Usage of battery energy storage in power systems in ancillary services

[1]*Jakub URBANSKÝ (3rd year)*
Supervisor: [2]Ľubomír BEŇA

[1,2]Dept. of Electric Power Engineering, FEI TU of Košice, Slovak Republic

[1]jakub.urbansky@tuke.sk, [2]lubomir.bena@tuke.sk

***Abstract*—— this paper deals with utilization of battery energy storage in power systems. Energy storage systems play a significant role in proper integration of renewable energy resources in maintaining reliable and modern power system. They can reduce power fluctuation, enhance electric system flexibility, and enables the storage and dispatching of the electricity produced by variable renewable energy sources. Battery energy system seems to be necessary addition for future of the power system.**

***Keywords*— renewable energy sources, battery energy storage systems, ancillary services, accumulation**

I. INTRODUCTION

The electric power system, as any part of the industry, is undergoing a constant development. In the recent years has tendency to incline more toward so called "green sources" or in other words renewable energy sources (RES), mainly from environmental reasons. The Renewable Energy Directive enact goal for European Union to achieve its 20% renewables target by year 2020 [1] and 27% by year 2030 [2].

Electric power systems needs to preserve stable balance between production and consumption of electric energy [3]. Penetration of RES such as, photovoltaics and wind energy has brought new issues for the stable operation of power system, due to their unpredictable electricity production character [4]. Recent development in field of RES. mainly in photovoltaic, and emission free transport brought increased interest in energy storage. Due to unpredictable electricity generation from RES, energy storage plays important role in maintaining stable and secure operation of power grid, system flexibility and enables the storage of electricity in time of their increased production. On other hand, at time of insufficient production it can dispatch stored energy for their immediate usage. [5]

Energy storage can be utilized in power systems as stable source of ancillary services to provide reliable operation of power grid [4]. My dissertation thesis will be focused on collaboration of renewable energy sources with battery energy storage systems (BESS).

II. BATTERY ENERGY STORAGE SYSTEMS

BESS can be defined as an integration of battery cells, connected in series or in parallel to reach desired voltage and capacity, with purpose to form large electric energy storage device. It stores direct current (DC) energy. It is connected to the power grid via power electronic converters. It can provide negative (with charging) or positive (with discharging) regulation power to the grid. [7].

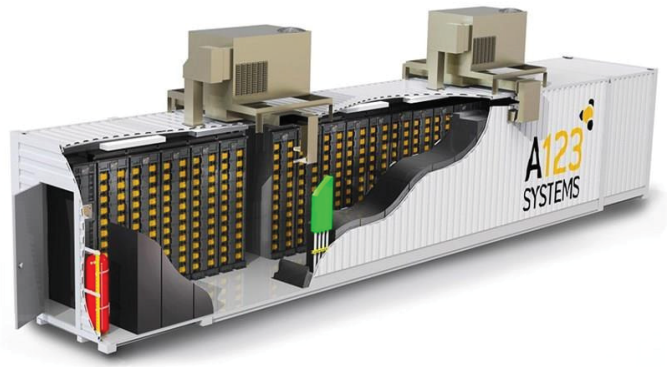

Fig. 1. An example of a battery energy storage system

Basic composition of BESS was presented by [8], the main components are:

- battery,
- power converter,
- transformer,
- controller,
- battery management system.

Manufacturers of BESS tends to ship them in form of containers, as they provide flexibility for the system design and transportability (Fig. 1.) The battery is connected to the power converter. When batteries are discharging power converter acts as inverter. When batteries are being charged power converter acts as rectifier. Converter is connected to transformer, which transfers voltage to higher value and vice versa. Battery management system, which is connected to battery and controller, monitors each cell and maintains them. Controller has the logic necessary to manage proper BESS function by the defined algorithm.[9]

Application of the BESS in power systems

The installed power capacity of grid BESS (Fig. 2.) is currently around 2.5 GW globally [8].

Utility side application such as frequency regulation, spinning reserve, voltage support, peak power shaving (arbitrage), load leveling, island grid, black start support. [9]

Customer side applications such as peak shaving, load shifting, off-grid supply. [9]

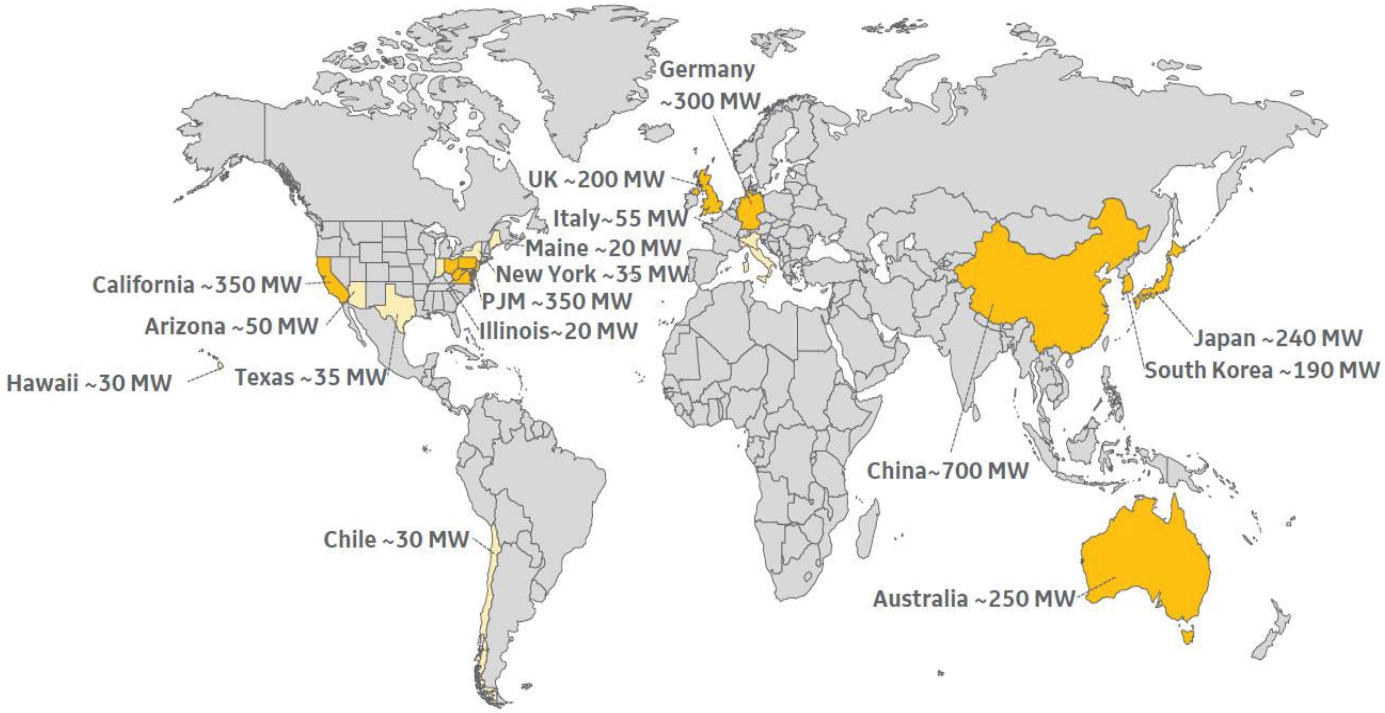

Fig. 2. The installed power capacity of grid BESS globally [8]

III. Publications

To this date, I am author or co-author of 38 publications:

- ADE (1),
- ADF (6)
- AED (11),
- AFA (3),
- AFC (11),
- AFD (6).

Of which 6 are indexed in Scopus database and 2 are indexed in Web of Science. Partial results of my research are published in articles of which I am author or co-author.

IV. Thesis of Dissertation Work

1. Analysis of current requirements of Slovak republic power system for possibility connection of RES and energy storage systems
2. Analysis of current requirements of Slovak republic electric power system on ancillary services.
3. Identification and description of BESS suitable for providing ancillary services.
4. Identifying the optimal combination of RES and BESS for providing ancillary services.
5. On selected examples, evaluate the economic efficiency of RES in collaboration with BESS for providing ancillary services.
6. Analysis of the achieved results and making recommendations for future direction of the research.

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