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Actualidad Tecnológica

Literature review of BESS implementation in DER

Revisión De La Literatura De Implementación de BESS EN DER

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Para citar: T. E. Gutiérrez-Castro, J. M. López-Lezama, E. Rivas-Trujillo "Literature review of BESS implementation in DER". *Revista Vínculos: Ciencia Tecnología y Sociedad,* no. 2, julio-diciembre de 2019, pp. 321-326. DOI:https://doi.org/10.14483/2322939X.16662

Enviado: 20/10/19/ Recibido: 24/10/19/ Aprobado: 05/11/19

Abstract
Distributed Energy Resources (DER) have been a fundamental part of the inclusion of Battery Energy Storage Systems (BESS) in the generation and distribution system. This work shows an exhaustive review of the different approaches that the authors have developed when implementing BESS in DER, its scope and applications in different environments, observing that the most covered topics are Smart Grid (SG), Distributed Generation (DG), Energy Storage (ES) and where little information is found on the topics of Electric Vehicles (EV), Advanced Measurement (AM) and Demand Response (DR), this is to give an overview of the progress the authors have had and it allows to know in which field of application less information is found, facilitating the search for new researchers.

Keywords: Renewable energies, energy storage, optimization models, distributed generation, investment costs.

Resumen
Los recursos energéticos distribuidos (DER) han sido parte fundamental para la inclusión de los Sistemas de almacenamiento de baterías (BESS) al sistema de generación y distribución. Este trabajo muestra una revisión exhaustiva de los diferentes enfoques que han desarrollado los autores al implementar BESS en DER sus alcances y aplicaciones en diferentes entornos, observando que los temas más abarcados son Smart Grid (SG), Generación Distribuida (GD) , Almacenamiento de Energía (AE) y en donde se encuentra poca información son los temas de Vehículos eléctricos (VE), Medición Avanzada (MA) y Respuesta a la Demanda (RD), esto tiene como fin dar una visión mas general sobre los avances que han tenido los autores y permite conocer en qué campo de aplicación se encuentra menos información facilitando la búsqueda de los nuevos investigadores.

Palabras Clave: Energías renovables, almacenamiento de energía, modelos de optimización, generación distribuida, costos de inversión.

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ISSN 1794-211X • e-ISSN 2322-939X • Vol 16, No 2 (julio-diciembre 2019). pp.321-326.Universidad Distrital Francisco José de Caldas-Facultad Tecnológica.

1. Introduction

The expansion of the alternative energy market has led to further development in battery energy storage (BESS) systems due to this, the literature on this topic has increased, causing a wide range of applications related to this topic, but not There is a classification or an exhaustive review, which makes it difficult for some authors seeking to carry out research with some specific focus, when implementing BESS in the DER distributed energy resources it is necessary to take into account the following topics, Electric vehicles (EV), Response On Demand (DR), Smart Grid (SG), Distributed Generation (DG), Advanced Measurement (AM) and Energy Storage (ES).

2. Theme development

Figure 1 shows the distribution by continent of the articles analyzed with respect to the integration of BESS in DER applications and their information is synthesized in Table 1 in the period (2009-2019)

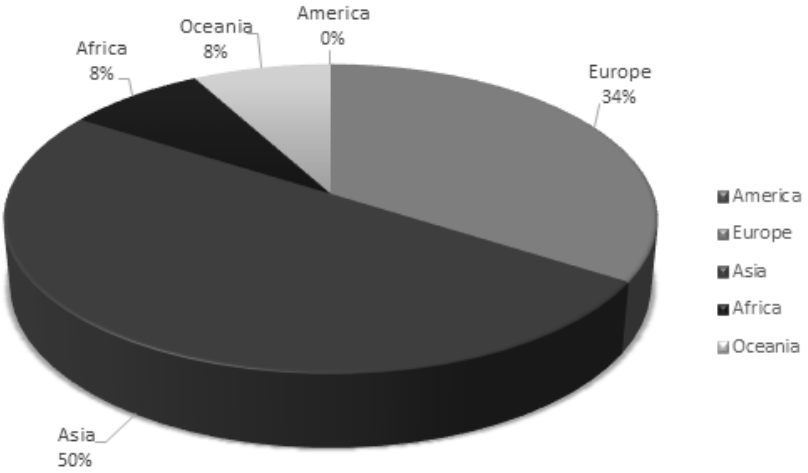

Figure 1. Distribution of BESS literature in DER
Source: Own elaboration

Ref.	Bibliographical data	Scope and applicability
[1]	Muruganantham, 2017	This article describes various load flow methods which are used to analyze the parameters in the Distribution Network (DN), emphasizing the challenges of (DN) with the integration of Renewable Energy Systems (RES), in a way analogous methodology are verified with respect to the price of the energy delivered. The objective is to explore the importance of Demand Side Management (DSM) and energy storage, performing an analysis of the nodal voltages in a (DN), which is carried out by implementing photovoltaic solar energy sources, in Plug-in Hybrid Electric Vehicles (PHEV) and diesel. The different power flow distribution methods discussed in the document show the various algorithms and their applications, some of them are as follows: nodal distribution algorithm used to track the real and reactive power flow where transmission losses are included, There is also the three optimal phase power flow (TOPF) that is responsible for locating the outputs of the microgenerators and storage systems, the push-rebel algorithm was introduced that reviews the optimal power flow for the system, among others seen in the literature. These algorithms are provided to provide a clear picture of the growth and challenges it has in (DN), helping researchers get a better idea of the types of methods available to calculate the energy flow in the distribution.

ISSN 1794-211X • e-ISSN 2322-939X • Vol 16, No 2 (julio-diciembre 2019). pp.321-326.Universidad Distrital Francisco José de Caldas-Facultad Tecnológica.

Ref.	Bibliographical data	Scope and applicability
[2]	Zhang, 2018	The article presents the characteristics, materials, performances and costs of various potential battery systems, where its advantages and disadvantages are analyzed. Some revised batteries are: lead acid, aluminum ions, lithium ions and metallic air batteries. Lead acid batteries have the lowest cost on the market and have been used in power systems since they are backup batteries for power plants and electrical substations, but they have some disadvantages such as their short useful life, self-discharge and high pollution to the environment. Lithium ion batteries have a high initial cost, these are implemented in most cases in electric vehicles since they are ideal for electronics in small-scale applications, currently they are widely used in renewable energy and microgrids. The aluminum ion batteries charge / discharge is ultra-fast, it is very stable and functional. It does not have great applicability and the author proposes to inform other researchers to address its potential. There are several factors to consider when choosing a battery, the author proposes that depending on the application to be given, the following characteristics are available: useful life, efficiency, cost of operation and maintenance, response rate, among others
[3]	Amano, 2012	In this paper, the authors present a control scheme that uses two types of Area Control Error (ACE) allocation for the effective use of Battery Energy Storage System (BESS), with filter-based allocation being optimal. The first is the proportional allocation of (ACE) and the second is Filter-based ACE Assignment. The author concludes that the second method considerably reduces the required capacity of (BESS) with respect to the first, this on a large scale, it is also analyzed that this reduction is usually greater when Renewable Energy (ER) has less fluctuations and these occur because its components are larger and cause them to vary slowly.
[4]	Chen, 2014	The article performs experiments and simulations on batteries in order to observe the performance and voltage differences of the battery packs, the study consists of 8-cell batteries which are connected in series and three important factors are analyzed: the state load (SOC), internal resistance and capacity on voltage difference. As a result, it is obtained that a lower SOC causes a low voltage there, a high internal resistance generates a high voltage in the load but a low voltage in the discharge.
[5]	Ogunniyi, 2017	In this document, the authors present the progress in the use of Battery Energy Storage System (BESS) as an intelligent storage technology, being this a propeller for a much more efficient electric future and the development of new technologies in transport and public services.
[6]	Rominger, 2018	In this document the Battery Energy Storage System (BESS) are studied as a contained Frequency Reserve Element (FRC) using simulation in Simulink / Matlab, which is required by the operators of the European transmission system to limit the frequency deviation in the operation of the network, which in Germany had previously been provided by speed regulators for turbines of thermal and hydroelectric plants. This document introduced the regulatory framework for batteries that provide (FRC) for the first time.

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Ref.	Bibliographical data	Scope and applicability
[7]	Feng, 2019	Due to the flow of the second harmonic, from the system to the batteries, the temperature in the batteries is increased, significantly reducing the useful life of the Battery Energy Storage System (BESS); Differential topologies are proposed in this document to reduce this second order harmonic.
[8]	Tang, 2009	The Battery Energy Storage System (BESS) is used for daily spike systems as a tool to improve system stability, level the load, control the frequency of charge, and aid energy transfer, increasing reliability and quality of energy in power systems. The document performs a feasibility study when using BESS by improving the stability of the system, a comparison is also made between static synchronous compensator (STATCOM) and BESS, resulting in a higher BESS with respect to its transfer capacity.
[9]	Aguado, 2017	The article analyzes the feasibility of using Battery Energy Storage System (BESS) to delay the expansion of the transmission network, for this an IEEE system of 24 nodes is carried out, and a cost and capacity study is also carried out. In the results it is feasible to postpone the construction of new lines if additional batteries are connected to certain nodes, although the price is quite high, it shows a beneficial solution. The main benefits are related to the operation of the network (voltage control, management and restoration of energy flow).
[10]	Divya, 2009	The document provides various energy storage technologies, it is noted which are currently available, what storage technologies can be implemented in a real system, possible future applications are identified, their benefits both economic and technological, the analyzes that would be given in an energy system and finally it is discussed what would be the use of energy from an Electric Drive Vehicle (EDV) that allows improving the reliability of electrical services. The prospects for Battery Energy Storage System (BESS) are promising and their applications are likely in energy systems. They are classified according to their time scale into different types, which are: instantaneous, short-term, part-time, long-term applications. The ones currently used are applications designed for less than 5h storage, this is due to its ability to react instantly to disturbances in a system. BESS technology plays an important role in the reliable and economical operation of the smart electrical networks from which renewable energy is to be incorporated
[11]	Kyriakopoulos, 2016	The document explores the following questions: What technologies will be used? What technologies are there spaces for further development? What implementation problems are there? Taking as central themes: energy policies with respect to electrochemical, mechanical and thermal energy storage technology, shows a review of the literature of the collected studies of the periods (2005-2015) In conclusion, the author proposes that what constitutes good technology depends on the perspective that the researcher wants to give regarding the applicability of Electrical Energy Storage (EES) technologies. The document evaluates the different factors of selection and use of energy storage technologies and reviews advantages and disadvantages of each of them.

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Ref.	Bibliographical data	Scope and applicability
[12]	Wu, 2019	It is observed that the important requirements for the network frequency regulation service are the following: High power capacity, which is the instantaneous active power, long service life to a partial cycle, a quick response and low cost of the battery cycle this is defined as the investment cost. In the cost analysis, there are two different points of view from the Battery Energy Storage System (BESS) providers and the system operators, the first one observes that the BESS cost is the initial investment cost, the maintenance operation cost and the electricity bill of the second recharges the costs of BESS are considered in the payment of auxiliary bidding services to BESS providers.

Table 1. Applications of BESS in DER. **Source:** Own elaboration

3. Conclusions

It is determined based on the compilation of information that advances have been made in different topics, facilitating the handling of the literature and allowing a more general vision to exist on the topics on which the authors can focus in their investigations where little is found information and also know what progress there is in the issues to determine what new approaches can be given to research.

It is concluded that of the consulted literature from different continents, 50% of these articles originate from Asia, this is because this continent has a great development and evolution in the subject of battery storage systems, being a pioneer in this field.

In most of the authors consulted, the inclusion of BESS has been developed in the topics of distributed generation, energy storage and smart grid, some of its applications have been developed for the expansion of transmission lines, distribution networks, renewable energy, electric vehicles, control and supervision systems.

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