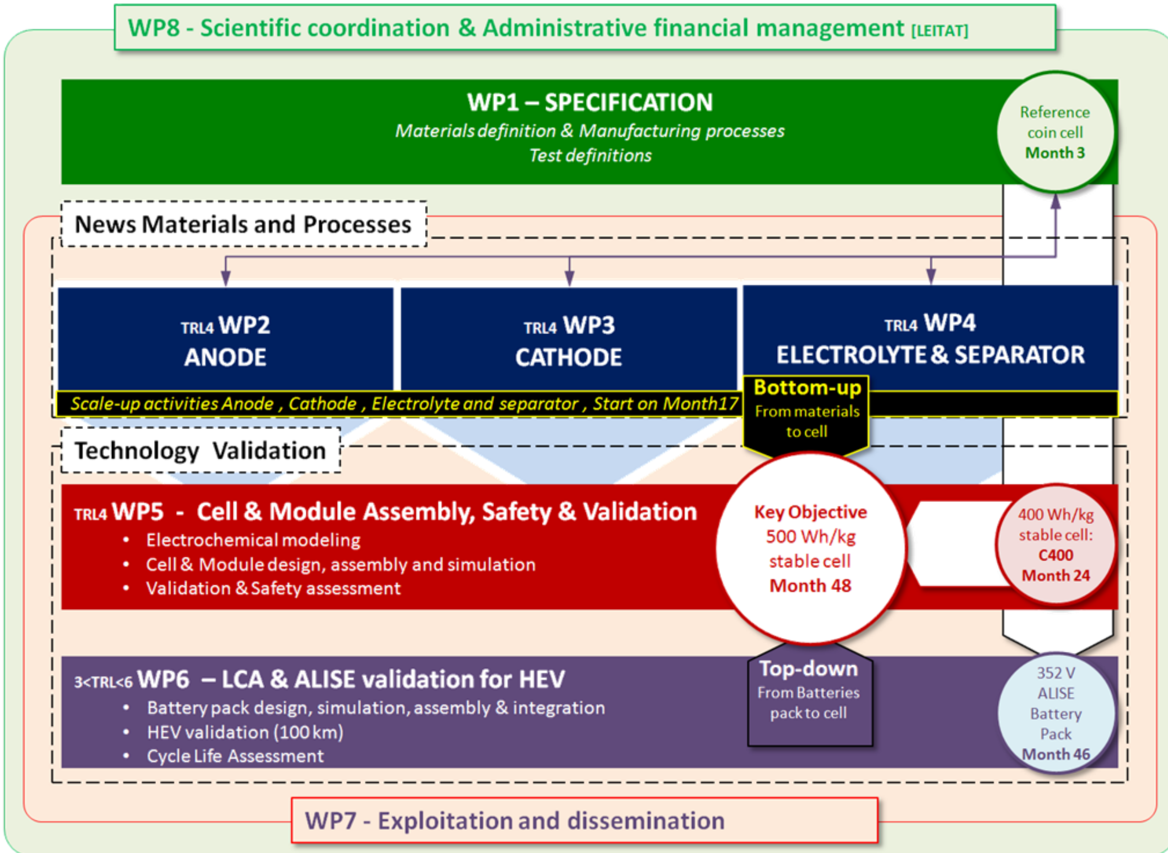
KPI Objectives

- X2 PHEV electrical range
- Li-S cell (pouch, cylindrical)
- 400Wh/kg, 440Wh/L (TRL7)
- 500Wh/kg, 550Wh/L (TRL4)
- 2.000 cycles 80%BoL, 80%DoD (TRL4)
- 2.000 cycles 50%BoL, 50%DoD (TRL7)
- Reference Li-S (TRL3)
- Sulphur 80 %wt and 80% use
- 80% BoL at C/2
- Design, simulation, module, pack
- Module (82V)
- Pack (352V, 17kWh)
- Safety evaluation (HL4)



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ALISE Status

Cell KPI	PHEV cell Baseline	ALISE Objectives	ALISE 1st GEN	ALISE 2nd GEN	ALISE Module target	ALISE 3rd GEN target
Date	May 2015	May 2015	May 2017	Aug. 2018	May 2019	May 2019
TRL	9	5	5	5	5	4
Safety (EUCAR Hazard Level)	HL4	HL4	HL6	HL6	HL6	HL4
Nominal Capacity (Ah, 0.2C or lower)	-	-	12.5	14.3	14	16
Nominal Capacity (Ah, 2C or higher)	25	25	9	11.8	10	12.5
Gravimetric Energy (Wh/Kg)	130	400	290	310	>250	400
Volumetric Energy (Wh/l)	222	440	200	240	>200	440
Cycles (up to 1C or lower, DOD 80 % BOL 80%)	1600	800	50	50	50	300

- **TRL**: 9 = commercial, 5 = module level test bench (82V), 4 = validated in lab. (16Ah)
- **HL**: 6 = using lithium as-received (1 short circuit failed and thermal runaway issue), 4 = using protected lithium
- **Ah:** %2 due to cell voltage and Li-ion pack Inverter Max./Min voltage + due to optimized Ah for Li-S
- **Power**: 72% of the C/5 BoL at 2C
- **Cycles**: 50 = using lithium as-received, 800 = using protected lithium
- **Wh/l**: Li-ion = Li-S

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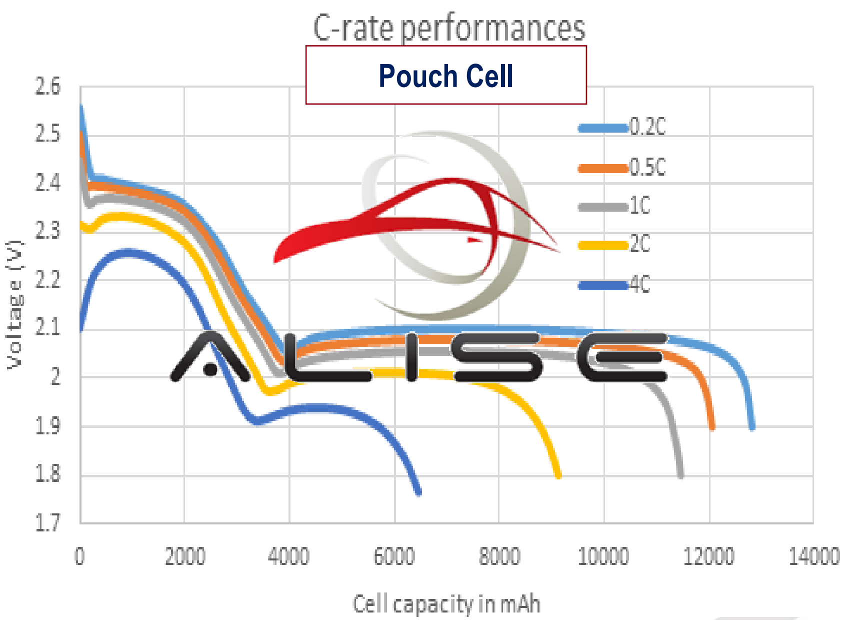
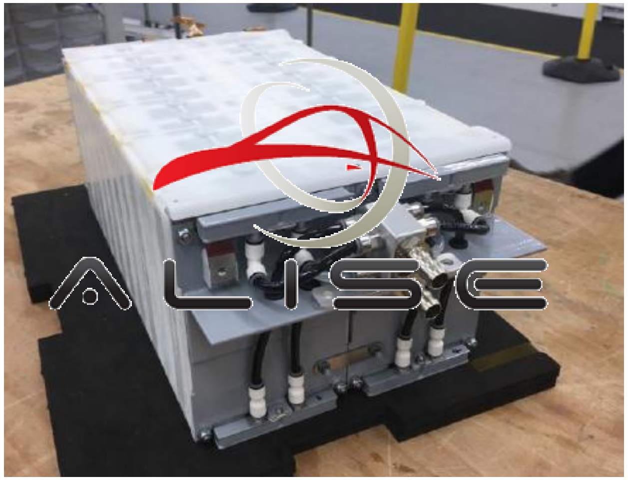
ALISE Results Highlight

- 2017, 1st GEN, >100 Units 290 Wh/kg, 200 Wh/L, 12.5 Ah pouch cells produced
- 2017 High performance cathode pilot production (>1.200 mAh/g, 72% of the C/5 BoL at 2C)
- 2017 1st Li-S module for PHEV is built with 82 Lithium Sulphur cells (41s2p)
- 2018, 2nd GEN, >300 Units 310 Wh/kg, 240 Wh/L, 14.3 Ah pouch cells produced
- 2018, ALISE Li-S SoC estimator





2.15 kWh, 82V, 140 Wh/kg, 125 Wh/l

Real: 21.47 Ah (instead of 25 Ah), 1.89 kWh, 125 Wh/kg, 117 Wh/l, 135 < W/kg < 158

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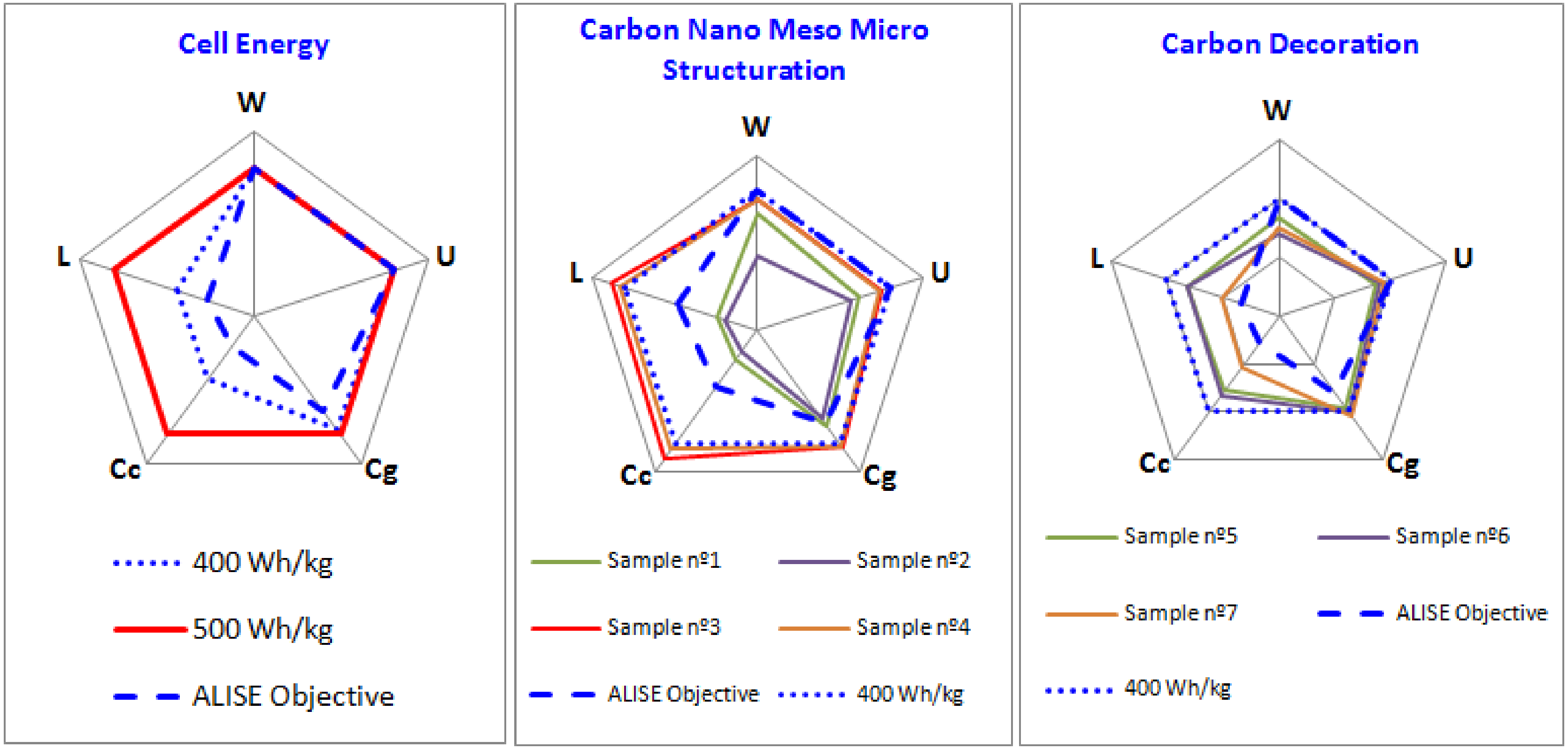
ALISE Results Highlight

> 70 %wt S, > 0.7 g/cm^3, >1.350 mAh/g, >4 mAh/cm^2



Achievement for LiS cathode online with ALISE objectives. Results are given for C/10 and not more than 5µl of electrolyte per 1mg of Sulphur. W: Sulphur Content in cathode (%wt), U: Sulphur utilization (%), Cg: Specific weight capacity of S @ 100% DoD (mAh/g), Cc: Areal specific capacity of S @ 100% DoD (mAh/cm^2), and L: Loading of S (mg/cm^2)

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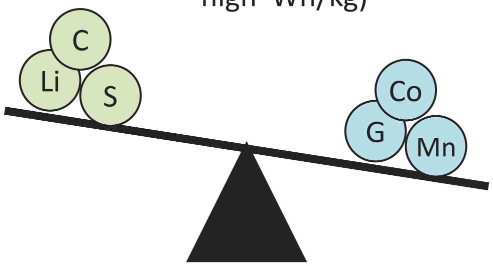
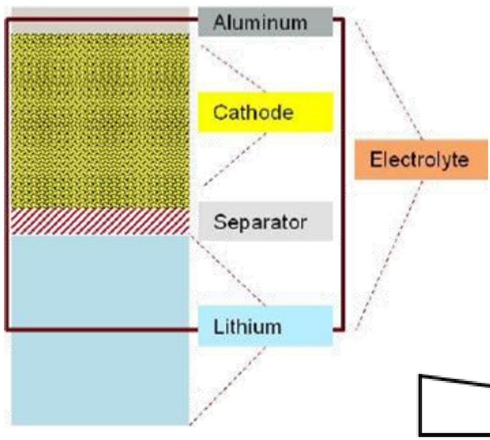
Li-S improvements

+

Li-S is the lighter technology

(high capacity and low density then high Wh/kg)





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Li-S is not compact

(low Wh/l, low power)

PHEV Criticalness parameters

		Safety	Wh/L	Power	Cycles	Cost
Anode	To protect metallic lithium	●●●	●	●	●●	Higher
Anode	To make it thinner and to reduce lithium excess		●●●	●		●●
Anode	To develop lithium alternative	●	Lower	Lower	Lower	●●
Dielectric	To improve stability	●●●	●	●	●●	●
Dielectric	To reduce electrolyte content		●●●	●		●●
Dielectric	To stabilize artificial SEI	●●	●	●	●●	●
Dielectric	To improuve PS solubity	●	●	●●	●●●	●
Dielectric	To build selective membrane separator	●	●	●	●●	Higher
Dielectric	Solid Electrolyte?	●●●	●	?	●	Higher
Cathode	To make denser and thinner electrode		●●●	●		●●
Cathode	To keep PS at the neighborhood of the cathode	●	●	●●	●●	●
Cathode	To nano/micro structured for electrolyte content and S reaction sites	●	●●●	●●	●●	●
Cathode	To reach higher conductive network and mechanically stable			●●●	●	●

Improvement rate expected: Low (●), Medium (●●) and High (●●●)

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Extract from public ALISE delieverable: D7.4 Market Analysis

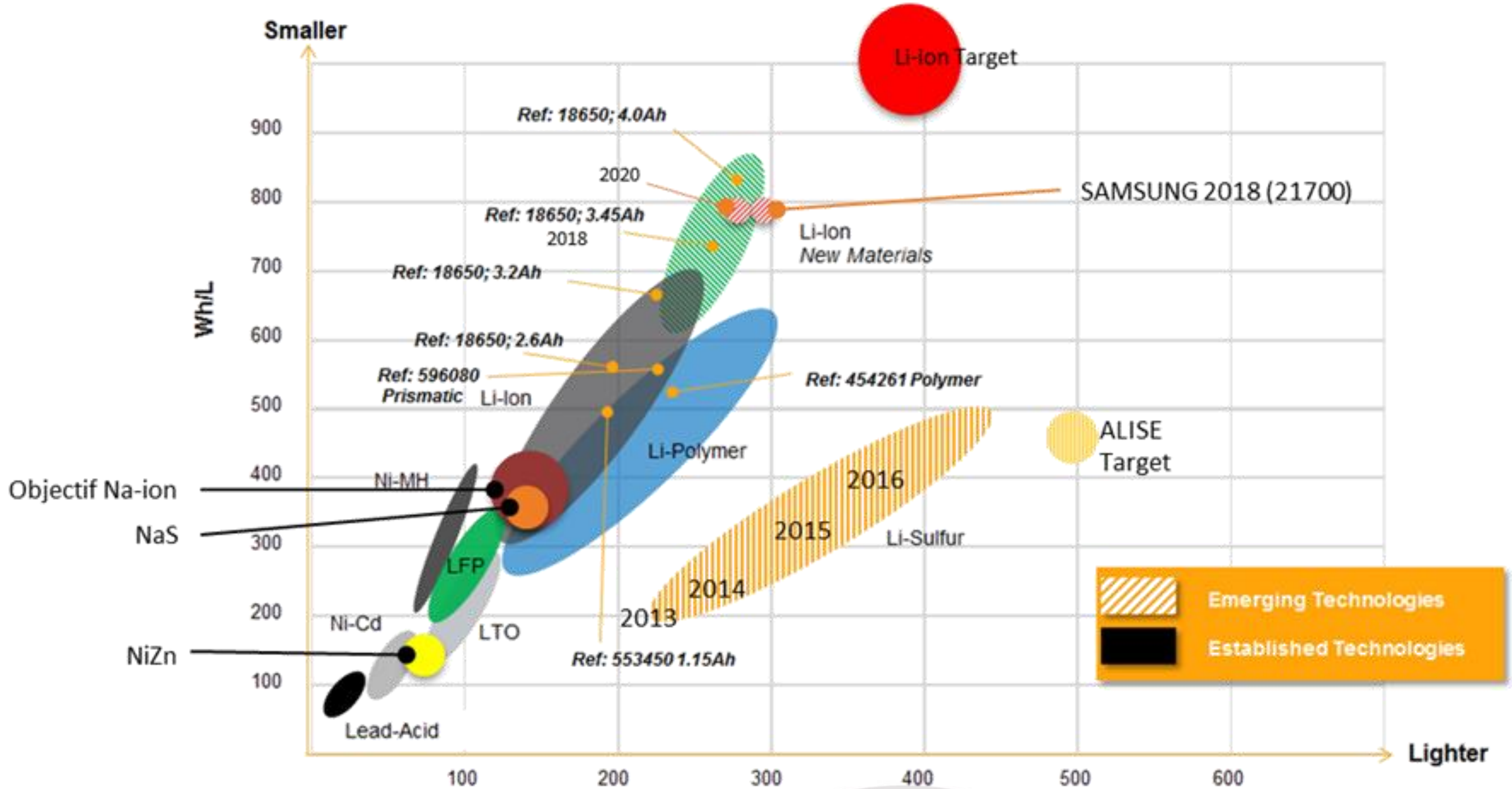

Figure 2: Projection of ALISE LiS technology Vs. other battery technology

Sources AVICENNE ENERGY 2018

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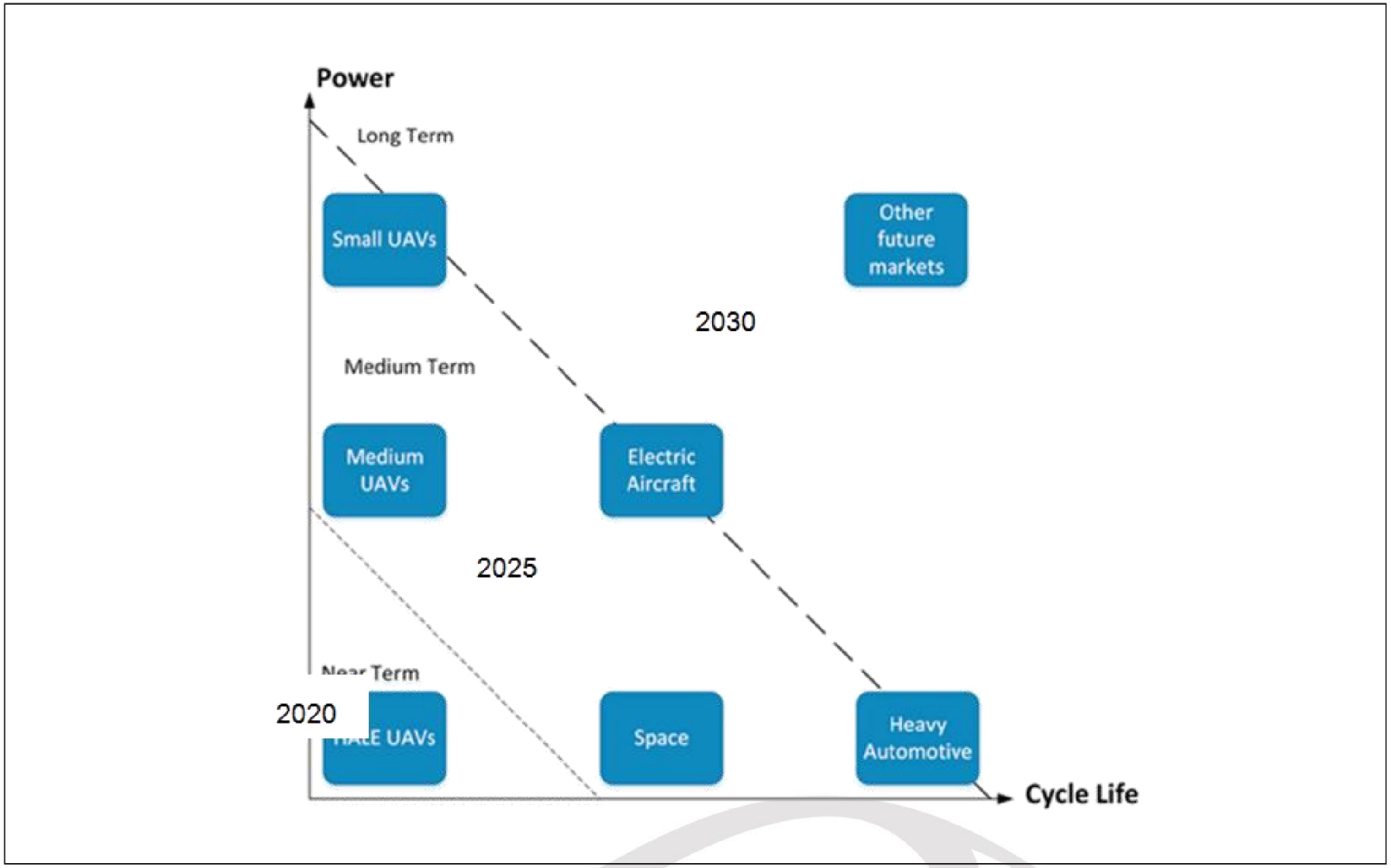

Figure 4: Li-S cell applications versus improvements to power, cycle life and timescale-
Source: Lithium-Sulfur Battery Technology Readiness and Applications, Oxis, 2017

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Take away

- Compromised between safety and performance has to be reached
- Lack of lithium protection and up scaling manufacturing associated
- Limitation in Wh/l, power and cycle versus intercalation chemistry

- European leading technology
- Free NMP and Co technology is provided
- x2 gravimetric energy density versus commercial lithium ion

- New SoC estimator and electronic control in development for usable LiS technology
- First Li-S PHEV module manufactured
- Electrical driving test will be simulated for both PHEV and BEV at module level
- Lab scale demonstrator (>15Ah) will be built from lithium protection researches

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