



European Green Cars Initiative



EPoSS
European Technology Platform
on Smart Systems Integration

Report on the Joint EC/European Green Cars Initiative Expert Workshop 2013 EV Batteries: Moving from Research towards Innovation

10 April 2013

1) Objective of the workshop

The workshop was a joint activity of the European Commission and the European Technology Platforms involved in the European Green Cars Initiative PPP, EPoSS and ERTRAC and prepared by the Coordination Actions “Implementation for Road Transport Electrification” (CAPIRE) and “Smart Electric Vehicles Value Chains” (Smart EV-VC).

The aim of the workshop was to provide recommendations on R&D&I support activities in the framework of H2020 based on:

- A review of the results of collaborative research projects on batteries funded under the European Green Cars Initiative.
- A review of relevant attempts in implementation of prototype manufacturing and mass production in Europe
- A discussion on current EU activities and policies for bridging the gap between research and innovation in the domain of batteries for EVs, including European activities and policies to foster innovation
- Evaluation and benchmarking of electrification approaches from a system perspective

Invited experts included the coordinators of European collaborative research projects on batteries, leaders of major pilot activities for battery manufacturing, as well as representatives of European companies active in battery technology, automotive manufacturers and – suppliers, and research institutions. Representatives of relevant Directorates General of the European Commission also participated.

Structure of the workshop:

- Opening Session by Günter Lugert (Siemens, Chairman EPoSS Executive Comm and Vice Chairman of EGVIA) and keynote by Liam Breslin (Head of Unit Surface Transport, DG RTD of the European Commission)
- Session 1: Results of Current Research Projects
- Session 2: Knowledge Transfer from Research to Innovation
- Session 3: Supporting Innovation in Europe
- Session Discussion
- Conclusions & Wrap Up by Gereon Meyer (VDI/VDE) and closing remarks by Wolfgang Steiger (Volkswagen / Chairman ERTRAC and EGVIA) and Willy van Puymbroeck (Head of Unit Nanoelectronics, DG CNECT, EC)

Simultaneously EV projects focusing on battery related research were presented in a poster session.

Report from Workshop Sessions

Günter Lugert (Siemens, Chairman EPoSS Executive Comm and Vice Chairman of EGVIA) welcomed the participants and noted that batteries are a key topic for the vehicle electrification. This is mentioned in the ERTRAC-EPoSS-SmartGrids Electrification Roadmaps, targeting ambitious performance increase and cost reduction. Currently, there are approximately 20 projects dealing with battery matters: materials, technologies and processes, manufacturing.

Liam Breslin (Head of Unit Surface Transport, DG RTD, European Commission) delivered the keynote pointing out the necessity of cooperation/coordination between the different EC areas involved in the EGCI. The different areas have already been implemented by joint calls, which will continue and be improved within H2020. He pointed out that, although roadmaps are already available, workshops like this one are useful to define the scope and breakthroughs, the potential need for larger projects in this area and what should be done in the specific domain of batteries, dominated by Japan and China, to support the European industry.

Session 1: Results of current research projects

The purpose of this session, chaired by Emma Briec (Renault - France), was to review current international R&D projects which target aspects relevant to EV battery systems and their manufacturing.

The following projects were presented:

AMELIE

Jean Yves Sanchez (INP Grenoble, France) presented the “Advanced fluorinated materials for high safety, energy and calendar life Li-ion battery” project. It focuses on 5V batteries with 200 Wh/kg and developing new stable liquid electrolytes, discarding unsafe/unstable LiPF₆, and new nanoporous separators with lower ohmic drop for batteries with LNMO cathodes and lithiated graphite anode.

Easybat

Chanan Gabay (Better Place Labs, Israel) gave a presentation on the Easybat project. Easybat stands for “Models and generic interfaces for easy and safe battery insertion and removal in EVs” and deals with standard interfacing for safe battery switch in an EV. The interface includes a mechanical interface, a high voltage power interface, cooling interface, low voltage and data interfaces. Main project objectives are the development of generic interface concepts, the development of recommendations for standards and the assessment of the proposed solutions in terms of cost, logistics and environmental impact.

He highlighted the experience in Amsterdam where the Airport Taxis are electric vehicles (Renault Fluence). It has been proposed to develop new standards to allow for interoperability and interchangeability between the battery and the vehicle on-board systems.

ESTRELIA

Presentation of the ESTRELIA project was given by *Ewald Wachmann* (AMS, Austria). ESTRELIA stands for “Energy storage with lowered cost and improved safety and reliability for electric vehicles” and focuses on the development of ICT for improving battery

performance, safety and life: new safety sensors, BMS concepts with fuse cells, and cost efficient systems for batteries and an ultracapacitor-battery packs (a power pack extension for Li-ion batteries).

Specific project deliverables are dealing with new antifuse devices, new Li-ion battery emission sensor, new MEMS based spark detection sensors, new ultracapacitor power cells with higher energy density, Li-ion cell demonstrator with BMS, sensors and fuse cells as well as new cell balancer and monitor IC: either active or passive balancing through integrated switches.

SOMABAT

Leire Zubizarreta (Asociación ITE, Spain) presented the SOMABAT project dealing with the development of novel solid materials for high power Li polymer batteries.

The general objective of the project is the development of novel breakthrough recyclable solid materials to be used as components (anode, cathode and electrolyte) for a high energy density and safe Li polymer battery, to study and test the potential recyclability of components, and to study the sustainability of the final developed battery.

Additionally SOMABAT aims at developing Li polymer batteries with an energy density higher than 220 Wh/kg and a final cost lower than 150 €/kWh. Research areas within the project focus on materials (cathode, anode and polymer electrolyte), design and integration (modeling, BMS and battery) and sustainability (recycling and life cycle analysis). The presentation then went into each individual research area and the results that have been obtained until now.

SuperLIB.

Can Kurtulus (AVL List Austria) presented “Smart Battery Control System based on a Charge-equalization Circuit for an Advanced Dual-cell Battery for EVs”. The main objective is the development and control of an integrated battery with Li-ion high energy and high power cells in a highly integrated package with shared cooling. The electronic architecture for an efficient energy and current distribution allows extending usable SOC of the battery. Two different target applications were mentioned: an EV (Fiat 500) and a plug-in hybrid bus (Volvo). The dual cell concept will be evaluated and benchmarked with respect to the single type cell concept by load cycle simulation and testing.

New developments to be highlighted are high energy-high power combined module design with a dual cell battery that includes LFP pouch type cells, with improved cycle life and roundtrip efficiency. Cell temperature sensor design based on the printed electronics technology and DC/DC converter concept were also mentioned.

He concluded by highlighting some aspects beyond SuperLIB: total cost of ownership (TCO) of batteries; production technologies and system integration; cost optimized new battery concepts; battery packs increased high energy and power density; high voltage systems (up to 1000 V); high safety; heating/cooling/insulation with a lifetime over 10 years and standardized battery systems.

Smart LIC

The SmartLIC project was presented by *Jochen Langheim* (STMicroelectronics France) and focuses on new BMS systems for Li-Batteries. Objectives include a new BMS system architecture, accurate battery state determination system, BMS communication systems EMC taking into account EMC effects, reliable, secure & cost effective packaging/system integration, plagiarism and testing. The presentation explained that distribution of BMS functionalities down to (macro-)cell level brings higher efficiency due to local control at

(macro-)cell level. It also causes increase precision in determining SoC, SoH, and SoF, implementation of a new cell / battery model based on electrochemical impedance spectroscopy (EIS), increased safety so that cells can perform at maximum rating without thermal risks due to redundant sensors and HT joints, reduced cost of ownership for the end user due increase in battery lifetime caused by the smart battery management (if battery technology and market evolution is well considered). The next steps for the project will be proof of concept for power module functionalities (safety switching, balancing, ...) and proof of concepts for electronic / power module reliability improvement due to overmoulding by means of various (combined) APCTs.

Standards are also a key issue for the sector: Japan is standardizing everything at 30V: maybe they provide a better solution than 48V.

ELIBAMA

Jerome Peyrard (Renault France) presented “European lithium-ion battery advanced manufacturing”. Major challenges for the project includes battery cost, quality, battery manufacturing and recycling, environmental impact, production scale-up and the strong competition from Asia.

ELIBAMA is a large project based on 3 pillars: a powerful consortium with 17 partners, main actors covering a wide spectrum of battery manufacturing steps and 3MEuros dedicated to the demo. Currently the project has finished the lab scale process phase and is preparing pilot scale.

It covers organic solvent free electrode coating, efficient cell manufacturing processes, clean manufacturing process control and non-destructive testing of Li-ion cells for production quality control (EIS). In 2014 they will produce and test 20-40 Ah cells to demonstrate the forecasted improvements.

Results up to date are in line with projects initial objectives.

Session 2: Knowledge Transfer from Research to Innovation

The second session dealt with specific energy roadmap for commercial battery cells and was chaired by *Pietro Perlo* (IFEVS Italy). He gave an introduction to the evolution of Li-Ion Battery Technologies, amount of battery capacity needed in the future and a comparison with the Japanese approach to research and the market. The fact that in Japan the main growth application of Li-ion batteries is not EVs but Vehicle to Home (V2H) applications was also pointed out.

Jesus M. Goiri (CIC Energigune Spain) talked about the technology centre’s responsibility for the coordination of Energy Storage research activities in the Basque Country. There is a strong public focus on the development of EVs in the Basque country: a pilot of EV fleets (e-Vito, e-Smart), new vehicles as well as IBIL (EVE+REPSOL) to build and operate an EV-charging network . In the Basque country there is a strong industry for smartgrids, power electronics, automotive industry and suppliers, therefore energy storage is a key area, and specifically materials related to electrochemical and thermal energy storage. Their main goal is the creation of economic activity, through industrial development and job creation, involving universities and private companies. However, they faced difficulties related to the commercialization, the need to attract seed capital and lack of entrepreneurial culture.

Werner Tillmetz (Helmoltz- Institut Ulm Electrochemical Storage / ZSW, Germany) discussed Li-Ion Batteries in transportation applications, power supply markets and LiB

battery manufacturing. He also discussed competencies needed for the successful commercialization of the LiB – technology as well as achievements based on these competencies. In the future, the Institute aims at production technology (industrial) for large size Li-Ion-batteries. Batteries are a core technology for the majority of future drivetrains in transportation (electric mobility EVs, PHEVs, REHEVs, HEV), but are also important in power supply markets: decentralized storage of renewable energies, grid independent power supply, power quality & load leveling, and emergency power (UPS).

All investments in developing materials will prove fruitless, if the ability to manufacture batteries cannot be developed.

These competencies are needed to manufacture batteries in the following domains:

- Materials: synthesis, particle morphology, electrochemistry,
- Manufacturing processes: slurry preparation, coating technologies
- Assembly: cell design assembly technologies, formation technologies
- Testing: performance testing, safety testing, BMS
- Disassembly and post-mortem analysis.

ZSW has built a research center lab with public money from the German recovery package for electric mobility (30 MEUR), and plans to increase its competencies with a new e-lab for production technologies for large size Li-ion batteries. This will then create a platform to establish the production of large battery cells (20-30 Ah) with optimized yield, quality and cost (target 200 USD/kWh).

Different installations are required for different technologies: mixing into slurry preparation, coating & calendaring, assembly and formation. Commissioning of the complete production from June 2014 on.

Christophe Garnier (Renault/CEA Lab, France) then spoke about the “Paths Towards EV Battery Production”. The Renault-Nissan zero emission strategy aims at offering affordable EVs. The ZOE, a FEV with a 210 km range (following NEDC) and 100-150 km in suburban use, cost 13700€ in France (including the 7000 rebate) plus a battery fee of 79 /month, R link system with EV specific applications and the first EV with fast AC charging capability (3 to 43 kW). The Battery is a key component but not yet a mature technology, with different Li-ion chemistries available (Bolloré LMP, Honda LTO anode, Renault LMO/graphite). Batteries imply a lot of components and technical fields to master, from R&D to production. For this reason Renault has established partnerships with different stakeholders. The increase of European added value would lead to the building of a strong local industry. Renault and the CEA signed a strategic partnership in 2010 on the development of new generation batteries for electric vehicles. The R&D Laboratory involves more than 100 people, covering a set of technologies in a single place and benefiting from CEA technical experience and skills. According to the company strategy, 3 key points must be mastered to lead the race: R&D to anticipate new products, production for cost reduction and quality assurance, and network of partners/suppliers to consolidate the global framework. Strong investments were made in batteries in the last 3-4 years.

Ian Faye (Bosch, Germany) spoke about system integration. He pointed out that Europe is leader in system integration and BMS. Battery and system integration in the power train involves battery integration & several interfaces: mechanical and environmental, electrical power and recuperation, thermal, communication and management and safety aspects. The battery is the component with the most weight, volume and cost in the electric powertrain (battery/power electronics/e-motor). An integrated system must lead to lower weight volume and cost reduction. Thus, it is evident that the interplay of increasing energy efficiency and advances in battery system development will lead to synergetic reductions in cost and energy

consumption. Another important point is scaling of production. High volumes provide a smaller share of development costs per battery. An additional development cost of 500 Euro/battery for small manufacturers is estimated.

According to the presentation, system integration should provide additional value to components, optimization of the power train, communication and the whole vehicle system as well as covering safety and supports standardization. Research efforts are still needed to find solutions for product integration, reducing energy consumption of controls and auxiliaries, preheating-cooling of passenger compartment and temperature sensitive components, such as batteries. 2nd Life concepts, reliability & safety and recycling; standardized protocol of SOH of cells/modules; safety level achievement, including data communication are also key issues. However at this moment, recycling capacity is well over the volume of batteries sold.

Session 3: Supporting Innovation in Europe

The third session of the workshop, chaired by *Jesus Monclús* (CDTI, Spain) was dedicated to different schemes for supporting innovation in Europe.

The first presentation was given by *Dimitri Corpakis*, (Head of Unit Regional Dimension of Innovation, DG RTD, EC) and related to synergies between Horizon 2020 and Cohesion Policy (2014-2020).

As Innovation Union, a single innovation market, the EU is committed to support R&D investments through H2020 and structural funds to support R&I of SMEs. However, it appears to be somewhat of an innovation paradox since European actors do not seem able to translate new ideas into new products in the market. Synergies would be achieved via more interactions between the R&I framework programme and the cohesion policy so as to reinforce the European competitiveness.

Keys to fostering synergies are smart specialization and thematic concentration. Smart specialization is a new role for all regions in the knowledge economy to identify competitive synergies (smart specialization matrix). Smart specialization is a 3-step process: vision, strategy and action plan.

Gunnar Muent (Director Innovation and Competitiveness Department, European Investment Bank) then gave an overview on financing schemes supported by the EIB. Since the start of the EGCI the EIB has granted about EUR 17 Billions to the automotive industry. Alone in 2012, EIB has granted almost EUR 2 billion (of which 50% to suppliers) to the automotive industry. Its financing of R&D&I concentrates on lower fuel consumption, emission reduction, active & passive safety technologies and restrictions for incremental innovation – limited to significant cross-market effects.

Technology deployment includes R&D&I such as electric mobility and infrastructure for a more sustainable technology path. EIB lending can be either direct lending (investment loans, RSFF loans for RDI investments, sub-ordinated/mezzanine debt for Mid-Caps) or indirect lending (SMEs or intermediated through commercial banks).

EIB lending schemes for the automotive sector:

- Direct loans: up to 400 M€ investment loans, RSFF loans for R&D investments, and subordinated / mezzanine debt for mid-caps.
- Indirect lending: SMEs for the purchase of new commercial vehicles, intermediated through commercial banks (up to 12,5 M€)

The EIB has recently increased capital for innovation/skills, SMEs and midcaps, resource efficiency and strategic infrastructure. Lending is always linked to an investment proposal, with eligible costs.

Ezio Spessa (Politecnico di Torino, Italy) made a final speech on competencies and skills required for the development of electric mobility. This is illustrated by the e-gomotion project whose goal is to raising awareness of job opportunities and education paths within electric mobility. Through degree programs and project activities such as the regional electrification concept competition, a community of young people with strong awareness of smart-mobility is growing. Long-term impact can be achieved but endorsement/commitment of municipalities, local authorities and industrial advisory board is required to maintain the web platform and support the educators.

Session Discussion

An open discussion followed, from which the following should be pointed out:

- In order to remain an automotive industry leader, advanced battery technologies need to be acquired/developed by the European automotive industry. Hence cost optimized new battery concepts should be researched into by the European FEV community.
- Key enabling technologies are important for structural funds and EIB
- SME participation is to be done via specific instruments and represents 20% of total H2020.
- Smart specialization does not only refer to technologies but also to social innovation. In this respect, clear positioning of the regions is needed.
- Total cost of ownership structure of batteries has to be further worked out in order to develop feasible business solutions for e-mobility.
- Special attention should be turned to efficiently exploit cost reduction potentials provided by mass-production.
- Production technologies and system integration are matters for which Europe has good assets. These assets should be used for the development of European value chains for the smart FEV.
- Safety of battery systems still remains a crucial issue, and considerable research effort has to be dedicated to this aspect.
- Besides the battery cells themselves, heating/cooling/insulation systems with a lifetime over 10 years should be taken into account when designing and developing a battery pack system.
- Currently there is still a lack of standardization rules for battery systems

Closing Remarks

Wolfgang Steiger (Volkswagen / Chairman ERTRAC and EGVIA) made the closing remarks and pointed out that we are facing a double revolution: from ICE to electrification on the one hand and from fossil energy fuels to renewable energy on the other hand.

He noted that, after 100 years of ICE vehicles, the coming 40 years will lead us to electrification in 2050. A clear acceleration is required and, especially, a strong effort in batteries is necessary in order to connect all the value chains in Europe. This track could lead to millions of new jobs in Europe.

Willy van Puymbroeck, Head of Unit Nanoelectronics, DG CNECT, EC, concluded the discussions of the day by pointing out the importance of standards, skills and safety.

Final Conclusions and recommendations

- Given that the most important cost reduction of the battery is achievable with high production volumes, it is imperative that the European OEMs produce EV equipped with batteries made in Europe.
- Meaning that, ambitious European *large scale* R&D programs and investments are necessary to rapidly catch up with the Asian battery manufacturers, which are clearly in front of the European companies since they already possess capacity for producing batteries for portable electronics or hybrid cars.
- Therefore, the complete batteries value chain including materials, components, systems R&D as well as manufacturing and recycling is needed to be in Europe
- Innovation processes in the EV battery domain should be accelerated by equipping laboratories and research centres with appropriate tools for converting promising results of basic research into industrial products, and scaling up production batch sizes to industrial dimensions, in particular for new electrochemical systems.
- In this context is the further support of emerging battery technologies with reduced quantities of rare materials of crucial importance for securing the European supply chain and reducing the dependency on the import of these materials.
- The support of complete electro-mobility clusters and a broad stakeholder community is needed, including policy- and standardization makers.
- A key area for the cost reduction of batteries includes advanced cost-effective BMS associated to thermal management to allow the battery to show a longer lifetime, higher reliability and safety level.
- Modularization of battery systems is also a key factor for cost-effectiveness in the EV battery industry. It covers a wide range of functions fitting into a large number of battery geometries and supporting different vehicle platforms.
- For boosting the deployments of EV's, EU project funding and the EIB are important for supporting the development of new EV/PHEV technologies, batteries and manufacturing. The whole European community working around the electrification of road transport should be involved, with special attention for SME's.

The agenda and all presentations of this workshop can be accessed at <http://www.smartev-vc.eu/workshops/electric-vehicle-batteries-moving-from-research-towards-innovation>.

The proceedings of this workshop will be published as a volume of the Springer Series Lecture Notes in Mobility.



Joint EC / European Green Cars Initiative Workshop 2013
EV Batteries: Moving from Research Towards Innovation
10 April 2013, Fondation Universitaire, Rue d'Egmont 11, Brussels

Agenda

- 9:30** **Opening**
Welcome
Günter Lugert, Siemens / Chairman EPoSS Executive Comm / Vice Chairman EG VIA
Keynote
Liam Breslin, Head of Unit Surface Transport, DG RTD, European Commission
- 10:00** **Coffee Break**
- 10:30** **Session 1: Results of Current Research Projects**
Chairperson: Emma Briec, Renault (France)
AMELIE, Jean Yves Sanchez, INP Grenoble (France)
Easybat, Chanan Gabay, Better Place Labs (Israel)
ESTRELIA, Ewald Wachmann, AMS (Austria)
SOMABAT, Leire Zubizarreta, Asociacion ITE (Spain)
SuperLIB, Can Kurtulus, AVL List (Austria)
SmartLIC, Jochen Langheim, STMicroelectronics (France)
ELIBAMA, Jerome Peyrard, Renault (France)
Discussion (*all*)
- 12:30** **Lunch / Posters on all other battery projects**
- 13:30** **Session 2: Knowledge Transfer from Research to Innovation**
Chairperson: Pietro Perlo, IFEVS (Italy)
Strengthening Industrial Competitiveness in Energy Storage Systems
Jesus M. Goiri, CIC Energigune (Spain)
Pilot Production of Li-Ion Batteries
Werner Tillmetz, Helmholtz-Institut Ulm Electrochemical Storage / ZSW (Germany)
Paths Towards EV Battery Production
Christophe Garnier, Renault/CEA Lab, Grenoble (France)
System Integration
Ian Faye, Bosch (Germany)
Discussion (*all*)
- 15:00** **Coffee Break**
- 15:30** **Session 3: Supporting Innovation in Europe**
Chairperson: Jesus Monclus, CDTI (Spain)
Structural Funds and Horizon 2020
Dimitri Corpakis, Head of Unit Regional Dimension of Innovation, DG RTD, EC
Financing Support Schemes by the EIB
Gunnar Muent, Director Innovation and Competitiveness Department, EIB
Competencies and Skills for Electric Mobility
Ezio Spessa, egomotion project, Politecnico di Torino (Italy)
Discussion (*all*)
- 16:30** **Conclusions**
Wrap-Up
Gereon Meyer, VDI/VDE-IT

Closing Remarks

Wolfgang Steiger, Volkswagen / Chairman ERTRAC and EGVI

Willy van Puymbroeck, Head of Unit Nanoelectronics, DG CNECT, EC

Posters from APPLES, AUTOSUPERCAP, ELECTROGRAPH, EUROLIION, LABOHR,
SmartBatt, ELIBAMA, GREENLION, OPERA4FEV, NECOBAUT, STABLE,
Battery2020, Eurolis

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EV Batteries: Moving from Research Towards Innovation
10 April 2013, Fondation Universitaire, Brussels



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