

5<sup>th</sup> Issue  
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# NEWS



**Silicon based materials and  
new processing technologies  
for improved lithium-ion**

## In this Issue

Introduction



Project Progress



General Assembly



Newsflash



Event Watch



Consortium



## Introduction

According to the European Energy Storage Technology Development Roadmap towards 2030 (EASE/EERA) energy storage will be of the greatest importance for the European climate energy objectives.

The Sintbat project aims at the development of a cheap energy efficient and effectively maintenance free lithium-ion based energy storage system offering in-service time of 20 to 25 years. Sintbat will use innovative approaches to address these aims. These include, the latest generation of anode materials based on silicon as well as a prelithiation process for lifetime enhancement will be implemented in the cell manufacturing process. Insights gained from advanced in-situ and in-operando analysis methods will be used for multi scale modelling targeting on the simulation of aging mechanisms for a reliable life-time prediction and enhancement.

The implementation of high energy materials combined with a low cost and environmental benign aqueous cathode manufacturing process will lead to remarkable cell costs reduction down to 130 € per kWh.

This will enable battery based storage system for an economic reasonable price of less than 400 € per kWh (CAPEX) and will lower the OPEX down to less than 0.09 € per stored kWh for the targeted in-service time of 20 to 25 years (10,000 cycles).

The technical developments will be supported by the set-up of a relevant roadmap as well as a catalogue for good practice. To guarantee the highest possible impact for the European economy the Sintbat consortium installed an Industrial Advisory Board including various European battery material suppliers, cell manufacturer and end-users whereby the whole value added chain in this way is completed within the Sintbat project.

This strong interaction of the Sintbat consortium with relevant stakeholders in the European energy economy will assure that battery based energy storage systems are becoming an economic self-sustaining technology.

## Project Progress

In this newsletter we would like to give you a brief overview of the latest findings of the Sintbat project.

### Project Management (WP 1):

The project is constantly assessed regarding technical progress and the budget is being controlled. Although first deliverables had to be slightly postponed due to technical and organisational matters, no severe problems occurred and the project is on schedule.

### Research and Development:

#### Cell Benchmark, Advanced Electrode Development and Balancing (WP 2):

The project partners drive the development on towards the „Generation 3“ anodes with low (partner Varta Micro Innovation) and high prelithiation levels (Partner CEA-liten). First cells were assembled and tested. Beforehand extensive testing, selecting of electrodes from prior generations and the up-scaling of the prelithiation was necessary. The electrochemical properties following different prelithiation levels are now evaluated to find the optimum.

#### Aging Mechanisms and Tailoring of Electrolytes (WP3):

In order to examine in operando the ageing of Silicon anodes (Gen1) and of prelithiated silicon anodes (Gen3) the synchrotron at European Synchrotron Radiation Facility (ESRF) at Grenoble was used to conduct Wide-Angle X-ray Scattering (WAXS) and Small-Angle X-ray Scattering (SAXS).

Operando SAXS/WAXS allow to correlate the

nanoscale morphology to (de)lithiation mechanisms, in particular in composite (graphite-Si) material.

The impact of ageing and prelithiation are evidenced. Quantitative data analysis is in progress (volume changes, specific surfaces). Further analysis is underway such as X-ray Raman Scattering starting at ESRF (chemical environment of light elements) X-ray Raman scattering and X-ray scattering tomography.

Parallel work was done by University of Uppsala to optimize the liquid electrolyte for Si electrodes and exploring alternative salts to LiPF<sub>6</sub> and additives to stabilise the SEI. The aim is to develop electrolytes in volume 1-3 litre.

#### Modelling, Simulation and experimental validation (WP4):

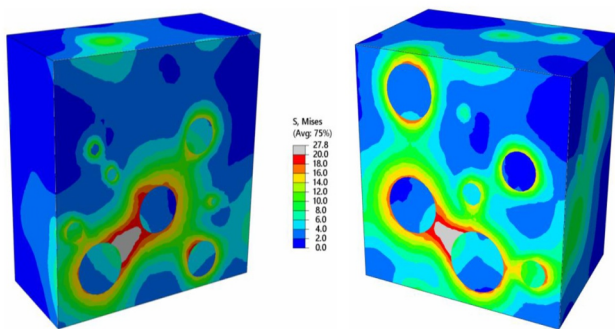
In collaboration with UW, the validation of the electrochemical model voltage response and capacity fade has begun. Using experimentally determined electrochemical parameters of the Sintbat anode (Gen 1) the model is populated and an NMC cathode is assumed to simulate the full cell performance. To support WP6, work has also begun to develop a simplified model to predict capacity fade of the cell.

The approach is based on recurring neural networks and will be a novel approach in the application of Si anode batteries.

A computer-based procedure was developed for reconstructing anode microstructure, in terms of Si particle size distribution and Si particle dispersion, based on data provided by MCL.

## Project Progress

The approach was implemented using Matlab and Python scripting to create a computational model of the anode using the Representative Volume Element (RVE) concept for subsequent Finite Element simulations with ABAQUS software. Simple case studies were tested with the generated RVEs to verify the procedure (see Figure below).



An example of test results (von Mises stresses) with the Finite Element software ABAQUS using the re-constructed anode microstructure with RVEs containing a distribution of Si particles in an effective anode matrix.

The 3D reconstruction of the pristine anode material including the development of specific image analysis algorithm has been extended towards further analysis with respect to the particle size distribution, next neighbor and texture of the Si-particles. Here, various samples with different Si contents have been investigated.

The understanding of the microstructure for different Si contents shall give direct input to the production of the anode material and trigger improved design guidelines.

### Implementation, Cell Development, Analysis and Safety Tests (WP5):

The latest work was dedicated to the 3D analysis of coin power cells by non-destructive XCT measurement and the further development of an automatized thickness measurement tool. Difference of thickness (Anode + Separator) between the strongly and slightly calendared cell were detectable.

Almost no difference exists between loaded and unloaded coin cells, which were slightly calendared. Further 3D characterization of coin power cells for the used/unused case is next. So XCT measurements are able to support non-destructive characterization of battery cells.

### Prototyping and Demonstration (WP6):

This WP has understandably its peak rather late in the project. Nevertheless the development of an advanced BMS and EMS is in full swing. Module specification and design is in progress, alternative cell connector for better pack performance are considered, simulations for state estimation (SOC and SOH) are ongoing and the software architecture is evolving.

The next 12 months are reserved for final requirement specification and design of the battery module, further BMS simulation and software implementation and last but not least the start of cell production.

## Project Progress

### Life Cycle and Health Risk Assessment (WP 7):

The task to provide all general definitions, settings and system boundaries to guarantee a coherent LCA is completed.

An updated varta model was used for the environmental impacts which showed in comparison the importance of data accuracy. LCA-modelling and LCC-modelling of the Sintbat battery is coming up.

### Dissemination, Exploitation and Business Plan (WP 8):

The market analysis will be completed these days which is a building block for the Business Development Plan.

Therefore a survey was conducted and relevant european roadmaps were taken into consideration. The obtained results are to discussed with the Industrial Advisory Board which has gained a new entry.

In the past months Sintbat has been presented to a wide scientific and industrial audience on several events throughout Europe, e.g.

- 6th European Conference on Computational Mechanics, Glasgow, UK
- 7th European Conference on Computational Fluid Dynamics 2018, Glasgow, UK,
- International Symposium on Electrocatalysis, Szczyrk, Poland.

## General Assembly Meeting

**Date:** 18<sup>th</sup>-19<sup>th</sup> April 2018 **Location:** Warsaw, Poland

For the fourth General assembly meeting of the project Sintbat, the project consortium met at Warsaw, Poland. Our host University of Warsaw was founded as a Royal University on 19<sup>th</sup> November 1816 with permission of tsar Alexander I of Russia. Nowadays it is the largest polish university and provides graduate courses for 53,000 students on top of over 9,000 postgraduate and doctoral candidates.

The meeting started with a welcome by the host who gave a brief overview and wished for an interesting and fruitful meeting. During the morning session the work results concerning advanced electrode development and balancing, aging mechanisms' and tailoring of electrolytes as well as modelling and simulation were presented and a lively debate commenced. The lunch break allowed enough time for an interesting University tour whereupon the modelling and simulation work package was concluded.

The afternoon session was mainly dedicat-

ed to the progress in Implementation, Cell Development, and Analysis as well as in Prototyping and Demonstration.

At the beginning of the second meeting day matters regarding the Project Management were presented and it was confirmed that the project is well in line. Presentations on Life Cycle and Health Risk Assessment as well as Dissemination, Exploitation and Business Plan completed the treatment of the work packages. Afterwards various topics could be addressed as such meetings provide an excellent occasion for a rapid exchange of views such as the use of the EC innovation radar, the collaboration with the Industrial advisory board and general raw material issues.

After all details were clarified the next meeting was scheduled on October 2018, Warwick, UK. The meeting was then concluded with a very positive feedback thanking all partners for their active cooperation and contributions of the project by underlining the good standard of work performed in the project.



## Newsflash

### New materials for sustainable batteries

A new conductive material and a new electrode material could decisively advance the development of cost-effective aluminium batteries. This would allow renewable energy to be stored on a large scale.

Aluminium batteries consist of inexpensive raw materials in large quantities. Scientists from the Swiss Federal Institute of Technology (ETH) Zurich and Empa led by Maksym Kovalenko, Professor of Inorganic Functional Materials, have found two new materials that could decisively advance the development of aluminium batteries. It is a corrosion-resistant material for the conductive parts of the battery and a new material for its anode that can be adapted to a wide range of technical requirements.



Picture:

The researchers produced aluminium button batteries in the laboratory. The battery case is made of stainless steel coated with titanium nitride on the inside to make it corrosion resistant. © Kostiantyn Kravchyk, ETH Zurich.

Because the electrolyte fluid in aluminium batteries is extremely aggressive and attacks stainless steel, gold and platinum, for example, scientists are looking for corrosion-resistant materials for the conductive parts of such batteries. Kovalenko and his colleagues found titanium nitride, a ceramic material with sufficiently high conductivity. "This compound consists of the very common elements titanium and nitrogen and is easy to produce," explains Kovalenko.

While the negative pole of such batteries is made of aluminium, the positive pole is usually made of graphite. The researchers have found a second material that can be used to store as much energy in a battery as with graphite. They are polypyrene, a hydrocarbon with a chain-like molecular structure. In particular, material samples in which the molecular chains accumulated in a disordered manner proved to be ideal in experiments. One of the advantages of polypyrene-containing electrodes is that scientists can influence their properties, for example their porosity. This offers the possibility to optimally adapt the material to the respective applications. "The graphite used so far is a mineral. It cannot be changed from an engineering point of view," says Kovalenko.

<https://www.springerprofessional.de/materialentwicklung/funktionwerkstoffe/neue-materialien-fuer-nachhaltige-batterien/15791820>

## Newsflash

### Germany is looking for the super battery

New materials such as nickel oxide, lithium-oxygen and lithium-sulphur should reduce the performance values of batteries.

While the European automotive supplier Bosch has stopped its battery cells research earlier this year BASF has ambitious goals in this regard.: Through innovative battery materials used in middle class e-mobiles in the year 2025 a real range of around 600 km, a charging time of 15 min, halving of size and a cheaper production would be achieved.

These leaps in performance should succeed mainly through innovative battery materials, for example by means of particularly highly compressed lithium-nickel oxide for the cathodes of lithium ion batteries. The porous surface of these cathode materials favour faster charging cycles, explained Martin Bruder Müller, Chairman of the Executive Board and CTO of BASF. He's convinced: "They hold the greatest potential for improved performance at lower cost." The chemical company is making an effort are concerned worldwide with the optimization of nickel-cobalt-alumina compounds (NCA) and nickel-cobalt-manganese oxide compounds (NCM) as battery materials.

The Meet (Münster Electrochemical Energy Technology) is also dedicated to the cell system and researches here primarily cell design, battery aging and safety. Furthermore, there is a focus on electrode materials. A three-year project Joint project will specifically focus on Further development of lithium oxygen bat-

teries. Since the oxygen in the ambient air can be used, result in advantages of this material for size and capacity.

The Fraunhofer Institute IWS, on the other hand, relies on lithium-sulphur as well as sodium sulfur compounds as battery basis. Besides high gravimetric energy densities and low material costs the high availability of these Materials are important. Experiments are currently underway including carbon-sulfur nano-composite cathodes and with anodes of lithium metal, silicon or carbon instead of graphite. Special electrolyte additives are to be used for a longer battery life.



Photo: BASF SE, testchamber

There are other candidates for battery cell materials. The Institute for Energy and Climate Research Jülich has been devoted to the modernization of iron-air batteries. Also calcium, magnesium-sulphur or aluminium compounds can at least theoretically store more electric charge than today's lithium batteries.



## Newsflash

Battery research is regarded as a figurehead of the Federal Ministry of Education and Research (BMBF). Funding has been available since 2007 in the areas of battery materials and process technologies for battery cells. The "Battery 2020" initiative continues the strategic line of the BMBF. Focus on materials and process technology for lithium-ion systems, which will be used in the near future will be achieved.

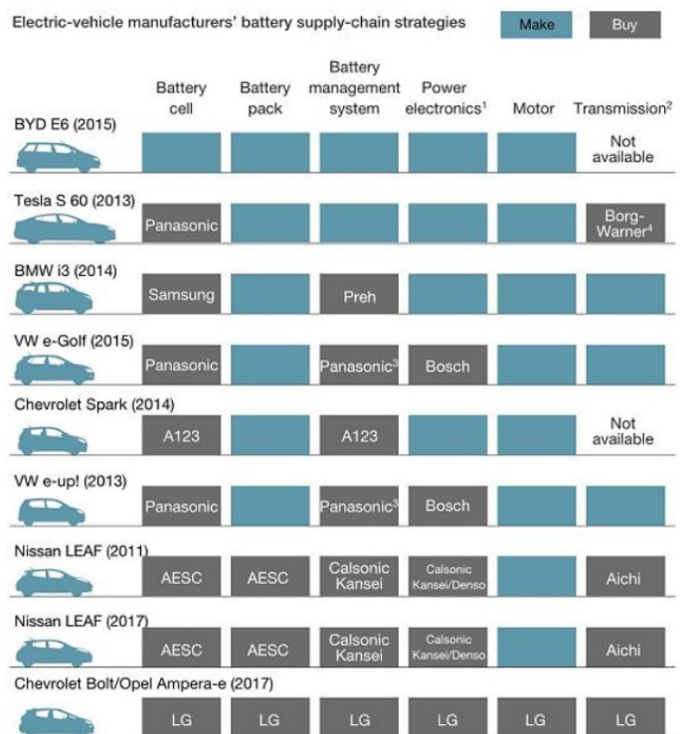
Source: VDI nachrichten · 6. July 2018 · Nr. 27/28

### Battle for rechargeable batteries

German car manufacturers are completely dependent on battery manufacturers from Asia.

Mercedes, BMW & Co. are in a dangerous dilemma with electric mobility. The production of the cells needed for the production of high-performance batteries is in the hands of a few Asian companies.

The battle for battery cells - a core component of electric mobility - is already in full swing and German carmakers have a bad hand in this. After all, batteries are crucial for success in electromobility and only those who get high-performance battery cells in sufficient quantities and at fair costs have a chance of offering their electric cars at a competitive price. After all, the battery is a very expensive component in the vehicles of the future. And this is precisely where German carmakers find themselves in a dangerous predicament that could lead to a disastrous dependence on the manufacturers of coveted battery cells.



Picture: McKinsey analysis - almost all car manufacturers buy batteries from (asian) third parties.

Currently, the market is dominated by a handful of manufacturers of battery cells, all of which are located in Asia. The big players in this difficult game are LG Chem, Panasonic, Samsung, SK and CATL from China. What about the production of battery cells in Germany? So far, attempts to start a production in this country have failed entirely. Be it Daimler with Evonik and the joint venture Li-Tec (production ended at the end of 2015) or Bosch with Samsung in the SB LiMotive joint venture, which was established in 2008. Bosch frustratedly threw in the towel in 2012. Also a second attempt with the Japanese from GS Yuasa failed recently.

## Newsflash

Technologically, the Germans lag about ten years behind the Asians and the construction of the gigafactories necessary for production would cost tens of billions. In order to take the risk, suppliers would need reliable promises from automobile manufacturers.



Picture: Battery package of BMW i3- No loss of interior space if constructed from the outset as an e-car.

There is no lack of initiatives: The TerraE consortium started a project with Fab4Lib at the beginning of the year with 19 companies that want to start the production of battery cells in Germany. Innovative production techniques are intended to significantly reduce costs and reduce the gap to the Asians.

So far there has been talk of a production of six gigawatt hours per year, small fish compared to the gigafactories sprouting from the ground far to the east. To achieve this, the production facility is to have a modular structure and be installed where capacity is currently required.

Flexibility instead of mass is the motto. Whether this calculation will work out remains to be seen.

Car manufacturer BMW has taken 200 million euros in its hands to create a "competence centre for battery cells" in which 200 engineers are ultimately working on the batteries of the future. Compared to the manpower with which the Asians do their research, this is marginal. Inventing high-performance rechargeable batteries is one thing; the manufacturing processes for battery cells are extremely important.

VW wants to take billions into its hands to make up for the shortfall. While planning is still in progress, the Asians are creating facts.

At the moment there is a crowding-out competition among cell manufacturers. LG Chem, Panasonic and the Chinese from CATL currently have the best chances of asserting themselves, who are pushing into the market with power and want to pull up gigafactories in the Middle Kingdom. As soon as the cut and thrust on the manufacturer's side is done, the Asians dictate the market. According to analysts, demand will exceed the supply of battery cells by the end of the 2020s at the latest - probably even earlier. Prices will pick up again by then at the latest and it can be expected that asian car manufacturer will be in a stronger negotiating position.

Source: [https://www.focus.de/auto/elektroauto/kampf-um-akkuzellen-monopolgefahr\\_id\\_8702061.html](https://www.focus.de/auto/elektroauto/kampf-um-akkuzellen-monopolgefahr_id_8702061.html)

# Newsflash

3rd Graz Battery Days



UPCOMING EVENT:

**3<sup>rd</sup> Graz Battery Days on Cost Effective Li-Battery Production Methods – Materials, Cells and Packs 24<sup>th</sup> to 26<sup>th</sup> Sept 2018**

Kunsthhaus Graz – room „Space04“

Organized by:  
VARTA Micro Innovation GmbH & Fraunhofer IKTS

Contact: [GBD@vartamicroinnovation.com](mailto:GBD@vartamicroinnovation.com)  
[www.vartamicroinnovation.com](http://www.vartamicroinnovation.com)

Foto: Universalmuseum Joanneum, Eduardo Martinez

## Cost Effective Li-Battery Production Methods - Materials, Cells and Packs

On behalf of our project member Varta Micro-innovation we are pleased to invite you to the 3rd Graz Battery Days from 24<sup>th</sup> and 26<sup>th</sup> of September 2018 taking place in Graz, Austria. Conference programmen, registration and further information: [www.vartamicroinnovation.com](http://www.vartamicroinnovation.com)

This years theme of the conference is „Cost Effective Li-Battery Production Methods - Materials, Cells and Packs“.

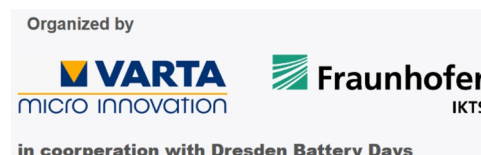
**It would be our pleasure to welcome you in Graz.**

This two-day meeting will be dedicated to the exchange of knowledge between international electrochemical energy storage experts on the specific topics of

Contact: [GBD@vartamicroinnovation.com](mailto:GBD@vartamicroinnovation.com)

- Cost cutting potentials for state of the art materials and perspectives for future technologies
- Future cells concepts and their cost competitiveness against the lithium ion system
- Cost-downsizing for battery packs

Organized by



in cooperation with Dresden Battery Days

# Newsflash

Energy Symposium 2018



The 5th Energy Symposium of the Energy Innovation Europe (EIE) network takes place on 11<sup>th</sup> and 12<sup>th</sup> of September 2018 in Karlsruhe (Germany).

This year's event focuses on recent developments on hydrogen within the energy sector thereby covering the areas of electrolysis, production and refining, storage, use, e.g. in mobile and private applications and safety.

The international symposium starts the day before with an interesting evening programme with:

- Guided visit to Total Multi Fuel Station
- Pitch your idea!  
Opportunity to introduce yourself and your project idea for efficient networking
- Dinner discussion on suitable European pilot projects to accelerate the large-scale implementation of hydrogen as energy carrier

In addition to 16 expert presentations, the hydrogen test centre HYKA of the Karlsruhe Institute of Technology (KIT), a hydrogen-powered bus and a hydrogen refuelling station can also be visited.

Test drives with hydrogen-powered cars are also possible.

Conference programmen, registration and further information:

[www.energy-innovation-europe.eu](http://www.energy-innovation-europe.eu)

**It would be our pleasure to welcome you in Karlsruhe.**

Contact: [andre.nadolny@aura-ag.de](mailto:andre.nadolny@aura-ag.de)

## Event Watch

### AsiaSolar PV Expo

AsiaSolar Photovoltaic Innovative Technology Exhibition & Cooperation Forum  
04.09. - 06.09.2018 Shanghai, China



### ESC - Energy Storage China

19.09. - 21.09.2018 Tangshan, China



### SPI - Solar Power International

24.09. - 27.09.2018 Anaheim, USA



### EU PVSEC - European Photovoltaic Solar Energy Conference and Exhibition

24.09. - 28.09.2018 Brussels, Belgium



### Power Efficiency.Energy-Saving.Innovative Technologies and Equipment

02.10. - 05.10.2018 St. Petersburg, Russian Federation



### Solar & Storage Live (formerly Solar Power UK)

16.10. - 18.10.2018 Birmingham, Great Britain



### Energy Storage North America (ESNA) - Conference and Expo

07.11. - 08.11.2018 Pasadena, USA



### Intersolar India / ees India

The leading energy storage exhibition to secure India's energy supply  
27.02. - 01.03.2019 Tokyo, Japan



### ENERGY STORAGE EUROPE - Fair and Conference

12.03. - 14.03.2019 Düsseldorf, Germany



### eMOBILITY WORLD - Sustainable Mobility Exhibition

The leading trade exhibition dedicated to energy efficient solutions for the  
20.03. - 24.03.2019 Friedrichshafen, Germany



### Energy / HANNOVER MESSE

Leading international trade fair for integrated energy systems and mobility  
01.04. - 05.04.2019 Hannover, Germany



### Solar Canada - Canada's Largest Solar Energy Exhibition and Conference

08.05. - 09.05.2019 Calgary, Canada





## improved lithium-ion batteries

### Consortium

#### VARTA Microbattery GmbH



VARTA Microbattery (VMB) is an internationally leading and globally active manufacturer of retail and OEM batteries and has been operating for more than 125 years. VMB employs nearly 750 persons in Germany and approx. 2,000 worldwide. The company headquarter is located in Ellwangen in the southern part of Germany where the entire research, engineering and production of the electrochemical cells are done. 150 VARTA employees work in the Innovation Tower at our headquarters in Ellwangen.

This central Research and Development department focuses on developing new products and optimizing existing solutions. Particular attention is paid to material and structural research, converting and storing energy (light, heat, vibration, etc.), and nanotechnologies, fuel cells, and printed batteries.

#### Uppsala Universitet



Uppsala Universitet (UU), founded in 1477, is the oldest University in the Nordic countries. In all different ranking lists UU is among the top 100 universities in the world. Today, it trains more than 43,000 students, and employs 6,000 people. There are about 2,500 active graduate students; 44% of these are women. Each year, the University awards some 270 doctoral degrees.

The Ångström Advanced Battery Centre (ÅABC) is an integral part of the Department of Chemistry – Ångström Laboratory, Uppsala University; it is housed within the Ångström Laboratory – one of Europe's best equipped Materials Research Laboratories. The Centre involves the full-time activities of 35-40 researchers, of whom 8 are Senior Staff and research engineers; the remainders are PhD students and postdocs. It is the leading basic research environments for the development of electrochemical storage materials and advanced battery technology in the Nordic countries. It is publishing more than 20 battery research papers per year. It is a member of ALISTORE-ERI a network of excellence for battery research started more than 10 years ago within FP6. It is a member of SHC (The Swedish Hybrid Vehicle Centre) and of several existing and former FP7 programs.

## Consortium

### Varta Storage GmbH



The VARTA Storage GmbH (VS) is a developer and manufacturer of stationary battery storage systems. The company has substantial know-how in the field of energy storage by using long-life lithium-ion batteries and conducts in the context of innovative research and development activities. The first commercial product from VARTA Storage is the ENGION Family, a modular storage system which allows the storage of PV-Energy in order to increase the self-consumption of private households up to 70%. With the development of novel large-sized storage systems the company addresses new applications like the efficient use of renewable energies and the support of grid stability.

### Commissariat à l'énergie atomique et aux énergies alternatives



CEA is a French government-funded technological research organization. With more than 15,000 researchers and co-workers, its activities cover four main areas: Energy, Defence & security, Health & information technologies, and Fundamental research. Two Institutes from CEA both located on the CEA Grenoble centre are involved in the Sintbat project. CEA-INAC is a fundamental research institute (420 people) involved in nanoscience, while CEA-LITEN is a technological research institute (1,000 people) specialized on energy R&D (fuel cell, batteries, biomass, and solar application).

CEA-INAC develops expertise in advanced characterization on the Nanocharacterisation platform, a large facility devoted to up-to-date electron microscopy, spectroscopy and NMR on the Minatec campus of Grenoble. INAC also manages X-rays beam line at ESRF facility and ILL neutron reactor. For many years, CEA-INAC has developed strong knowledge in LIB investigation and in particular for Si based electrodes. The Nanocharacterisation facility not only provides access to high tech equipment with experienced staff, but also develops new characterisation methods to add to its portfolio.

The Laboratory for Innovation in New Energy Technologies and Nanomaterials (CEA-LITEN) has a unit dedicated to energy for transport application (Department of Electricity, Hydrogen and Transport, DEHT) which has more than 15 years experiences in new materials for Li-ion batteries. Today, this entity is equipped with a dry room of 300 m<sup>2</sup> dedicated to Li-ion batteries prototyping from the electrode material up to the cell and more than 600 m<sup>2</sup> dedicated to Li-ion module and pack system development. CEA-LITEN intellectual properties portfolio on Li-ion batteries is more than 100 on the topics of material synthesis, battery architecture, and BMS.



## improved lithium-ion batteries

# Consortium

### WMG, University of Warwick



The University of Warwick is one of the UK's great success stories. In less than fifty years since being founded the University has become one of the UK's best universities, consistently at the top of UK league tables and rapidly climbing the international league tables of world class universities. Warwick is globally connected, forward-looking and entrepreneurial. At its heart Warwick is about creating new ways of thinking and achieving: making us stand out from our competitors and the more 'traditional universities' and creating an inspiring place to study and undertake research.

As one of the largest academic departments at the University, WMG is able to make a real impact on industry through collaborative R&D and top class education. UK government reviews have cited WMG as an international role model for university and business collaboration. What makes it unique is a multidisciplinary approach to innovation; pushing the boundaries for science and technology and enabling the transfer of knowledge into new areas. Working at the forefront of emerging technologies, and across diverse projects and industry sectors, WMG tackles real world challenges in an environment that inspires confidence and creativity.

### MCL Leoben



The Materials Center Leoben Forschung GmbH (MCL) is the leading Austrian institution in the field of applied materials science with around 150 employees. In particular, it is operating the Comet K2 Center on Integrated Research in Materials, Processing and Product Engineering (MPPE) which is the largest competence center in the field of research on application of materials in Austria. The research focuses on Integrated research in materials, processing and product engineering and covers the entire supply chain from material synthesis via materials processing and manufacturing and is also including the behavior of components in service till their deployment. About 50 scientific institutions and about 90 companies are collaborating in this network on material based innovations in the fields of (a) new materials and novel material solutions for future applications like energy storage and harvesting, (b) new and optimized processes and process chains, (c) new design concepts, (d) innovative material driven products, and (d) reliability of products in service.

The MCL has modern Lab equipment suitable for cutting edge failure characterization and material characterization.





## improved lithium-ion batteries

# Consortium

### VARTA Micro Innovation GmbH



VARTA Micro Innovation GmbH (VMI), with registered office in Graz (AUT), is a joint venture between the battery manufacturer VARTA Microbattery (Ellwangen, DE) and Graz University of Technology (AUT). The business purpose of VARTA Micro Innovation GmbH is R&D in the area of electrochemical energy storage systems. Within VARTA Micro Innovation both, the industrial fabrication know how from VARTA Microbattery and the basic research know how from Graz University of Technology for various electrochemical energy storage systems are merged together. This unique configuration enables VARTA Micro Innovation to perform a fast transfer of newly developed technologies into production state. The R&D activities of VMI are divided in three main research areas:

- Lithium Power - Improvement of specific energy (Wh\*kg<sup>-1</sup>) and energy density (Wh\*l<sup>-1</sup>)
- Heat Power – Enlargement of the temperature operation range
- Rapid Power – Improvement of the rate capability

VARTA Micro Innovation is highly experienced in research, reverse engineering and ordered analysis in the area of lifetime prediction and reliability of Li-Ion Batteries for different application fields (e.g. EV, storage etc.). VARTA Micro Innovation has also many years of experience in working with high capacity negative electrode materials for lithium ion batteries. This work includes on the one hand basic research of high capacity electrode materials as well as electrode fabrication and construction of batteries with these materials on prototype level.

### EurA AG



EurA AG has been established in 1999. As an innovation service provider, EurA advises more than 800 mainly medium-sized companies in Germany, covering all industrial sectors. EurA mainly focuses on consulting and assisting companies in national and European R&D projects. This comprises the entire innovation process, including the generation of promising ideas, the search for suitable partners, the establishment of the project consortium, the technical and administrative coordination of the project as well as the project controlling.

## Consortium



### Uniwersytet Warszawski

University of Warsaw (UW) was founded in 1816. The University brings together scholars from a variety of disciplines. It is the place of a diversity of scientific research. Nearly 60,000 people study at the University of Warsaw every year. The candidates are offered a very broad range of courses in the fields of humanities, social sciences and natural sciences, as well as many interdisciplinary courses combining knowledge and skills of many disciplines. The University offers undergraduate and doctoral studies, organizes summer schools, postgraduate studies and vocational courses, initiates interdisciplinary programmes and introduces new teaching techniques.

The Faculty of Chemistry, University of Warsaw, is a large research and teaching centre. There are fully developed programs in analytical chemistry, biochemistry, inorganic, nuclear, organic, and physical chemistry as well as in chemical physics. The faculty has been regarded as one of the top chemistry departments in the country for decades, and it attracts outstanding faculty and students. Many faculty members have distinguished themselves both nationally and internationally.



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