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Optimal Placement of Energy Storage Devices in Microgrids Via Struture Preserving Energy Function

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ABSTRACT

As system transient stability is one of the most important criterions of microgrid (MG) security operation, and the performance of an MG strongly depends on the placement of its energy storage devices (ESDs), optimal placement of ESDs for improving system transient stability is required for MGs. An MG structure preserving energy function is firstly developed for voltage source inverter based MGs since the existing energy functions, based on synchronous generators and the conventional power system, are not applicable for MGs. The concept of internal potential energy of distributed energy resource is presented instead of the kinetic energy term in traditional energy function. And then, a novel approach for the optimal placement of ESDs is proposed based on MG structure preserving energy function for improving MG transient stability. Simulation and experimental results show that the proposed method can be used to find the optimal placement of ESDs, and to improve the system stability effectively.

Keywords: Transient stability , structure preserving energy function, energy storage devices, optimal placement, micro grids.

I. INTRODUCTION

Environmental concerns and fuel cost uncertainties associated with the use of conventional energy sources have resulted in rapid growth in the amount of the renewable energy resources (RES). For instance, between 2005 and 2030, the share of RESs in the 27 European Union member states gross power generation will be more than double from 14.3% to 36.1%. In fact, the share of intermittent RESs will reach 20.7% of the total power generation in 2030. With respect to wind and solar as the most use of renewable generation, however, when the renewable resource penetration reaches sufficiently high levels (about 20%–30% of total generation), the intermittent nature of such generation can begin to have noticeable, negative effects on the entire grid. Recently, the integration of ESDs with RESs has become one.of the most viable solutions for facilitating increased penetration of renewable DG resources. Beginning with the U.S.Department of Energy (DOE) “Grid 2030 Vision” Conference in April 2003, energy storage emerged as a top concern for the future. In 2007 the DOE convened an Electricity Advisory Committee (EAC) to make recommendations for an energy road map for the United States including energy storage. These dispatch able storage technologies will provide lots of benefits such as greater reliability, improved power quality, and overall reduced energy costs for utilities, DG owners, and customers. However, ESDs benefits are strictly related to their location and sizing as well as storage technology, which have been frequently

addressed in the literatures by using a variety of optimization techniques.

BLOCK DIAGRAM

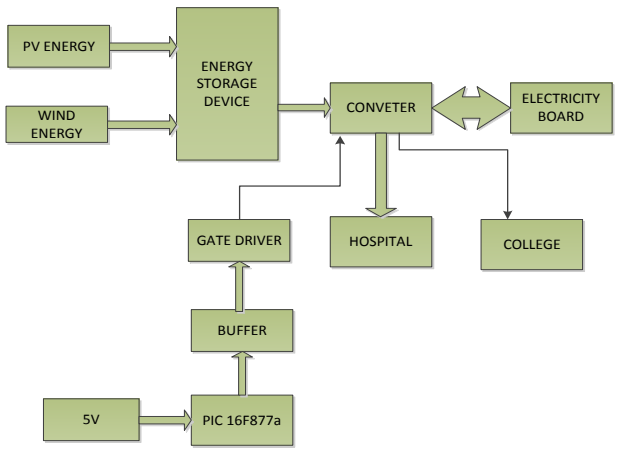

Figure 1

II. EXISTING SYSTEM

Existing energy function is derived based on synchronous generators andthe large power system. Synchronous generators store energy through rotor, so there is kinetic energy in existing energy function. The large power system is a high-voltage system which is inductive. However, MG is a low-voltage system which is mainly resistive, and also the different load character needs to be considered. Specifically, inverter-based DG units do not have rotating parts, which means that the kinetic energy term in traditional energy function does not exist. Therefore, the components and analysis have a big difference between the large power system and MG. So existing energy function can hardly be used to analyze the stability of MG. It is worthwhile to develop an energy function based on MG for assessing stability of MG effectively.

III. PROPOSAL SYSTEM

A novel approach for the optimal placement of ESDs is proposed based on MG structure preserving energy function for improving MG transient stability. Simulation and experimental results show that the proposed method can be used to find the optimal placement of ESDs, and to improve the system stability effectively.

Energy Storage

- ✓ Energy is stored to use it at a different time than when it was generated
- ✓ The process of converting the energy to storable form means that some energy is lost due to inefficiency and heat
- ✓ Additional energy is lost when the energy is released or recovered due to a second inefficiency
- ✓ Ideally, storage is avoided to have a more efficient process
- ✓ Shifting the energy from usage peaks to low-use times helps the utility, and customers would be rewarded by lower charges
- ✓ Renewable energy is often intermittent (like wind and sun), and storage allows use at a convenient time
- ✓ Compressed air, flywheels, weight-shifting (pumped water storage) are developing technologies
- ✓ Batteries are traditional for small systems and electric vehicles; grid storage is a financial alternative
- ✓ Energy may be stored financially as credits in the electrical "grid"

MATLAP CIRCUIT

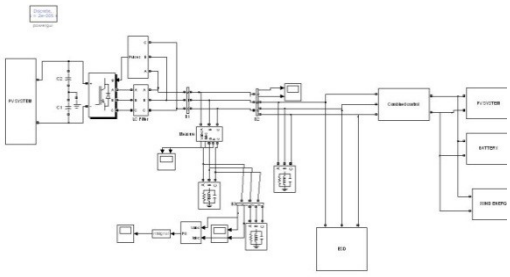

Figure 2

SIMULATION OUTPUT

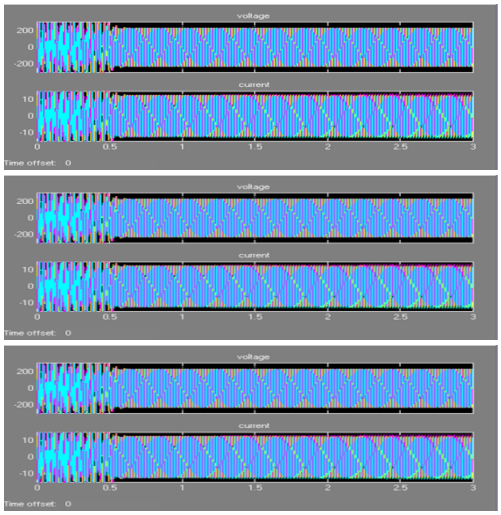

Figure 3

Abovediagram shows first node output, second node output, third node output.

ADVANTAGE

As the world moves towards renewable energy generation and acts to counter climate change, micro grids offer a range of benefits which can provide assistance both locally and nationally in terms of the environmental benefits.

- ✓ Reduced Electricity Bill
- ✓ Diverse application
- ✓ Low maintenance cost
- ✓ Wind is a renewable energy resource and there are no fuel costs. ...

HARDWARE

Figure 4

IV. CONCLUSION

This paper studies the optimal placement of ESDs on the basis of MG structure preserving energy function. Firstly, a MG structure preserving energy function has been proposed based on the voltage-source inverter based MG. Secondly, a novel approach for optimal location of ESDs is proposed based on the MG branch transient energy function to improve MG transient stability. For the sake of system stability, the proposed stability-oriented optimizing method sacrifices economy for faster recovery time and less overshoot. In other words, the proposed method provides a more specific method to improve reliability and stability that ESDs contribute to system. Finally, the simulations and experimental results verify: 1) the validity and practicality of the proposed method in optimizing placement and mitigating transient unbalance energy; 2) the proposed method further improves system transient stability compared with existing and state-of-art research. Other issues such as the ESS cost analysis and the integration of probabilistic nature of failures and multiple and/or cascading failures into the proposed method will be investigated in future work.

V. REFERENCES

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