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Voltage Regulation in Distribution Feeders using distributed control

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ABSTRACT: Today Distributed generation plays a vital role in providing electricity at the consumers end. when a large number of DG units are connected among loads may cause severe voltage regulation problem and the utility side voltage regulator might no longer be able to use conventional control techniques. But the smart grid provides new technologies to improve the performance of the network. Multi agent technology is used to provide decentralized decision making. The above technology is applied to construct a distributed control which has the capability to provide proper voltage regulation in smart distribution feeders. In this paper, a 16-bus distribution feeders system is modelled by real time simulation in MATLAB / Simulink in order to evaluate the effectiveness of the proposed scheme. The results shows the capability of the proposed system to regulate the voltage in a smart distribution feeders.

KEYWORDS : distribution feeders, DG

I. INTRODUCTION

Smart grid is an advanced system and which has sophisticated sensors and monitoring technology, two ways communications, and Distributed Generation (DG) units. Connecting the DGs in distribution level to power gridaffects significantly on the flow of power and voltage conditions, either positive or negative. The positive effects can be: 1) Voltage support, 2)Loss reduction 3) transmission systems and distribution systems capacity release and 4) improved utility system reliability. Traditionally, the transformer tapchangers (LTC). The line regulators, and the shunt capacitors are placed at the substations and distribution feeders to provide the proper voltage regulation. Having many DG units connected among the loads on mid voltage or low voltage feeders makes the controlling of these devices quite convoluted.

- In conventional power systems, the controlling of entire system is accomplished by Supervisory Control and Data Acquisition (SCADA). The hardware and software protocols designed is very essential to exchange the system and control signals.

In this paper, a proper distributed control for voltage regulation in distribution grid is presented. A controller for distribution feeders consisting of LTC, DG and load is designed in order to provide better regulation. It includes modelling the proposed controller by a real time simulation in MATLAB/Simulink for a 16-bus distribution feeders. The results shows how the proposed control scheme can regulate the voltage in the distribution grid.

II. IMPACTS OF DG ON LOCAL VOLTAGE CONTROL

The impact of DG units on the voltage profile and their interference with the local voltage control devices depend on the DG size, type and location,feeder parameters, and loading conditions.
a). Over voltage issue when voltage regulator keeps the secondary voltage constant.
b) Under voltages and over voltages when the voltage regulator uses LDC control and DG units are connected between the regulator and its target point.
c). Over voltages when the SVR uses LDC and DG units are connected after the SVR target point.
d). Excessive tap operation when the SVR uses LDC and the DG units are variable power sources

III. PROPOSED DISTRIBUTOR CONTROL STRUCTURE

The distributed control structure is designed in such a way that it consists of local control units which are known as agents and independent functional modules operating on their own data and perform operations by communicating with other agents. It can receive or send message to other agents . the overall goal of entire system is to

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disassemble a complex system into simple independent systems. The co-operation between agents based on the exchanged message through a communication infrastructure, can solve convoluted problems.
The proposed system consists of different agents like control, LDC, DGs, and load agent operation mechanisms and each of them has its own controller along with the capability to optimize its operation via local measurements and two-way communication act. The local controller receives data which can be either a local measured data from sensors or a message from other agents. The decision maker makes the proper decision based on the received information and the agent's objectives. Finally, the execution module carries out the decision to the actuator or sense it as an information package to other agent.

A. LTC Agent operation mechanism

Tap changer agent has two goals: the first one is keeping voltage in feeders within a standard voltage range by changing transformer tap. The other one is minimizing the number of tap changing operations to prevent excessive tap operations

B. DG agent operation mechanism

Same as the LTC agent, DG agent has two goals. First, is to keep voltage of its feeder within standard voltage range. Second one is keeping generation of DG unit Maximum. The deviation of voltage from the allowed voltage range in the

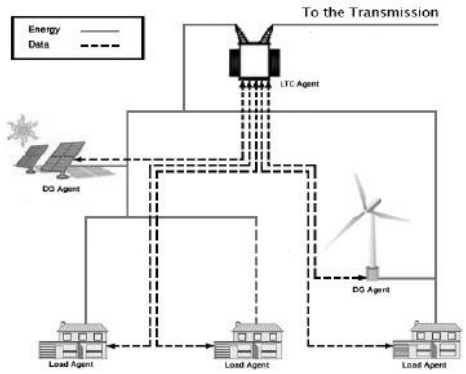

Fig.1.Proposed distribution control for distribution feeders

bus at DG unit connection point is sensed by a local measurement.

C. Load Agent operation Mechanism

The main task of the load agent is measurement of bus voltage at load point. so after receiving information from the sensors, it compares it with the allowed voltage in the bus to detect deviations from reference value, either over voltage or under voltage.

IV. SIMULATION RESULTS AND DISCUSSION

The 16-bus distribution feeders shown in figure. has been used to investigate the performance of the proposed two-way communication based distributed voltage regulation scheme.

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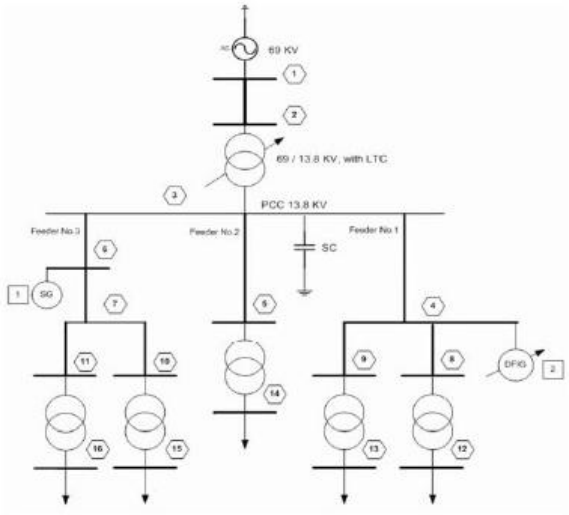

Fig.2. Proposed 16-bus system with DGs

The test system has been implemented in MATLAB/Simulink. The test system includes two DG units and a LTC transformer in substation. A 69/13.8 KV transformer with 32 tap is modified as LTC transformer. One of the DG unit is dispatchable and is modellled as a 1.5 MVA synchronous machine connected to bus 6. The other one is renewable energy unpredictable source and it is modelled as a 6 MVA DFIG wind turbine connected to bus.

The simulation is carried out in MATLAB/Simulink and the output waveform is shown below

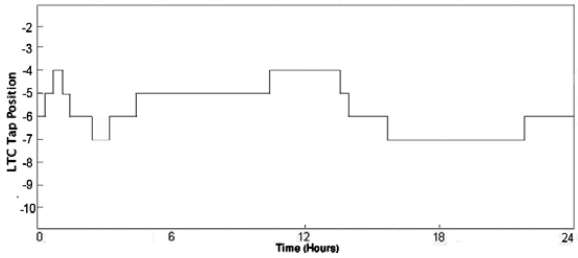

Fig.3.LTC Tap changer operation

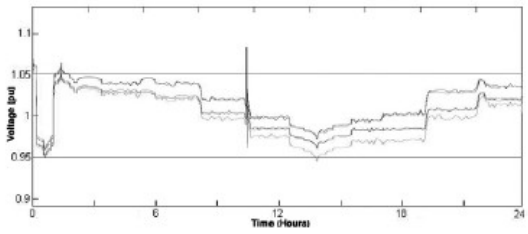

Fig.4.Voltage of the proposed system after regulation

V. CONCLUSION

The smart grid technologies will facilitate the two-way communication and also the application of multi agent control in future active distribution networks. a real time simulation has been done to show the capability of

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the proposed multiagent control structure in regulating the voltage by keeping voltage within standard range during 24 hours.

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