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Smart Distribution Coupled Microgrids

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Abstract: *Distribution system provides major opportunities for smart grid concepts. One way to deal with the problems of delivery systems is to reconsider our distribution system to include the integration of high level of distributed resources, using micro grid concepts. Improving the basic objectives improves reliability, high penetration of renewable sources, dynamic island, and better generation capacity through the use of waste heat. Managing important levels of distributed energy resources (DER) with a broad and dynamic set of resources and control points can be overwhelming. The best way to manage such a system is to break the distribution system into small clusters or micro ridges, coordinating the distributed optimizing control multi macro grids. Consortium concepts for Electric Reformation Technology Solutions (CERTS) look at the loads associated with cluster generation and grid processing or BMICrgrid. [Cluster sources and loads can be operated in parallel to grid or as an island. This grid can disconnect from the utility during processing events (i.e., defect, voltage collapse), but whenever the quality of the power falls below the grid, it can be intentionally disconnected. This paper focuses on the possibility of smart distribution system using the current state of DER-based distribution, the basics of micro grid, coupled micro grid and autonomic micrograph technology.*

Index Terms: *Consortium for Electric Reliability Technology Solutions (CERTS); cooling heat and power (CHP); clustered microgrids; distributed generation; intentional islanding; microgrid; smart distribution; uninterruptible power supply (UPS).*

I. INTRODUCTION

Economic, technology and environmental incentives are changing the face of electricity generation and transmission. Centralized generating facilities are giving way to small, more distributed energy resources partly due to the loss of traditional economies on the scale. Distributed Energy Resources (DER) includes a wide range of Prime Mower Technologies, such as internal combustion (IC) engines, gas turbines, microturbines, photovoltaic systems, fuel cells, wind power and AC storage. Most emerging technologies like microturbine, photovoltaic system, fuel cells, and AC storage have an inverter to interfere with the power distribution system. These emerging technologies have low emissions and the cost of discouraging traditional economies of capacity is low. Applications include high fuel efficiency through substituting power support, postponement of T & D upgrades, catching waste heat, utilizing renewable energy, high power quality and smart delivery system. Today's high voltage transmission network is reliable and controlled but cascading is suffering from failures. Its efficiency and utilization of resources is also poor. Due to the loss of the line and smoking stack waste heat, the central plants are 35% efficient. Approximately 20% of the generation demand exists to reach 5% of the time. These issues have been mixed with high penetration of renewable sources due to their constraint behavior. There is no hope of a radical change in the transmission network, but improvements through sustained growth can greatly reduce events such as the 2003 Blackout [1]. Distribution system provides major opportunities for smart grid concepts. Public policies related to global climate change initiatives, CO₂ reduction and other pollution emissions, and incentives for renewable energy, will raise issues related to delivery systems. Retail customers also require faster sophisticated energy service requirements which require higher power quality compared to the past. Need to redesign the distribution system to adhere to the high level of distributed energy resources create a smart and more flexible system. The basic objectives of a DER based delivery system have improved the generation capacity through reliability, high penetration of renewable sources, dynamic island, distributed control and the use of waste heat. To use the emerging variety of DER technology at critical levels of entry for distribution system, the original distribution pyridine needs to be re-considered. Management of such a wide and dynamic set of resources and control points can be overwhelming. The best way to manage such a system is to break the distribution system into small clusters or microgridges, coordinating the distributed optimizing control multimacrgrids. Microgrids are integrated energy systems that include embedded loads and distributed energy resources, because a system can operate in a parallel with a grid or intentionally in island mode. Dynamic islands are a key feature of a micrograph. For events such as flaws and voltage sags, they earn many benefits from this island's potential. Smart Islanding can increase value proposition for utility and customer [2]. This

paper focuses on the possibility of smart distribution system using the current state of DER-based distribution, the basics of microgrid, coupled microgrid and micrograph technology.

II. DER-BASED DISTRIBUTION

The use of DER in distribution system reduces physical and electrical distance between generation and weight. Bring the source closer to the load increase the voltage profile, increase distribution and transmission barriers, reduce loss, increase the use of waste heat, and contribute to deferred investment in the new transmission and large-scale generation systems [3]. Take Portugal as an example; The loss at the transmission level is approximately 1.8 to 2%, while the loss on the distribution grid is about 4%. This is the total loss of approximately 6% except the low-voltage network. Portugal's power consumption in 1999 was about 18 TW. This means that the bigger integration of DER says 20% of the weight, resulting in loss of at least 216 GWH losses. Therefore distributed generation can reduce the loss of 2-4% in the European transmission and distribution network, contributing 20 million tons to Europe contributing per year. A basic issue for DER is technical difficulties related to the control of a large number of distributed energy sources. For example, California could translate the distributed generation objectives to 120 000 one hundred kilowatt generators on their system. If you include renewable goals then the number of DER units is very high. This issue is complicated but the call is one for speedy sensor and comprehensive development in complex control . The fundamental problem with the potentially complex control system for the disaster is that failure of the control component or software error can bring the system down. In the distribution system, DER units should be able to respond to incidents from autonomy using only local information, i.e. voltage, current and frequency. Need to switch to DER Island operations with local loads for voltage droplets, defects, blackouts etc. This will require an immediate change in the output control of the generator because they meet the demands of the transmitted load mode as well as the transmitted power mode to a controlled frequency of the islands of the network. The two main advantages of DER-based distribution have increased capacity by using increased customer reliability through island during the reduction of waste heat and line loss and electricity system outage. The main roadblock is the system's complexities of managing such a wide and dynamic set of resources and control points.

A. Optimal Location for Use of Waste Heat

To use a waste heat, the use of waste heat through optimum location coordination or combined cooling heat and power (CCHP) is an integrated energy system, which provides both electricity and useful heat from natural sources such as natural gas. . Most existing power plants provide electricity to user sites at 28 to 32% of the total fuel-to-electricity efficiency of around 70% of the primary energy supplied to the central or distributed, consumer. Figure 1 indicates that the combined efficiency of 45% of a system, which independently produces heat by electricity and natural gas. It is compared to a CHP system for the same electrical and heat load. This CHP system efficiency is 85% [4]. To reduce the loss of energy, it is necessary to increase the efficiency of electricity and / or waste heat from the fuel of the generation plant. The size of the emerging distributed generation technologies can be better placed in the respect of the heat load. Level of production from individual level. The units are small and therefore provide greater flexibility in meeting the requirements of the heat. For example, to match the requirements of the hot water of each floor, fuel cells can be kept on every floor of the hospital and electricity can be provided to the electricity load of the hospital.

B. Power Quality and Reliability

Due to the increase of digital systems and sophisticated controls, many industrial, commercial and residential customers now require high quality power quality. These customers are particularly sensitive for transient voltage sags due to remote defects. Power quality, availability and reliability are important issues for all customers. Proposals have been made to create a more reliable power system using two-way command and control system [meters to meet customers' demands. This approach is complex and costly and if the DER is well integrated with the distribution system then it is not necessary. DER has the potential to increase system reliability and quality of electricity due to decentralization of supplies. Clusters of DER units and loads can be designed by the system for unrest, which provide the necessary level of power quality, beneficial and provide the required reliability by the customer. It has been found that, in the context of energy source security, many small generators are more efficient than relying on a large to reduce electricity bills. [5] Smaller generators are better at automated loads and help avoid large standby charges seen by sites using single generators. Having multiple DER units in a microgram is less likely to cause all-out failure, especially if

additional generation is available. DER-based distribution can be better organized using many connected building blocks or micro grid. Each microgram has cluster DER units and components with known characteristics are loaded. For example, the larger generation can provide real and reactive power to the power system on a known operating range, while the weight consumes the known real and reactive power. It enables the operation and control of the electricity system. MicroGrid is a new grid resource that provides or absorbs a known range of real and reactive power based on the details of its internal components. Unlike the generation or load, a micrograph can be transmitted uninterrupted between being a standalone island providing energy for a grid resource and local load.

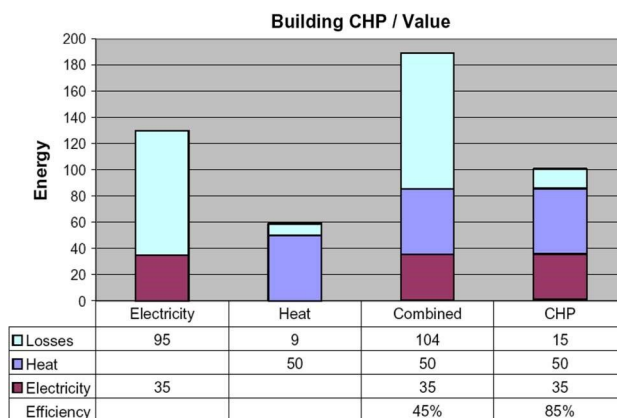


Fig. 1. Combined heat and power.

III. MICROGRIDS

The use of individual distributed energy resources, DER, can cause many problems as it can be solved. A better way to realize the emerging potential of distributed energy resources is to take a system approach to see DER and related loads as grid processing or beamicrogrid [[6)]. Can work in parallel to source and weight grid or as an island. It can provide the customer's important needs while providing services to delivery systems Microgrids can provide the following: • Increases the strength and increase of local load distribution system; • Upgradation facilities such as small air and photovoltaic systems; • Increase level of local reliability of energy efficiency and demand for customer load. Microgrid control is designed to facilitate an intelligent network of autonomous units. Microgrids have an interface switch, DER units and loads. Interfaces switch has the ability to autocomplete the island with disturbances such as errors in microdrudies, IEEE 1547 events or electrical quality incidents. After the island, after the tripping phenomenon no longer exists, microblogging re-connection autonomy is obtained. Each DER component can seamlessly control the power and provide the necessary energy for each load. In the island's micrograph, DER units use a power versus frequency drupe controller to track the energy requirements of the load. If there is insufficient generation then the frequency below the normal operating range that activates the frequency load shading will be reduced. The coordination between sources and loads in an ischy microgrid is through frequency [7]. In each DER unit a voltage controller provides local stability. Without local voltage control, the systems with high penetrations of DER can experience voltage and / or reactive power oscillations. Voltage control should also insure that there are no large circulatory reactive currents between the sources. For this, voltage vs. reactive power drup controller is required. These concepts are similar to the solid-state synchronous voltage sources used on high voltage power systems [8] Since the reactive power generated by the source becomes more capacitive, the local voltage set point decreases. On the contrary, the reactive power becomes more irreversible, the voltage set point increases. Figure 2 represents a bridge resource [or microgrid in which different types of loads, distributed energy resources and delivery systems include an interface switch. For example, the mixture of load contains both significant and noncritical Non-Critical can be dropped as needed. DER

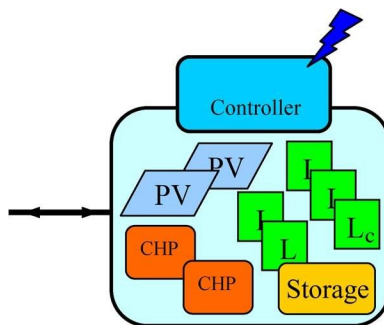


Fig. 2. Grid resource or microgrid.

the components include a wide range of electrical technologies such as IC engine, synchronous generator, gas turbine, microturbine, photovoltaic panel, fuel cells, wind turbine and storage system. Each DER resource has a different reaction time. For example, storage and some fast IC engines can respond in cycles while most of the micro-turbines require seconds to respond to the same load change [9]. These feedback times are important to give a successful response. It is important to keep DER units fast in order to insure the load requirements of the load, firstfewwks can be supplied during the aftershocks. Pharmaceuticals propodea buffer allows slow response sources to reach their operating points. The controller shown in Figure 2 provides overall system control. This controller interfaces with each DIR unit in microgrid. Its aim is to provide a distributed control system to coordinate the operation of multimicrogrid in the distribution system. This communication system is not used for the dynamic operation of microgrid. Faster dynamic requirements are provided through autonomous control over each DER units. This controller not only optimizes the internal operation of the micrograph, it can also respond to system requests for actual and reactive power flows between the microgram and the distribution system. Different micrograph objectives can be achieved based on the mix of DER units and loads. The three main possibilities are high power quality microgridges designed to export high levels of PV energy with the effective use of wastewater, multi-megawatt micrographs and micrographs.

A. High Power Quality Microgrid with CCH

Microgrid components must adhere to peer-to-peer and plug-and-play concepts to insure effective use of high power quality and waste heat. Each source is connected in a peer-to-peer fashion, in which a local control scheme is applicable for each component. This arrangement enhances the reliability of the system against master-slave or centralized control scheme. In case of master-slave controller architecture, failure of the master controller can compromise the operation of the whole system. Plug and Play concepts allow us to expand the microgram to meet site requirements without extensive redistribution. This means that microgrid can continue to operate with the loss of any component or generator. With an additional source, $\delta Np1P$, we can insure full functionality with the loss of any source. The plug-and-play model provides the facility of keeping the generator near the heat load, which allows more effective use of waste heat without the complex heat distribution systems like steam and cooling water pipes. Dispatchable microscuts, such as small variable speed internal combustion engine, require an inverter interface to run a synchronous generator or microturbine. To reduce the effect of source mobility on the microgram operation, sources need a fast response energy storage module, [10]. Storage battery can be

Or supercapacitors which are connected by the DC bus of each source. DC storage has many advantages over AC storage. First of all, the DC storage decouples the dynamics of a source from a microgrid source. Second, DC storage promotes peer-to-peer concepts, where each source contains the necessary energy storage for fast dynamic response and it is not dependent on central AC storage system. This modularly promotes high reliability because the loss of a storage module does not have significant impact on the operation of micrograph. In contrast, the loss of central AC storage system can greatly reduce the efficiency of the micrograph. High power quality micrographs have been successfully studied in AEP / CERTs microgrid test facilities [11].

B. Multi-MW Based Microgrid

At the high voltage and power level, microgrid technique scaling transforms the DER mixture. Higher power quality applications are less practical based on peer-to-peer models and inverterbase interfaces. Inverters are prohibited in comparison to other options at several MW level. It is preferred to operate the synchronous generator directly connected to the micrograph [12]. In this case, the governor and the exciter need to modify to comply with the CERTs micrograd criteria. Decrease response time is. Generally the reaction of the synchronous generator is very slow to support the seamless archipelago. Using a directly connected synchronous generation, a micrograph will also need an inverter-based energy source to support the archipelago. There are three source energy sources requiring an inverter interface. They are fuel cells, AC storage and photovoltaic array. Fuel cells are basically defined source systems which require large DC storage to support the island. The photovoltaic array responds rapidly, provided it is solar energy, but is required for micrograph by using directly connected synchronous generator in normal AC storage. The simplest distribution microgrid contains many directly connected synchronous generators and AC storage. AC Storage provides the fast electricity changes required for island and load tracking. Generators provide base load power. In this model DER units still adhere to the plug-and-play and autonomous control model, but the loss of AC storage can prevent uninterrupted islands.

C. PV Microgrid

At present, relatively few entry levels of renewable systems create some problems. As soon as admission gets greater, the availability of the sun becomes a major problem which requires the generation of electricity to the central generation. Such systems are temporary and can be combined with interval loads such as rolling mills and arc furnaces to cause problems of similar stability. Central generation or DER units are required to facilitate power fluctuation from these renewable sources. In any case when there is no sun then the stock is required. A clear solution includes DER units on distribution systems. Without it
Laterer: Smart distribution: Coupled microgridges Volume. 99, Number 6, June 2011. IEEE 1077 proceedings There is a technical limit for storage and / or PV generation on the local generation distribution system. The system of high level of PV entry should be supplemented with resources like storage and local generation to fill local BD spreadable [for temporary loss of solar energy]. PV micrographs can be designed for high export of PV energy without short-term problems related to temporary power fluctuation. DIR units in a PV micrograph can have multi-roles such as control of the actual and reactive power flows between the microgram and the distribution system, when the generation of electricity is not available and the local load is supported during the island, the electricity is filled. Generally, a PV micrograph has photovoltaic energy for export, local generation and / or storage. Generates energy and filling energy required to make the power provided to the generation and size distribution system. Inverter-based AC storage allows the generation to connect directly to the micrograph without the inverter. If the storage is not used then the generation needs a faster response provided through the inverter interface. There are special issues in the island of PV micrograph. For example, PV power level in a PV microgrid can be higher than loading. For this to absorb the extra energy, there is a need for high storage capacity or ways to reduce the generation of solar panels. Power vs. Frequency Drup Controller provides an elegant way to support solar production during low load archipelago. An extra generation island will experience an increase in frequency, which reduces the generation of autonomy from generation to generation, runs storage in a charging mode, and essentially leaves behind PV output easily.

IV. SMART DISTIBUTION

Smart distribution can be obtained through the fast control of hundreds of individual DER units. For this, real time information will be required on each DER unit and key load. Control complexity and reliability of such a system by using coupled microgrids greatly reduces. Firstly, systems with several micrographs do not require fast communication as discussed above and are displayed on the AEP test site. Any other communication system will again transmit each micrograph without the need for detailed information on each DER unit. Remember that the basic smart distribution system's objectives include better reliability, self-treatment, simplified control and increased generation capacity through the use of waste heat. Better reliability, simplified control, and increased capacity are included in basic micrograd grid or as an island. It can be disconnected from the utility during the events (i.e., defect, voltage collapse), but can also be intentionally disconnected when the quality of the power from the grid falls below some standards providing high standards and is beneficial for these weights. Is available as a form Within the island Clustering of loads and sources inspires capacity due to the low loss and ability to use waste heat. Control complexity problems are reduced by controlling them to send microbridges to all DER units. The number of a

micrograph and the type of DER units is no longer relevant to the transmission of its resources. For example, in a conventional model, a control center transmits the actual and reactive power output of each generator to meet the expected demands of load and can reduce the load in some situations (i.e., Smart Load). Microgrid is a separate grid resource that provides or absorbs a known range of genuine and reactive power based on micrograph details. A micrograph can respond in response to a request for load reduction by closing its internal generation and / or any significant load. It is important to implement smart distribution concepts, there is information on the range of actual and reactive power available for transmission from each micrograph. A PV microgrid can get requests for all the available renewable energy. To portray a multi-MW microgrid potential self-treatment imaginable connected to a 12 KV substation using a quick interface switch. There are several low-voltage high-power quality microgrids with this microgrided fast interface switch. This example assumes that only control over each DER unit and interface switches are autonomous algorithms. The simplest MW micrograph can include many synchronous generators and storage. Low voltage, high power quality microgrids will usually be a faster inverter-based source. Each source is connected in a plug-and-pea fashion with a peer-to-peer and autonomous control. The multi-megawatt microgrid island will be with the opening of the voltage collapse interface switch on delivery substation. The storage unit will supply the lost energy within a few milliseconds, the synchronous generators slow down their output. In the end, in the collaboration with the storage generator, it will revise its production autonomously. Island system will be arranged at low frequencies based on electric versus frequency drupt characteristics. Two other interface switches will open either on the original event or this frequency duplex. With rapid changes in the generation of electricity, this fast islanding provides the power of uncontrolled power supply (UPS) quality to low voltage load. If the multi-megawatt microgrid does not have enough generation to support all its loads then the frequency will continue to trigger the load shedding of low priority loads. In the new stable state, there were three related microscopes which supported their related load. When the substation voltage becomes normal, the multi-megawatt microgrid interface switch re-connects with the utility that returns its frequency to the utility. This frequency change will allow two other microgrids to re-connect autonomy distribution microgrid. In essence, this example shows self-treatment and improved reliability features through the use of coupled microgrids.

V. STATUS OF AUTONOMOUS MICROGRIDS

The complexity of the coupled micrographs in the autonomous control concept distribution system implemented on DER units can be very simple. Current testing sites have demonstrated the feasibility of using microgrids as a grid resource. It is meant to configure each DER component with the same autonomous control features that promote this plug-and-play app. These concepts have been applied to two test sites in the hardware. In addition, two field sites are now under construction. The CERTs / AEP microgrid test beds in Ohio are actively testing CERTs concepts in the last five years. Testing involves islanding and reconnecting for many configurations, power quality performance and security strategies. Some important outcomes in Section VI have been discussed in more detail. University of Wisconsin has a micrograd testing facility. It has a low voltage system with a mix of different DER units with a rating of 15 kW or less. This system has successfully displayed an Invertbase microgrid with a smart switch. As part of the UW micrograph, battery storage has been successfully demonstrated in the last two years to include directly connected synchronous generation [13]. A multi-megawatt microgrid is being constructed in Almeida County, CA. This system will integrate AC storage, diesel generator, photovoltaic array, fuel cells, and wind turbine. The original feeder is at 12 KV, which is close to 3 MW of extreme weights. Chevron Energy Solutions is the leading contractor. Sacramento Municipal Utility District, (SMUD) is establishing a high powered quality microgrid with its CHP at its corporate headquarters. SMUD expects to collect electrical quality and CHP data for many years. Base load is 310 kW with a peak of 375 kW. This system will use the three techonic premium power modules rated at 100 kilowatts, along with the CHP and thyristor-based interface switches.

VI. CERTS/AEP MICROGRID TEST-BED:

The CERTs / AEP microgrid test beds are shown in Figure 3. Loads and three feeders with three 60 kW inverter based sources. Two sources are on a feeder, with a third on parallel feeder. There is also a feeder outside the stationary switch. The feeder with two sources has a distance of 100 yards of cable between sources, which impedes plug and play and barrier to verify local stability features. These two feeders can be used by the utility using the stable switch. Fixed switch hardware includes back-to-back thirists with local implementations of CERTs microgrid islands and local synchronization processes. There are four load banks, which can be controlled remotely from 0-90 KW and 0-45 KVAR. There are also remote fault loads in each load bank, which have high impedance defects (60 and 83 kW) from bolted defects. Other loads include 20 HP induction motor. Additional equipment included; Safety relay, shunt trip breaker and a comprehensive digital acquisition system.

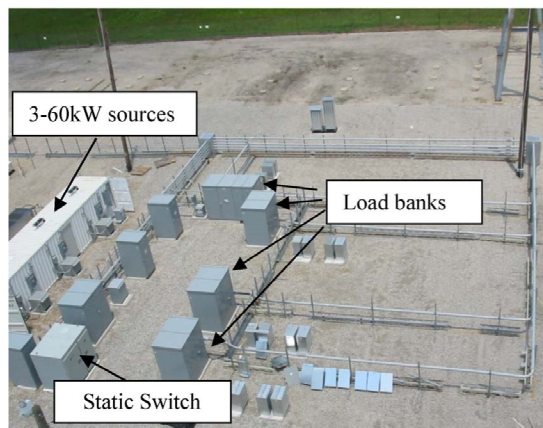


Fig. 3. CERTS microgrid test-bed (AEP's walnut site).

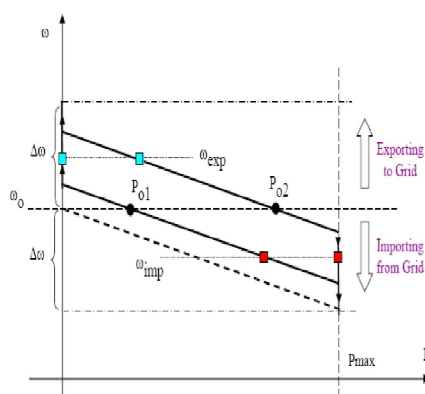


Fig. 4. Steady-state power versus frequency droop.

This process system consists of twelve 7650 ION meters which provide wide voltage and current waves for each stage conductor including neutral. When the microgrid is connected to the utility, its power grows stronger than both the grid and local DER units. If the grid power is lost due to IEEE 1547 events, voltage sags, defects, blackouts etc., then microgrid autonomy will be transferred to the island operation. Figure 4 shows power versus frequency drops for two of the three sources. The slope for AEP is chosen by allowing it to fall to 0.5 Hz because the power extends from zero to maximum output. Figure 4 also shows the Power Set Point P_{o1} and P_{o2} for two units. It represents the power transmitted by each unit when connected to the grid. If the system is transferred to the island while importing from the grid, then the generation needs to increase the power generation to replace the lost power from the utility. The new operating point will be at a lower frequency than the nominal value. In this case both sources have increased their power output to their maximum power point with Unit 2. If the system is transferred to the island while exporting the power to the grid then the new frequency will be higher as compared to the low power generation from the sources. These concepts are displayed in the three major tests shown in Fig. 5-7 The first case sees two sources on the same feeder during the island [14]. The effectiveness of sharing this case loading load and the power of maximum limit are displayed. The second test shows smooth reactions to three sources during the island. The final test demonstrates the high level of power quality achieved by using autonomic micrograph concepts. The features shown in Figure 4 are stable-state specifications. They have a certain slope in the area where the unit is operating within its power range. As soon as a limit reaches, the slope becomes vertical. The droop is the location of the stationary-station operating point, but during mobility, the projection will be distracted by these characteristics.

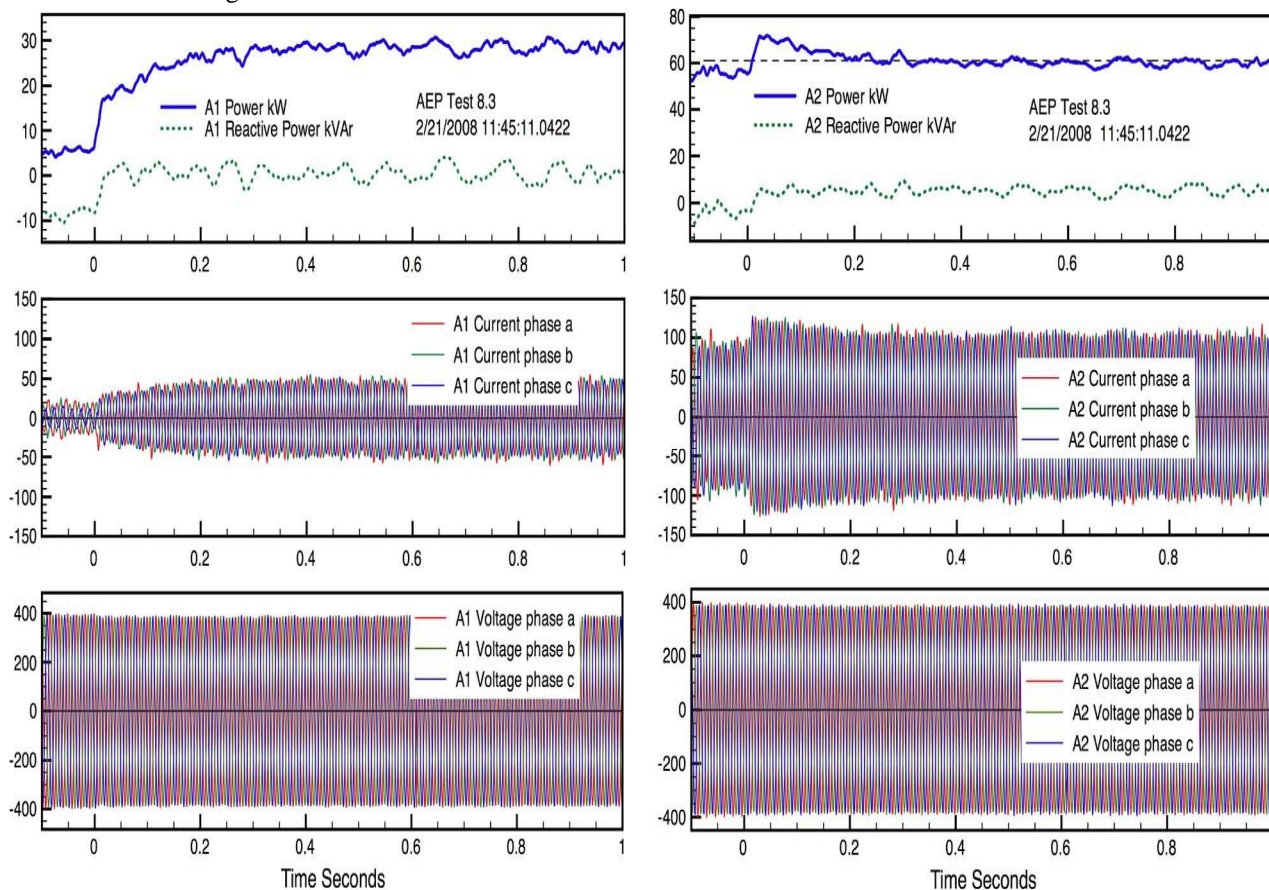
Fig. 5. (a) Dynamic response of unit A-1. (b) Dynamic response of unit A-2.

The dynamics of frequency drops are shown in Fig. 5. This figure shows the reaction of two sources during an island event. There is no communication between the two units in this system. Before the island both sources are connected to the AEP system. The real power output of A1 is 5 kW and the reactive power (capacitive) 9 kVAR is close to Figure 5 (A). Three phase streams from the source are shown in the middle plot and display the voltage in relation to the lower conspiracy feeder. Figure 5 (B) mark is

measured on unit A-2. A-2 is 55 kW and there reactive power (capacitive) power output of is close to 5 kVAR before the island. Imported grid-related microgrid import implements 32 kilowatts from the utility. After compensation for two units to lose the grid power independently after the island. A-2 overhauled its steady state

Maximum of 200 kilograms for less than 200 million. Control retreats from generation because the unit enhances its output to meet its share of A-1 load. The new stable state operational point for A1 is 29 KW and A2 is 60 KW. Note that the reactive output is greatly reduced. Voltage dimensions are stable through the archipelago phenomenon, which exhibit inductor voltage and stiffness of microgrid stability. Figure 6 shows microgrid islands with three sources working in unit control mode. There are three loads each drawing 37 kilowatt and 20 kVAR. According to the grid load, provides 22 kW with the source providing 89 KW of the required. The top plot in Figure 6 shows the imported power through the steady switch and the power provided by each source. This island event displays the mobility of sources because they lift the lost power from utility. In this figure three other plots are the streams provided by each of the phase-three streams. The voltage on each source is constant and has not been shown. The power sharing displayed in this test is contained in the CERTS concept. The answer to a Power

Quality Event is shown in Figure 7. This phenomenon appears as a ground fault on stage-A-Phase-B utility. The depth of voltage greens is light and the duration is short. The reason was either a temporary accident like a tree contact or a distant mistake, which was cleaned by downstream reclosures. There is no upstream distribution protection device operated to overcome this mistake for our knowledge. As a result of this mistake, the distribution supply for 100 ms was 83% voltage SAG between phase A and B, see the top voltage plot in Figure 7. The middle voltage plot shows the high quality of the voltage of the load during this event. The reaction of the stable switch shown in the lower current plot indicates the opening time of approximately one cycle. The purpose of the CERTS microgrid lab test bed project was to demonstrate the ease Fig. 5. (a) Dynamic response of unit A-1. (b) Dynamic response of unit A-2. of integrating distributed energy sources into a micrograph. It includes autonomous sources with peer-to-peer and plug-and-play functionality. The tests demonstrated stable behavior at key operational points and reconnected to the island's capacity and grid in an autonomous manner. Expected all tests and high level of robustness demonstrated. Fig. 6. Response of three sources to an islanding event.



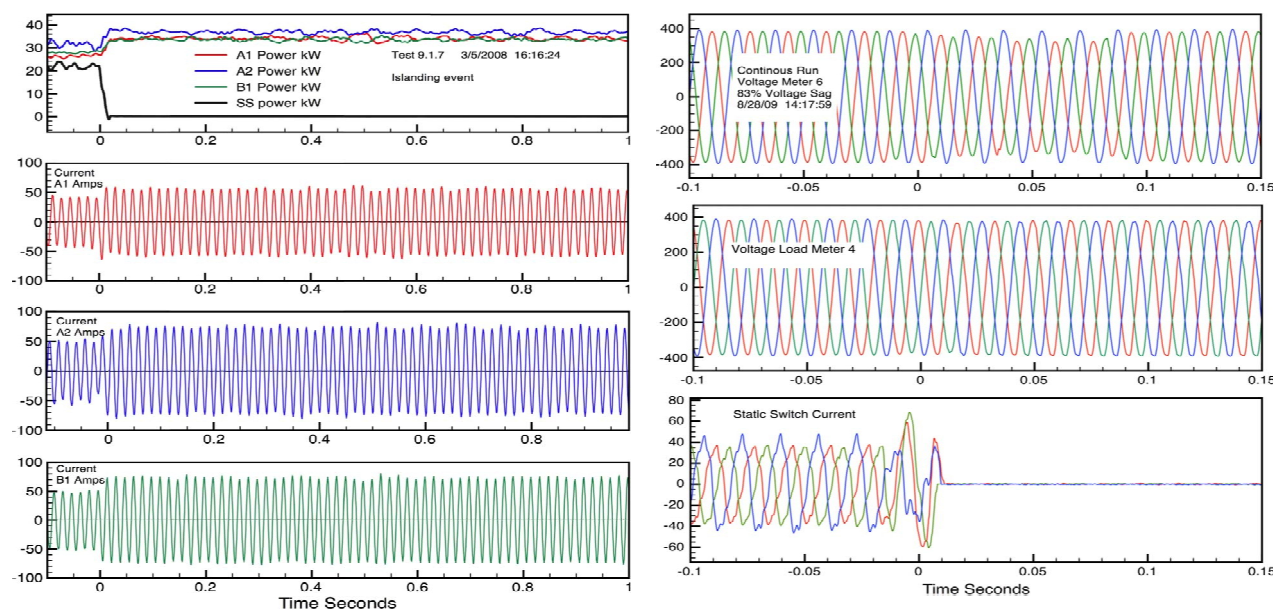


Fig. 6. Response of three sources to an islanding event.

VII. CONCLUSION

Using a variety of DER units with a sophisticated command and control system, one option of smart grid concepts is to build on microgrid concepts. The use of many microgrids in the delivery system looks simple. Many BSSMAR grids (functions like high reliability, high penetration of renewable sources, self-healing, active load control and better generation capacity through insufficient heat utilization can be implemented using coupled micrographs). Microgrid technology is maturing at this point that it is possible to use the PV sources to form a full range of microgrid functions with high power quality. To achieve the desired BSMART grid [Objectives], the need to act on the way to transmit many microgrids in the distribution system.

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