

A Study on ESS-based hybrid power generation system with easy expansion

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Abstract This study is the central axis of the MG (Micro-Grid) configuration and it has the link through the modular hybrid power source and the DC bus, and it provides the function to detect and block the illegal connection by using the standard socket, And to achieve stabilization. Development of power conversion device, smart distribution panel, integrated control system and efficient demand management are required, and compatibility with MG whole system is urgent. This is a hybrid power generation system that is safe with a common power connection protocol and can be easily connected to anyone. This makes it easy to manage data and prepare for expansion of various manufacturers' systems.

Key Words : Solar Power Generation, Smart Distribution Board, ESS, Micro-Grid, Optimal Control Technology

요약 본 연구는 스마트분전반 MG(Micro-Grid) 구성의 중심축으로 모듈형 하이브리드 발전원과 DC 버스를 통하여 링크를 갖으며 표준소켓을 사용하여 불법연결을 감지 차단하는 기능을 부여하고, 전력 계통의 안정화를 달성함을 목적으로 한다. 전력변환장치, 스마트분전반, 통합제어시스템의 개발과 효율적인 수요관리가 필요하며, MG 전체시스템과의 호환성이 절실하다. 이는 공통 전력 연결 규약으로 안전하고 누구나 연결을 쉽게 할 수 있는 하이브리드발전시스템으로 데이터 관리가 용이해지고 다양한 제조사의 시스템 확대설치에 대한 대비가 가능하다.

주제어 : 태양광발전, 스마트분전반, 에너지저장시스템, 마이크로그리드, 최적제어기술

1. Introduction

At the present time, the efforts of each country to respond positively to the limitations of the energy resources possessed by the earth globally

and the abnormal climate caused by global warming are accelerating. The national support for the energy new industry has been strengthened, and new industries have been created through the

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development and commercialization of energy related technologies. At the center of this is MG(;;Micro-Grid), and it is necessary to develop and demonstrate power conversion devices for ESS(;; Energy Storage System) and hybrid power generation system. The government is trying to support various policies for the activation of the 'ESS Interworking Rate System' and 'ESS Emergency Resource Recognition'[1].

In order to effectively operate the MG, an ESS-based hybrid power generation system with distinct functions and objectives is required. It is necessary to provide power conversion control technology with parallel operation method which can apply various renewable energy resources at the same time and easy to expand. It is necessary to present concrete business model for convenience and cost reduction.

Domestic has already reached the level of element technology through R&D, pilot, and demonstration phases through MG and ESS projects linked to energy new business. However, it is urgent to apply MG to various types of buildings to ensure safety, interconnectivity between systems, and economical efficiency[2,3].

2. Materials and Methods

Countries' self-help efforts to respond positively to the global energy resource limitations and warming due to global warming are accelerating. This is reinforcing the national support for the energy new industry and for the development and commercialization of energy related technologies[4].

2.1 Development of modular power generation system

Conventional micro grids, ESS systems, solar power systems, fuel cell power systems, etc. are already set for capacity at design time. There is a problem that it is difficult to manage because the capacity is enlarged by the fireworks when the

capacity is increased[5].

The proposed system can easily increase / decrease the power generation system through the development of standard socket and common protocol, so that the total capacity can be easily adjusted according to the demand of the consumer. DC buses and standard sockets make the configuration of the system very convenient for non-experts.

Fig. 1 shows the hybrid power generation system of the DC bus link ON/OFF circuit for communication with the smart distribution board of the solar power generation circuit[6].

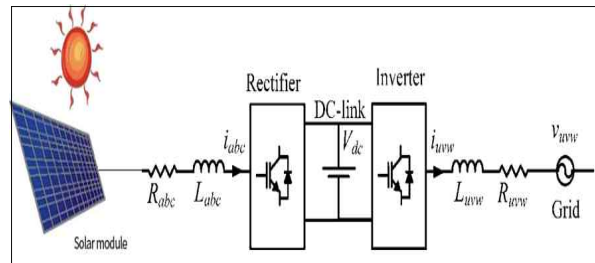


Fig. 1. Solar power circuit configuration diagram

2.2 Development and introduction of friction wind power generation system

In the conventional wind power generation system, noise is generated due to rotation of the blades, which can cause complaints. In addition, a mechanical error may occur in the rotating portion due to the load of the rotating torque.

We are going to introduce a friction wind power generation system that can reduce noise compared to existing system by using friction material wind power generation system using new material (fiber), generate less trouble due to no mechanical movement, and can generate at low wind speed.

Fig. 2 below shows the circuit configuration for managing the battery and the wind power supply in one system by analyzing the condition that the system specialized for the power generation source can be conveniently connected to the DC link[7,8].

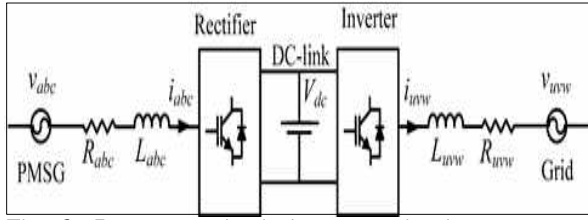


Fig. 2. Battery and wind power circuit

2.3. Application of power generation prediction system

Based on the meteorological climate conditions of the power generation complex, it is possible to predict the amount of new and renewable energy generated and to accurately grasp the amount of power supplied. This allows the end user to establish a power usage plan and distribute the peak power to prevent overloading and stabilization of the power system. In addition, a panel board with AI function is applied to implement the function of appropriately configuring the grid power and the renewable energy source in the event of an accident or specific event, and delivering it to the load side.

The power generation forecasting system is classified into the weather forecasting part for predicting the solar power generation amount and the power generation forecasting part using the weather forecasting data. When the weather forecast data are calculated by the physical model and the statistical model, the generation amount of each generator is calculated as the total generation amount considering the characteristics and environment of the power generation plant, and the final generation amount estimation value is calculated.

Meteorological forecast data and power generation forecast data are databased with monitoring data from the main server and provided to users through a visualization system. Data of 1 hour interval within the next 48 hours is produced every hour and converted into a database. In order to predict the power generation in real time, various input

data for weather data prediction are received in real time. The operation time is designed so that it can be operated stably with physical model, statistical model, calculation of power generation, and display.

Fig. 3 shows the development of an algorithm to transfer power generation forecast information to EMS (Energy Management System), which is applied to EMS for system operation.

This is a system for transmitting solar power generation information from the forecast system to EMS through meteorological observations, physical model weather forecast data and Meteorological Agency numerical forecast model data[9,10].

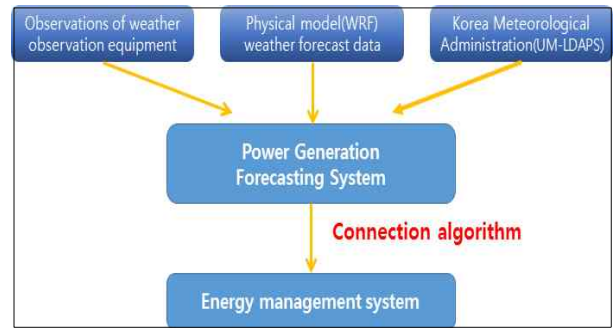


Fig. 3. Development of bi-directional DC / DC converter topology

2.4. Friction wind power generation PMS control technology

The PMS (Power Management System) control technology for friction wind power generation according to the common power interface protocol is a power generation system control for a safe DC link connection, and a stable link test with a smart distribution panel requires a DC link connection control which is easy to expand[11].

The optimal control technology of parallel - connected power converters in a friction wind turbine system requires analysis of the hybrid PCS (Power Conversion System) parallel connection control condition for friction power generation capacity follow - up. We develop convenient control technology to expand parallel connection of hybrid PCS.

The friction wind power generation system configuration is required to optimize long term stabilization condition and nanofiber friction pad for long term operation by supplementing system protection factor according to wind strength[12].

Friction wind power package technology development utilizes nano fiber pads manufacturing technique for frictional wind power structure for frictional wind power by package design suitable for urban aesthetics which is different from conventional rotor wind power generation. Nanofibers are fabricated to optimize the combination of materials for high-efficiency triboelectric generation and maximize surface area. Construct a mechanism that mechanically vibrate the friction pad by wind and design a flow cell optimized for wind energy utilization.

3. Results and Discussion

The MG environment optimization study using the loop (HIL) simulation of the controller hardware (C-HIL) in the micro grid loop constitutes the same control system as the actual micro grid.

Controls the power generation system for stable DC link connection to PMS control technology for PV system according to the common power interface protocol. Stable link test with smart distribution panel, DC link is linked to facilitate expansion.

In order to develop the optimal control technology for parallel-connected power converters in PV systems, we will develop convenient control technology for hybrid PCS parallel connection expansion for analysis of hybrid PCS parallel connection control conditions for solar power generation capacity follow-up.

3.1. ESS-based hybrid power generation system

As shown in Fig. 4 for the stable link with the smart distribution panel, the DC link linkage control which is easy to expand and the parallel converter power converter optimum control in the PV power system are performed. Develop hybrid PCS parallel connection control condition analysis and convenient control technology for extension of solar power generation capacity[11].

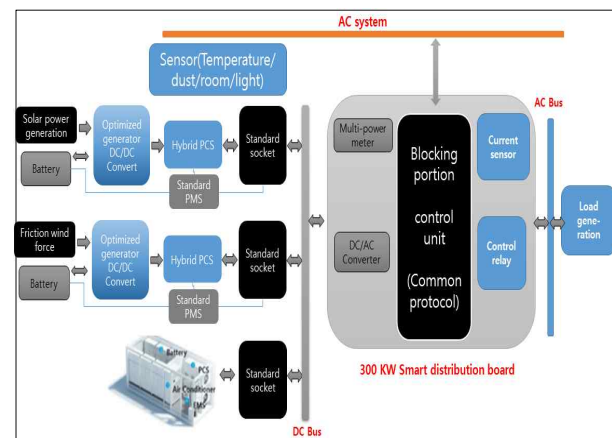


Fig. 4. ESS-based hybrid power generation system configuration diagram

3.2. Verification of power generation forecast accuracy and module development

We verify the accuracy by comparing the accuracy of the power generation prediction algorithm developed for verification and advancement of power generation prediction accuracy with actual power generation. We confirmed the accuracy of power generation forecast data through weather forecast data. (1 hour to 48 hours) is analyzed by comparing the actual output value with the predicted value of power generation amount.

Fig. 5 shows the improvement of accuracy by analyzing the cause of error and algorithm improvement and applying the improved algorithm to the power generation prediction system[12].

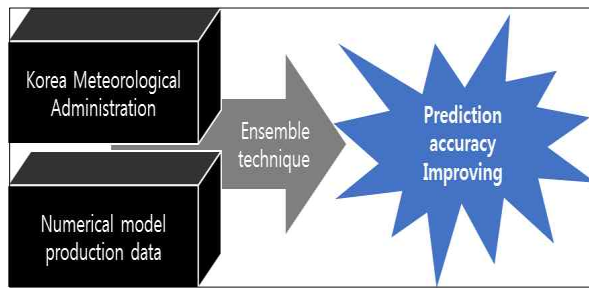


Fig. 5. WRF model and UM convergence ensemble weather forecasting

3.3. Operation of power generation prediction system

Enhancement of power generation prediction system means improvement of weather forecast, meteorological data observed in meteorological observation equipment installed in test bed, and weather prediction data predicted in statistical model. Power generation prediction system Prototype test operation is developed and tested in Prototype form with customized power generation prediction system for test bed.

Applying the meteorological prediction module including the developed physics model and statistical model, the power generation prediction system combined with the power generation estimation module is applied. Establish system performance improvement and stabilization based on continuous testing and operation of system considering environment variables and Prototype test operation.

The Smart Distribution Board is a central axis of the MG configuration. It has a link through the modular hybrid power source and the DC bus, controls the AC generation through the AC bus, controls the DC generation through the DC bus, to external grid.

If there is a problem in AC system, it can be configured as stable MG through bimodal control. The renewable power generator is composed of a modular standard package that is easy to expand and is linked to the DC bus by the common power interface protocol.

4. Conclusion

The new and renewable energy generation source is a modular standard package that can be easily expanded. It is connected directly to the DC bus and can be easily expanded. The power converter control technology of the parallel operation type which is easy to expand due to the system configuration is used.

PLC communication can be used for DC bus communication, and ZIGBEE, WIFI, Lo-Ra communication can be used for wireless communication. Use a standard socket to detect and block illegal connections and achieve stabilization of the power system.

We will secure technological competitiveness in distributed power supply, smart grid, and ESS market through development of universal input energy storage system that connects distributed power. By upgrading the energy storage system, we will develop standard products that can benefit from substantial operational benefits in areas where power infrastructure is vulnerable. By securing competitiveness in the distributed power supply, which is a future market, we will develop growth power products and related technologies for the energy new industry.

Standardizes the modular ESS system, smart distribution board standard, and operating rule security requirements and guidelines and presents them to related customers, thereby providing infrastructure infra-structure for expanding domestic systems. By expanding in future, it is possible to enter into various customized MG market and diversify distribution power in connection with new and renewable energy market by entering various customized overseas micro grid market.

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