International Journal For Technological Research In Engineering
Volume 7, Issue 9, May-2020 ISSN (Online): 2347 - 4718

IMPLEMENTATION OF NANOGRIDS FOR FUTURE POWER SYSTEM

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ABSTRACT: Microgrid is a new technology in power generation and this system is used to provide power and heat to its local area, such as cogeneration systems and renewable energy (wind turbines, photovoltaic cells, etc.). They are preferred for medium or high power applications. Nanogrid most likely to be used in small local loads for rural area as they will be more economic then the normal grid power system. Nano grids can operate independently or be connected to the mains and most likely the internal voltage can be utilized as ac or dc. In this research paper a small scale microgrid system is proposed for smart homes called "Nanogrid". Each houses have small electrical power system from them can be shared among houses. If it uses a DC system instead of a general AC system, it can reduce energy loss of inverter because each generator doesn't need an inverter. Furthermore, it can continue to provide a power supply when blackout occurs in the bulk power system. A model of a nanogrid is developed to simulate the operation of the centralized power control. Finally a Simulink model is presented for small houses power range 90-285 KW.

Key words: Nanogrid, microgrid, cogeneration, energy storage, nanotechnology, centralized power system

I. INTRODUCTION

A HIGH penetration of renewables requires profound changes to the current grid system [1]. Indeed, the conventional ac grid system is a rigid architecture built around centralized fossil fuel or nuclear power plants that distribute energy over long transmission lines, substations, and distribution network before arriving at the end users. The conventional grid is increasingly becoming a bottle- neck for expanding the share of renewables. Most promising renewable sources like solar and wind are geographically distributed (distributed energy resources—DERs) and often depend on weather or environmental condition. However, dis- tributed generations (DGs) cause problems such as voltage rise and protection problem in the utility grid [2]. The vari- ability and intermittency in power output are posing a serious issue for managing the demand-response requirements for electricity networks. This is especially true as plug-in hybrid electric vehicles (EV) add a large stochastic load onto the system [3]. Large and fast energy storage units (most promis- ingly Lithium-ion batteries [4]) are needed to handle the transient mismatch of generation and consumption. To propose solutions for these challenges, a wide range of new energy grid systems, often grouped as smart grids [5], are now emerging. Though there is no standard categorization [6], we define three main approaches: 1) microgrid; 2) nanogrid; and 3) virtual power plant (VPP). Microgrids are promising solutions for integrating large amounts of micro-generation by reducing the negative impact to the utility network [7]. In general terms, microgrids can be defined as structures that combine DG units, energy storage systems (ESSs), and loads [8]. Microgrids including batteries allow to shift peak demand and flatten the consumption pat- tern. While their architecture may vary greatly depending on the type or number of building blocks as well as the application context [8]–[10], a clear distinction can be drawn between ac and dc-based microgrids. Justo et al. [8] concluded that even though ac microgrids are now predominant, the number of dc microgrids is expected to increase in the coming years as they will soon be the right candidates for future energy system. Nanogrids can be seen as smaller and technologically sim- pler microgrids, typically serving a single building or a single load. As they face less technical and regulatory barriers than their microgrid counterparts, substantial deployment is already undergoing [11]. This is why compared to microgrids, nanogrids are often seen as a bottom-up approach, well suited also for off-grid areas and with a clear preference for dc solutions [11].

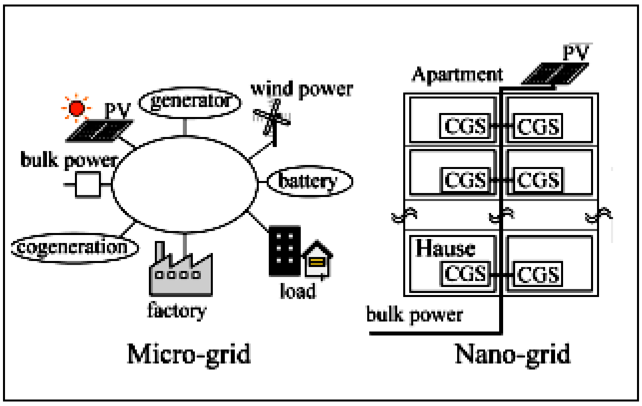

Fig 1 : Microgrid and Nanogrid System

The main grid consists of wide area and microgrid cover medium area and utilizes the alternative energy resources. The Nanogrids consists of devices and used its own power system such as PV solar cell and heating system. The microgrid systems are the focus of research all over the world the sharing of electronic power and heat (CHP) system. The microgrid system consists of distributed generators such as cogeneration systems and renewable energy systems (wind turbines, photovoltaic cells, fuel cell etc.). The concept of Nano-grid is that at small scale we select houses around 50-150 houses and the each house has its own PV cells or a fuel cell cogeneration system as shown in figure 2. The outputs of all distributed system of generations are connected to the distribution line, and the electrical power can be borrowed and lent among houses through the distribution line.

However, to prevent both power outages and wasting generated electricity, most microgrids/nanogrids include a utility grid connection.

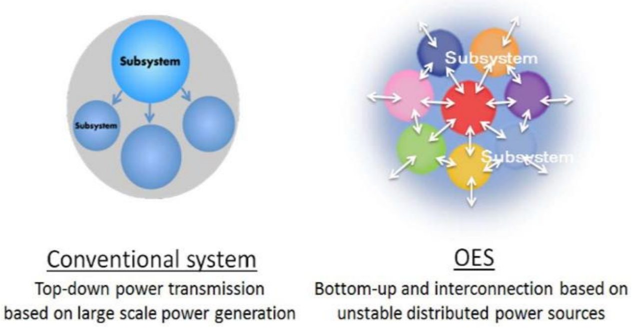

Fig 2 : OES concept compared to conventional approach.

the conventional grid and including energy storage [12]. Interconnections and energy storage facilities are required to reduce the stress that intermittent renewables cause on primary generation such as nuclear and thermal [13], [14]. Thus, the future energy grid in those areas is predicted to be based on the various DG units, storage devices, and controllable loads that are connected with advanced information and commu- nication devices such as automated meter infrastructure. In those systems, DG units, ESS, loads, and also microgrids are aggregated in clusters and can be seen as VPPs [15] that can then be treated as single entity. VPP can be considered as top- down approach that taps into the existing grid via smart meters and software to add the intelligence necessary to manage demand-response [8]. The aim is to remotely and automati- cally dispatch and optimize DG via an aggregation platform linking retail to wholesale markets [16]. For supporting both a wide range and flexible number of DERs, VPPs must be both loosely coupled and generally adopted by all players requiring standardization of communication [17]. All together, nanogrids and microgrids are usually bound to fixed building blocks, and VPPs are essentially software solutions bound to the existing utility grid infrastructure. In this paper, we propose Open Energy Systems (OESs) as a new type of scalable and bottom-up distribution network that shares some characteristics of all three approaches: building blocks are a flexible number of dc nanogrids, interconnected via a local dc power grid and controlled in a distributed way see the Appendix for comparative table. The general concept may be seen as a multilevel dc grid system whose two-level implementation we investigate. It provides both hardware and software for exchanging energy in-between dc nanogrids of a local community so that we can spread fluctuations over the community without needing to feed-in energy to the util- ity grid. Each house is equipped with one subsystem, a dc nanogrid including batteries, that is connected to a dedicated, shared dc power bus as well as a communication line allowing power exchanges within a community.

II. ENERGY STORAGE DC NANO-GRID

In modern power system, role of energy storage has become even more important. Energy storage is necessary in micro-grid applications to ensure stability of the system in presence of bi-directional power flow of the micro-grid, alleviate the intermittency problem of small-scale renewable energy sources improve power quality, and support local generators for additional functionality such as peak shaving Load-shifting, frequency regulation etc.

For medium-scale and large-scale renewable energy plants, energy storage is necessary to improve controllability and reliability of the plants such that they can be integrated into power system without causing performance degradation of the system or requiring additional flexibility and operating reserves from the power system. DC technology In the ”War of Currents” in the late 1880s, AC current won over DC current due to its ease of step-up/down and ease of protection. However, there has been recently a return of DC technology [4] due to the presence of power electronics.

ADVANTAGES OF NANOGRIDS

Followings are advantages of the Nanogrids

- Controllers discover other grids and generation system
- sharing power (price, quantity)
- Power can be exchanged mutually beneficial
- Controllers can track cumulative energy.
- Only data exchanged based on price and quantity
- Visibility of the systems adjacent grids
- Bring individual devices into grid context
- Pave way for Microgrids
- Increase microgrid utility; enable local microgrid prices
- Reduce microgrid cost and complexity
- Can scale/deploy much faster than Microgrids
- Enable “Direct DC” (~10% savings)
- Better integrate with mobile devices, mobile buildings
- Help bring good electricity services to developing countries
- It is more secure
- Coordinate only with immediately adjacent (directly attached) grids / devices
- No multi-hop “routing” of power

ISSUES RELATED TO THE POWER GENERATION AND CONTROL

The followings are the issues related to the power generation and control.

a. The energy storage will play important role in electrical power system. Physical size in the energy storage system play important role because more energy can be stored. If the size of a generator is greater than more output power is available in peak time. In smart grid system energy storage will play major role in energy generation side because grid will always use maximum stored energy to fulfill the demand of energy in the peak hours. By using the nanotechnology the energy storage system will store more energy to meet the demand.

b. The smart grid must control power generation system that can be varying instantaneously as load varies according to the requirement of the consumer. In future wind and solar energy system will be more and since these systems are depend on the weather conditions so the grid operator will need to take sudden actions as changes occurred in Power output [1].

c. The reliability of the grid depends on the synchronization between voltage and current. Since power equal to voltage multiply by current and since current fluctuations in an AC system and voltage has to fluctuate in the same way. Real or complex Power depends on the "Power factor," and it should be near to one. But typically it runs between 85-95%. If power factor reduce within the certain limits, it causes to lower the system fuel efficiency. It is happening because the generators will produce same amount of power by using the same amount of fuel but it will deliver less power to load and losses will be increased.

d. Complex power produce by capacitance and inductance and it generated from electrical equipments for example capacitors, tube lights and motors etc. These devices causes current to be out of phase with voltage and it should compensate, so power factor may vary in grid time to time and since this phenomena must happen due to presence of inductive type of load so operator needs to take necessary actions to improve the power factor up to the desired value.

e. Location is always play important role while calculating losses. The resistance of a wire depends on the length of the wire, as length increases the resistance of wire increases. Voltage is directly proportional to the resistance and current. Losses increase with distance and more wire is needed to provide electrical power to long distances. When more wire is needed to connect the generator with load, it reduces current and hence greater energy losses for any given voltage. The line losses should be minimized by impedance matching. These are between 3-5% on average. But these losses increase sharply during peak hours and often exceed up to 25% when wire are congested. Keeping in view above issues it can be concluded more fuel is required to generate the same amount of electrical energy and more money investment is required in the power generation system of any system with generators using in the remote site. These line losses will be reduce in future because researcher are improving transmission line wire by mixing Nanomaterials with copper wire.

f. electricity generation is very low and cost of electricity is very high as compared to the other developing countries. It totally depends on the centralized system. There is still no proper planning for future due to the influence of the arm forces around 35 years. This is big issue for country to fulfill the demand of electric supply and hence reduce the cost. In future the decentralized system will be preferred because uses can use its own system in case of blackout. The cost of the energy can be controlled if different options are available.

III. CONCLUSION

As the demand for sustainable energies continues to increase, it is important to find ways not only to generate but also to distribute the power coming from inherently distributed and unstable power supplies such as renewable resources. This paper analyzes a new type of dc based, distributed interconnec- tion of dc nanogrids. In this paper, we propose a new concept, both in terms of hardware and software architecture and show the benefits on four-node simulations using physical model. We further demonstrate the feasibility on a full-scale platform, which is one way of putting the concept in practice. Note that the research is still ongoing and some parts of the concepts still need to be studied further. In the future, this paper will con- stitute the basis of higher-level intelligent exchange strategies using weather forecasts, predictions for peak cutting or even further implementing mechanisms such as monetary control. It explores such an alternative grid system that can develop alongside with the existing grid system but that also work without it. Because of its open architecture it can develop gradually, one subsystem at the time, thus requiring gradual investment. This is particularly interesting for areas that are currently off-grid. On a theoretical level, it provides an appli- cation model for open systems science in practice as well as explores the limitations of decentralization.

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