EVERLASTING

Electric Vehicle Enhanced Range, Lifetime And Safety Through INGenious battery management

D8.1 - Dissemination and exploitation plan

February 2017

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Public

PROJECT SHEET	
Project Acronym	**EVERLASTING**
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Coordinator	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK NV (BE) - *VITO*
Consortium Partners	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (FR) - *CEA* SIEMENS INDUSTRY SOFTWARE SAS (FR) - *Siemens PLM* TECHNISCHE UNIVERSITAET MUENCHEN (DE) - *TUM* TUV SUD BATTERY TESTING GMBH (DE) - *TUV SUD* ALGOLION LTD (IL) - *ALGOLION LTD* RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN (DE) - *RWTH AACHEN* LION SMART GMBH (DE) - *LION SMART* TECHNISCHE UNIVERSITEIT EINDHOVEN (NL) - *TU/E* VOLTIA AS (SK) - *VOLTIA* VDL ENABLING TRANSPORT SOLUTIONS (NL) – *VDL*
Website	www.everlasting-project.eu

DELIVERABLE SHEET	
Title	**D 8.1 – Dissemination and exploitation plan**
Related WP	WP8 (Dissemination)
Lead Beneficiary	TU/e
Author(s)	Will Hendrix (TU/e) Tijs Donkers (TU/e) Anouk Hol (VDL ETS)
Reviewer(s)	Ilya Zilberman (TUM)
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EXECUTIVE SUMMARY

This Plan for Exploitation and Dissemination of Results (PEDR) is a document that will guide and report project exploitation and dissemination activities. The document will evolve in the course of the project. A first version has been issued in M6 (February 2017) and is mainly based on the Impact chapter of the EVERLASTING project proposal. Updated versions will be issued at each reporting period, which is at M18 and M36 with a final version at M48.

For both exploitation and dissemination activities the subsequent versions of the report present the general strategies and approaches, a status update on the completed activities and an overview of the planned activities. Depending on the work progress and the (intermediate) results, but also on developments in the project's technology field outside the project, specific strategic approaches and planned activities might be tuned to achieve maximum impact. The Exploitation and Dissemination Team formed by project partners TU/e and VDL ETS will monitor and steer the exploitation and dissemination activities, and will take all necessary measures to enlarge the innovation potential and impact of the project.

Up till now the following has been achieved:

- 4 scientific papers have been published or submitted for publication
- 3 presentations at conferences have been given
- The project website has been launched
- 4 public deliverables have been published
- First contacts with two related H2020 projects has been made

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List of Abbreviations and Acronyms

ACRONYM	DEFINITION
WP	Work package
WPL	Work package leader
DOW	Description of Work
PEDR	Plan for Exploitation and Dissemination of Results
BMS	Battery Management System
SOC	State-of-Charge
SOF	State-of-Function
SOH	State-of-Health

INTRODUCTION

This Plan for Exploitation and Dissemination of Results (PEDR) is divided in two main parts, with a similar structure for each part.

Chapter 1 will focus on exploitation of results. Section 1.1 will first explain the general strategy and approaches that the project consortium has agreed upon. In section 1.2 the completed activities up to the date of this report's appearance are listed and described including any IP settlements that were needed. Section 1.3 described the future planned exploitation activities looking ahead for a period that at least includes the next PEDR update.

Chapter 2 will focus on dissemination activities. Again section 2.1 will describe the general strategies and approaches, section 2.2 the completed dissemination activities and section 2.3 the planned activities for the coming period.

With this structure the document gives the required flexibility to incorporate periodic updates and modifications if project progress and results ask for this.

1 EXPLOITATION OF RESULTS

1.1 EXPLOITATION STRATEGY AND APPROACH

1.1.1 PARTNER'S EXPLOITATION INTERESTS

The activities regarding exploitation of results is very much based on every partner's particular interest in the project research and development topics as formulated below.

VITO. It is VITO's intention to grow its battery management activity significantly within the EnergyVille cooperation with the University of Leuven and IMEC. Currently about 7 FTE are working on the development of innovative battery management features and it is the plan to grow this to 16 FTE by 2018. This growth should be enabled by significant commercial success in the licensing of innovative BMS features to commercial partners. To achieve this goal, VITO is involved in projects like MAT4BAT and SPICY to increase modeling competences, that are the basis of model-based battery management systems. In parallel, VITO is working on developing the actual features in projects like NAIADES and EVERLASTING.

CEA. Although no direct impacts on employment or any deployment in activity or changes in strategies can be foreseen for CEA, its substantial activity in the project on battery safety management is certainly an important commitment for future activities. Indeed, renewable energies and energy efficiency are two of the 3 main research programs led by CEA-LITEN. Inside these two programs, electrochemical storage for transport and stationary applications are key activities bound by industrial collaborations (e.g. Renault, Alstom). The project output on '*new model-based tooling & methods for smart detection and prediction of safety hazards*' will be of strategic importance within this context to consolidate and enlarge CEA RD activities in the field.

Siemens PLM. The EVERLASTING project will allow Siemens PLM to extend its software sales to battery control business, as previously done for other automotive domains. These results combined with the IMPROVE project's one will enable a complete and validated EV offer, covering simulation, controls and RT models for HiL. An ESS solution growth of 100% over the 3 years after the end of the project is expected. Current market size and Siemens business shares couldn't be disclosed. In terms of employment, EVERLASTING will contribute to the Siemens French team's skill and support their growth in France.

TU Munich (TUM). The participation of TUM in the EVERLASTING project will give its researchers and students a foundation to grow and continue current research activities on Battery Management topics. Academic and industrial partners within the consortium will establish a network for scientific exchange, allowing Master and PhD students to complete their internships outside Germany. It will not only form new long-term international relations for future projects, additionally it will also have a positive impact on lecture and seminar quality.

TÜV SÜD. The EVERLASTING project will allow TÜV SÜD to improve its knowledge for test setups and testing of cells, modules and packs with the aim to customer service. This can be offered by the compiled knowledge as well as the new test procedure. The scientific and technical prospects of success 1-3 years after project end are to be seen in the removal of the test benches what becomes possible by the compiled knowledge. During the following two years originate the other individual testing methods which check even more typically the security of cells, modules and packs. From 5 years manufacturers are supported in cell, module and pack development, while easy and adaptable tests can be carried out. This project has no direct impacts on employment or any deployment in activity or changes in strategies.

ALGOLiON. This project will provide ALGOLiON with an excellent opportunity to evaluate its safety predictive algorithms on cells made with real and proxy internal shorts created by a variety of methods. The project also provides a means for the company to gain experience in integrating its algorithms with the host BMS in the Demonstrator for predicting/early warning of internally developed shorts, monitoring dc internal resistance, and data processing techniques and analysis. Finally, cooperation with project partners who may be potential customers and academic institutions for providing basic knowledge.

RWTH Aachen. The project will allow RWTH Aachen to continue and extend research on battery modeling and management – specifically in parameterizing and applying physical models to be integrated on embedded systems. This generates employments for new researchers and opens new research aspects for dissertations and final theses for students in the section of electronics / software development and battery fundamentals research. In long term view the gained knowledge is used for a better education of students in lectures and seminars. The publication of highly relevant research results will strengthen the visibility of RWTH Aachen and further improve the dialog in the international research community.

LION Smart GmbH. EVERLASTING will support LION Smart with the unique opportunity of assimilating the company's own developments in its production cycles, while simultaneously gathering the accumulated experience provided by the leading institutions that share the consortium's membership. To broaden and to strength those valuable relationships will be an important revenue for LION Smart during the cooperation within EVERLASTING. Especially valuable for the company will be to lead and to participate in the activities of formulation, validation and further dissemination of a new technical standard of Battery Management Systems due to, among other reasons, the early possibility of discussing and formulating as a standard what it is the consortium's shared concept of a standardized BMS. From the most general point of view, EVERLASTING will consolidate the presence and prestige of the organization in the field of the ion-lithium batteries and its managements systems and, in particular, in the young sector of the electro mobility.

TU/e. The EVERLASTING project allows TU/e to collaborate with industries, thereby providing novel research questions to TU/e. Also, these industrial/academic collaborations will give TU/e access to state-of-the-art demonstrators and real-vehicle measurement date, which allows TRLs to be achieved that are not possible within the existing facilities of the TU/e. Finally, it should be noted that TU/e is also an institute of higher education. This means that this project allows establishing long-term contacts to participate in student exchange programs and to set up internships. Finally, because of intensive collaborations between TU/e and industries, TU/e graduates might find a way to becoming future employees of the industrial parties involved in the project.

Voltia. With the availability of a standardized BMS, Voltia expects to increase the reliability of its battery packs and to slightly decrease their prices. This will result in a more affordable and attractive product for a bigger end-user group. Realistically, a better product could directly lead to two to three times' increase of the end-user portfolio, which is equivalent to an increment of five to ten new end-users in the next year after project completion. New clients will bring adequate revenues, but will also require new products in order to serve them appropriately. We expect to triple our team within the next 5 years. Voltia is at the beginning of its international expansion and it is planned to cover 7 EU countries till 2020. The correct battery health monitoring has influence in a better second-life battery utilization. Based on findings and data of EVERLASTING project, Voltia is expecting to develop its new products/services in the area of stationary energy storage application.

VDL ETS. The EVERLASTING project allows VDL ETS to improve its knowledge and models with the aim to further reduce the energy consumption of hybrid and fully electric buses. With the growing demand of low CO2 foot print transport in our cities the demand for fully electric buses will grow very fast; every city or route in the city will need a specific solution for their operations. So without an affordable control system and simulation models this growing demand of customized CO2

optimized transport solutions will be blocked by the high costs of the traditional integration processes and the limitations of the current testing methods. It is impossible to have extensive road- and functional tests for every customized adapted low series of buses or their components.

1.1.2 IPR Management

Any exploitation activity will be subject to the procedures on ownership of results and transfer of ownership as laid down in article 8.1, 8.2, and 8.3 of the Consortium Agreement.

1.2 Update on completed and on-going exploitation activities

No activities yet.

1.3 Future exploitation activities

The EVERLASTING consortium consists of a complementary mix of industrial parties, who can valorize the results directly and universities and research organisations, who can valorize the results indirectly through subsequent cooperation with industrial partners or by founding spin-offs. The table below gives an overview of the exploitation opportunities.

Exploitation mechanism	Exploitable foreground	Partner
Software as a Product (SaaP) for sale and/or license	Advances in knowledge, safety, battery control	ALGOLiON
Software as a Service (SaaS) for sale and/or license	Improved device user experience, data base for machine learning and crowd-sourcing	ALGOLiON
Application for BMS communication with cloud servers	Novel data recording, storage, transmission and analysis technology	ALGOLiON
Use in industrial bilateral and collaborative projects at national and European level	Novel algorithmic architectures for early detection of thermal runaways	ALGOLiON
Use in industrial bilateral and collaborative projects at national and European level	Novel algorithmic architectures for early detection of thermal runaways	CEA
Use internally on CEA battery platform to consolidate current know-how in the field. Will also be exploited for industrial bilateral and collaborative projects at national and European levels.	New knowledge on degradation of Li-ion materials/components/cells in overuse and abuse conditions.	CEA
Use in industrial bilateral and collaborative projects at national and European level	New knowledge on PCM design, PCM integration into battery systems and passive thermal management efficiency	CEA
Use in industrial bilateral and collaborative projects at national and European level	New knowledge on critical degradation roots and kinetics. New software tool for safety prediction and safe battery design.	CEA
Product	Safer and more reliable mechanical architecture of battery pack	Voltia
Product	Advanced battery management systems for battery packs of electric utility vans.	Voltia
Service	E-mobility services based on pay-per-km principle offered by EVs with prolonged drive range	Voltia
Service	Acquisition of precise and standardized SoH records for EV battery second life usage	Voltia
Exploitation through spin-off Batterie Ingenieure	Advanced BMS hardware and software	RWTH
Engineering services for European industry partners	New knowledge in advanced BMS systems	RWTH
Product	New features, models and demonstrators in our Electrochemical Storage Systems (ESS) library of our Amesim product: new battery models, identification/reduction tools (fast models), BMS detailed coupling and methodologies.	Siemens

Licensing	Physico-chemical state estimation model for BMS application	TUM
Licensing	Optimal balancing algorithm for non-dissipative circuits	TUM
Use in industrial bilateral and collaborative projects at national and European level	Highly modular prototyping BMS hardware and software platform for research purposes	TUM
Service	Testing according to new BMS testing standard proposal	TÜV SÜD, VITO
Licensing	Battery reconfiguration architecture and algorithm	VITO
Use in industrial bilateral and collaborative projects at national and European level	Self-learning algorithms for the estimation of battery SoH	VITO
Licensing	Efficient heat-pump architectures	VITO
Software as a Product (SaaP) as a Service (SaaS), for sale and/or license. Use in industrial bilateral and collaborative projects at national and European level	Application Programming Interfaces for the implementation of Safety Features, data Transmission, States Estimations, Graphical User Interfaces and Network Communications in BMS	LION Smart
Software as a Product (SaaP) as a Service (SaaS), for sale and/or license. Use in industrial bilateral and collaborative projects at national and European level	Hardware Abstraction Layers for BMS	LION Smart
Software as a Product (SaaP) as a Service (SaaS), for sale and/or license. Use in industrial bilateral and collaborative projects at national and European level	Implementation of Complex, single cells States Estimation Algorithm on Open Computing Language	LION Smart
Product. Use in industrial bilateral and collaborative projects at national and European level	Standardized-modular BMS hardware and software, also as part of a demonstrator	LION Smart
Product	New features, models and controllers for newly produced buses in order to improve the total cost of ownership (TCO).	VDL ETS
Service	Improved energy management model to be able to provide a better estimation of the range, battery life and energy consumption to VDL customers.	VDL ETS
Use in industrial bilateral and collaborative projects at national and European level	New knowledge on models integration in (test) vehicles and control development.	VDL ETS
Product	BMS Standard proposal	All

2 DISSEMINATION

2.1 DISSEMINATION STRATEGY AND APPROACH

2.1.1 RAISING THE GENERAL AWARENESS OF THE BENEFITS OF BATTERY MANAGEMENT SYSTEMS

In the world of EV (and stationary) batteries, the focus is almost exclusively on battery materials. Battery management systems are almost entirely neglected or considered to be a 'necessary evil'. Obviously battery chemistry and cell design are main determinants of the system behaviour. Nevertheless the battery management can also play a major role by reducing certain drawbacks of the battery chemistry or even enabling promising battery types that would not be possible without a powerful BMS. To raise awareness on this vital and positive role of the BMS, the consortium will write a number of white papers (1-3 pages) that will be distributed via the EVERLASTING website and by the partners. The target audience of these white papers will be the 'general technical public', not the battery (management) experts.

2.1.2 DISSEMINATION OF SCIENTIFIC RESULTS

The scientific dissemination will be implemented through:
- The publishing or the generated results in open access peer-reviewed scientific journals
- The presentation of project results on scientific conferences and events

Prior to any disclosure (conference, publications, defence of PhD theses or Masters) the protection of the project progress must be secured. The project will generate research data in a wide range of levels of detail from simulation and lab results to demonstrator validation. Most data will be associated with results that may have a potential for commercial or industrial protection and therefore cannot be made accessible for verification and reuse in general due to intellectual property protection measures. However, data necessary for the verification of results published in scientific papers will be made accessible in a data repository according to the approaches as described in the Data Management Plan (D8.2). Only in case this data contains confidential information it will be stored under embargo and will be opened for use after protection is no longer needed. The decision concerning the publication of data will be made by the decision-making bodies of the consortium. Details on the agreed procedures regarding dissemination have been described in the Consortium Agreement (Article 8.4). All scientific publications will be done through 'open access' and can also be found on the project web site. Further details concerning the research data management (specification of datasets, underlying database management system, accessibility, etc.) will be specified in a data management plan which will be elaborated in Task 8.2 'Data management planning'. Like the PEDR, the data management plan will also be a "living document" with regular updates whenever important changes occur in the available datasets like e.g. in the underlying data of scientific publications.

Timing	Publications	Presentations
Year 1	1	2
Year 2	5	6
Year 3	5	6
Year 4	5	6
Total	**16**	**20**

The following peer reviewed scientific journals have been identified as possible targets:
- Journal of the Electrochemical society

- Journal of Power Sources
- World Electric Vehicle Journal
- International Journal of Electric and Hybrid Vehicles
- IEEE Transactions on Signal Processing
- IEEE Transactions on Control System Technology
- Applied Energy
- Journal of Applied Physics
- International Journal of Energy Research
- Power Electronics Journal
- Journal of Electrical Storage

The following scientific conferences will be targeted:

- International Meeting on Lithium-ion Batteries (IMLB)
- Electrochemical Society Meetings (ECS)
- Advanced Automotive Battery Conference (AABC)
- Power our Future (organised by CIC)
- Industrial Conference on Acoustics, Speech and Signal Processing (ICASSP)
- Lithium Battery Power and Safety
- IFAC World Congress and Advances in Automotive Control
- IEEE Conference on Decision and Control
- Vehicle Power and Propulsion Conference (VPPC)
- International Telecommunications Conference (INTELEC)
- Kraftwerk Batterie

2.1.3 INTERACTION WITH COMPLEMENTARY PROJECTS

The hurdles for the large scale introduction of electric vehicles can only be tackled by a system-wide approach. Therefore time and resources will be reserved for interaction and alignment with other projects in the GV8-2015 call, on the complementary topics of EV architecture and integration with the IT and charging infrastructure. Through this interaction, opportunities for dissemination and exploitation of the results across the consortia will emerge.

2.1.4 OTHER DISSEMINATION ACTIVITIES

EVERLASTING project will make results available to parties outside the project consortium in the following way:

- EVERLASTING has a significant number of public deliverables that will be freely available from the EVERLASTING website.
- Some of the deliverables will be shared under NDA with the members of the advisory board. During the project the advisory board can be extended with other interested parties. The Advisory Board members will also be invited to give their input.
- Taking into account the important contribution of academic partners in the EVERLASTING project and their natural role to use the knowledge gained for education and further research, a number of the EVERLASTING results will be spread among students and academic partners.
- A considerable part of the EVERLASTING project is focused on the development of a standard interface and architecture, which will be publicly shared with the rest of the industry. A workshop (probably at an existing automotive or EV event such as the Advanced Automotive Batteries Conference, AutoMechanika…) will be organized to involve industry stakeholders.
- The demonstrators developed in WP7 will be shown to the general public and this will be an additional opportunity to share results of the EVERLASTING project through presentations and workshops and to raise the awareness and interest of the relevant industrial and non-industrial parties.

2.2 CURRENT STATUS OF COMPLETED AND ON-GOING DISSEMINATION ACTIVITIES

2.2.1 WHITE PAPERS

No white papers have been issued yet. White papers are scheduled to be issued every three months starting from M12. See also list of Public Deliverables in 2.3.4.1.

2.2.2 SCIENTIFIC PUBLICATIONS

1. L. Xia, E. Najafi, H.J. Bergveld, M.C.F. Donkers. A Fast Implementation of an Electrochemical Model of a Lithium-ion Battery. Submitted to IFAC World Congress
2. T.C.J. Romijn, M.C.F. Donkers, J.T.B.A. Kessels, S. Weiland. A Distributed Optimization Approach for Complete Vehicle Energy Management. *Submitted to Trans. Control System Technology*
3. Z. Khalik, T.C.J. Romijn, M.C.F. Donkers. Effects of Battery Charge Acceptance and Battery Aging in Complete Vehicle Energy Management. Submitted to Proc of the IFAC World Congress
4. J. Sturm, F. B. Spingler, B. Rieger, A. Rheinfeld, A. Jossen. Non-destructive detection of local aging in lithium-ion pouch cells by multi-directional laser scanning. Submitted to Journal of Power Sources

2.2.3 INTERACTION WITH COMPLEMENTARY PROJECTS

First contacts with the **NeMo** and **ELECTRIFIC** project consortia have been established. Both these projects were funded under the same GV8 call and cover the complementary area 'EV charging system integration'.

2.2.4 OTHER DISSEMINATION ACTIVITIES

2.2.4.1 Presentations at conferences

1. L. Xia, E. Najafi, H.J. Bergveld, M.C.F. Donkers. Fast Simulation of an Electrochemical Model of a Lithium-ion Battery. To be presented at the Benelux Meeting on Systems and Control, Spa, Belgium, March 2017
2. N. Jin, D. Danilov, M.C.F. Donkers. Parameter Estimation of an Electrochemical Model of a Li-ion Battery Using Two-Stage Estimation Procedure. To be presented at the the Benelux Meeting on Systems and Control, Spa, Belgium, March 2017.
3. I. Zilberman, A. Jossen - Efficiency of Dissipative Balancing Systems. Presented at Batterieforum Deutschland, Berlin, January 2017.

2.2.4.2 Project website

The EVERLASTING website has been launched in M3. Its URL is: http://everlasting-project.eu/.

The EVERLASTING project web site URL has been placed on the partner's websites to increase visibility:

- VITO: http://energyville.be/en/project/electric-vehicle-enhanced-range-lifetime-and-safety-through-ingenious-battery-management
- CEA: http://liten.cea.fr/cea-tech/liten/en/Pages/techno%20Energy%20Efficiency/LiionBatteries.aspx
- SIEMENS PLM: www.plm.automation.siemens.com/fr_fr/products/lms/imagine-lab/automotive/electrical-systems/electric-storage.shtml
- TUM: http://www.ees.ei.tum.de/en/research/everlasting/
- TUV SUD: www.tuev-sued.de/home-en/focus-topics/e-mobility/battery-testing
- ALGOLiON: www.algolion.com

- RWTH Aachen: https://www2.isea.rwth-aachen.de/de/content/everlasting-0
- LION SMART: *http://www.lionsmart.com/research-development/*
- TU/e: https://www.tue.nl/universiteit/faculteiten/electrical-engineering/onderzoek/onderzoeksgroepen/control-systems-cs/research/all-projects/electric-vehicle-enhanced-range-lifetime-and-safety-through-ingenious-battery-management-everlasting/
- VOLTIA: http://voltia.com/eu-projects
- VDL ETS: www.vdlets.nl/?page/6948682/Everlasting+Project.aspx

2.2.4.3 Public Deliverables

Public Deliverable Reports that will be available through the EVERLASTING website:

Deliverable number	Deliverable title	WP	Lead beneficiary	Type	Due date
D8.4	Public website	WP8	TU/e	Website	M3
D6.1	Analysis of the state of the art on BMS	WP6	LION Smart	Report	M6
D6.2	Requirements and architecture concept of a highly modular prototyping hardware platform	WP6	TUM	Report	M6
D8.1	Dissemination and exploitation plan	WP8	TU/e	Report	M6
D8.2	Data management plan	WP8	VITO	Report	M6

2.2.4.4 Advisory Board

There have been first contacts with possible candidates for taking membership of the AB. Also first means of interaction with AB members have been explored.

2.3 PLANNED FUTURE DISSEMINATION ACTIVITIES

Following the 'dissemination strategy and approach' as described in section 2.1, the paragraphs below present the concrete lists of planned future dissemination activities. The lists will be updated frequently. As the project work progresses, new items will be added based on intermediate and expected results, items that have been completed will be removed and presented in section 2.2.

2.3.1 WHITE PAPERS

To raise the awareness of the vital and positive role of battery management systems, a three-monthly white paper will be written on a general BMS topics, aimed at a general technical public (not BMS experts). These white papers are 1-3 pages long and will be distributed via the EVERLASTING website and through the partners. During Reporting Period 1, the first 3 white papers shall be developed.

Here you can find a list of potential topics. This list can be updated based on feedback and requests we get from the readers:

- BMS functions
  - In this white paper we discuss the reasons for having a BMS (safety, predictability…). We also list what functions are typically part of a BMS (balancing, SoC…), what functions can be considered to be optional and how typical BMS's are implemented. Last but not least we will discuss the extent to which a BMS is only monitoring or whether it should also be predicting and managing.
- The definition of SoC
  - In this paper we discuss the different possible definitions of SoC. SoC is based on battery capacity so first we discuss what is meant with capacity: is it the currently available capacity or the initial capacity. Furthermore we will deal with remaining capacity: is it the remaining capacity under ideal circumstances or under the current circumstances? State-of-Function (SoF) will also be introduced in this context. Based on these different definitions, a number of different ways of calculating SoC can be distinguished, each with their own benefits and drawbacks. Last but not least we will deal with how to communicate SoC to the user in a clear and consistent way.
- Evaluation of SoC accuracy
  - In this white paper we will discuss how to evaluate the accuracy of an SoC estimation algorithm. We first have to agree on a reference measurement that we trust to be correct. It is often claimed that an algorithm is x% accurate but what does that mean ? Is this the average error or the maximum error ? Under which circumstances was this measured ? What charge/discharge cycle was used ? In order to be able to compare the accuracy of several algorithms, a standard definition and measuring procedure will be needed.
- The definition of SoH
  - In this white paper we will discuss the different possible definitions of SoH. In general, the SoH is a measure for the health of the battery. Depending on the application, the demands asked from the battery can vary. Does the health only involve the capacity that can be delivered or does it also take into account the internal resistance? Furthermore we will deal with how to communicate SoH in a clear and consistent way to the user.
- Evaluation of SoH accuracy
  - In this white paper we will discuss how to evaluate the accuracy of SoH estimation. We first have to agree on a reference measurement that we trust to be correct. Another topic is the aging regime that is to be used to determine SoH accuracy. We will also briefly touch the ageing of a battery even when it is not used, calendar ageing, and the effect of temperature.

- Balancing: what vs how
  - In this white paper we discuss a topic that is often given too little attention when discussing balancing. Most scientific papers on this topic deal with different electrical schemes to maximize the balancing current. However, another important aspect of balancing is deciding which current to apply to which cell: this is the so-called balancing strategy. We will explain that the balancing strategy is equally important as the electrical setup and smart combinations of both lead to the optimal balancing solution.
- Evaluation of balancing
  - In this white paper we will discuss how to evaluate the performance of the balancing system. In most cases the maximum balancing current is given as a measure of performance, but as will be explained in the previous white paper, this is not entirely correct. Therefore we should evaluate the performance of the balancing system by measuring how well it is able to achieve its goal. So we will first define the goal of balancing. Is it used to maximize the module capacity or to reduce aging? In both cases the evaluation procedure will have to be different.
- Power capability
  - Battery management systems often indicate the remaining energy that is left in the battery, but the power capability is not communicated. It is assumed to be constant and as specified in the datasheet of the battery. However, especially at low and high SoC, this can be different and in some cases it may be important to communicate this power capability. This relates to the State-of-Function (SoF) of a battery, a combination of SoC and SoH. We will offer a few ideas on how to calculate and communicate this measure.
- Energy management vs battery management
  - In this white paper we will discuss the difference between battery management and energy management. We will list the features that are typically considered to be part of an energy management system and how these features are dependent on the features of the BMS.
- Battery management for different types of batteries
  - Battery management systems are an accepted feature in Li-ion batteries, but their use with other types of batteries is discussed much less. In this white paper we will discuss whether battery management systems can be useful for other types of batteries (lead-acid, nickel-based, flow batteries…), what features would be useful and how they should be adapted.
- Thermal management
  - Thermal management is an example of a feature that is often not considered to be part of a battery management system. In this white paper we discuss how this feature interacts with the features of a typical BMS (e.g. power capability).
- The future of BMS
  - In this white paper we discuss the future of BMSs. Will BMSs still be needed? What will change? What features will become less important? What new features will be added ?

2.3.2 SCIENTIFIC PUBLICATIONS

The table below shows the planned dissemination through scientific publications. Per WP, topics and lead partners are indicated. Based on the research progress, the list will be updated throughout the course of the project.

Topic	Dissemination method	Partners
WP1: Improved simulation and modelling tools		
Dissemination of research results with respect to tools and methods achieving a relevant prediction of pack behaviour, with coupled controls, including validation (Siemens)	Conference presentation	Siemens PLM
Presentation of (pre-)industrialized new models, tools and features allowing the modelling and prediction of battery pack behaviour and BMS coupling	Siemens user conference (including major carmakers, suppliers, OEMs, battery suppliers…)	Siemens PLM
Demonstrating multi-level battery modelling, simulation, reduction and control coupling applied to automotive transportation	Simulation@Siemens (Siemens divisions)	Siemens PLM
Modelling order reduction techniques	Conference presentation, Journal paper (Open Access)	TUM, TU/e
WP2: Increased reliability		
The use of self-learning algorithms for estimation of SoH	Conference presentation, Journal paper (Open Access)	VITO, ALGOLiON
Test procedures for BMS testing	Conference presentation, Standard proposal	TÜV SÜD, VITO
WP3: Extended vehicle range		
Challenges of parametrization of physico-chemical battery model and comparison to standard electro chemical battery models	Conference presentation	RWTH
Deduction of minimum parameter set for physico-chemical model and adaption of model for application on embedded hardware	Journal paper (Open Access)	RWTH
Maximizing operation range of Li-Ion batteries to maximize energy output without losing safety	Conference paper, Journal Paper (Open Access)	RWTH
Embedded BMS hardware requirements towards execution of extended battery models	Conference paper	RWTH
Costs for more complex BMS hardware, enabling the extraction of more energy vs. higher capacity of battery cells	Conference paper	RWTH
Development of common BMS software towards integration of more complex battery models	Conference paper	RWTH
Advanced BMS Models and Model Adaptation	University courses and seminars	RWTH
Full Physico-Chemical Parameterization of the Battery Cell	Journal paper (Open Access)	RWTH
Aging behaviour of the Battery Cell	Journal paper (Open	RWTH

	Access)	
Methodology for onBoard estimation of lithium loss and anode and cathode degradation	Journal paper (Open Access)	RWTH, ALGOLiON
Drive power prediction of electric busses	Conference presentation and journal paper (Open Access)	TU/e
Online real-time vehicle parameter estimation	Conference presentation and journal paper (Open Access)	TU/e
Energy Management of Electrified Auxiliaries of electric busses	Conference presentation and journal paper (Open Access)	TU/e
Range extension and optimization: tradeoff between travel-time and energy consumption	Conference presentation and Journal paper (Open Access)	TU/e
WP4: Safer batteries		
Battery and cell safety and failure modes, early degradation mechanisms of materials leading to cell thermal runaway	Conference presentation, Journal paper (Open Access)	CEA
Safety monitoring of Li-ion batteries: signal processing for battery safety applications, multi-sensing safety algorithms	Conference presentation, journal paper (Open Access), demonstration at trade exhibitions, trade journal article	CEA, ALGOLiON
Multi-scale, multi-physics modelling of safety hazards in Li-ion batteries	Conference presentation, Journal paper (Open Access)	CEA
WP5: Longer battery life		
Active and passive thermal management of Li-ion batteries	Conference presentation, Journal paper (Open Access)	CEA, VITO
Battery reconfiguration	Conference presentation, Journal paper (Open Access)	VITO
Influence of cell-to-cell parameter variations on cell balancing	Conference presentation, Journal paper (Open Access)	TUM
Optimal utilization of dissipative cell balancing	Conference presentation, Journal paper (Open Access)	TUM
Optimal utilization of non-dissipative cell balancing	Conference	TUM

	presentation, Journal paper (Open Access)	
WP6: Standardized architecture		
BMS architecture	Standard proposal	LION Smart
Requirements and architecture concept of a highly modular prototyping hardware platform.	Journal paper (Open Access)	LION Smart
Implementation of a selection of the developed technologies in WP2-W5 according to their readiness levels on standardized BMS	Journal paper (Open Access)	LION Smart
WP7: Demonstrator		
Battery pack demonstrator, integrated in electric vehicle	Presentation to scientific community and general public	Voltia

The following journal publications are under development:

1. N. Jin, D. Danilov, P.M.J. Van den Hof, M.C.F. Donkers. Parameter Estimation of an Electrochemistry-based Lithium-ion battery model using a Two-Step Procedure and Sensitivity Analysis. Journal publication.
2. L. Xia, E. Najafi, Z. Li, H.J. Bergveld, M.C.F. Donkers. Fast Simulation of a Full and Reduced-Order Electrochemistry-based Model for Lithium-Ion Batteries. Journal publication.
3. T.C.J. Romijn, M.C.F. Donkers, J.T.B.A. Kessels, and Siep Weiland, Real-time Distributed Energy Management for Complete Vehicle Energy Management. Journal Publication.

2.3.3 INTERACTION WITH COMPLEMENTARY PROJECTS

The following projects have been selected as relevant complementary projects that we would like to contact to exchange experience, results, R&D directions etc.:

- **NeMO**:
  - Hyper-Network for electroMobility
  - http://nemo-emobility.eu/
  - Project ID 713794, Cordis page: http://cordis.europa.eu/project/rcn/204973_en.html.
- **ELECTRIFIC**:
  - Enabling seamless electromobility through smart vehicle-grid integration
  - http://electrific.eu/
  - Project ID 713864, Cordis page: http://cordis.europa.eu/project/rcn/204977_en.html

Apart from these projects a further inventory of relevant on-going research projects will be made in the coming period. We will then:

- Make a short list of most relevant projects.
- Establish a first contact with these consortia.
- Identify interesting relevant topics that: could lead to synergies, are similar but with different approaches, are complementary and have interfacing aspects.
- Agree on an approach to exchange knowledge.

2.3.4 OTHER DISSEMINATION ACTIVITIES

2.3.4.1 Public Deliverables

Below the list of planned Public deliverables up to the next Periodic Reporting (M18):

Deliverable number	Deliverable title	WP number	Lead beneficiary	Type	Due date
D5.2	Proposed standard reliability test procedures for BMS	WP5	TUV SUD	Report	M18
D8.3	Three-monthly white paper; first issue	WP8	VITO	Report	M12
D8.5	Three-monthly white paper; second issue	WP8	VITO	Report	M15
D8.6	Three-monthly white paper; third issue	WP8	VITO	Report	M18

2.3.4.2 Advisory Board

Further interaction with the Advisory Board members will be set-up and complementary Advisory Board members will be invited. The role of the Advisory Board members will grow during the project, when more research results become available. Especially related to the standardization activities an active contribution from the Advisory Board members is expected by giving feedback on progress of standardization working groups in the field of battery management system architecture, progress on other research projects at national, European or international level and assistance to write recommendations in line with standardization organizations expectations, for a fast dissemination and integration of the EVERLASTING results.

2.3.4.3 Conferences

Following conferences are on the interest list of EVERLASTING partners to participate and/or to give presentations. This list is to give an indication of potential conferences.

Date	Name	Place	Link
14-16/03/2017	EEVC 2017	Geneva	http://www.eevc.eu/
22-23/03/2017	5th EU Electromobility Stakeholder Forum	Brussels	http://zeeus.eu/events/5th-eu-electromobility-stakeholder-forum
21/06/2017	FREVUE Final Conference	London	http://frevue.eu/newsroom/frevue-final-conference-21-june-2017-save-date/
5-6/07/2017	The Future of Transportation World Conference	Cologne	http://www.thefutureoftransport.com/
9-14/07/2017	IFAC World Congress	Toulouse	https://www.ifac2017.org/
9-11/10/2017	EVS30	Stuttgart	http://www.messe-stuttgart.de/en/evs30/

REFERENCES

EVERLASTING Consortium Agreement, 31-08-2016.

Fact Sheet, *The Plan for the Exploitation and Dissemination of Results in Horizon 2020*, European IPR Helpdesk, July 2015.