	EUROPEAN COMMISSION RESEARCH AND INNOVATION DG	Periodic Report

Project No: 266074

Project Acronym: SmartBatt

Project Full Name: Smart and Safe Integration of Batteries in Electric Vehicles

Periodic Report

Period covered: from 01/01/2012 **to** 31/03/2013

Start date of project: 01/01/2011

Project coordinator name:
Mr. Hansjoerg Kapeller

Version: 1

Date of preparation: 30/11/2012

Date of submission (SESAM):

Project coordinator organisation name:
AIT Austrian Institute of Technology GmbH

Periodic Report

PROJECT PERIODIC REPORT

Grant Agreement number:	266074
Project acronym:	SmartBatt
Project title:	Smart and Safe Integration of Batteries in Electric Vehicles
Funding Scheme:	FP7-CP-FP
Date of latest version of Annex I against which the assessment will be made:	30/08/2012
Period number:	2nd
Period covered - start date:	01/01/2012
Period covered - end date:	31/03/2013
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Declaration by the scientific representative of the project coordinator (1)

I, Mr. Hansjoerg Kapeller AIT Austrian Institute of Technology GmbH , as scientific representative of the coordinator of the project SmartBatt and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

The project has fully achieved its objectives and technical goals for the period.

The attached periodic report represents an accurate description of the work carried out in this project for this reporting period.

The public website is up to date.

To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section 6) and if applicable with the certificate on financial statement.

All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name	Mr. Hansjoerg Kapeller AIT Austrian Institute of Technology GmbH
Date	

This declaration was visaed electronically byHansjörg KAPELLER(ECAS user name nkapelha) on

1. Publishable summary

Summary description of project context and objectives

The European countries are committed to keep on reducing CO2 emissions and slowing down the climate change. For the individual transport system, the pure electric vehicle technology powered by "green" electricity offers a great chance for an important contribution to the protection of the environment. Resulting from low energy density of batteries and the need to offer a convenient range, the battery packs of the near future will be heavy and bulky (despite the latest advances in Li-Ion cells).
The project context of SmartBatt (full title: "Smart and Safe Integration of Batteries in Electric Vehicles") is to develop and proof an innovative, multifunctional, light and safe concept of an energy storage system which is integrated in the electric car's structure. The main challenges of this smart integration are the combination of lightweight design with a high safety level against all kinds of hazards, the optimization of functions and the intelligent design of interfaces to various on-board systems. In order to meet the various challenges, a consortium of 9 companies and institutes from 5 European countries with good reputation was formed capable of viewing on the problem from all important sides and willing to contribute with their knowledge and capacities to the solutions for this specific topic.
• AIT Mobility Austria
• AIT LKR Austria
• Axeon United Kingdom
• Fraunhofer Germany
• Impact Design Europe
• Ricardo United Kingdom
• SP Sweden
• TU Graz Austria
• VOLKSWAGEN Germany
The expertise of all partners comprises complete vehicle competence, electrics, electronics, batteries, lightweight design, engineering, materials, testing and validation.
The consortium is well balanced: 4 industrial (incl. 2 SMEs) and 5 research partners. The exploitation is not limited to the partners but results will be distributed on different ways e.g. project website, papers or trainings as well as face-to-face workshops and meetings with OEMs.
Goals of the SmartBatt project and partners
The goal of the SmartBatt project is to develop an innovative multi-functional and at the same time safe lightweight construction housing for the battery system of purely electrically operated vehicles of the future. Here the battery case is no longer a separate supplement to be considered for the design of the bodywork but a fully integrated and basic structural component of the vehicle body (e.g. vehicle underbody).
To achieve this goal multidisciplinary domains of engineering sciences (e.g. electrical engineering, chemistry, mechanics, material sciences) have to come to appliance in an interdisciplinary way.
Difference of SmartBatt compared to other battery research programs
In purely electric driven vehicles there is a high claim to energy- and power density of the battery systems. But in foreseeable time battery and cell technology will not be so far advanced that they fulfill the wishes of the OEMs. Thus, the battery system will have the largest proportion in the total vehicle weight.
The SmartBatt project – in contrast to other battery research programs – seeks to reduce the overall weight from the battery system by an optimization of the housing structure and through intelligent vehicle integration. The objective will also be reached through innovative simulation tools and the combination of lightweight construction and new, innovative lightweight materials. A complete "tool chain" will be provided for the development of such a lightweight housing that nevertheless has to comply with highest safety standards.

Description of work performed and main results

Efficient communication and cooperation between partners were ensured during the entire project duration. Meetings were aligned and sequenced. To ensure quick information exchange and to keep travel costs low periodically WebEx telephone conferences (to synchronize and share action items between involved partners) were organized. The SmartBatt project ended successful in March 2013.

WP2 Specification Analysis/Requirements
In WP2 the main result shows a list of specifications and targets for the smart battery. It comprised electrical, mechanical, crash, environmental, thermal and miscellaneous requirements. These requirements were developed from an analysis of currently used standards and specifications and the knowledge of all partners.

WP3 Concepts & feasibility study.
Aim of this work package was to develop concepts for the smart battery integration taking inputs from WP2 (specification analysis / requirements) and WP4 (risk assessment). Rather than the planned single concept 4 concepts were under consideration. At the end of the review period the final selection was made from the results of WP4. The key milestone M3 (concept to be carried forward into WP5) has been met on 20th January 2012 and the deliverable report D3.1 (report on concepts) was completed and approved by all partner organisations on 8th February 2012.

WP4 Risk assessment.
In order to describe all relevant risks that are seen on battery integration and on operating a battery in a vehicle, a theoretical and an experimental approach were applied within WP 4.
From the theoretical point of view a generic battery design FMEA was generated considering implications on cell, housing, hardware, software and vehicle level with inputs from every partner.
The major risks identified were:
• Water, both ingress and condensation
• Coolant leakage
• Mechanical protection against crush and crash
A testing plan has been developed based on the outcome of WP2, WP3 and task 4.1. Cells have been purchased and prepared for the tests and distributed to the testing partners and facilities booked for the tests. The following tests have been conducted:
• Thermal Shock Test
• Mechanical Shock Test
• Overcharge Test
• Nail Penetration Test
• Hard Short Circuit Test
• Thermal Stability Test

WP5 Design & Development.
In WP5 the final design for the SmartBatt demonstrator was developed and realized in CAD. With the input of WP2, WP3, and WP4 the consortium decided to use prismatic cells. The consortium worked in two subgroups – housing group and inner parts group – to finalize the WP5 in time.
The inner parts group focused on the module design and the electrical components. Solutions for modules, BMS and wiring were found.
The housing group focused on the mechanical integration of the SmartBatt battery system. Innovative materials were used, for example APM hybrid sandwich material for the cover and cast aluminium for the tunnel. Functional integration helped to meet the weight and safety targets D2.1. The ratio between cell mass and the total mass is over 80%, which is well over the assumed target of 75%. A detailed list of parts and their mass is listed in D5.2. First results showed also an improved crash safety compared to the SLC.
The SmartBatt battery system can store 23 kWh of electrical energy. With a total mass of 155 kg the gravitational energy density is 148 Wh/kg on system level. The SmartBatt battery system has 85% higher energy density in comparison to state of the art vehicles like the Mitsubishi i-MiEV (80 Wh/kg) or Nissan Leaf (80 Wh/kg).

WP6 Hardware Build-up & final Validation.
Evaluation models for testing them against the different criteria's based on the requirements from WP2 (specification analysis / requirements) were developed and built up:
• Build up and validation of housing and cover (floor structure dummy)
• Build up and validation of battery modules
• Build up and validation of fully functional battery package
• Build up of evaluation model for validation of crash worthiness of the battery- and car structure (test-bench: parts of the housing – assembly process)

The demonstration of the final concept for battery integration was realized and presented on the EEVC 2012 in Brussels to a broad public.
Validations of the battery housing to get measurable criteria's were performed and tests relating to different safety/protection aspects were conducted:
• High voltage/current related basic safety aspects
• International Protection code (IP tests)
• Explosion test
• Fire resistance testing in order to identify the behavior of the housing in case of external fire
• Electromagnetic compatibility test on fully functional battery package with simulated electromagnetic fields that are typical on electric vehicles, coming from high voltage and current and from fast switching devices.
• Basic functional test on fully functional battery package
• Crash and deformation test of the demonstrator (front pack) built up and equipped with used cells in order to demonstrate the battery integration

WP7 Assessment
The work package answered the question "what were the improvements/benefits with the proposed solution?". The objectives of WP7 were to identify and assess the potential improvement of the developed technology for the electric vehicle (EV) market and to quantify the cost benefit of the new developed technology compared to other commercial solutions.
Summary:
• Weight reduction of battery housings and compensating this mass with additional battery cells will improve driving range of BEVs
• Technological edge within lightweight design (innovative materials and innovative production technologies)
• The SmartBatt concept is suitable for mass production and the cost outlook indicates potential in price reduction for cells
• Participation in standardisation committees (ISO/TC 22/SC21 WG3 Electrically propelled vehicles, Lithium Ion traction batteries, UNECE/REESS amendment to R100 Battery Electric vehicle safety for Lithium Ion batteries)
• Reviewed standardization of cells, modules, battery management system, electrical connectors and communications and battery enclosure. Existing standards partially identified

WP8 Exploitation
In WP8 the dissemination of work was performed. This was done by communicating the goals, approaches and results of the SmartBatt project to the electric vehicle (EV) community and the broader public (conferences, press releases, newspaper, homepage), secondly to promote the results of the SmartBatt project to the automotive value chain to accelerate uptake of the innovation (workshop, exhibitions and conferences). In month 4 the homepage of the project was going active and gave a short overview of the project and it is now dealing with results of WP4 and WP6. Step by Step the homepage was updated. In May 2012 a "Battery Integration Workshop" was organized in Brussels. Consortium partners of five different EC-projects (SMARTBATT, ELVA, OSTLER, EASYBAT and DELIVER) met for a one day discussion of some relevant future EV-topics. . 25 participants from 15 partners of these projects joined the workshop. Five papers in different conferences were published. Up to now 9 oral presentations has been held at conferences (i.e. ECCOMAS-2012 in Vienna and at the EEVC-2012 in Brussels), at workshops (fire-fighter workshop) and exhibitions.

Expected final results and potential impacts

The SmartBatt project focuses on the physical integration of heavy and bulky battery packs in the structure of pure electric and plug-in vehicles. The proposal is relevant for such electric vehicles since it particularly focuses on the development of innovative concepts for the physical integration in the vehicle structure by considering different sometimes contradicting issues like the smart integration of the battery pack in the various on-board systems, the interfaces to electric, cooling and monitoring devices and an increased safety level regarding normal operating and abuse load cases (including electrical- or fire hazards) and an reduced mass ratio (related to the actual mass of the cells).
Expected final results:
• offer the technological basis for a new generation of light, safe and smart battery systems

• improve the safety of electric vehicles
• economic benefits to customers by developing an integrative battery topology system
• ensure competitiveness of Europe’s engineering and automotive industry
• secure employment in the manufacturing sector by technological leadership
• provide an added value due to European R&D work through its intrinsic effectiveness synergies

Significance of cross-border cooperation for the battery research
In order to have a real impact on the green economy, the research in the field of electric and hybrid vehicles must include all aspect of the electric vehicles technologies in close conjunction with the rest of the transport system including smart electricity grids or intelligent vehicle charging systems tailored to market needs. Another important aspect is smart electrical storage in vehicles.
Due to the cross-border cooperation of different partners, the requirement for reduction of CO2 emissions in the EU countries can be met, particularly as the individual passenger transport will grow steadily in future. The development related to e-Mobility in general and battery research specifically can give a valuable contribution for this purpose.

Project public website address:	www.smartbatt.eu

2. Core of the report

Project objectives, Work progress and achievements, and project management during the period

The Project Summary Pdf document contains the core of the report.

3. Deliverables and milestones tables

Deliverables (excluding the periodic and final reports)

Del. no.	Deliverable name	Version	WP no.	Lead beneficiary	Nature	Dissemination level	Delivery date from Annex I (proj month)	Actual / Forecast delivery date	Status	Comments
1	Requirements Report	1.0	2	VOLKSWAGEN AG	Report	CO	6	09/09/2011	Submitted	
1	Report on Concepts	1.0	3	RICARDO UK LIMITED	Report	CO	10	09/02/2012	Submitted	
1	Risk quantification	1.0	4	AIT Austrian Institute of Technology GmbH	Report	CO	12	09/05/2012	Submitted	
1	Report on preliminary lay out of the battery housin g	1.0	5	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	Report	CO	12	02/04/2012	Submitted	
2	Report on optimized desig n of the battery housing with demonstration of the complete tool chain	1.0	5	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	Report	CO	18	28/08/2012	Submitted	
1	Evaluation Models	1.0	6	AIT Austrian Institute of Technology GmbH	Demonstrator	CO	20	18/12/2012	Submitted	
2	Summary of test reports	1.0	6	AIT Austrian Institute of Technology GmbH	Report	CO	23	27/03/2013	Submitted	
1	Assessment Report	1.0	7	SP SVERIGES TEKNISKA FORSKNINGSINSTITUT AB	Report	CO	23	10/12/2012	Submitted	

1	Website online	1.0	8	AIT Austrian Institute of Technology GmbH	Other	PU	6	28/06/2011	Submitted	
2	Recommendations for rescu e teams	1.0	8	TECHNISCHE UNIVERSITAET GRAZ	Report	PU	24	18/12/2012	Submitted	

Milestones

Milestone no.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
1	Targets and specifications for battery housing and integration completed	2	10	30/04/2011	Yes	08/06/2011	Targets and specifications identified
2	Initial 3 proposed concepts	3	7	30/06/2011	Yes	24/08/2011	3 concepts selected
3	Concept to be carried forward into WP5	3	7	31/08/2011	Yes	31/01/2012	Final concept selected
4	List of risks available	4	1	30/09/2011	Yes	30/09/2011	Summary of risks completed
5	List of risks with quantification	4	1	31/10/2011	Yes	29/02/2012	Risk quantification completed
6	First CAD design available	5	4	31/12/2011	Yes	31/01/2012	CAD concept design of housing and mounting (as a basis for further detail optimisations) is available
7	Optimized CAD design available	5	4	30/06/2012	Yes	30/06/2012	CAD design of the final (optimised) housing and mounting solution is available, including all relevant details
8	Release of the test plan	6	1	30/06/2012	Yes	06/11/2012	Test matrix defined
9	Evaluation models available	6	1	31/08/2012	Yes	12/11/2012	Hardware integration finished
10	Final Validation and test	6	1	30/11/2012	Yes	27/03/2013	Test procedure and

	report available						evaluation finished
11	Detailed drawback and advantage assessment	7	8	30/11/2012	Yes	30/11/2012	Assessment report available
12	SmartBatt Website online	8	1	30/06/2011	Yes	04/04/2011	Website online
13	SmartBatt workshop	8	9	31/05/2012	Yes	18/09/2012	Workshop conducted

4. Explanation of the use of the resources

The **explanation on the use of resources** was removed from the scientific periodic reports in SESAM. These deta ils now have to be entered in the cost statement forms in FORCE instea d.

Attachments	Project Summary - SmartBatt Periodic Report - Core of the report.pdf, Publishable summary periodic report SmartBatt.pdf, Recommendations for Rescue Teams.pdf, Flyer_SmartBatt_A5_folder.pdf, SmartBatt_EGCI_WS2013_Poster_A1.pdf, Poster Aluminium 2012 Pulvertechnologie2-smartbatt.pdf, AIT Mobility_Pressreview_SmartBatt.pdf, 09SmartBatt_team.pdf, 08SmartBatt_prototype_d.pdf, 07SmartBatt_prototype_c.pdf, 06SmartBatt_prototype_b.pdf, 05SmartBatt_prototype_a.pdf, 04SmartBatt_BMS.pdf, 03SmartBatt_front.pdf, 02SmartBatt_toolchain.pdf, 01SmartBatt_roadmap.pdf, SmartBatt_contact names.pdf, SmartBatt_list of publications.pdf
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Name of the scientific representative of the project's coordinator and organisation:	Mr. Hansjoerg Kapeller AIT Austrian Institute of Technology GmbH
Period covered - start date:	01/01/2012
Period covered - end date:	31/03/2013
Name	
Date	

This declaration was visaed electronically by Hansjörg KAPELLER (ECAS user name nkapelha) on