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CONSTANT POWER GENERATION USING ANN IN GRID CONNECTED WIND SYSTEM

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ABSTRACT

Today India is ever more choosing to replace fossil fuels with renewable energy sources. Among the factors driving people to seek out different sources of energy are fears about reliability on fossil-fuel imports, resource depletion, and anthropogenic climate change. The renewable energy sources, particularly 'Wind Energy' development, showed its remarkable growth in the recent years, that can create pollution less and environment friendly atmosphere. India, over the years, has been a trend-setting nation with regard to Wind Power Utilization and decades of concentrated efforts have started to yield gratifying results. The Indian Wind Energy program has been very successful in commercializing wind energy and India stands 5th in the World in terms of installed wind power capacity of 19832 MW as on June 2013, contributes to around 75% of the grid-connected renewable energy power in the country. The wind energy market is continuing to grow steadily in India along with the rest of the world. India is now one of the global manufacturing hubs for wind turbines with about 23 large wind turbine manufacturers, capacity ranging from 225 kW to 2500 kW and several small wind turbine manufacturers producing capacity ranging from 300 W to 50 kW.

Energy resources have always played an important role in the development of human society. Since the industrial revolution the energy has been a driving force for the modern civilization development. A burning demand for more electric power coupled with depleting natural resources has led to an increased need for energy production from renewable energy sources such as wind and solar. The latest technological advancements in wind energy conversion and an increased support from governmental and private institutions have led to increased wind power generation in recent years. Wind power is the fastest growing renewable source of electrical energy. Integrating the wind energy into the grid impacts the power quality due to continuously varying wind speed components.

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The major power quality problems are active power, reactive power, voltage sag, voltage swell, flicker, and harmonics. This proposal shows the existence of power quality problem due to installation of wind turbine with the grid. An advanced ANN based power control strategy by limiting the maximum feed-in power of DG System i.e. Wind systems has been proposed, which can ensure a fast and smooth transition between grid and Wind System. Regardless of the Variable Speed, high-performance and stable operation are always achieved by the proposed control strategy. It can regulate the DG output power according to any set-point, and force the DG systems to operate at the efficient methodology without stability problems.

Literature review:

In recent years, the research attention on dc grids has been resurging due to technological advancements in power electronics and energy storage devices, and increase in the variety of dc loads and the penetration of dc distributed energy resources (DERs) such as solar photovoltaics and fuel cells.

Many research works on dc microgrids have been conducted to facilitate the integration of various DERs and energy storage systems. In [5], [6], a dc microgrid based wind farm architecture in which each wind energy conversion unit consisting of a matrix converter, a high frequency transformer and a single-phase ac/dc converter is proposed. However, the proposed architecture increases the system complexity as three stages of conversion are required. In [7], a dc microgrid based wind farm architecture in which the WTs are clustered into groups of four with each group connected to a converter is proposed. However, with the proposed architecture, the failure of one converter will result in all four WTs of the same group to be out of service. The research works conducted in [8]–[10] are focused on the development of different distributed control strategies to coordinate the operation of various DERs and energy storage systems in dc microgrids. These research works aim to overcome the challenge of achieving a decentralized control operation using only local variables. However, the DERs in dc microgrids are strongly coupled to each other and there must be a minimum level of coordination between the DERs and the controllers. In [11], [12], a hybrid ac/dc grid architecture that consists of both ac and dc networks connected together by a bidirectional converter is proposed. Hierarchical control algorithms are incorporated to ensure smooth power transfer between the ac microgrid and the dc microgrid under various operating conditions. However, failure of the bidirectional converter will result in the isolation of the dc microgrid from the ac microgrid.

An alternative solution using a dc grid based distribution network where the ac outputs of the wind generators (WGs) in a poultry farm are rectified to a common voltage at the dc grid is proposed in this paper. The most significant advantage of the proposed system is that only the voltage at the dc grid has to be controlled for parallel operation of several WGs without the need to synchronize the voltage, frequency and phase, thus allowing the WGs to be turned ON or OFF anytime without causing any disruptions.

Many research works on designing the controllers for the control of inverters in a microgrid during grid-connected and islanded operations is conducted in [13]–[15]. A commonly adopted control scheme which is detailed in [13], [14] contains an inner voltage and current loop and an external power loop to regulate the output voltage and the power flow of the inverters. In [15], a control scheme which uses separate controllers for the inverters during grid-connected and islanded operations is proposed. Although there are a lot of research works being conducted on the development of primary control strategies for DG units, there are many areas that require further improvement and research attention. These areas include improving the robustness of the controllers to topological and parametric uncertainties, and improving the transient response of the controllers.

To increase the controller's robustness against variations in the operating conditions when the microgrid operates in the grid-connected or islanded mode of operation as well as its capability to handle constraints, a model-based model predictive control (MPC) design is proposed in this paper for controlling the inverters. As the microgrid is required to operate stably in different operating conditions, the deployment of MPC for the control of the inverters offers better transient response with respect to the changes in the operating conditions and ensures a more robust microgrid operation. There are some research works on the implementation of MPC for the control of inverters. In [16], a finite control set MPC scheme which allows for the control of different converters without the need of additional modulation techniques or internal cascade control loops is presented but the research work does not consider parallel operation of power converters. In [17], an investigation on the usefulness of the MPC in the control of parallel-connected inverters is conducted. The research work is, however, focused mainly on the control

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of inverters for uninterruptible power supplies in standalone operation. The MPC algorithm will operate the inverters close to their operating limits to achieve a more superior performance as compared to other control methods which are usually conservative in handling constraints [18], [19]. In this paper, the inverters are controlled to track periodic current and voltage references and the control signals have a limited operating range. Under such operating condition, the MPC algorithm is operating close to its operating limits where the constraints will be triggered repetitively. In conventional practices, the control signals are clipped to stay within the constraints, thus the system will operate at the sub-optimal point. This results in inferior performance and increases the steady-state loss. MPC, on the contrary, tends to make the closed-loop system operate near its limits and hence produces far better performance. MPC has also been receiving increased research attention for its applications in energy management of microgrids because it is a multi-input, multi-output control method and allows for the implementation of control actions that predict future events such as variations in power generation by intermittent DERs, energy prices and load demands [20]–[22]. In these research works, the management of energy is formulated into different multi-objective optimization problems and different MPC strategies are proposed to solve these optimization problems. The scope of this paper is however focused on the application of MPC for the control of inverters.

Summary:

The major power quality problems are active power, reactive power, voltage sag, voltage swell, flicker, and harmonics. This proposal shows the existence of power quality problem due to installation of wind turbine with the grid. An advanced ANN based power control strategy by limiting the maximum feed-in power of DG System i.e. Wind systems has been proposed, which can ensure a fast and smooth transition between grid and Wind System. Regardless of the Variable Speed, high-performance and stable operation are always achieved by the proposed control strategy. It can regulate the DG output power according to any set-point, and force the DG systems to operate at the efficient methodology without stability problems.

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