A Demonstration of an integrated Battery Energy Storage System in Residential and Commercial buildings

Paschalis A. Gkaidatzis, Athanasios Tryferidis

CERTH/ITI.

ARTICLE INFORMATION	ABSTRACT
Published day month year Key words: Battery Energy Storage System, BESS, Demand-Side Management, Active consumer/s.	Recent technological advancements have made it possible for even small stakeholders, or consumers to participate in the electricity energy market, not as passive consumers, but as active stakeholders. In that regard, and within the framework of inteGRIDy project, in Thessaloniki, Greece one such aspect will be examined; the implementation and integration of a Battery Energy Storage Systems (BESSs) in residential and commercial buildings. CERTH will be responsible for providing the state-of-the-art solution and its specifications for that case study, with the collaboration of Sunlight and Watt+Volt.

Introduction

The last few decades a shift has taken place in the electricity sector, where the traditional structure is challenged by the introduction of new technologies, bearing with them new advancements in the field, such as Distributed Generation, Renewable Energy, Battery Energy Storage Systems (BESSs) etc. [1].

These technologies have made it possible for even small parties to enter the electricity market and the previously passive consumer to actively participate in it, as well, namely Demand-Side Management. This aim at leading to a smarter and more efficient collaboration between the existing infrastructure such as the electricity grid and new technologies and a better integration of the latter.

In that context, within the inteGRIDy framework, BESSs will be installed in both residential and commercial buildings in the Thessaloniki Pilot case and their setup will be tested and configured for an optimal deployment and operation, for both the end-user/consumer and the aggregator, in that case the utility provider.

The integration of a Battery Energy Storage System following inteGRIDy reference architecture

Following the inteGRIDy reference architecture [2], the proposed BESS setup, for both residential and commercial cases, will be integrated in the different corresponding inteGRIDy layers, as detailed in the following paragraphs, namely:

1. Field middleware equipment,
2. BESS model and consumer profiling,
3. Operation Analysis,
4. Optimization and Decision Making methods,
5. Integrated Visualization tools.

1. Field middleware equipment Layer

For extracting load measurement from field devices or points of aggregated load that the BESS serves and the BESS itself. The BESS and its accompanying equipment will be provided by Sunlight batteries system manufacturer in Greece. Additionally, control devices will be needed.

Moreover, all the data are assembled and stored in secured databases, depicted as the Reference Knowledge Warehouse in the diagram below. This concerns not only the data from the measurement points, but also all the data generated from all the tools and components performing various tasks, described below.

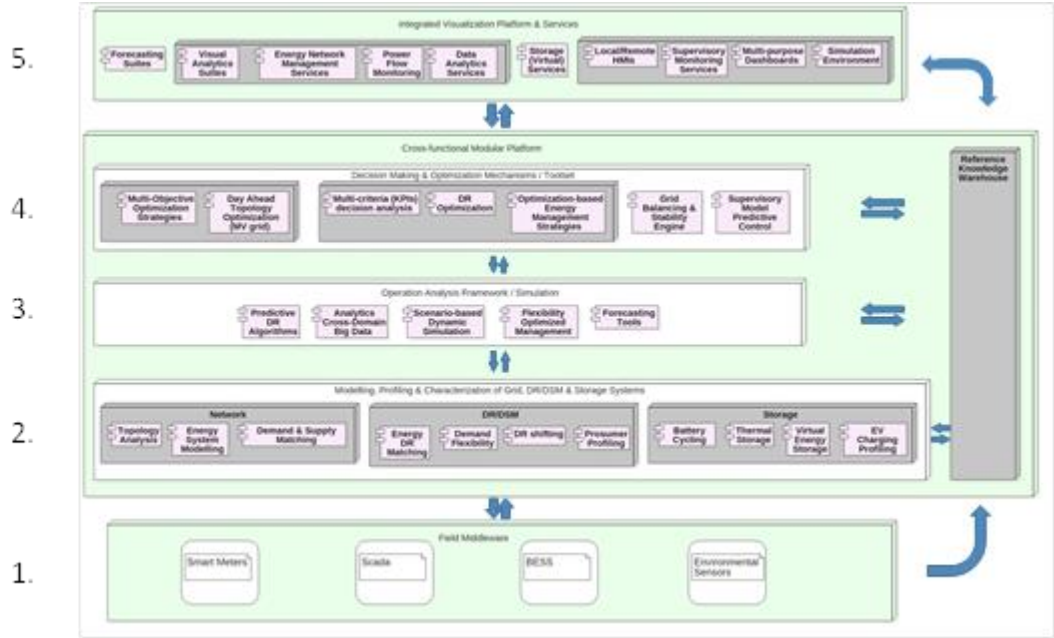

Figure 1: inteGRIDy Reference Architecture diagram.

2. Bess model and Consumer Profiling Layer

Model information of the BESS, such as maximum capacity, technology used etc. is necessary to specify its capabilities that is its maximum available Depth of Discharge, rate of charge/discharge for better exploiting it and avoiding its degradation. In addition, the load profile of the building, where the BESS would be installed, is also necessary. These would be mostly historical data of consumption.

Since access to more detailed information further requires more measuring equipment to be installed locally, usually leading to end-user/consumer discomfort, a more minimalistic approach has been decided and implemented. That is trying to exploit the least and fundamental information possible, leading to least possible equipment to be installed, and thus minimizing equipment cost and end-user/consumer discomfort, leading to the simplest setup possible, and therefore adding to its ease of use, replicability and scalability as a service.

3. Operation Analysis Layer

For this section, load forecast of at least a day-ahead is needed for the setup to determine the usage of BESS. Innovative techniques are used, such as Machine Learning, for generating the appropriate load forecasting, using historical data of load consumption [3].

The load forecast is generated for an entire day and it is being compared constantly with the current real-time load. If any deviation between them above a certain threshold has been detected and for a certain amount of time, then the load forecast is triggered again to recalculate and provide a more accurate forecast.

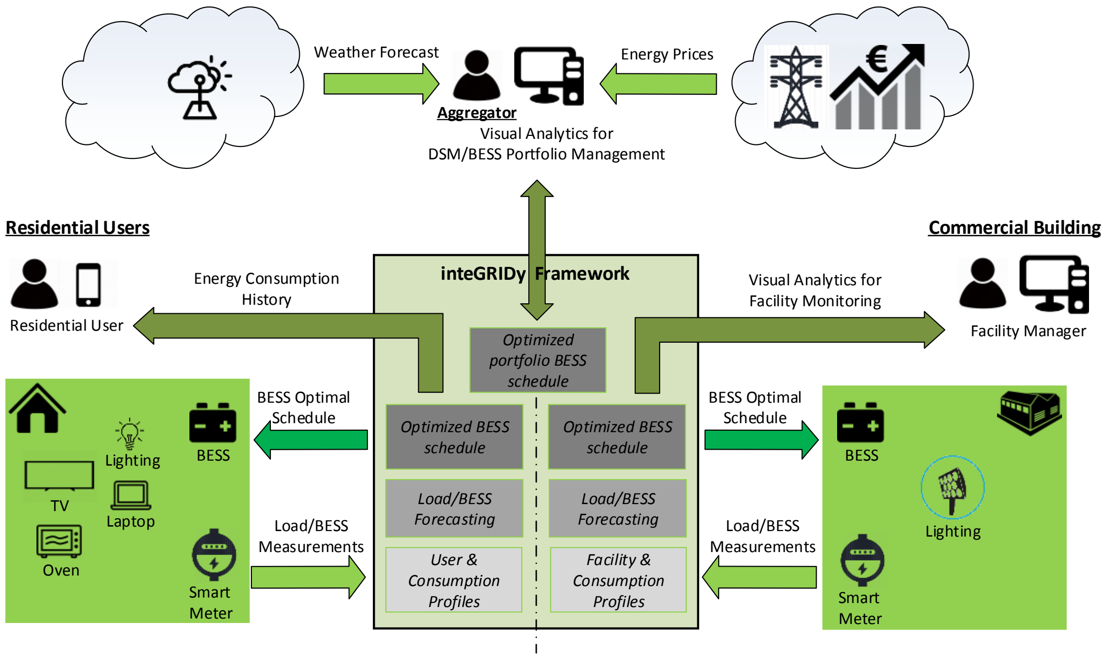

Figure 2: inteGRIDy Framework regarding BESS implementation in Thessaloniki Pilot.

4. *Optimization and Decision-Making Layer*

Based upon the load forecast, the optimal BESS schedule will be generated. The objective would be the minimization of cost of the electricity bill for the consumer, either commercial or residential. This can also be combined with the provision of Demand Response flexibility towards the aggregator, in that case the utility provider, i.e. Watt+Volt, or, if scaled up, by the aggregator towards the Distribution System Operator, leading to smarter and innovative grid solutions.

5. *Integrated Visualization Layer*

In order for the end-users/consumers, a visualization platform will be developed, offering both a mobile and a web user interface, in order for them to have access to operational and historical values, and further be able to provide configuration setup. For example, the end-users will be able to monitor the current status of the Setup, the current forecasted BESS schedule and the load forecast and the savings that have been made, either current or of previous days.

A visualization platform will further be created for the aggregator, allowing him to monitor the whole BESS portfolio, current status of the BESS installed and savings, and further provide configuration setup as desired.

Conclusions

An integration of Battery Energy Storage System in residential and commercial consumers has been presented. It has also been presented that through the exploitation of innovative technology and services this solution aims at leading to smarter grid solutions.

References

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[2]. D1.5 inteGRIDy Architecture & Functional/Technical Specifications, accesses at: http://www.integridy.eu/deliverables

[3]. Masum, S., Liu, Y., & Chiverton, J. (2018, June). Multi-step time series forecasting of electric load using machine learning models. In *International Conference on Artificial Intelligence and Soft Computing* (pp. 148-159). Springer, Cham.

About CERTH

Founded in 2000, the Centre for Research and Technology-Hellas (CERTH) has important scientific and technological achievements in many areas including: Energy, Environment, Industry, among others, as well as several cross-disciplinary scientific areas. Two different CERTH institutes participate in order to fulfil the objectives of inteGRIDy project: CERTH/ITI exhibits substantial research activity as well as technology transfer actions, and employs a high quality scientific group in the area of multi-sensorial and energy related systems, the development of simulation platforms and visual analytics for highly complex systems; CERTH/CPERI has a wide background on the study and construction of process systems and integrated systems used for energy production, management and storage and has unique knowledge in system design, engineering and industrial automation.

Information about the authors

Paschalis Gkaidatzis is a Research Associate at CERTH/ITI specializing in Distributed Energy Resource and their impact on the Distribution Network, involved in the inteGRIDy project on design and modelling of innovative Energy and Battery Solutions on top of the inteGRIDy Reference Architecture.

Athanasios Tryferidis has been a Research Associate at CERTH/ITI since 2012, specializing on technologies of Dynamic Management and Control and Demand Response use cases of Smart Distribution Grid towards Energy Efficiency, Smart Cities solutions and distributed IoT infrastructures. He is the Technical Manager of the inteGRIDy Project, further focusing on the design and integration of innovative ICT techniques (such as modelling, forecast and simulation) in different Smart Grid applications.

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