MULTIPLE RENEWABLE GENERATORS COORDINATION IN A MICROGRID

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ABSTRACT:

High renewable energy utilization in a micro grid to work autonomously, it has to maintain the supply-demand balance of active power of the entire micro grid. The Maximum peak power tracking operation, which is insisted for high renewable energy utilization, may cause a imbalance in the supply-demand of the micro grid. This will occur whenever the available renewable generation is more than demanded, especially in the case of autonomous operation of micro grids. Currently, droop control is one of the most popular decentralized methods which is for sharing active and reactive loads among the distributed generators. However, this conventional droop control methods suffer from slow and oscillating dynamic response and steady state deviations. In order to overcome these problems, this paper proposes a coordination of multiple renewable generators in a micro grid in which the supply-demand balance can be well maintained and the system dynamic performance can be significantly improved. Simulation results here demonstrate the proposed control solution and their effectiveness.

Keywords: Micro grid, multi-agent system, renewable generator.

INTRODUCTION:

A microgrid can be defined as a cluster of loads, distributed generators (DGs) and energy storage systems that are utilized by a distribution network and can be operated in both the grid-connected mode and the islanded mode. The size of a micro grid will be in the range from a typical housing estate, isolated rural community systems, to mixed suburban environments, academic or public communities, to commercial areas, industrial sites and trading estates, or municipal regions [1].

The benefits of micro grids include :

1) Increased in reliability.
2) Improved energy efficiency of the system.
3) Reduced environmental impact.
4) Timely response for the system.

A micro grid is an better alternative to over-come the challenges of integrating distributed energy resource units, including renewable energy sources, into power systems [2].

The solar and the wind energy are the most promising renewable power supply alternatives due to their abundance in nature, they are also pollution free and low production in cost/unit. However, the intermittency of wind and solar power poses new challenges to the operation and control of micro grids, especially under high penetration. One of the most important issues is the power reference control of distributed renewable generators (RGs) under dynamic weather and the load conditions.

The popular maximum peak power tracking (MPPT) algorithms [3], [4] emphasize high energy usage efficiency but may cause a supply-demand imbalance when the maximum available renewable generations are more than demanded, especially for autonomous microgrids. To overcome this problem, energy storage devices such as batteries, super-capacitors and flywheels can be used to absorb the excess energy [5]. However, if the installed energy storage device's capacity is still insufficient, the outputs of the renewable generators will have to be controlled to ensure the supply-demand balance. Their effectiveness is limited by the maximum charging and discharging rate and charging level, even if maximum sufficient energy storage devices are available

CONVENTIONAL SYSTEMS:

For microgrid with an autonomous condition, the control issues may be of very similar to those of the large-scale power systems network, such as that the supply-demand balance and frequency regulation can be achieved. Due to this similarity nature, the most existing idea on traditional operation of power system can be introduced to small scale autonomous micro grids. In [6], the authors propose a two-level control scheme for a wind farm, which consists of supervisory and machine levels of control.

In this scheme, the supervisory control level decides the active and reactive power set points for all doubly-fed induction generators (DFIGs), while the machine control level ensures that the set points are reached. In [7], the authors propose an optimal dispatch control strategy for a wind farm.

Thus, the DFIGs were controlled in order to adjust both active and the reactive power generation according to the request of the system's central operator. In[8],the authors present a control approach for a wind farm to provide a sufficient generating margin upon the request of supervisory controllers.

DISADVANTAGES OF CONVENTIONAL SYSTEMS:

1) All these methods are of centralized system, therefore they are requiring a complicated communication networks in order to collect the information globally and also a powerful central controller will be needed for processing their huge amount of data's.

2) These solutions required are costly to implement and susceptible to single-point failures.

3) Due to the intermittency of renewable generation, more frequent control updates are required.

4) If operating conditions change rapidly and unexpectedly, the centralized solutions may not be able to respond in a timely fashion

PROPOSED SYSTEM:

Conventional droop control methods suffer from slow and oscillating dynamic response and steady state deviations. To overcome these problems, this paper proposes the coordination operation of different types of distributed renewable generators in a micro grid.

The supply- demand balance can be well maintained and the system dynamic performance can be significantly improved. Simulation results demonstrate the effectiveness of the proposed control solution. In this scenario, each of the RG is controlled simply in order to operate under the MPPT technique. However, when a micro grid operates in islanded mode of operation, the supply-demand must be balanced autonomously. Therefore, each of the components in the micro grid should be cooperated to achieve this goal.

ALGORITHM IMPLEMENTATION:

The proposed control topology is shown in Fig. 2, which is mainly composed of RGs, an SG and loads. Each RG is assigned an RG agent. An RG agent can be able to measure the system's frequency, and can predict its maximum value of renewable power generation; it can exchange information among the neighbouring agents. Thus, the supporting communication system for the MAS based solutions can be able to designed independently for the topology of the power network system. Even for a complex system, simple communication network can be designed base on cost, location, convenience, etc. Each SG is assigned an SG agent, which does not participate in the utilization level updating process.

The maximum active power generation of a DFIG can be estimated using measured wind speed. In addition, there are many other MPPT algorithms for wind turbine generators available in literature survey, as summarized in conventional systems. Similarly, the maximum of power generation by a PV generator can be predicted is based on the weather condition like solar insolation, temperature, etc. A lot of the MPPT algorithms for the PV generators have been developed in the past years of power generation, such as the fuzzy logic control system, neural network system, etc.

Inaccuracy of the maximum power estimation always exists to some extend due to the prediction errors. Sometimes the predicted value is larger than practical, sometimes smaller. For under-estimation, the predicted generation can be realized. For over-estimation, such as due to the aging problem or internal failures of a PV system, the advantage of the proposed algorithm will present. The proposed algorithm updates generation references based on overall generation estimations and overall demand. Since the generation reference settings are usually lower than the under sufficient renewable generation, the impact of inaccurate estimation can be lowered.

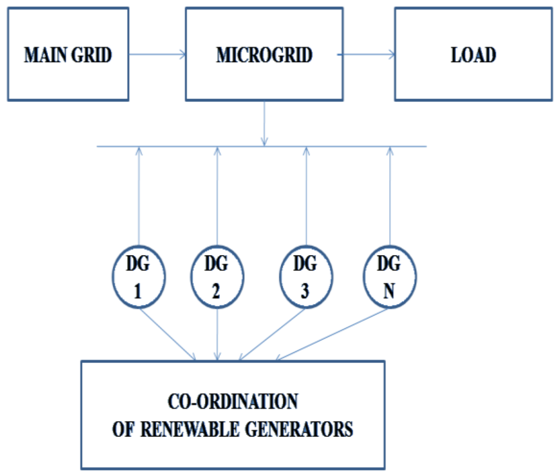

FIG 1: BLOCK DIAGRAM OF THE SYSTEM

CONTROL OF DIFFERENT TYPES OF DGs:

Control of DFIG

The machine-level control of each DFIG manages active power reference tracking, as well as reactive power or terminal voltage regulation and DC-link voltage regulation. As illustrated in Fig. 3, the machine-level control consists of the electrical control of two converters and the mechanical control of pitch angle. A typical DFIG model introduced in is adopted in this paper

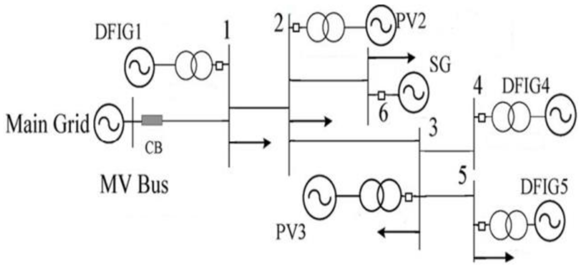

Fig 2. Illustration of the control topology of a microgrid.

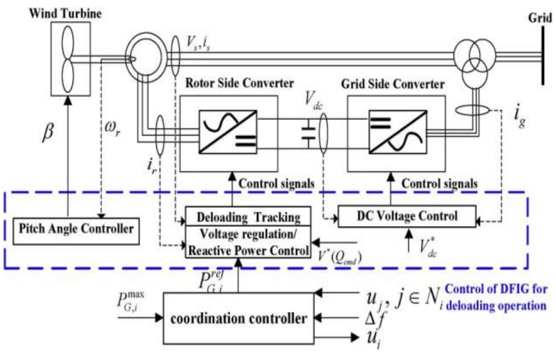

FIG. 3. CONTROL STRATEGY FOR DFIG

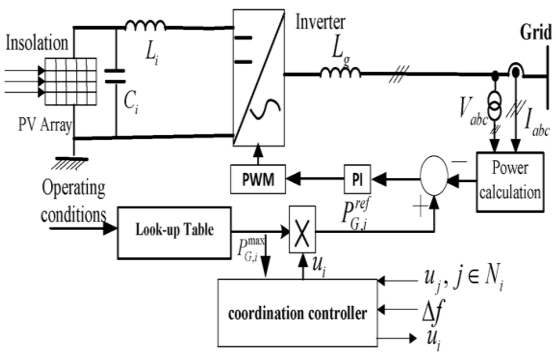

FIG. 4. CONTROL STRATEGY FOR PV SYSTEM.

The active power generation of the DFIG can be regulated by controlling rotor speed and/or tuning pitch angle [40]. The former method is preferred for two reasons.

First, is controlled by converter control, whose response speed is faster than the mechanical pitch angle control. Second, electrical control of can decrease wear and tear on the pitch blade. However, when the rotor speed reaches the upper bound, it is necessary to activate the pitch angle tuning. The implementation details of DFIG control are presented in.

1) Converter Control:

In this paper, the DFIG is controlled by back-to-back converters. With the decoupled control method introduced, the rotor-side converter (RSC) controls both the active and reactive power of the DFIG. There are two modes for reactive power control, the voltage and reactive power regulation modes. Both modes regulate q-axis rotor current. In voltage regulation mode, is controlled to reduce voltage fluctuation.

Here, GSC is used only to stabilize the DC-link voltage.

2) Pitch angle control:

The pitch angle control method, as Depicted in Fig.5, consists of a PI controller and a pitch angle actuator. The threshold speed is set to 1.3 p.u. , and is set to 0.The maximum pitch angle change rate is limited by $(\mathrm{d}\beta/dt)_{\max}$ and $(\mathrm{d}\beta/dt)_{\min}$.

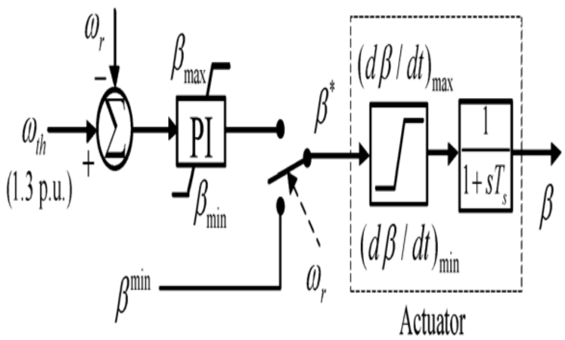

FIG. 5. PITCH ANGLE CONTROL SYSTEM.

where is the module maximum power at standard test condition (STC), is the incident irradiance, is irradiance at STC 1000, is the temperature coefficient of power, and are the cell temperature and the reference temperature (25), respectively. Once & have been calculated, the generation reference can be updated according to (6). After that, simple PI control can be used to control the inverters for active power tracking, as shown in Fig.4.

CONTROL OF SG:

In this paper, the SG in the renewable microgrid has two functions. If the renewable generation is sufficient to power all loads, SG is just used for voltage regulation. If the renewable generation is insufficient, in addition to voltage regulation, the SG also generates active power to compensate the deficiency. The SG does not need to participate in the discovery of desired utilization level. The SG agent can monitor the instantaneous utilization level of one of its nearby RGs in order to determine its control mode through CMS, as shown in Fig. 7.

If the utilization level equals to 1 and the frequency deviation is negative, the SG will generate active power to compensate the deficiency of the renewable generation. Otherwise, the SG will only provide re-active power support to maintain local voltage level.

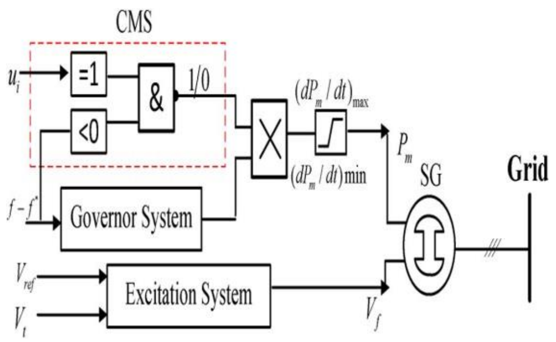

FIG. 7. CONTROL LOGIC OF SYNCHRONOUS MACHINE.

SIMULATION STUDIES:

The proposed system with the cooperative control algorithm is tested with a 6-bus microgrid model using MATLAB/ SIMULINK, as shown in Fig. 8.

The system contains six loads, three DFIGs, two PVs and one SG. The DFIG at bus-1 (abbreviated as DFIG-1) is controlled in reactive power regulation mode, the DFIG-4 and DFIG-5 are controlled in voltage regulation mode, and the PV-2 and PV-3 are controlled in unit power factor mode.

RESULTS AND DICUSSION:

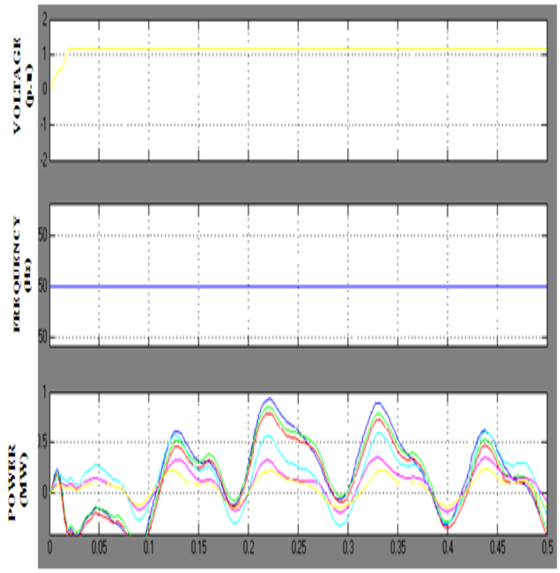

FIG. 8. SIMULATION RESULTS

CONCLUSION:

This paper targets at the coordination problem with an autonomous microgrid under high penetration of renewable energy. First of all, the MPPT algorithms that emphasize high renewable energy utilization will cause supply-demand imbalance whenever the available renewable generation of power is more than demanded. Secondly, every MPPT algorithm has the most promising problem of impreciseness to a certain degree and the predicted maximum available generation might be of unachievable in nature. Thus ,the proposed control scheme has the following four main advantages. The first advantage is the introduction of a simple MAS-based fully distributed method. Due to the simplicity of the network topology and the reduced amount of information to exchange, the cost of the supporting communication network will be much lower than that of a centralized solution. The second one is of its avoidance of the direct measurements of the loading conditions. The third is of its distributed coordination of the different types of DGs such as the (DFIG, PV, and SG), which can be able to maintain the supply-demand balance within the microgrid and improves the system's dynamic performance. Simulation studies demonstrate that the multiple RGs and the SG are well coordinated to maintain the power supply-demand balance for the autonomous microgrid in both excessive and insufficient available renewable power situations.

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