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Renewable Sources Based Electric Vehicle Charging Station Controlling Grid with ANN Controller Modeling and Simulation

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ABSTRACT

This study suggests a framework for managing the charge-discharge of electrical vehicles (EVs) that will allow for the effective use of solar (PV) and wind energy through control that is based on information sharing between home energy management systems (HEMS) and grid energy management systems (TREASURES). The HEMS identifies an EV fee discharge plan for lowering the residential process expense and PV in our proposed framework. On the basis of voltage constraint information in the grid provided by the treasures and also projected power accounts, with wind curtailment without interfering with EV usage for driving. The HEMS then controls the EV charge-discharge in accordance with the predetermined strategy and the real-time monitored data, which is used to lessen the negative effects caused by inaccurate power profile projections. The proposed structure was evaluated using a simulation of the Japanese distribution system. The simulation results demonstrate how well our suggested structure performs in terms of PV curtailment and a reduction in the cost of residential operation.

Key words: *BESS, Circuit Breaker, Switch Off Time, and ESS.*

I. INTRODUCTION

A global challenge is reducing carbon dioxide emissions to prevent global warming. By 2040, power will account for about a quarter of all energy consumed [1], therefore the sector must pave the way for a decarbonizes energy system. Together with carbon dioxide emissions, essential power self-sufficiency is a major issue in Japan. After the 2011 Fukushima Daiichi catastrophe and the Great East Japan earthquake, energy self sufficiency has remained at just 6%. The federal government wants to raise it to about 25% by 2030 in order to break down this situation [2] However, in the domestic market alone, there were 201 million CO2 discharges in 2013, and the goal is to reduce this number by 39.3% by 2030 [3]. The government is building newly constructed homes with no average emissions for release by 2030, and the concept of "net-zero energy homes" (ZEHs), which have an annual net energy intake of zero or less, is gaining a lot of attention [4]. Utilizing household solar (PV) systems is crucial for achieving ZEHs; in addition, power storage devices must be installed in homes for flexible use of electrical power from the PV systems. A significant component of comprehending ZEH in Japan is also projected to be the home energy management system (HEMS), which may be made available to all (about 50 million) families by 2030 [2]. While initially used for transportation, electric vehicles (EVs) can be used for power storage to efficiently use solar energy. In terms of power monitoring, connecting EVs to the power grid with RESs will result in a variety of cost savings [5], but the power flow tends to be complicated since the power flow from EVs has a significant and unexpected temporal variation compared to conventional flows. Therefore, in addition to making effective use of RESs, consideration must be given to the impact of EV charge-discharge on the grid in power monitoring of EVs. The management of EV charge-discharge has been the subject of numerous prior studies.

When an EV is charged, SMES will lessen the transformer's second side voltage fluctuation, which is brought on by errors or fluctuating grid loads. Increases the utilization of renewable resources like solar power plants as a result of concerns about the electricity supply. By adopting SMES technology, the voltage variance is reduced, improving power quality as well as security. In order to make up for the voltage in the EV charging terminals, SMES, a better power compensator, will supply active as well as responsive power with extremely quick action. Given that EVs inject unpredictability into the charging or releasing states, the situation for smart grids with EVs is much more complicated. Transient security should be crucial in today's world because numerous faults, especially during electrical storms, occur in urban areas. Therefore, the dynamic performance was assessed using balanced errors such a three-stage to ground fault.

2. CONNECTED RESEARCH:

SMES is first envisioned as a number of cutting-edge tools that are used to both smooth out the utility's daily ideal need and conserve large amounts of energy. Electrical energy is conserved in SMES by passing current via a superconducting coil. Its performance is particularly high since no power conversion to other types is necessary. SMES has a very quick response time when absorbing or receiving electricity from the grid or load. Due to its quick response, SMES can benefit a utility by improving transmission line stability and power quality in addition to serving as a load-leveling device. SMES can therefore be thought of as a Flexible Transmission system (Realities) Transmission Security and Voltage/VAR Assistance are two SMES applications used in transmission substations. Significant Progress Regularity Control, Spinning Get, and Dynamic Response are SMES applications used in the generation system. The basic idea behind SMES is to store energy in the magnetic field that is produced when a direct current (dc) passes through a coil of wire. When a regular cable is used to damage the coil, a magnetic field and heat are produced. Despite the fact that the coil is a DC device, cost and discharge are often handled by an AC energy grid, necessitating the employment of a power conditioning system (PCS) as the user interface A common strong state DC/AC converter can be used by PCS to move power back and forth between the superconducting coil and the load or grid. The utility grid and superconducting magnet are connected via a computer (AIR CONDITIONING). Through an inverter/rectifier made up of SCR and GTO plans with a specified obligation cycle, the DC/AC conversion is carried out. For determining plant efficiency, the PCS losses from conversion and idling are crucial. SMES system demonstrates the distinction based on size and duty cycle. The High Temperature Superconducting Coil is the SMES's key component (HTS). The coil might be either a solenoid or a toroid depending on the size of the application. For large SMES systems, solenoid coils are substantially more cost-effective.

As a result, the battery may still undergo high-frequency power changes that cause uncomfortable charging and discharging. As a result, a modified fraction control strategy is designed to distribute the power between the SMES and the battery. The SMES deals with power disturbances first in the new method, which keeps the battery and SMES in series. The battery keeps the SMES current by serving as an energy buffer. As a result, rather than using instantaneous internet power, the battery charges and discharges in accordance with the SMES current. The experiment shows that the new control system is able to protect the battery against abrupt power changes when compared to the previous fraction-based HESS regulation.

3. METHODOLOGY

We take into consideration two power monitoring systems (EMSs), namely GEMS and

HEMS. GEMS consists of an on-load tap changer (OLTC) and a treasures controller, while HEMS is made up of a roof PV, an EV, and a HEMS controller. Each EMS controller has automatic control over its parts, allowing it to change the specifications of parts at predetermined intervals. Generally speaking, these two EMSs are independently operated to meet their respective needs. A significant requirement for the HEMS is to reduce the cost of property operation while maintaining the use of EVs for transportation. The HEMS controller will charge the EV when the PV is not producing and discharge it to cover the household's electrical power usage when the PV is producing, reducing the cost of operation of the home as much as possible. However, such procedures increase the reverse power circulation, which leads to overvoltage in the DS and causes the PV inverter to frequently tend to reduce the PV output. This prevents the PV inverter from generating the anticipated power sales revenue, and the property operation costs rise as a result. The GEMS's responsibility is to maintain the highest possible standard of power in the power system. To keep the voltage within the proper range, the OLTC is extensively released in the DS. The availability of more PV should result in lower costs for GEMS since PV will replace the source of power with the highest fuel cost. Because of this, the reduction in PV curtailment is a common profit for both the GEMS and the HEMS, and there is potential to increase the mutual profit by collaborating with the two EMSs. In this section, we outline our suggested working framework for the EV charge-discharge monitoring in order to save domestic operation costs as well as PV curtailment by effectively charging the EV for the predicted PV curtailment. Our suggested structure, as shown in Fig. 1, operates on a schedule similar to that suggested in [26], EV functioning being its primary concern. It begins by estimating projected household power profiles, which include PV results as well as household power consumption for the approaching period from 6:00 to 6:00 the following day. Then, during the functional plan phase, information sharing is used to synchronise the HEMS and also GEMS. Based on the predicted PV result and anticipated PV curtailment due to the voltage limitation informed from the GEMS, the HEMS generates an EV charge-discharge plan to reduce the household operating expense. When the projected PV output contains a significant error, the planned charge-discharge quantity will be greater or less than the ideal quantity for meeting the goals. Therefore, in the control phase, the EV charge-discharge is managed to accordance with the identified plan as well as the real-time observed data (hereinafter called "following control"). The following control measures are taken to reduce the deficit and excess of charge-discharge amount caused by the discrepancy between the anticipated and actual accounts in order to prevent the unnecessary purchase of electricity and potential loss of surplus PV sales. After the HEMS surfaces in anticipation of the day's power accounting, the remaining portion of this region clarifies the detailed procedures.

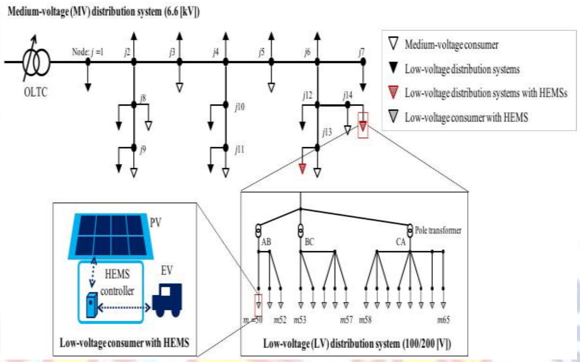

Fig.3.1. Proposed model.

4. SIMULATION RESULTS:

Let $n \in N$ be the index of house without HEMS where N be the index set of the houses without HEMSs. The appropriate voltage control parameter set of the OLTC are determined using the forecasted power profiles and the EV provisional plan $x^G = \{x^{PV}_m, x^r_m, y_m; m \in M\} \cup \{x^{PV}_n, x^r_n; \in N\}$ and the EV provisional plans sent from the HEMSs y are evaluated under the voltage constraint. Our grid management is carried out by the GEMS composed of a GEMS controller and an OLTC. The tap ratio of the OLTC is regulated using the line drop compensator (LDC) method [27] so as to maintain the voltage in the DS. In this method, the OLTC monitors its secondary current and voltage to dynamically control the tap position. Let i_t and $\dot{v}_t$ be the secondary current and voltage of the OLTC, respectively.

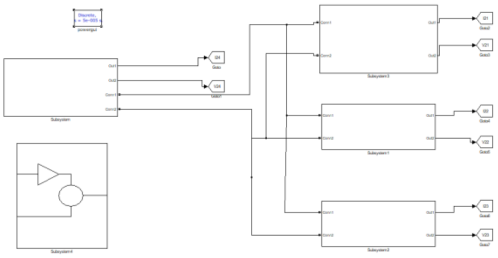

Fig.4.1. Simulation Circuit.

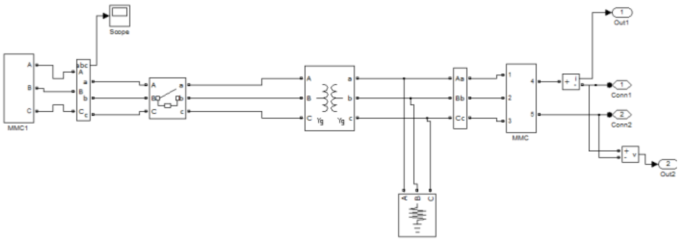

Fig.4.2. Generating station Simulation circuit.

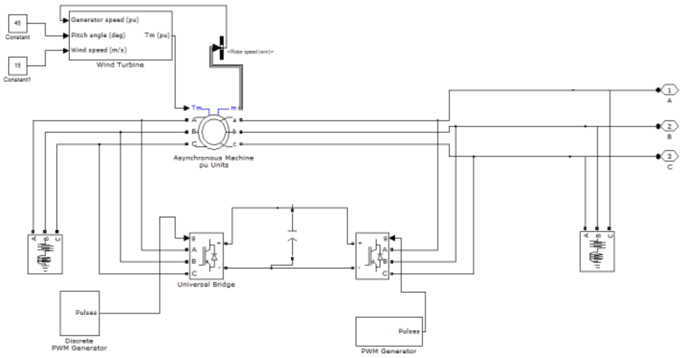

Fig.4.3. Wind power generation circuit.

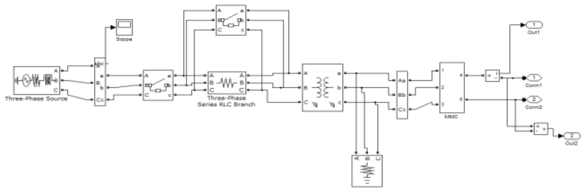

Fig.4.4. Subsystem circuit with phase voltage circuit.

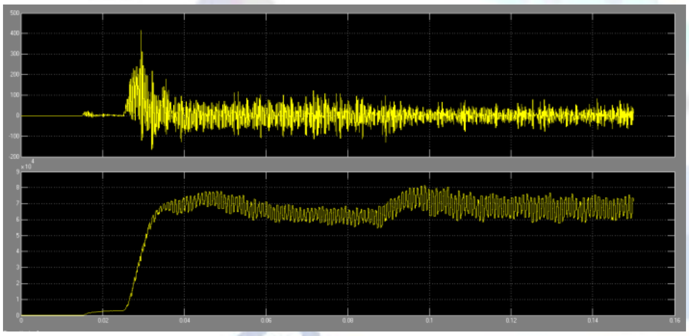

Fig.4.5. Voltage and current across the Subsystem.

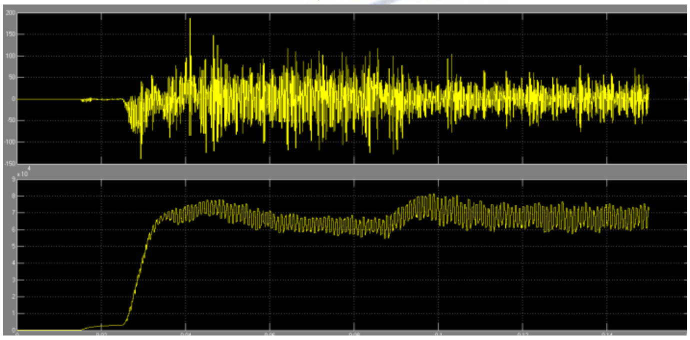

Fig.4.6. Output voltage across the subsystem 2.

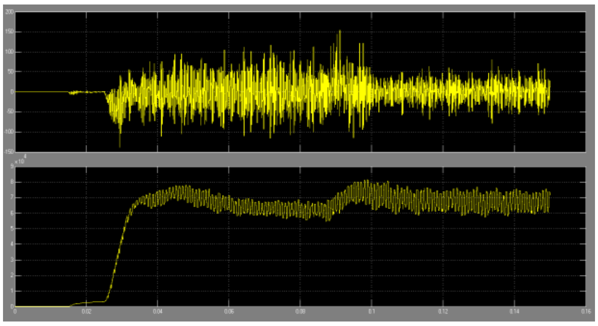

Fig.4.7. Output voltage across the subsystem 3.

5. CONCLUSION:

We proposed a coordinated EV charge discharge management framework. The coordination is based on the information exchange between the HEMS and GEMS. The proposed framework determines a daily EV charge-discharge plan on the basis of the exchanged information and day-ahead forecasted power profiles to ensure the adequate free capacity for charging the curtailed PV during the daytime and the charged capacity for the scheduled EV drive. We also proposed a following control scheme. The scheme controls the EV charge-discharge amount following to the realtime monitored data for mitigation of the deficiency and excess of charge-discharge amount caused by the forecast errors. The effectiveness of the proposed framework was evaluated using a DS simulation model from the viewpoint of the residential operation cost and the amount of PV curtailment. The simulation results implied that the proposed framework achieves to reduce the residential operation cost and the PV curtailment by the information exchange and the following control.

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