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REVIEW ARTICLE

REVIEW OF CHALENGES, ISSUES AND CONSTRAINTS OF MICRO-GRID TECHNOLOGY

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Abstract

Micro grid is the core technology of intelligent power grid security, reliability, self-healing and survival. However it can cause several technical problems in operation, control and protection due to many reasons. This paper presents some of the key issues of micro grid various challenges and constraints or difficulties. Various benefits of using micro grid technology are also highlighted.

I. INTRODUCTION

The micro grid is a miniature power supply, load and an independent control system to provide local power and heat. The autonomous operation of micro-grids is a very promising function in terms of reliability, security and power quality. There are numerous benefits of micro-grid system. Despite of this there are also many challenges and technical issues of its implementation and constraint its operation. This paper addresses different challenges associated with the operation of micro-grids in Section II. Section III highlights the benefits received from micro grid system. Section IV presents various key constraints or difficulties in micro grid implementation. Conclusions are drawn in section V.

II. TECHNICAL CHALLENGES

A. Voltage and frequency control:

Basic P-Q control is not applicable for integration of large numbers of micro sources into a micro grid and voltage regulation is necessary for local reliability and stability. Without local voltage control, systems with high penetrations of micro sources could experience voltage and/or reactive power oscillations. It is essential to insure that there are no large circulating reactive currents between sources while controlling voltages. The issues are identical to those involved in control of large synchronous generators. In the power grid, the impedance between generators is usually large enough to greatly reduce the possibility of circulating currents. However, in a micro grid, which is typically radial, the problem of large circulating reactive currents is significant. With small errors in voltage set points, the circulating current can exceed the ratings of the micro sources.

B. Islanding :

A micro grid with clusters of micro sources and storage could be designed to operate both in isolation and connected to the power grid. The main purpose of the islanding operation is to confirm the control performance of the energy management systems. During the islanding operation, it is necessary to maintain the balance between electricity supply and demand instantaneously. Because the governor control built into the gas engines is generally inadequate and slow, fluctuations are first dealt with at high speed by the battery inverter control system and then gradually taken over by the gas engines.

When the micro grid operates in isolation, load tracking problems will arise because micro turbines and fuel cells respond slowly and are inertia-less.

In island mode, problems such as slight errors in frequency generation at each inverter and the need to change power-operating points to match load changes must be addressed. Power versus frequency droop functions at each micro source can take care of the problems without the need for a complex communication network.

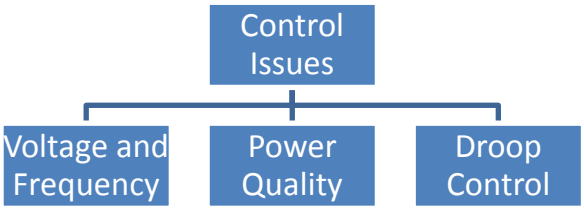

Fig. 1 Control issues

C. Droop control:

In droop control strategy, load dynamics are not directly included in the control loop. Thus, large and/or fast load changes may result in voltage/frequency instability. Moreover, the other shortcomings of the conventional droop control method include a tradeoff between power sharing accuracy and frequency/voltage regulations, slow transient response, and high dependency on the link filter impedance of the interfaced converter.

In order to overcome the drawbacks of the conventional droop control, a number of modified droop control strategies are required. For example method which integrates the droop method with the other controls strategies to provide good transient and steady-state performances. To achieve fast and accurate dynamic response, the load dynamics are also to be considered in the micro grid model. The load is modeled by a parallel RLC network whose parameters are within the pre specified limits.

D. Transient and stability concern during Transition:

Also when the micro grid separates from the grid, the voltage phase angles at each micro source in the micro grid change, resulting in an apparent reduction in local frequency. This frequency reduction coupled with a power increase allows for each micro source to provide its proportional share of load without immediate new autonomous functioning of micro grid is very important from reliability and quality point of view**.**

Fig. 2 Challenges

E. Protection

As micro grids add a significant number of electrical sources to a customer's system the protective relay design for micro grids must be different than that been used for grid distribution systems. Some of the differences are obvious; for example, once sources are added, energy can flow in either direction through protection system sensing devices. There are no two directional flows on most radial systems. A more subtle difference between micro grids and traditional grids is that micro grids will experience a significant change in short circuit capability when they switch from grid-connected to island operation. This change in short circuit capability will have a profound impact on the vast majority of protection schemes used in today's systems, which are based on short-circuit current sensing. The protection coordinator must respond to both system and micro grid faults. For a fault on the grid, the desired response may be to isolate the critical load portion of the micro grid from the grid as rapidly as is necessary to protect these loads.

F. Power Quality:

Both voltage and frequency should remain within acceptable limits to maintain power quality.

G. Issues associated with simulation and design:

Traditional methods of simulation and analysis are not finding satisfactory. New methods of analysis for 1 phase and 3 phase with modeling of grounding and bounding of system with 3 wire, 4 wire and 5 wire system are necessary. New software are required to develop.

H. Safety:

Distributed energy sources are operated at low voltages. However any fault on utility can generate high voltages. It is necessary that all generating sources are to be grounded and consider this grounding in modeling the system.

I. Unbalance/A symmetry:

Micro grid systems are heavily loaded with single phase loads and are also not symmetric due to distributed generating resources. These situations generate unbalance conditions which needs to control by different methods. Use of zig zag transformers, grounding with decreased impedance, placing neutral in symmetric locations with multi grounds, increasing size of neutrals. All these create need of modeling of system with 3 phase, neutral and ground conductors and grounding.

J. Plug in Play operation of DER:

This functionality is the feature for switching to suitable mode of operation either grid connected or island operation and capability to synchronize safely connected micro grid to main grid.

K. Electromagnetic capability:

The design and arrangement of circuits affect the level of electromagnetic fields. Since micro grids are nearer to users magnetic field effect of circuit will have significant effect on consumers electronics devises, monitors, space makers, flickering of displays, current distribution in another circuits causing local heating and health effects. These issues can be considered and rethought to provide good engineering practices. Analytical methods to address these issues are essential.

L. Stray voltage and current:

Due to a symmetry and unbalance micro grid systems stray voltages and stray currents are generated. Micro grids are in close proximity with end consumers and exposure to human is high. Design with common neutral which is grounded in more than two locations is require consider.

M. Integration of small scale renewable energy generation:

To realize the potential of integrating the distribution system with DER it is required to take a system approach which views generation, storage, protection and loads as an integral part of the distribution system. Such integration must not depend on fast, complex command and control systems. Each active component of the new distribution system must react to local information such a voltage, current and frequency to correctly change its operating point. This is not different than what is currently done on T&D system. Currently generation and transmission does not use fast centralized communication for load following, response to transients or faults.

III. BENEFITS

A. Power Quality:

Due to the increase in digital systems and sophisticated controls power quality has become utmost important for many industrial, commercial and residential customers. These customers are especially sensitive to momentary voltages sags caused by remote faults. Power quality, availably and reliability are important issues to all customers. This can be easily achieved if distribution and DER are well integrated. Micro grid gives solution to all these and power quality is enhanced significantly.

B. Energy surety:

Customers benefit from a Micro Grid because it is designed and operated to meet their local needs for heat and power as well as provide uninterruptible power, enhance local reliability, reduce feeder losses, and support local voltages/correct voltage sag. The pattern of exchange of energy services between the Micro Grid and the bulk power provider grid is determined by prevailing economic conditions

C. Energy efficiency:

Combined heat and power which produces both electricity and useable heat using distributed generation, can converts as much as 90 percent of its fuel into usable energy. This intrinsic efficiency and resulting environment improvements has enormous potential benefits to the power system.

D. Reliability:

DER has the potential to increase system reliability and due to the decentralization of supply. Increase in reliability levels can be obtained if DER is allowed to operate autonomously in transient conditions, namely when the distribution system operation is disturbed upstream in the grid. In addition black start functions can minimize down times and aid the bulk distribution system. Micro grid concept can provide the necessary high levels of power quality, availably and reliability required by the customer.

E. Combined Heat and Power :

Micro grid provides an increased opportunity to utilize the waste heat from conversion of primary fuel to electricity. The potential gains from using this heat productively are significant because about half to three-quarters of the primary energy consumed in power generation is ultimately released and unutilized to the environment. This will reduce fuel cost, carbon emissions and reduction in to environmental problem due to disposing of large power plant waste heat into the environment .

F. **Production of heat closer to the point of use:**

With micro grid fuel cells can be placed nearer to end user. Because electricity is more readily transported than heat, generation of heat close to the location of the heat load will usually make more sense than generation of heat close to the electrical load. The micro grid permits generators to be placed optimally in relation to heat loads.

G. Economic combination of waste-heat:

With micro grid the amount of heat production for individual units is small and therefore it offers greater flexibility in matching to heat requirements. A Micro Grid could be constructed from the most economic combination of waste-heat-producing generators and non-waste-heat producing generators so that the combined generation of electricity and heat is optimized.

H. Economical:

The micro grid may be able to operate some or all of its end uses at lower cost than would be possible on the grid. The cost of delivered energy from the traditional power system includes losses, customer services, congestion, and other costs that together typically exceed the generation (bus bar) cost alone. The micro grid will likely have smaller losses as well as other advantages that will lower its costs relative to the costs of the distribution system

I. Benefits to grid:

Micro grids can benefit the grid by reducing congestion and other threats to system adequacy if they are deployed as interruptible or controlled loads that can be partially shed as necessary in response to changing grid conditions. The power electronics in a micro grid could also be designed so it behaves like a constant impedance load, a modulated load, or a dispatch able load, to list a few. In addition, micro grids could provide local premium power and ancillary services, such as local voltage support, although the low voltage limits its ability to feed into the grid. If the micro grid had such features it could be considered a model citizen of the grid.

IV. CONSTRAINTS/ DIFFICULTIES:

A. Resonance:

A resonance condition can cause a current waveform to have zero crossings occur more than once every half-cycle the presence of harmonics because it is sensing a peak value that does not directly correspond
to the rms value of the wave shape. Other consequences are:

a) Disoperation of electronic equipment
b) Inaccurate meter readings and errors in measuring equipment.
c) Disoperation of protective relays
d) Interference with motor controllers and telephone circuits.

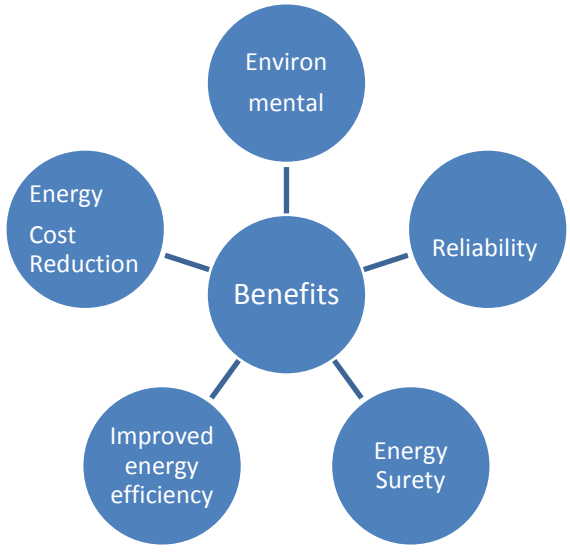

Fig. 3 Benefits of micro grid

B. **Communication interference:**

Magnetic or electrostatic coupling between electrical power circuits and communication circuits can cause communication interference. Current flowing in the power circuit produces a magnetic or electrostatic field that will induce a current or voltage in the nearby conductors of the communication circuit. The amount of interference will depend upon the magnitude of the induced current or voltage, frequency, and the efficiency of the magnetic or electrostatic coupling. Other types of communication interference are

a) Reduction of equipment operating reliability and service life
b) Induced line noise
c) Interference to communication systems, and sensitive electronic devices
d) Nuisance tripping to protection Relays and plant shutdown.

C. **Communication hardware**:

Local control without fast-centralized communication requires that each active component controls its reactive injection based on local voltage and has a power vs. frequency droop function to insure power balance when the parts of the feeders intentionally island during a disturbance.

D. Structure:

The constraint due to the part of the Micro grid structure include the interface, control and protection requirements for each micro source as well as Micro grid voltage control, power flow control, load sharing during islanding, protection, stability, and over all operation.

E. Economics:

These are problems that, at least at the distribution system scale, have received intense academic scrutiny; as a result, established and reliable tools are
available to guide operations and should, with some adaptation to the specifics of micro grids, be effective. The other concerns the relationship of the micro grid to the distribution system. In many ways these problems resemble familiar ones related to the interface between customers and utilities, for example, the need to provide a real-time price signal to the micro grid so that optimal use of resources by both the micro grid and grid can be achieved simultaneously.
Micro Grids' ability to participate in grid-scale ancillary services markets will most likely be limited by voltage and losses, but micro grids could still provide some local services, such as voltage support.
Creating a market for localized voltage support, or even placing meaningful value on it, seems unlikely at the present time.
Delivering true price signals in time and space raises some significant problems. Because Micro Grids embed new generation within the existing radial distribution system, system upgrades that would otherwise be necessary to meet growing load can be postponed or entirely avoided. Ideally a price signal could be delivered to customers within the distribution system at times of increasing congestion in a form that would encourage micro grid development and investment in generation and/or load control to mitigate the congestion.

V. CONCLUSION:

Micro grid can provide improved power quality and better reliability. Since different power systems have largely different characteristics, the issues raised by micro grid are also diverse in nature. The overall operation of the Micro grid is again a big challenge and researchers have to show a rapid growth in this area.

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