© 2017 IJSRST | Volume 3 | Issue 3 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

Review on Integration of Wind and Solar DC Microgrid Using Matlab

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ABSTRACT

Operational controls are designed to support the integration of wind and solar power within microgrids. An aggregated model of renewable wind and solar power generation forecast is proposed to support the quantification of the operational reserve for day-ahead and real-time scheduling. Then, a droop control for power electronic converters connected to battery storage is developed and tested. Compared with the existing droop controls, it is distinguished in that the droop curves are set as a function of the storage state-of-charge (SOC) and can become asymmetric. The adaptation of the slopes ensures that the power output supports the terminal voltage while at the same keeping the SOC within a target range of desired operational reserve. This is shown to maintain the equilibrium of the microgrid's real-time supply and demand. The controls are implemented for the special case of a dc microgrid that is vertically integrated within a high-rise host building of an urban area. Previously untapped wind and solar power are harvested on the roof and sides of a tower, thereby supporting delivery to electric vehicles on the ground. The microgrid vertically integrates with the host building without creating a large footprint.

Keywords: Distributed energy resources, droop control, electric vehicle (EV), emission constraint, fast charging, microgrid, multilevel energy storage, optimal scheduling, power electronic conversion, solar power, wind power

I. INTRODUCTION

In the year 2012, 44.8 GW of new wind energy conversion systems were installed worldwide. The trend has been toward increasingly larger turbine sizes, culminating in the installation of off-shore wind parks that are located far from the load centers. This can lead to rather large distances between generation and load in the electricity sector. The transportation sector reveals an even larger disconnect between the locations of fuel production and consumption. The energy system proposed in this paper seeks to address both issues related to electricity and transportation sectors. One potential solution is a microgrid that can be vertically integrated with a high-rise building as frequently encountered in urban areas. The harvesting of renewable wind and solar energy occurs at the top of the building. The rooftop generation connects to the ground level via a microgrid where electric vehicle (EV) charging stations are supplied, and a battery supports maintaining the balance of supply and demand. The potential value of an urban integration within buildings as considered here comes from the usage of rooftop energy resources, the storage of the latter for offering EV fast charging at the ground level, the contribution to emission-free EV transportation in urban areas, the co-location and integration of generation and load in urban areas, and the grid-friendly integration of the microgrid with the rest of the power system main grid. The combination of wind and solar energy resources on a rooftop was also

investigated. It was verified that the combination of wind and solar energy leads to reduced local storage requirements. The combination of diverse but complementary storage technologies in turn can form a multilevel energy storage, where a super capacitor or flywheel provides cache control to compensate for fast power fluctuations and to smoothen the transients encountered by a battery with higher energy capacity. Microgrids or hybrid energy systems have been shown to be an effective structure for local interconnection of distributed renewable generation, loads, and storage. Recent research has considered the optimization of the operation on one hand and the usage of dc to link the resources on the other. The dc link voltage was shown to be maintained by a droop control that relates the dc link voltage to the power output of controllable resources.
In this paper, it is proposed to set the droop as a function of the expected state of charge (SOC) of the battery according to its operational optimization set point versus the actual real time SOC. The proposed operational optimization is further distinguished in that it quantifies the uncertainty associated with renewable generation forecast, emission constraints, and EV fast charging.

II. LITERATURE SURVEY

Asger B. Abrahamsen, Kais Atallah, Richard A. McMahon presented this paper reviews the trends in wind turbine generator systems. After discussing some important requirements and basic relations, it describes the currently used systems: the constant speed system with squirrel-cage induction generator, and the three variable speed systems with doubly fed induction generator (DFIG), with gearbox and fully rated converter, and direct drive (DD). Then, possible future generator systems are reviewed. Hydraulic transmissions are significantly lighter than gearboxes and enable continuously variable transmission, but their efficiency is lower. A brushless DFIG is a medium speed generator without brushes and with improved low-voltage ride through characteristics compared with the DFIG. Magnetic pseudo DDs are smaller and lighter than DD generators, but need a sufficiently low and stable magnet price to be successful. In addition, superconducting generators can be smaller and lighter than normal DD generators, but both cost and reliability need experimental demonstration. In power electronics, there is a trend toward reliable modular multilevel topologies.

A.G. Madureira J. A. Pecas Lopes presented this paper proposes a new methodology for coordinated voltage support in distribution networks with large integration of distributed generation and microgrids. Given the characteristics of the LV networks, it is shown that traditional control strategies using only reactive power control may not be sufficient in order to perform efficient voltage control. Therefore, microgeneration shedding must also be employed, especially in scenarios with extreme microgeneration penetration. An optimisation tool based on a meta-heuristic approach was developed to address the voltage control problem. In addition, neural networks were employed in order to decrease computational time, thus enabling the use of the tool for online operation. The results obtained revealed good performance of this control approach.

M. H. Nehrir, C. Wang, K. Strunz, H. Aki, R. Ramakumar, J. Bing, Z. Miao, and Z. Salameh presented this paper, prepared by a special task force of the IEEE PES Renewable Technologies Subcommittee, is a review of hybrid renewable/alternative energy (RE/AE) power generation systems focusing on energy sustainability. It highlights some important issues and challenges in the design and energy management of hybrid RE/AE systems. System configurations, generation unit sizing, storage needs, and energy management and control are addressed. Statistics on the current status and future trend of renewable power generation, as well as some critical challenges facing the widespread deployment of RE/AE power generation technologies and vision for future research in this area are also presented. The comprehensive list of references given at the end of the paper should be helpful to researchers working in this area.

Kai Strunz and Henry Louie presented this paper, Energy storage is an enabling technology for power system integration of renewable sources, while data storage enables computer system integration. In this paper, a functional analogy relating energy and data storage is derived. Battery or hydrogen storage can provide large energy capacity similar to a hard disk providing large data capacity. Supercapacitors or flywheels provide fast and frequent access to cache energy similar to the computer's RAM providing fast and frequent access to data. In analogy to computer engineering, a cache control that coordinates the operation of a multilevel storage consisting of such

complementary capacity and access-oriented storage technologies is designed. It is illustrated how for an industrial distributed energy system with renewable generation, local load, fueling station, and connections to the electricity and gas distribution networks, the cache control provides energy management to support a modular plug-and-play-like system integration. The benefit of the analogy in education is evaluated on a representative sample of electrical engineering students at the University of Washington. While familiar with computing, students do not typically have the same level of exposure to power engineering. The understanding of distributed energy systems concepts is shown to improve thanks to this bridging analogy between computer and power engineering.

Majumder, Ritwik and Chaudhuri, Balarko and Ghosh, Arindam and Majumder, Rajat and Ledwich, Gerard presented this paper, investigates the problem of appropriate load sharing in an autonomous microgrid. High gain angle droop control ensures proper load sharing, especially under weak system conditions. However it has a negative impact on overall stability. Frequency domain modeling, eigen value analysis and time domain simulations are used to demonstrate this conflict. A supplementary loop is proposed around a conventional droop control of each DG converter to stabilize the system while using high angle droop gains. Control loops are based on local power measurement and modulation of the d-axis voltage reference of each converter. Coordinated design of supplementary control loops for each DG is formulated as a parameter optimization problem and solved using an evolutionary technique. The supplementary droop control loop is shown to stabilize the system for a range of operating conditions while ensuring satisfactory load sharing.

Aymen Chaouachi, Rashad M. Kamel, Ridha Andoulsi, and Ken Nagasaka, presented this paper, a generalized formulation for intelligent energy management of a microgrid is proposed using artificial intelligence techniques jointly with linear-programming-based multiobjective optimization. The proposed multiobjective intelligent energy management aims to minimize the operation cost and the environmental impact of a microgrid, taking into account its preoperational variables as future availability of renewable energies and load demand (LD). An artificial neural network ensemble is developed to predict 24-h-ahead photovoltaic generation and 1-h-ahead wind power generation and LD. The proposed machine learning is characterized by enhanced learning model and generalization capability. The efficiency of the microgrid operation strongly depends on the battery scheduling process, which cannot be achieved through conventional optimization formulation. In this paper, a fuzzy logic expert system is used for battery scheduling. The proposed approach can handle uncertainties regarding to the fuzzy environment of the overall microgrid operation and the uncertainty related to the forecasted parameters. The results show considerable minimization on operation cost and emission level compared to literature microgrid energy management approaches based on opportunity charging and Heuristic Flowchart (HF) battery management.

Rodrigo Palma-Behnke, Carlos Benavides, Fernando Lanas, Bernardo Severino, Lorenzo Reyes, Jacqueline Llanos and Doris Sáez, presented this paper a novel energy management system (EMS) based on a rolling horizon (RH) strategy for a renewable-based microgrid is proposed. For each decision step, a mixed integer optimization problem based on forecasting models is solved. The EMS provides online set points for each generation unit and signals for consumers based on a demand-side management (DSM) mechanism. The proposed EMS is implemented for a microgrid composed of photovoltaic panels, two wind turbines, a diesel generator and an energy storage system. A coherent forecast information scheme and an economic comparison framework between the RH and the standard unit commitment (UC) are proposed. Solar and wind energy forecasting are based on phenomenological models with updated data. A neural network for two-day-ahead electric consumption forecasting is also designed. The system is tested using real data sets from an existent microgrid in Chile (ESUSCON). The results based on different operation conditions show the economic sense of the proposal. A full practical implementation of the system for ESUSCON is envisioned.

Hiroaki Kakigano, Yushi Miura, and Toshifumi Ise, presented this paper Microgrid is one of new conceptual power systems for smooth installation of many distributed generations (DGs). While most of the microgrids adopt ac distribution as well as conventional power systems, dc microgrids are proposed and

researched for the good connection with dc output type sources such as photovoltaics (PV), fuel cell, and secondary battery. Moreover, if loads in the system are supplied with dc power, the conversion losses from sources to loads are reduced compared with ac microgrid. As one of the dc microgrids, we propose "low voltage bipolar type dc microgrid" which can supply super high quality power with 3-wire dc distribution line. In this paper, one system for a residential complex is presented as an instance of the dc microgrid. In this system, each house has a cogeneration system (CGS) such as gas engine and fuel cell. The output electric power is shared among the houses, and the total power can be controlled by changing the running number of CGSs. Super capacitors are chosen as main energy storage. To confirm the fundamental characteristics and system operations, we experimented with a laboratory scale system. The results showed the proposed system could supply high quality power under several conditions.

Leandro Roggia, Luciano Schuch, Jos´e Eduardo Baggio, Cassiano Rech, and Jos´e Renes Pinheiro, proposes a novel integrated converter topology for interfacing between the energy storage system and the dc bus for a residential microgrid application. The proposed integrated full-bridge-forward dc–dc converter presents the following features: low number of active devices compared to the converters usually applied to similar applications, low input and output current ripple, high voltage ratio, bidirectional power flow, and galvanic isolation. A double-ended forward converter with particularities such as no extra transformer demagnetizing circuit is originated from the integration process. This converter is approached in detail in this paper, including three different clamping circuits which are analyzed and compared. The structure, principle of operation, analysis, transformer design methodology, comparison with the dual active bridge converter, and experimental results of the proposed topology are presented.

III. METHODOLOGY

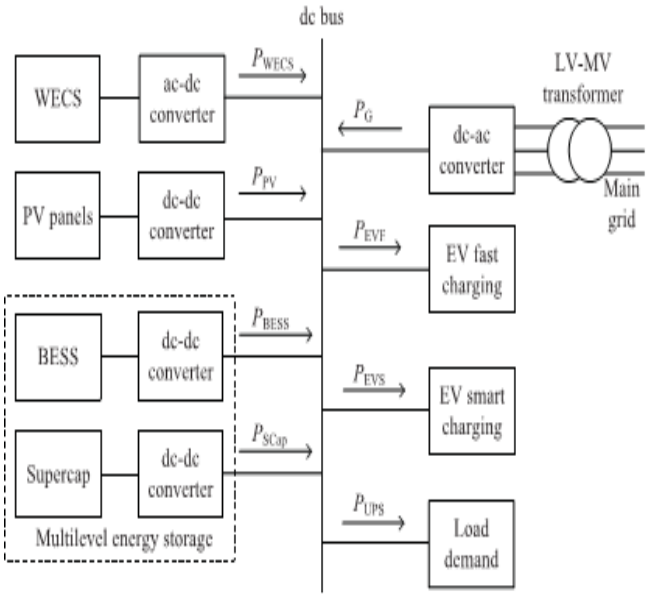

Fig.1 Layout of the dc microgrid

A. Outline of dc Microgrid

A schematic of the dc microgrid with the conventions employed for power is given in Fig. 1. The dc bus connects wind energy conversion system (WECS), PV panels, multilevel energy storage comprising battery energy storage system (BESS) and super capacitor, EV smart charging points, EV fast charging station, and grid interface. The WECS is connected to the dc bus via an ac–dc converter. PV panels are connected to the dc bus via a dc–dc converter. The BESS can be realized through flow battery technology connected to the dc bus via a dc–dc converter. The super capacitor has much less energy capacity than the BESS. Rather, it is aimed at compensating for fast fluctuations of power and so provides cache control as detailed in.

IV. CONCLUSION

A dc microgrid for renewable power integration has been proposed. The operational optimization and power-electronics based voltage–power droop control was developed, and the functioning was demonstrated through simulation. Interaction with the main grid was controlled as a result of an operational optimization that seeks to minimize cost and emissions. A method to

quantify the uncertainty affiliated with the forecast of aggregated wind and PV-based power generation was created and used to quantify the energy reserve of the battery energy storage system. The battery is parallel-connected with a supercapacitor to form a multilevel energy storage. The latter plays a critical role in compensating renewable power fluctuations and providing the power needed when EVs stop by for fast charging. In accordance with the microgrid paradigm, operation is also supported in autonomous mode to support UPS when the connection to the main grid is unavailable. During such periods, fast charging is not supported, as the priority shifts to supplying critical local loads.

V. REFERENCES

[1] Asger B. Abrahamsen, Kais Atallah, Richard A. McMahon "Trends in water turbine generator systems." in Sep. 2013.

[2] A. G. Madureira and J. A. Pecas Lopes, "Coordinated voltage support in distribution networks with distributed generation and microgrids," IET Renew. Power Generat., vol. 3, no. 4, pp. 439–454, Dec. 2009.

[3] M. H. Nehrir, C. Wang, K. Strunz, H. Aki, R. Ramakumar, J. Bing, et al., "A review of hybrid renewable/alternative energy systems for electric power generation: Configurations, control, and applications," IEEE Trans. Sustain. Energy, vol. 2, no. 4, pp. 392–403, Oct. 2011.

[4] K. Strunz and H. Louie, "Cache energy control for storage: Power system integration and education based on analogies derived from computer engineering," IEEE Trans. Power Syst., vol. 24, no. 1, pp. 12–19, Feb. 2009.

[5] R. Majumder, B. Chaudhuri, A. Ghosh, G. Ledwich, and F. Zare, "Improvement of stability and load sharing in an autonomous microgrid using supplementary droop control loop," IEEE Trans. Power Syst., vol. 25, no. 2, pp. 796–808, May 2010.

[6] A. Chaouachi, R. M. Kamel, R. Andoulsi, and K. Nagasaka, "Multiobjective intelligent energy management for a microgrid," IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1688–1699, Apr. 2013.

[7] R. Palma-Behnke, C. Benavides, F. Lanas, B. Severino, L. Reyes, J. Llanos, et al., "A microgrid energy management system based on the rolling horizon strategy," IEEE Trans. Smart Grid, vol. 4, no. 2, pp. 996–1006, Jun. 2013.

[8] H. Kakigano, Y. Miura, and T. Ise, "Low-voltage bipolar-type DC microgrid for super high quality distribution," IEEE Trans. Power Electron., vol. 25, no. 12, pp. 3066–3075, Dec. 2010.

[9] "Global wind report: Annual market update 2012," Global Wind Energy Council, Brussels, Belgium, Tech. Rep. 2012.

[10] F. Giraud and Z. M. Salameh, "Steady-state performance of a grid connected rooftop hybrid wind-photovoltaic power system with battery storage," IEEE Trans. Energy Convers., vol. 16, no. 1, pp. 1–7, Mar. 2001.