Smart grid integration, self-consumption strategies & enlarged RES penetration factor

Òscar Càmara

AIGUASOL

ARTICLE INFORMATION	ABSTRACT
Published November 2020 Key words: energy consumption, savings, RES, smart buildings, Building Energy Management System.	The pilot site for the Barcelona demonstration is the Rambla del Celler sports, located in Sant Cugat. This centre is currently consuming electricity and gas from the grid as well as producing its own energy through a hybrid solar-thermal system. Smart tools will be developed on the specific site of high energy demand, in order to carry out DR optimisation. Alongside, additional storage solutions (thermal) or (electrical) the use of distributed Li-Ion batteries will be addressed along with the analysis of the capability of distributed end-user energy storage facilities to help the grid penetration of RES.

Introduction

The European guidelines are aiming to unify all countries' legislations and energy operating systems and, moreover, it is expected that a higher RES penetration will be highly encouraged through different strategies during the upcoming years. In addition, the demand aggregator figure is already starting to appear in the Spanish legislation, which will make the energy market to operate under different conditions and will open the door to Demand Response (DR) strategies to be applied.

This expected high RES penetration will imply a challenge in terms of operating and managing the distribution grid, which will require the implementation of DR strategies offering the end-users to be able to manage they assets (consuming elements, batteries, PV systems, etc) in order to obtain significant savings. Having said that, it is far from trivial to identify the optimum conditions and actions that would derive in an economical saving. Therefore, the technology developed within the inteGRIDy project will be demonstrated in the Barcelona pilot in order to handle the aforementioned challenges.

The pilot site for the Barcelona demonstration is the Rambla del Celler sports, located in Sant Cugat (20km from Barcelona city centre and being one of the city owned sports centres managed by the Eurofitness foundation. The sports centre has approximately 6200 members and consists of a main swimming pool next to a smaller pool, a spa area as well as several rooms dedicated to guided sessions, cycling and other fitness activities. This centre is currently consuming electricity and gas from the grid as well as producing its own energy through a hybrid solar-thermal system with a power of approximately 25kWp. In addition, ten other tertiary municipality buildings will be monitored and analysed in order to potentially increase the flexibility of the grid.

The scope of the inteGRIDy project is the main swimming pool since it has been identified as the major consumer, which requires from different elements to operate; an Air-Handling Unit (AHU) and a combination of a Seasonal Thermal Energy Storage (STES) and a heat pump in order to maintain the swimming pool under comfortable conditions. The STES was implemented in the center as part of the CHESS SETUP project, a Horizon 2020 project under grant agreement No 680556.

Several interesting energy saving measures will be implemented in this centre, including monitoring equipment and a Building Energy Management System (BEMS).

The Solution

Smart tools will be developed on the specific site of high energy demand, in order to carry out DR optimization. Alongside, additional storage solutions (thermal) or (electrical) the use of distributed Li-Ion batteries will be addressed along with the analysis of the capability of distributed end-user energy storage facilities to help the grid penetration of RES.

These tools will give solution to the following project use cases:

- Optimization of swimming pool control. A numerical model coupled with an optimiser will replicate the behaviour of the pool hall area and optimise the control parameters. Optimised control parameters of the swimming pool will be obtained based on the weather forecast, electricity pricing and swimming pool schedule.

- Usage of the swimming pool as a thermal storage system: The high inertia of the swimming pool provides certain degree of energy consumption flexibility which is exploited to provide virtual energy storage capabilities to the grid.

- Smartening the distribution grid: stacking battery functionalities. The charge and discharge of the battery system connected to a solar PV system can be controlled via a number of strategies: arbitrage; peak shaving; maximize self-consumption of solar PV production; and provide grid services.

- Smartening the distribution grid: service to the grid: Aggregation of tertiary consumers as well as prosumers, to provide grid flexibility, grid congestion management and increase the penetration of renewable energy. This service is triggered by generation schedule or DR events and requires information of the flexibility of battery and swimming pool systems, as well as forecast of energy demand and generation of site solar PV system.

- Usage of battery system in case of grid outages. Use the battery system to feed a critical demand at the sport centre in case of grid outage.

Conclusions

The implementation of the cross-functional platform provided within inteGRIDy to the Rambla del Celler sports centre aims to increase the energy efficiency of the sports centre and, thus, to offer an associated economic savings to the end-user.

Moreover, this technology can also be used by ESCOs/demand aggregators in order to increase the grid flexibility, manage DR events and improve the distribution grid management. This technology is expected to have a high relevance in the upcoming years with the consolidation of the demand aggregator figure.

The solution proposed by the inteGRIDy project has been designed such as it can be replicated for any high energy consuming building with potential large inertias, being able to offer cutting-edge technologies within a replicable and scalable cross-functional platform.

The resulting main benefits of the solutions proposed in the Barcelona pilot are:

- Improve the energy efficiency of the system considered.

- DR strategies to end-users to obtain economic savings as well as improving the grid management performed by ESCOs/demand aggregators.

- Energy storage: optimisation of battery operation and offering a backup system for grid outages.

About AIGUASOL

AIGUASOL provides engineering and research services, promoting innovative solutions to reduce the impact associated with energy consumption (experience in urban planning, construction, industrial processes and power generation, with a focus on energy planning, savings measures, energy efficiency, process integration and renewable energy implementation).

In inteGRIDy, AIGUASOL leads the Modelling Mechanisms for Topology Analysis, DR Flexibility and Storage and uses individual tools developed by CERTH and POLIMNI for the development of a consolidated tool capable of optimizing the commitment and dispatch of an electric power system, including as well aspects of sub-hourly production cost estimates. Moreover, they support the demo activities in the Sport Centre of Barcelona, under the supervision of GNF, undertaking the roles of engineering and commissioning of the specific demo activity.

Information about the author

Òscar Càmara, Mechanical Engineer, senior expert - Since 2008 he is a project manager at AIGUASOL focusing on energy modelling, renewable energy and energy efficiency. He has been involved in TASK 44 IEA Solar and Heat Pump Systems. He is AIGUASOL's team leader in the EU project InteGRIDy and has contributed technically to the EU Projects RenewIT, PITAGORAS, INDUS3ES and CHESTER.

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