Advanced Flow Battery Energy Storage Systems in a Microgrid Network

Rapports

Informations projet

GREENERNET

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Site Web du projet

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Projet clôturé

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Periodic Reporting for period 2 - GREENERNET (Advanced Flow Battery Energy Storage Systems in a Microgrid Network)

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Résumé du contexte et des objectifs généraux du projet

During the GREENERNET project has been realized an innovative 10 kW Energy Storage System (ESS) based on organic flow batteries starting from an existing 1 kW prototype, integrated into a smart microgrid for distributed energy applications.
The main objective of the GREENERNET project is to develop an AQDS-based (anthraquinone disulfonate) flow battery that can ensure the integration of renewable sources (mainly solar and wind) and enable the building of a smart microgrid at utility and local scale (residential and communities).
It follows that four main tasks have to be accomplished by this project:
• Scale-up of the 1 kW AQDS flow battery to a 10 kW one.
• Design and deployment of the Microgrid Management Platform for the integration of the AQDS flow batteries as ESS.
• Validation of the 10 kW system integrated into the smart microgrid architecture in a real-world situation (test-environment site in Budapest) to prove how multiple AQDS flow batteries can improve the overall efficiency of the electricity grid.
• Development of a commercialization plan and of marketing strategies to launch the product into the European Market.
The main objective of the GREENERNET project is in total agreement with the scope of the call Fast Track to Innovation Pilot that aimed “to give the development of innovations the last push needed before their introduction to the market”.
Specific development was related to battery components such as stack's components, pumps and tanks, electrolytes. For the part on electrolytes the performance was optimized on the basis of the achieved electrochemical reuslts.
During the timeline the partners have collaborated in identifying the high-level design of the overall GREENERNET system, embedded with all the 4 levels of control: the Battery Control System, the Battery Management System, the Microgrid Management System and the Energy Management System. Following the activities on the technology scenarios, the partners collaborated on the definition of the use cases for the application and a final study of the user scenarios.
It has been prepared a battery stand-alone and grid-connected field test and preliminary investigations for the on-site pilot installation and demonstration. A preliminary design of the EMS functionalities and interfaces with the MCS was developed. The design of the MCS required HW and SW developments, and communication systems with the BCS and the EMS.
The BCS was revised, it controls the cyclability and all the RFBs properties, optimizing the charging/discharging procedures executed in a standalone modality.
The Energy Management System (EMS) has been implemented. One of the most relevant goals of the EMS consists of gaining economic benefits from the exploitation of flexibility and in delivering technical services to the DSO.
The optimiser manages to reduce the distance between the forecasted microgrid consumption profile before the optimisation and the request of the DSO to follow a particular one in a certain time period, exploiting the flexibilities put at disposal of the EMS optimisation tool by the battery and the EV recharge system. This behaviour demonstrates the capability of the microgrid to shape its power profile in order to meet requests from an external actor.

Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu'à présent

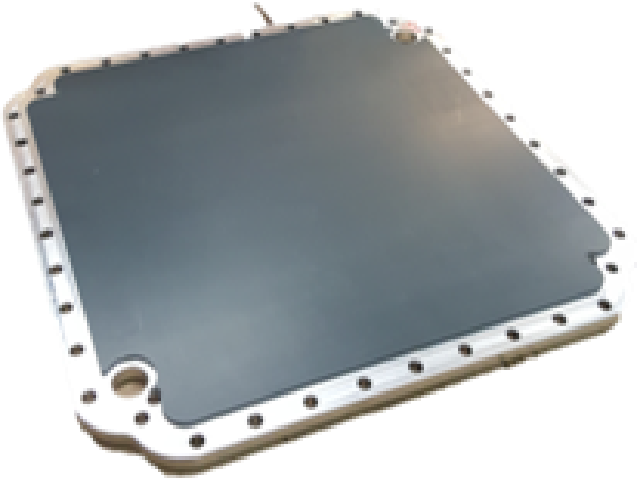
The main project objectives of the second period, are related to Work Packages 3-4-5.
Inside WP3, the battery components (electrodes, membranes, electrolytes, bi-polar plates, pumps) were analyzed. To respect the timeline of the project and be able to correctly test the battery system in the final pilot site, the structure of the single cell has been modified. The general architectural aspects of the BCS were revised.
The main objectives of WP4 were:
•To develop an innovative Microgrid Management Platform for the AQDS flow batteries.
•To continuously perform a multi-objective optimisation of the energy flows among microgrids components and with the Power Distribution Grid.
The most important progress was the implementation of the EMS, the ICT component of the Microgrid Management Platform responsible for the optimisation of the power flow inside the microgrid and its support to the Distribution network. The EMS and MCS are able to communicate to each other by a defined set of microservices, including MQTT messages for the asynchronous acquisition of the monitoring data registered from the field devices inside the microgrid. The MCS is able to interact with field devices by a wide set of protocols. The collaboration with the DSO for the provision of services for the balancing of the grid has been tested and demonstrated by means of the introduction of a consumption profile, provided by the DSO, which the microgrid can try to follow mainly exploiting the flexibility offered by the battery.
The prototypes have been stested into the demo site.
The main activities of WP5 were: preparation for battery standalone field tests, on site pilot installation and demonstration.
WP6 Dissemination and exploitation: During the second period of the GREENERNET project the overall communication and dissemination activities undertaken. The partners identified relevant target groups within specific stakeholder fields and addressed them with dedicated channels and means. In this way, partners disseminated the main results and outputs coming from the project.

Progrès au-delà de l'état des connaissances et impact potentiel prévu (y compris l'impact socio-économique et les conséquences sociétales plus larges du projet jusqu'à présent)

2nd period of the project.
Progress beyond the state of the art
The main activities have been implemented for the development of architectural aspects of the BCS and for standalone battery pilot studies.
The BCS controls the cyclability and all the Flow Batteries properties, optimizing the charging/discharging procedures.
Standalone battery on the pilot studies covered all the specific behaviour as such as the change-over between "on/off-grid" performance and energy flow optimization.
A series of standalone deep charging/discharging processes have been performed. Acquired data

and analysis proved the coherence between field and theoretical results.
The EMS has been implemented One of the most relevant goals of the EMS consists of gaining economic benefits from the exploitation of flexibility and in delivering technical services to the DSO.
In advanced microgrid solutions, beyond dealing with operation and communication between microgrid components such as energy sources (e.g. solar), uncontrollable and controllable loads (EV chargers), the intelligent management system shall also be capable of performing optimization with respect to the constraints of the microgrid devices, weather forecast, grid commands, user preferences. The microgrid controller provides a high- level sophisticated “service environment” that can serve not only as a flexible hardware component, but as a service orchestrator fulfilling business level requirements.
Impact of Greenenernet project
This aligns with the scope of the Call – Fast Track to Innovation Pilot that consists of “ giving to the development of innovations the last push needed before their introduction to the market”.
Furthermore, the project contributed to “develop sustainable innovations addressing societal needs or areas”. By providing a concrete solution to the storage and efficient management of the energy produced by clean power technologies, GREENERNET addresses key environmental and social challenges related to climate change and the de-carbonization of the global energy infrastructure.

battery stack



bipolar plate

battery prototype GES

pilot site Budapest

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