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TECHNOLOGY ISSUES IN MICROGRID SYSTEM

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Abstract--* *This paper provides an overview of the Microgrid paradigm. This includes the basic architecture, key feature, benefits and challenges to its adoption. The accelerating installation of variable renewable generation has made the need for a revised electrical system design more pressing. Based on specific configurations, appropriate rules and regulation will then need to be developed. The Microgrids can meet the cost, efficiency, and environmental benefits; and the demanding requirements for security, quality, reliability, and availability (SQRA) benefits of on-site generation, achieved by incorporating modern controls and operating with a degree of autonomy. Microgrid is useful in different field like defense, research and commercial purpose. In this paper Microgrid dream house concept is included and try to explain the benefits of that. Microgrid network topology is also included with its various components. Revenue by region is included in this paper and try to explain with the help of figure.

Index Terms; Microgrid, Renewable energy sources, Power grid, Ancillary services.

I. INTRODUCTION

Microgrids are modern, small-scale versions of the centralized electricity system. They achieve specific local goals, such as reliability, carbon emission reduction, diversification of energy sources, and cost reduction, established by the community being served. Like the bulk power grid, smart microgrids generate, distribute, and regulate the flow of electricity to consumers, but do so locally. Smart microgrids are an ideal way to integrate renewable resources on the community level and allow for customer participation in the electricity enterprise [1].

The U.S. Department of Energy (DOE) Microgrid Exchange Group defines a microgrid as “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.”

A microgrid is a semiautonomous grouping of generating sources and end-use sinks that are placed and operated for the benefit of its members, which may be one utility “customer,” a grouping of several sites, or dispersed sites that nonetheless operate in a coordinated fashion. The supply sources may include reciprocating engine generator sets, microturbines, fuel cells, photovoltaic and other small-scale renewable generators, storage devices, and controllable end-use loads. All controlled sources and sinks are interconnected in a manner that enables devices to perform the microgrid control functions unnecessary for traditional DER. For example, the energy balance of the system must be maintained by dispatch, and non-critical loads might be curtailed or shed during times of energy shortfall or high costs. While capable of operating independently of the microgrid, the microgrid usually functions interconnected, purchasing energy and ancillary
Services from the microgrid as economic, and potentially selling back at times[2].

II. MICROGRIDS INSTALLATION

Originally the idea was to improve reliability for specific customer and critical loads. Today, microgrid can be installed to provide better reliability, improve dispatchability of a customer’s load, firm up variable generation, try to reduces losses of electrical energy and control energy costs.

Three key potential features of the Microgrids are:
1. Its design around total system energy requirements
2. Its provision of heterogeneous level of power quality and reliability to end-uses
3. Its presentation to the macrogrid as a single controlled entity

III. THE MAJOR BENEFITE OF MICROGRIDS

- Providing energy services tailored to the requirements of microgrid end users, such as service continuity in time of main grid outage and increased renewable generation.
- Operation more efficient and reliably within the microgrid, as compared with dedicated backup generation in a classical microgrid model [3].

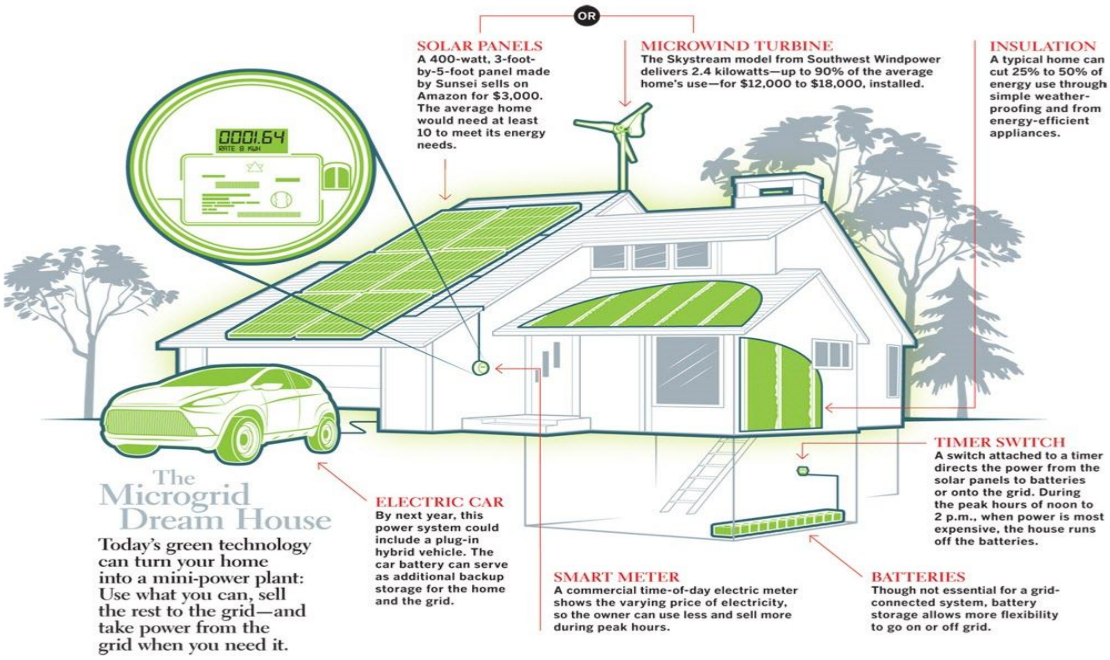

Fig 1. Microgrid Dream House (Source: Google)

- Enabling parallel operation with the main grid for improved financial performance through economic exchange of energy and ancillary services between the two.
- Enabling parallel operation with the main grid for improved service reliability through coordinated response during emergency situation to serve critical loads and to reduce outage impacts.
- Enabling innovation in new energy technology and services that have broad societal impact beyond local energy delivery [4].

IV. ONGOING MICROGRID ACTIVITIES

The bulk of the Department of Energy's microgrid R&D effort to date have focused on demonstration activities to meet niche application needs, such as those for meeting peak load reduction, renewable energy mandates and directives, and wnwrgy surety and reliability at certain critical facilities, including military installation[5]. These ongoing microgrid demonstration projects consist of lab and field scale R&D test beds, renewable and distributed systems integration projects for peak load reduction, select Smart Grid demonstration program projects funded under the American Recovery and Reinvestment Act of 2009 as part of office of Electricity and Energy Reliability implementation of grid modernization, and assessment and demonstration projects jointly supported by the U.S. Department of Defense and the Department of Energy's.

V. MICROGRID OPERATION AND INVESTMENT

Microgrids with power generation capacities of 10-50 MW, microgrids are usually intended for the local production of power with islanding capabilities and have capacity available for sale back to microgrids. A typical microgrid portfolio includes photovoltaic (PV) and wind resources, gas-fired generatio, demand-response capabilities, electrical and thermal storage, combined heat and power (CHP), and connectivity to the grid. Advance technologies such as fuel cells may also be included. The value of a microgrid portfolio depends on its projected return on investment and the potential growth in its operating income [6].

For a portfolio of financial assets, valuation are based on projections of the market prices, industry trends, and futures prices as a basis for the projections. For a microgrid, the investment payoff is directly linked to the operation of the physical assets, and return on investment depends on how these operation will be optimized and utilized in the short term. The long-term value of a microgrid depends on when investment were made and also on the amount of the investment and its fainancing costs[7]. Grid energy and fuel costs, the prices of the necessary technology (e.g., PV equipment, wind turbines, or storage), state incentives, and parameter such as finance charge rates, finance terms, and the relationship between the finance rate and the discount factor could all affect the optimal investment decision.

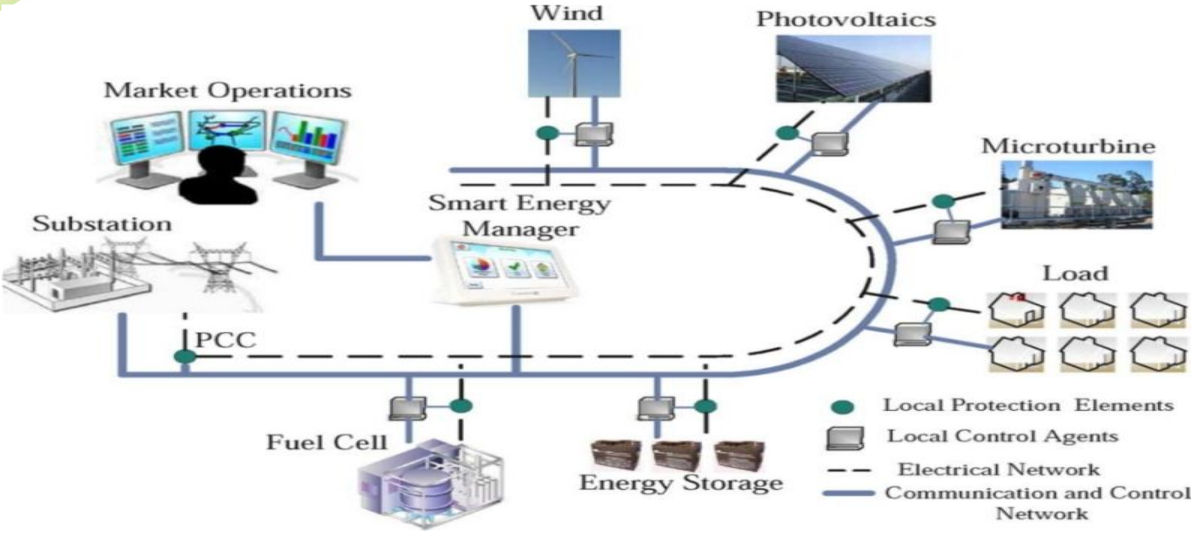

Fig-2 Microgrid Network Topology (Source: Google)

VI. THE FUTURE OF MICROGRIDS

Participation in the capacity markets and ancillary services markets are attractive revenue streams for microgrids. Inclusion of ancillary market commitments in day-ahead and intraday operations is a well-understood problem; the mathematics is very similar to that used for the co-optimization that independent system operator (ISO) market operations practice when scheduling grid resources today[8]. As with ISO-level market operations, incorporating significant storage in the formulation and obtaining co-optimized solution are challenges. Incorporating ancillary participation into investment decision is more complicated, however, as bidding strategies come into play. In the examples shown above, the microgrid is a simple "price taker" in the market that optimizes its resources once market prices are known. But to participate in the ancillary markets, the microgrid operator must make informed dicisions about what ancillaries and what energy to offer the markets as a bidder. This complicates the decision process and the investment decision required to enable that participation.

There is also interest from very large facility operators in co-optimization energy operation across multiple microgrids. This is an area being intensively investigated at Rutgers [9].

VII. CHALLENGES TO MICROGRID ADOPTION

Utilities have been reluctant to endorse microgrids. The valid historical argument has been the safety concern of unintentional "islanding", that is, a part of the grid that has become separated from the grid but not shut down during a black out. The safety concern is that unintentional islanding can be dangerous to utility workers, who may not be aware that a circuit within the "island" still has power. Secondly, islanding may prevent automatic reconnection of devices into the grid. Existing grid protocols address this concern in that they dictate that all distributed power generation must shut down during power outages [10]. To address these concerns, new inverter technologies are designed to integrate renewable energy sources such as solar and wind while allowing safe operation in island mode. Another challenge has been the lack of established standards for microgrids. A positive step in addressing this was the 2011 adoption of the Institute of Electrical and Electronics Engineers (IEEE) standard P1547.4, "Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems". The standard provides best practice guidelines for implementing different ways a microgrid can island and reconnect, all while seamlessly providing power to users of the microgrid. Another step in creating standards is the establishment of the Consortium for Electric Reliability Technology Solutions (CERTS) in 1999. This group consists of national laboratories, industry, and universities that collaborate on research and develop technologies to protect and enhance the reliability of the U.S. electric power system, including furthering the development of microgrid designs[11].

Three barriers have prevented the wider and more rapid deployment of microgris. First, microgrid developers have to persuade their customers, microgrids exceed the costs. In the electric area, it is hard to obtain an accurate assessment, and even when it's available, that assessment is difficult to understand [13]. The host institution typically is not in the electricity business. It requires an unusual degree of leadership for a major healthcare, education, or housing provider to understand the benefits and then make the decision to secure them by deploying a microgrid. It is no accident that many of the early microgrids were deployed by universities with significant internal expertise in engineering and the hard sciences.

Fig-3 Revenu by Region (Source: Google)

There are four key components to any effective microgrid solution.

1) Robust telecommunications with relatively low latency and high bandwidth capability.
2) High-speed data processing to enforce interconnection rules.
3) Monitoring and control system to communicate instruction to devices.
4) Sophisticated cyber security to protect the integrity of the control system and confidentiality of the participants.

VIII. NEXT IN MICROGRIDS

Although the technical immaturity, utility reluctance, and current cost structure of microgrids will limit their application to niche markets in the short term, the future for microgrids is promising. Power equipment companies now investing in pilot microgrid projects and currently available market opportunities will be well positioned for market leadership as the demand for microgrids increases over time. However, perhaps the largest benefactors of microgrids will be foresighted utilities, communities, industrial parks and the like, that will leverage microgrids to optimize their energy costs with the added bonus of generating revenue opportunities by selling energy back to the grid during periods of peak demand. There are one more important factor is that transmission losses in the transmission line should be less and in microgrid it is considered that losses will be reduced [14].

IX. CONCLUSION

The microgrid concept has been in existence for some time, but technological and cost factors have prevented its implementation on a large scale. More research needs for a revised electrical system design more pressing. More research needs to be done in the areas of variable generation, storage, and system control, including their interactions. The many demonstration project now underway will help direct the continuing evolution of the electrical grid. The work has begun at SCE, but there is still a long way to go.

Meanwhile, in the city the storm is starting to pass. The sun is rising. Utility crews have been out all night repairing damage to the electrical system. But many customer are not even aware that there was widespread storm damage to the electrical system, since their lights and heat never went out. This is one possible vision of the future for microgrids.

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XI. BIOGRAPHY

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