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# NEWS



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

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## 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.



## 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.



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### 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.



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# 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 Consult AG



EurA Consult 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 Consults 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.





improved lithium-ion batteries

## General Assembly Meeting

Date: 27<sup>th</sup>-28<sup>th</sup> September 2016 Location: Graz, Austria



From the 27<sup>th</sup> to the 28<sup>th</sup> September 2016, the first biannual General Assembly Meeting of the project "Sintbat" took place at Graz, where Varta Microinnovation is located. The date was chosen to allow for the participation of the 4<sup>th</sup> Graz Battery Days dedicated to the exchange of knowledge between international electro-chemical energy storage experts. On the evening an informal get-together gave ample opportunities to tune into one another for the forthcoming day.

The official meeting started on the 28<sup>th</sup> with a welcome by the host, Stefan Koller, who wished for an interesting and fruitful meeting. Afterwards the scientific work packages were represented by the respective work package leaders. These presentations gave the consortium the opportunity to learn in detail about the progress within each work package, the results already achieved, the issues encountered and the work planned for the future.

In extensive discussions after each representation the partners were given the opportunity to ask questions, provide ideas and clarify more details.

These discussions were very helpful as it was afterwards easily possible to agree on the tasks to be done in the next six project months. So, after all details were presented and the last questions answered, Stefan Koller summarised both, the successful meeting thanking all partners for their active cooperation and contributions and the first 6 month of the project by underlining the good standard of work performed in the project. By keeping this up, the project is on a very good path to reach its goals.

All project partners are looking forward meeting again end of April 2017 at Uppsala, Sweden.



## Project Progress

With most of the first project year behind us the project work is well underway. A lot of work has already been performed and first successes have become apparent.

### Project Management:

So far, the project management has not encountered any severe problems. All minor issues have been solved in a timely manner and without interferences. Budget control revealed no unusual figures. The preparation of reports and respective forms is on time, as well.

### Research and Development: Electrode development (WP 2)

After cell benchmarking of commercial available Li-ion-batteries was done the development of silicon based high capacity negative electrodes containing only silicon or silicon composites was tackled. The electrochemical evaluation revealed best candidates for developing prelithiated electrodes thereof in order to obtain long lifetime and energy density. Simultaneously, the evaluation of a green process at pilot scale for manufacturing of cathodes is underway. Starting from State-of-the art materials and processes the focus is on optimizing the process of applying/drying an aqueous slurry.

### Aging Mechanism (WP 3)

Pursued the characterization of powder and pristine negative electrodes applying extensive methods of measurements such as XRD/SAXS, SEM/FIB, NMR revealing domain size and organisation. In operando XRD is deployed to investigate strain evaluation during the cycling process in the different active crystalline

phases of the anode and compared to post-mortem species. Additional analytical methods are aimed at (micro-)structure, chemical composition and Li-environment via NMR.

### Modelling, Simulation (WP 4)

In November 2016 the partners of WP4 met at the University of Warwick (UoW) to discuss the experimental results and techniques for the micro-mechanical and electrochemical modelling simulation activity. MCL Loeben presented their latest findings related to the Si phases and the performance of a 3D segmentation algorithm when applied to the Sintbat anode electrode and University of Warsaw presented the cyclability performance of half cell battery arrangements. UoW discussed their modelling approaches to a stress-assisted lithiation in a single Si particle, and the parameter identification for the electrochemical model. Return visits are planned to develop the project progress.

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

The first project newsletter has been sent to major interest groups in August 2016. Moreover, the Sintbat project has been presented at the European workshop on nanotechnologies & advanced materials for batteries, Brussels 23<sup>rd</sup> February 2017 and to the cluster ZukunftSpeicher, Lucerne, 19<sup>th</sup> January 2017.

With great anticipation the first meeting of the Industrial Advisory Board took place in November 2016. Several actions were agreed upon. The General Assembly meeting in April 2017 will provide an excellent opportunity for an exchange.



# improved lithium-ion batteries

## Newsflash

### China Leading the Charge

Tesla’s Gigafactory 1 has been a center of attention for people interested in the growing momentum behind green energy, electric cars, and battery production. Therefore, it is no surprise that this facility was in the news again in January 2017, with Tesla starting to mass produce batteries as it ramps up to its goal of 35GWh of capacity and beyond.

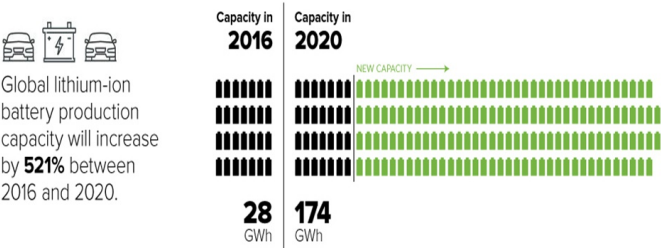
However, as exciting as this project is, it’s actually just one of multiple large-scale “megafactories” being built – with many of them being in China.

\$11.5 billion, and could be a dominant force globally in the battery sector if it successfully increases its lithium-ion production capacity six-fold to 50GWh by the year 2020.

Other Chinese manufacturers are on a similar trajectory. Panasonic, LG Chem, and Boston Power are building new megafactory plants in China, while companies such as Samsung and BYD are expanding existing ones. All lithium-ion plants in China currently have a capacity of 16.4GWh – but by 2020, they will combine for a total of 107.5GWh.

### CHINA IS LEADING THE CHARGE

Lithium-ion megafactories in China to grow capacity 6X by 2020



“While the Tesla Gigafactory is vitally important from an EV vertical integration perspective, the majority of new lithium-ion battery capacity is being built in China. Some of these plants are expected to be huge such as the CATL facility at 50GWh – there is little doubt that China’s lithium-ion industry has come of age” (Simon Moores, Managing Director at Benchmark Mineral Intelligence).

Contemporary Amperex Technology Ltd (CATL) has plans to build the largest lithium-ion megafactory of all – but the company is little known in North America. It’s already worth

### Capacity by Country

This ramp up in China means that the country will have 62% of the world’s lithium-ion battery production capacity by 2020. There are only three other players in the megafactory game: United States, South Korea, and Poland.

|               | 2016 Capacity (GWh) | 2020 Capacity (GWh) | % of Global Total (2020) |
|---------------|---------------------|---------------------|--------------------------|
| United States | 1.0                 | 38.0                | 22%                      |
| China         | 16.4                | 107.5               | 62%                      |
| Korea         | 10.5                | 23.0                | 13%                      |
| Poland        | 0.0                 | 5.0                 | 3%                       |
| <b>Total</b>  | <b>27.9</b>         | <b>173.5</b>        | <b>100%</b>              |

Above estimates on battery capacity courtesy of Benchmark Mineral Intelligence.

## Event Watch

The next big event on european soil, the ENERGY STORAGE 2017 will take place in Dusseldorf, Germany. Here the energy storage of future energy systems can already be experienced today. The high-quality specialist conferences consist of three events under one roof:

- RES-CONFERENCE (Energy Storage -Research & Development, Framework & Conditions);
- ESE-CONFERENCE Markets Business cases, Regulatory Framework, Safety...) and
- ESE-EXPO World Leading Exhibition Covering all Energy Storage Technologies.

**Battery Japan** (World Smart Energy Week) – Int. Rechargeable Battery Expo

**Eco House & Eco Building Expo** (World Smart Energy Week)

01.03. - 03.03.2017 Tokyo, Japan



**Energy Storage Europe** – Fair and Conference

14.03. - 16.03.2017 Düsseldorf, Germany



**New Energy Husum** - International Fair and Conference

16.03. - 19.03.2017 Husum, Germany



**Energy Show** - Trade Exhibition

05.04. - 06.04.2017 Dublin, Ireland



**InEnerg Innovative Energy** - Trade Fair

12.04. - 13.04.2017 Wroclaw, Poland



**Energy / HANNOVER MESSE** - Leading Trade Fair

24.04. - 28.04.20 Hannover, Germany



**RENEWABLE ENERGY ASIA - REA** (ASEAN Sustainable Energy Week)

07.06. - 10.06.2017 Bangkok, Thailand



**Battery China** - China International Battery

21.06. - 23.06.2017 Beijing, PR China



**Renewable Energy International Exhibition** - exhibition & forum

05.07. - 07.07.2017 Yokohama, Japan



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

08.08. - 10.08.2017 San Diego, USA



**CNIBF** – China Shanghai Int. Battery Industry Fair

23.08. - 25.08.2017 Shanghai, PR China



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