Joint “EERA/ON-SITE Project” Workshop on Hybrid Energy and Energy Storage Systems

21-22 September 2017

Ericsson – Via Anagnina 203, 00118 Morena, Rome, Italy

Introduction

Following the first workshop organised in San Sebastian in March 2017, we are pleased to welcome you to the second workshop on Hybrid Energy and Energy Storage Systems. The objective is to continue the discussion started in the first workshop about the use of different energy and energy storage technologies in combination. The workshop is organised in four sessions that will have an introduction by an expert followed by a discussion. We would really like all participants to contribute to the discussions, and we hope to draw some key comments from the debate.

To make participants better prepared, we are providing a short abstract to introduce the four sessions. We have also prepared two key questions to be discussed during each session. The discussion is not limited to these questions, but hopefully it will make the discussion easier and more focused.

- **Session 1: How to benchmark hybrid energy and enrgy storage systems**
- **Session 2: Scenarios and requirements for hybrid energy and energy storage systems**
- **Session 3: Markets and integration of hybrid energy and energy storage systems (2030-2040)**
- **Session 4: Technologies and strategies to integrate storage in power plants**

The workshop is hosted by Ericsson, and jointly organised by EERA Energy Storage, the Onsite project and Fuel Cells and Hydrogen Joint Undertaking. In addition to the four sessions with discussions, we will also get to know new projects and interesting results from Ericsson, the main results from the On-site project and some key messages from the Fuel Cells and Hydrogen Joint Undertaking.

The last session on the workshop, we will try to discuss and brainstorm some innovative ideas for hybrid storage and hybrid energy systems for the future. We also aim at making recommendations for further research, industrial applications and policy makers – and discuss the follow-up actions we hope to carry on with.

SESSION 1: Benchmarking of electro-chemical and hybrid energy storage technologies for stationary applications

Manuel Baumann[1], Marcel Weil[1, 2], Jens Peters[2 1] ([1]ITAS - KIT, [2]HIU – KIT)

Storage technologies have to fulfil simultaneously multiple requirements such as high power and high energy density, long life, excellent safety, abuse-resistance, a wide bandwidth of operating temperatures, low cost and minimal environmental impacts. Nowadays no technology can meet perfectly all of these goals, while different technologies are competing with each other in overlapping application fields. Although only a few of these have achieved full maturity yet (e.g., pumped hydro), new solutions are continuously being suggested like e.g., hybrid energy storage systems that allow to combine the properties of different technologies and to potentially cover multiple application fields. Within this framework, a decision for a specific energy storage system in a certain application is always a compromise, especially if conflicting results in different benchmarking metrics can be identified.

A typical approach for benchmarking is the comparison of life cycle costs (LCC), which can be used for a systematic evaluation of alternative project designs including total expenditures (initial investment, capital, replacement, operation, energy and disposal costs etc.) over the whole life time of a product. In environmental terms, the carbon footprint (CF) is often used as measure, quantifying the greenhouse gas emissions of a product or service over its entire life cycle.

An economic and environmental assessment of different battery technologies over their lifetime, with a special focus on different Lithium Ion battery chemistries is given as an example for LCC and CF based benchmarking of energy storage systems. It considers four different stationary application cases and includes a case-specific battery system optimization. Additionally, an economic benchmarking of a new hybrid energy storage system – the Liquid Hydrogen Superconducting Magnetic Energy Storage (LIQHYSMES) unveils major challenges for hybrid energy storage technology evaluation and comparison.

This case study provides an idea of the difficulties that arise when comparing energy storage systems and raises two key questions for **benchmarking of energy storage systems**:

- How can **energy technologies** be benchmarked considering their **specific properties** in face of **different grid needs?**
- How to define **suitable application cases** for single and especially hybrid energy storage technologies?

SESSION 2: Scenarios and requirements for hybrid energy and energy storage systems - On-grid and behind the meters

Alberto Gelmini (RSE)

1- Long term scenario

The current (or potential) economically viable use of storage system are concerning to:

i. Self consumption – Prosumers
ii. Fast charge for EV (some projects propose to use electrochemical SdA in order to reduce the impact of the fast charge on the local grid)
iii. Geographic little island not connected to the national transmission system ("piccole isole")
iv. Electrification of isolated villages (light and water in Africans' villages)
v. To balance the generation program of Intermittent renewable energetic source
vi. Support for the distribution grids in order to increase the hosting capacity (PV and other distributed generations) and to improve the quality of the service (voltage corrections).
vii. Grid defection

For the future the power system scenarios are constrained to respect the European climate and energy targets:

- For 2030 a 40% reduction of GHG emissions
- For 2050 80-95% of GHG reduction.

The burden sharing of the targets amongst the different energy sectors is more severe with the power system than with other sectors: the conclusion is in the long time the power system has to face not simply a strong renewable integration but a situation made quasi totally by RES (and with non dispatchable renewable source in relevant quota): for instance 97% of renewable in the Roadmap to 2050 for the power system.

This prospective changes our kind to think the storages from the research point of view. So we expect in the medium term some new economical opportunity for the storages, like the possibility of gain participating to the service market of frequency reserve and rapid reserve. Instead, in the **long term** the new resources will cover most of the demand service for all the type of the ancillary service.

➢ At the present exists limits in using with profit the SdA to give the ancillary services. What of these technical and regulatory limits will can be faced and overcame?

2- Possible Mid term scenario: the case of Sardinia island

The power system are changing speedly and we need to face many challenges. A very interesting case, for the storages arises from the new National Energy Strategy "SEN" which the Italian Government is issuing (expected in the first week of October). At the present a consultation document[1] has been diffuse and one of the proposals presented is to force the phase-out of the coal in the power sector (before 2030). This choice should cause to face a power system without (or quasi) fuel thermal plant in the Sardinia Island electric system (about 8-10 TWh/y of load). In fact, Sardinia is not collected to the natural gas pipeline but, currently, there are thermal coal plants and old fuel oil plant. Existing projects of new infrastructures to bring the natural gas in Sardinia are not sized to support power production. So we can imagine that after a decade the Sardinian power system will be made (quasi) only by renewable sources (mainly PV and wind).

The Italian TSO, TERNA, considering this situation, indicates that to guarantee the security of the national system with the targets indicated in the SEN, 5 GW of new hydro pumping plants (a part of these in Sardinia) occur. Pumping plant can guarantee flexibility, frequency reserve and replacement reserve, but due to the environmental impacts it' hard to think of realize so many new pumping plants in Italy. An alternative solution is to substitute part of these with electrochemical storages and / or hybrid systems.

Other relevant example is the introduction of the Enhanced Frequency Response service in the UK market power market where the TSO national Grid says:

The changing generation mix in Great Britain is reducing the contribution that synchronous generation makes to the energy market, which in turn is reducing the level of system inertia, particularly on low demand days when there is a high penetration of renewable plant. Lower system inertia affects the ability of the System Operator (SO) to manage the system frequency within normal operating limits. This in turn will drive the procurement of larger volumes of the existing frequency response products. We are therefore investigating alternative solutions, one of which is the creation of an enhanced frequency response (EFR) service. The aim of this service will be to improve management of system frequency pre-fault, i.e. to maintain the system frequency closer to 50Hz under normal operation, however as a dynamic service there will also be a benefit in post-fault frequency containment.

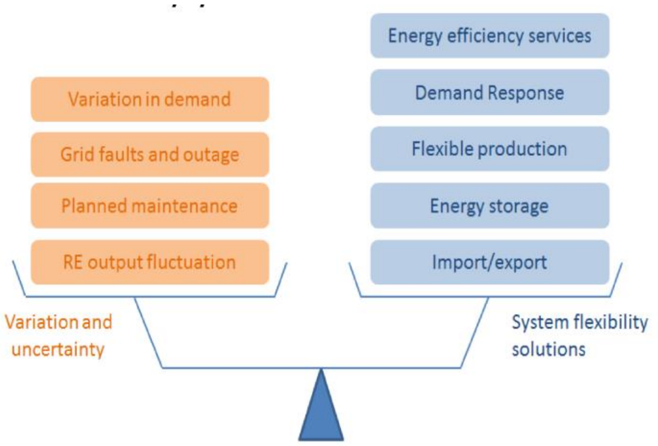
- What role can really play the electrochemical storage and hybrid system to ensure the security of the power system without thermal plants (now)? (in particular considering new needs or requirements.

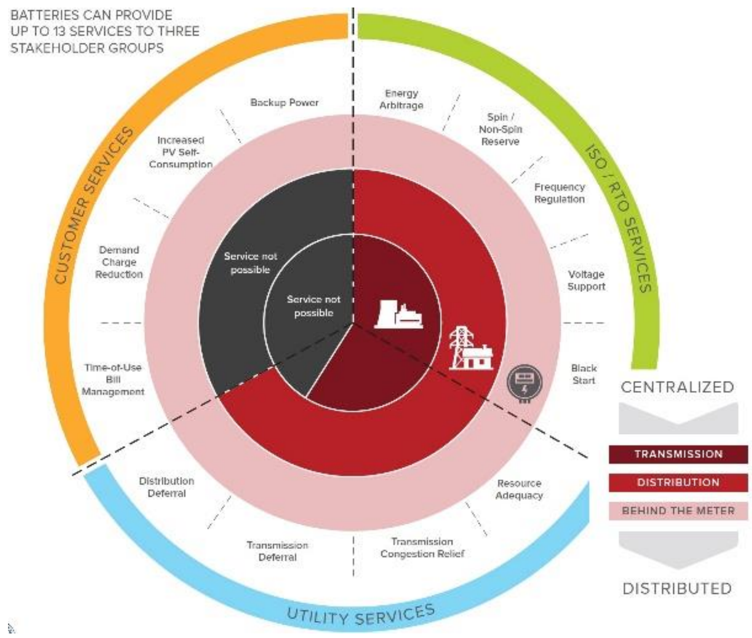
[1] http://dgsaie.mise.gov.it/sen/Strategia_Energetica_Nazionale_2017_-_documento_di_consultazione.pdf

<u>SESSION 3:</u> Markets and integration of hybrid energy and energy storage systems

Arshad Saleem (InnoEnergy)

Different storage technologies are getting its pace on the energy markets arena and expect to bring strong impact on the whole value-chain of electricity market. There is an agreed strong potential for application of storage services in the near future. This however require a clear and quantified value calculation from storage in each segment of the electricity market value-chain as well as designing right business models through which the value can be generated.





- ➢ What is value based potential of storage technologies in different market segments- now and in future?
- ➢ What are right business models for market integration of storage?

SESSION 4: Technologies and strategies to integrate storage in power plants

Giacomo Petretto (Enel Innovation – Global Thermal Generation)

Regulatory trends worldwide reflects greater attention to energy storage market, specifically defining energy storage activity, accounting for its peculiarities and establishing a level playing field with other sources. Potential effects of the market design at EU level are an improved access to markets also for behind the meter storage through aggregation, more price arbitrage opportunities, an increased need of flexibility solutions to hedge intermittency of generation sources, and a clearer scope of subjects allowed to own/operate storage.

Over the last decade, the energy storage system has become one of the important components for enhancing power system performance and grid reliability. Widespread application of battery energy storage (BESS) is driven by CAPEX decrease and system performance improvements: BESS does represent now a remunerative investment for many applications. Lithium ion batteries have been the technology of choice for utility-scale project to date, however research and development continues with the goal of improving key performance metrics for energy storage systems (ESS). Flow batteries, flywheels and other technologies hold significant promise for electrical storage needs in the future and may offer an alternative to lithium-ion technology.

From a utility perspective the ESS can be used to mitigate the voltage unbalance of the electrical networks, frequency control, imbalance compensation, spinning reserves, peak demand shaving, reduce operating costs and so on. However, storage systems generate greater value if used to supply multiple services and applications, particularly if flexible frameworks enable them. Enel has already installed ESS in isolated system (Ventotene and Gran Canaria) and integrated in conventional power plants and intends to develop ESS applications along three main business models: on-plant on network, in isolated system and standalone. A brief overview of Enel storage projects and main benefits achieved so far will conclude the presentation.

- What are the positive and negative effects on integrating storage at the generation site versus in the grid/closer to the consumer?
- What kind of frameworks do we need to enable storage systems to supply multiple services?