Insight

Energy Storage Systems and Renewable Generation

October 2022

The path towards the energy transition, arising from the sustainable development goals, faces the challenge of having dynamic and flexible energy systems in their operation. The technological development of batteries and their growing use in electrical systems make it possible to resolve some of the complexities associated with the new paradigm.

The use of Energy Storage Systems

The rise of renewable generation (solar and wind) in the world is leading to a very rapid development of energy storage systems since they allow solving regulatory, economic and operational issues related to the intermittency of the resource. Although there are several P2X technologies (Power to X solutions), battery energy storage systems (BESS) are the ones that allow the highest speed of conversion of the stored energy, being able to supply it to the network practically instantaneously. The other systems (power-to-heat / power-to-H2) require thermal and/or chemical processes with a conversion speed and performance lower than that of batteries.

The possibility of having the energy stored in batteries is so fast that, for example, in Chile a fast frequency control service has been defined in which the equipment must supply its entire installed capacity in less than a second.

The outstanding functionalities and advantages offered by the use of BESS systems in power systems are:

- Participation in auxiliary services or complementary services (frequency regulation)
- Demand management: use in times of higher demand compared to a lower renewable resource
- Frequency regulation for maximum use of the generation capacity of conventional plants
- Synthetic inertia services
- Extend the supply of energy in hours when the resource is not available for off-grid systems associated with distributed generation (DER)
- Optimization, greater flexibility and improvement in the quality of supply in electrical transmission and distribution facilities
- Delay in the requirement of investments in infrastructure
- Avoid additional costs for operation and maintenance of generation equipment affected by frequency regulation
- Purchase/sale of energy
- firm power sale
- Curtailment risk reduction
- Support for large users
- Support for black start of power systems

The particular analysis of each one of the uses and benefits will depend on the type of market, the characteristics of the energy matrix, the regulation and operating regulations, the dispatch criteria, the robustness of the electrical system, the characteristics of the demand to be supplied. and the evolution of the cost of BESS technology.

The electricity market with BESS

One of the main characteristics of non-conventional renewable generation (NCRE) is its volatility in energy production associated with the characteristic of the natural resource from which they are supplied, increasing the challenge of operating the electrical system safely.

The BESS contribute to mitigating the volatility of production by providing quickly managed reserves, resulting as a buffer between supply (conventional generation and NCRE) and demand. But in turn, their participation in the electricity markets as "energy traders" is possible, buying energy in hours of low marginal cost and then selling energy in hours of high marginal cost.

However, regulatory development has been extremely limited in the case of a pure storage agent (energy trader) who decides to develop on his own and participate in the various markets or payment mechanisms of each system. It is evident that there is a need to carry out certain regulatory adaptations that eliminate entry barriers for said technologies and promote internal competition in the market, with the aim of supplying demand at the minimum possible cost, also allowing the reduction of greenhouse gas emission levels (GHG).

Among the figures or market agents it is possible to identify two modalities:

- Energy / Power Trader
- Provider of Auxiliary Regulation Services (Reserve)

Likewise, it will be necessary to regulate the issues associated with the dispatch of the BESS and the possibility of providing services to the system operator, such as:

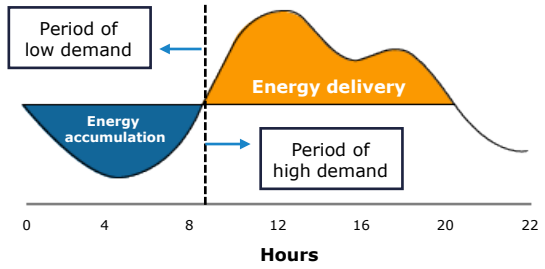
- Commercial Coordination Rules
- Operational Coordination Rules

Finally, the programming of the operation is the process by which the system operator seeks to predict with the greatest possible accuracy the operation of the market for each hour of the following day.

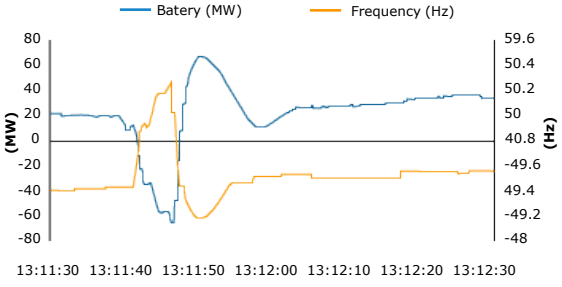
In systems with significant NCRE penetration, added to the growth of DER resources, unexpected variations and uncertainty in the energy generated can cause significant imbalances in the parameters of the electrical system, posing serious risks to control performance and operational characteristics, as well such as the reliability of an electrical network.

It is expected that with adequate regulation and technological cost, the BESS are available for the sale of energy in the hours of minimum reserve of the electrical system and therefore provide greater security of supply of the demand.

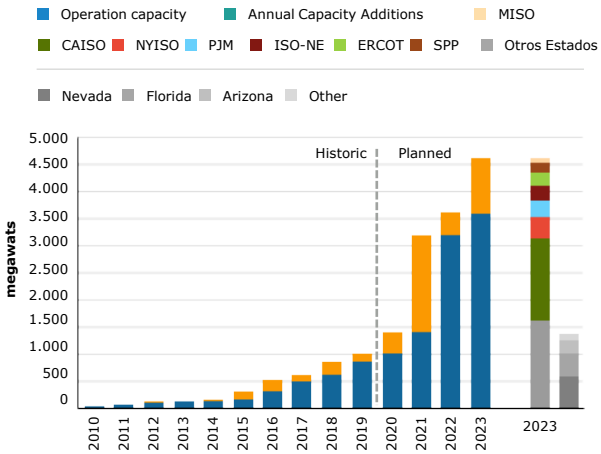
Demand Management



Frequency Control



Installed Power Growth BESS USA



Applications in Africa

The use of renewable energy resources for electricity production in Africa is not a nascent phenomenon. Countries within the region have mainly relied on hydroelectric power, with coal and use of natural gas only being present in a few countries in North Africa and South Africa. Nations like Kenya have an impressive 93% renewable energy generation with geothermal power contributing over 45% of total power demand, resulting in low grid emission factors of 0.04 tnCO2 /MWh in 2020. Namibia, a country with 91% renewable energy generation spread across Hydropower (70.8%), Solar (19.1%) and Wind (1%) also has low emission factors in the range of 0.058 tnCO2 /MWh (2019 figure, source Irena).

Morocco and South Africa on the other hand, have significantly high emission factors of 0.75 tnCO2 /MWh (2019) and 0.94 tnCO2 /MWh (2020) respectively. This is attributed to high shares of conventional power generation in these countries. Over 80% of Morocco's power demand was met by non-renewable sources ranging from Coal, Natural Gas and Oil in 2019. For South Africa, 90% of power demand in 2020 was met by coal-fired power plants.[1] [2]

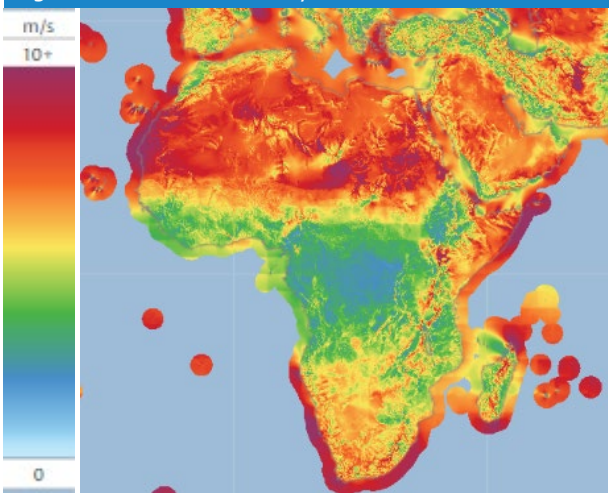
As part of our internal discussions with Res4Africa programs' team leaders during last month, and as a result from a study it was highlighted that in the last decade, while the rest of the world global installed RE generation capacity more than doubled, only 2% of that growth in renewable additions occurred in Africa. This is far too little and much less than what is needed to reach important goals such as SDG7 and those set in the African Union Agenda 2063.[3]

BESS is a technology that could foster the development of RE power plants in two dimensions: energy trading and infrastructure optimization.

In the case of energy trading, there are two main variable to consider: the competitive costs versus energy prices (given a certain expensive energy matrix in the country/region) and the storage time (based upon the dispatch analysis of the power plants).

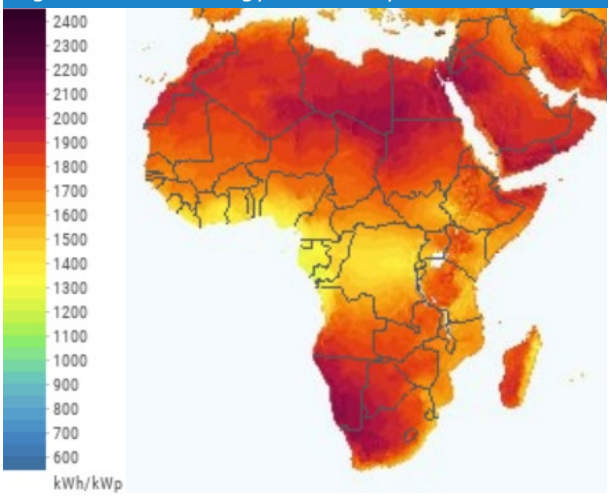
Regarding infrastructure BESS could help to optimize the use of transmission systems and make economically viable and attractive for investors transmission projects associated with RE sources, especially solar. Another initiative are the grid forming technology (instead of current grid following) that could be used for mini-grids and isolated systems for remote electrification.

Figure 1: Wind Availability in Africa



Source: *Global Wind Atlas, World Bank 2020*

Figure 2: Solar Energy Availability in Africa



Source: Global *Solar Atlas, World Bank 2020*

1. https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Morocco_Africa_RE_SP.pdf
2. https://www.eskom.co.za/wp-content/uploads/2021/08/2021IntegratedReport.pdf.
3. https://www.res4africa.org/library "Sustainable electricity for a prosperous Africa" 10th Anniversary

Recent initiatives

- Integration of Battery Energy Storage Systems (BESS) in Central America countries. Client: BCIE
- Primary frequency regulation study using BESS systems in the Dominican Republic. Client: AES.
- Study of Complementary Services of the National Electric System. Performance analysis of BESS systems in fast frequency regulation. Client: CEN Chile.
- Regulatory analysis and impact of new products and/or services in the electricity sector (EV, BESS, Demand Side Management). Client: CNE Chile.
- Seminar: Renewable Energies, Storage, Planning and Reliability. Organized by COPIME, IEEE PES, CIGRE ARG. Speaker George GROSS - University of Illinois.
- Regulatory framework and opportunities for energy storage in Spain and Chile. Confidential client.
- Participation and adequate inclusion of NCREs in the Guatemala MEM and regulatory changes to incorporate BESS systems. Clients: Bid Invest and AGER.
- Technical Standard for Complementary Services. Includes the necessary Technical Annexes for the incorporation of equipment to the electrical system (including RE generation and BESS). Client: CNE
- Electricity Transmission System expansion plan in Argentina including the possibility of installing energy storage systems technology, possible performance, benefits and costs. Client: IDB/Energy Secretariat
- Opportunities for batteries in Uruguay in auxiliary services and energy trading. Client: Bid Invest and Atlas Renewables Uruguay.
- Market and regulatory analysis of the BESS for Panama, Costa Rica and Guatemala, considering multiple applications. Client: ENEL X.
- Definition of the regulatory treatment of the BESS in the Guatemalan Market, Client: AMM.
- Discussion table on technical aspects related to the incorporation of BESS for the management of renewable energy production (photovoltaic) and the possibility of using it for demand management. Confidential client, El Salvador.
- Market advisor for a portfolio of renewable assets (wind, hydro, solar PV+ BESS) in Chile. Client: Innergex.

Insight developed by:

Nicolás Pérez
Renewable Technical Integration Leader
nperez@gme-global.com

Guillermo Betolaza
Partner and Commercial Director
gbetolaza@gme-global.com

More information: info@gme-global.com | www.gme-global.com