



axeon



Lithium Ion Batteries : Powering E-Mobility

Axeon Technologies Ltd,

Dr Valentina Gentili, Electrochemical Engineer **March 2012**

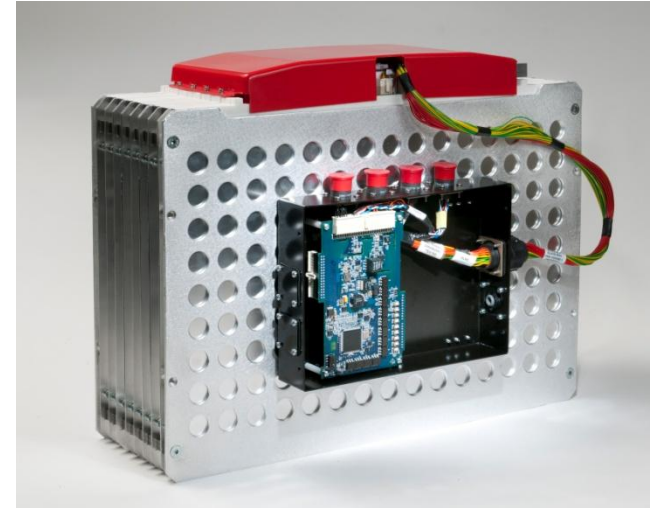


Company overview



About Axeon

- Over the last decade Axeon has developed a leading independent lithium-ion battery development team, recognised for leading-edge battery design and manufacturing capabilities
- This technology base enables us to design and manufacture advanced lithium-ion battery systems for a variety of end market applications:
 - Automotive (electric and hybrid vehicles)
 - Cordless power tools and mobile products
 - E-bikes
 - Energy storage
- Significant contracts have been won and delivered with blue chip clients on landmark future programmes





Global footprint

➤ 150 professional and 300 production staff



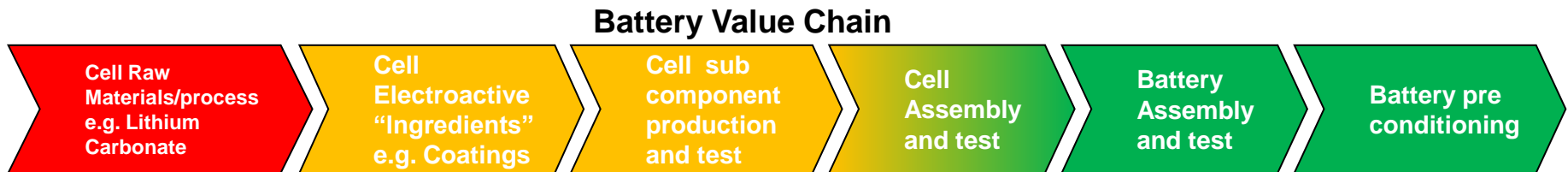


Technology overview



Technology development approach

- ❖ Axeon's core competence is in designing and assembling battery systems using its electro-chemical, electronic, electrical and mechanical engineering expertise
- ❖ Axeon is positioned as a partner to both OEM customers and cell supply partners providing a one stop shop answer to the OEMs need for a leading edge performance, cost competitive solution to their EV battery needs, including turn-key battery design, development, assembly and test capability throughout the product life cycle.
- ❖ Axeon offers an independent "cell agnostic" technology benchmark input which can be used to validate cell vendors technology claims.
- ❖ For production, Axeon can either provide turnkey standalone battery supply or a collaborative solution working with cell, OEM or assembly partners.



Axeon Value Proposition





Applications



Applications for Axeon technologies

Automotive



Power Tools and Mobile Power



E-Bikes



Energy Storage



Automotive experience – prismatic cells



Volume production; conversion of Peugeot vehicles for the leading British vehicle converter. Range includes cars, people carriers and vans

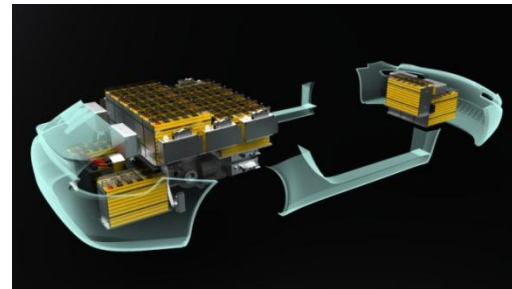
Prototype fully electric Land Rover Defender



Applus⁺
IDIADA



E-Cabstar - fully electric urban delivery vehicle



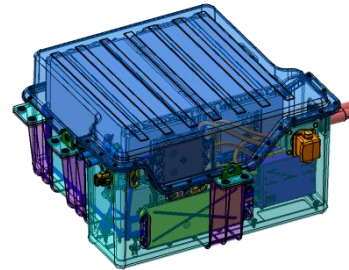
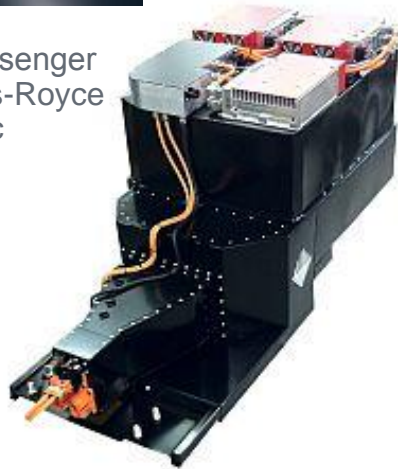
Electric conversion of Porsche 911 for Ruf. High range (250 – 320 km on single charge) and complicated packaging



Automotive experience – pouch cells



The world's most powerful passenger car battery for the 102EX Rolls-Royce Phantom Experimental Electric



REEvolution project - Parallel Hybrid plug-in electric vehicle, based on a X351 extended wheelbase XJ



Intelligent Energy™

Battery for range extended delivery truck with very lightweight chassis



New NCM pouch cell battery, tested in an electric Peugeot Partner, with 35% greater range

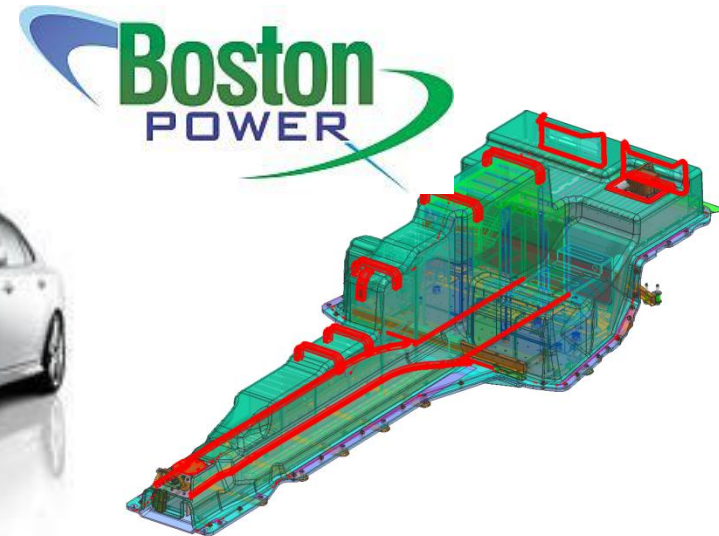
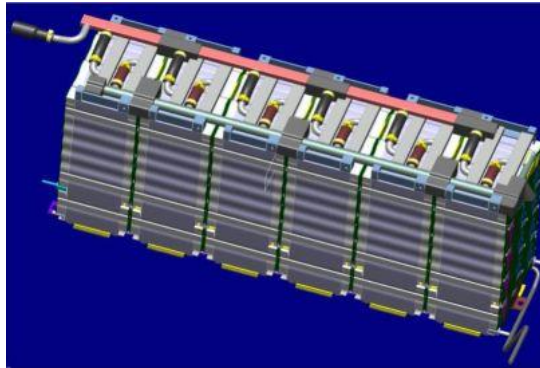




Automotive experience – cylindrical cells



HEV sports car: developing leading-edge technology for premium European manufacturer



Manufacture of US cell manufacturer's pack design for fully electric saloon car. Axeon chosen for manufacturing technology skills and experience.



E-bikes

- ❖ Axeon was recently awarded another major e-bike contract, based on our full service manufacturing capability
- ❖ Now working on several e-bike projects using various cells from different cell manufacturers
- ❖ Efficient and cost-effective service, producing 12,000 batteries per month (1.2mln cells)
- ❖ This is backed up by our excellent design capabilities, global sourcing capability and cell-agnostic approach

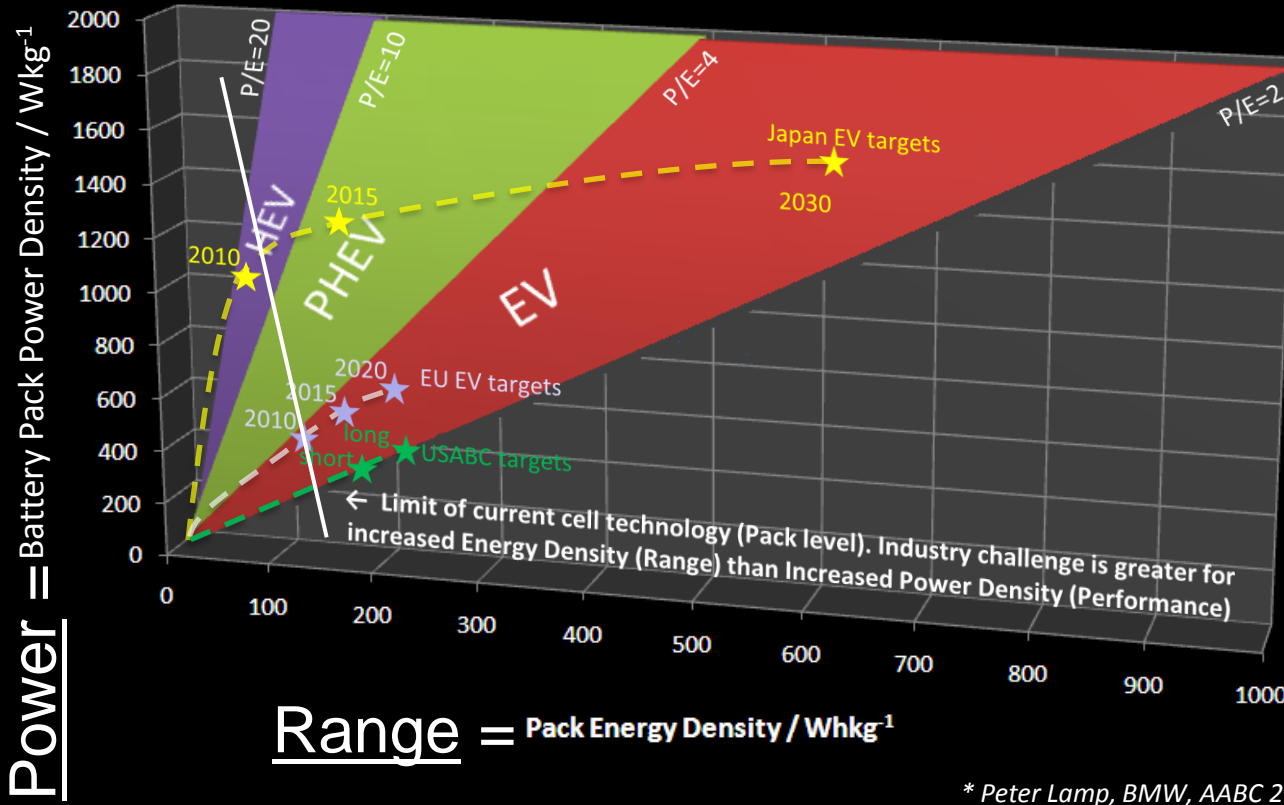




Industry Trends

Industry challenge is dominated by increased energy density (range)

Electric Vehicle Battery Requirements *



* Peter Lamp, BMW, AABC 2010

Industry challenge is greater for increased Energy Density (Range) than Increased Power Density (Performance)

- HEV (Hybrid EV) e.g. Toyota Prius. Internal combustion engine (ICE) combined with a small battery which captures energy during braking and reuses to boost acceleration. Short range in pure EV mode.
- EV (Electric Vehicle) e.g. Nissan Leaf. Pure electric vehicle with no ICE. Battery is the only source of power and is larger to deliver range.
- PHEV (Plug in Hybrid EV) e.g. Chevrolet Volt. Vehicle still has ICE but with a battery which can be charged externally and hence support longer EV range.
- Note:- REEV (Range Extended EV). Battery is primary source of power but vehicle has small ICE as a back up generator for longer range journeys.



Our cell partnerships are key

- Axeon has a wide variety of battery chemistries from which to choose, and the experience to engineer an optimized solution based on that chemistry
- We have strategic relationships and multiple supply contracts in place with all major global suppliers of high capacity Lithium cells
- Experienced in using all cell form factors (prismatic, pouch, cylindrical)
- All cells subject to in-house qualification
 - Verification of supplier specifications
 - Environmental testing
 - Cycle testing
 - Abuse testing





Battery Life Assessment



Summary

- ❖ Axeon has extensive real world experience of EV and HEV batteries including a range of cell chemistries and Battery Management Systems.
- ❖ Axeon is “Cell Agnostic” but well connected to cell vendors and participating in joint research and development programs.
- ❖ Multi-disciplinary engineering, with electrochemical performance and thermal analysis allow for complex understanding of cell performance as well as integration and calibration of BMS.
- ❖ These processes aid Axeon to develop and design manufacture bespoke battery solutions for demanding applications tailored to integrate effectively into EV/HEV and PHEV vehicle platforms
- ❖ Axeon has a future view of these rapidly developing technologies backed up by real research and development programs and real end customer development projects.





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