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# Nanogrid: An Introduction

Matthew N. O. Sadiku[1], Philip O. Adebo[1],
Sarhan M. Musa[1]
[1]Roy G. Perry College of Engineering
Prairie View A&M University
Prairie View, TX 77446

Abayomi Ajayi-Majebi[2]
[2]Department of Manufacturing Engineering
Central State University
P.O. Box 1004
Wilberforce, OH 45384-1004

***Abstract*:- The concept of nanogrid is relatively new and compelling. It arose from the need to enable "plug-and-play" integration of locally generated renewable energy. A nanogrid refers to a small microgrid, typically serving a single building or a single load. While microgrids are building blocks of a smart-grid, nanogrids are building cells of a microgrid. Due to their simplicity, the technology requirements for nanogrids are less complex than those for microgrids and they face less technical and regulatory barriers. This paper provides a brief introduction to nanogrid.**

***Key words:* Nanogrid, microgrid, minigrid, smart grid**

## INTRODUCTION

Constructing a standalone system such as a nanogrid to supply a cluster of remote loads is often cheaper than connecting the loads to the conventional power system [1].

The terms mini-, micro- and nano-grids refer to the size of small to medium off-grid or grid-connected systems, which make use of renewable energy sources. Minigrids involve small-scale electricity generation which serves a limited number of consumers. The generating capacity of the minigrid is in the range of 50 kW and 1 MW. They serve as a viable solution for rural electrification. Microgrids are similar to minigrids but operate at a smaller generation capacity (1 to 50 kW). A microgrid consists of a group of connected power sources and loads [2]. It can be as small as an individual house (called a nanogrid) or as large as a college campus or a business park. Nanogrids are small microgrids, typically restricted to a single building. A nanogrid interconnects generating sources and plants and provides in-house distribution. Like microgrids, nanogrids have the capability of operating in islanded or grid connected mode. The interconnection of several nanogrids forms a microgrid and facilitates the sharing of power between the nanogrids.

## COMPONENTS OF A NANOGRID

A typical nanogrid is shown in Figure 1 [3]. The figure shows the key components and their interconnection. The nanogrid consists of [4]: (1) local power production which could be wind or solar photovoltaic (PV), (2) at least one domestic load, (3) a gateway, (4) controller, (5) storage. A load may refer to household items such as refrigerator and lighting. The load on a nanogrid is typically less than 20kW, and the loads are located within 5 km of the sources. Electricity and communications flow through the gateways, which is a bidirectional connection between other nanogrids, microgrids or the national grid. The controller manages the flow of power from the local sources and the gateway, to the loads. The energy storage is not essential in a nanogrid, but it helps with stability. A nanogrid may also have step-up and step-down converters to interface the sources and loads to the nanogrid and a bidirectional converter that allows the storage node to charge from and discharge into the grid [5]. The system is power electronic based, with converters being used to interface both the sources and domestic loads. Nanogrids operate in a peer-to-peer manner, with no master.

## DC NANOGRID

A low-voltage DC distribution within house is called a DC nanogrid. It can generate DC at 1 kV or so for DC-based distribution. Although a nanogrid can be direct current (DC) or alternating current (AC), the majority of nanogrids are DC. DC nanogrid has some advantages such as improved transmission efficiency, ease of interfacing asynchronous sources, ease of integration with renewable sources and battery banks, and increased savings. The rising concern for energy savings has led to the evolution of DC systems being used in distribution. DC is used in the home because many modern home appliances use DC voltage and most renewable energy sources generate DC power. This eliminates the need and the cost for energy conversions associated with a conventional AC system [6]. DC power naturally avoids the power quality issues with AC power, and is readily coupled to a battery to ensure reliability.

A typical DC nanogrid is shown in Figure 2 [7]. Solar PV is the most widely used renewable energy source in DC nanogrid because it is available from few watts to megawatt. The DC bus voltage level (400V, 25V, 220V, 120V, and 48 V) determines the efficiency, cost, and safety of nanogrid [8]. For residential applications, the 48V-DC is sufficient enough to drive DC loads. (48V DC bus is used in the telecom sector and is safe.) DC loads such as LED lighting, PC, cell phone charger, battery system, and renewable sources can be connected to the nanogrid. The home appliances are connected or disconnected from the nanogrid according to the user requirements. DC Nanogrid allows plug-and-play operation so that systems can be added or removed from the nanogrid network seamlessly [9].

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A portable nanogrid has been proposed. It is designed for individuals like campers, hikers, and soldiers on the move. It is lightweight and compact. The power system can harvest solar PV panel and be used to charge battery and supply power to DC and AC loads [10].

## BENEFITS

The nanogrid technology is applicable to closely located households which may have solar PV. A nanogrid hides complexity and enhances interoperability. Nanogrids allow the integration of domestic activities such as irrigation along with the usage of electricity.

They are used in smart building and smart transportation. Nanogrids are also beneficial in areas where backup power or power quality is valuable. These include natural disaster and military installations. A nanogrid can continue to supply power when blackout occurs in the macrogrid. Since nanogrids are inexpensive to purchase and install, they will see significant growth.

## CONCLUSION

A nanogrid is an electrical power supply for a single house or single load, as opposed to a microgrid which is usually a power supply system for multiple buildings. Nanogrid feature DC electrical architecture instead of the conventional AC and are regarded building cells of a microgrid. By strategically interconnecting nanogrids, power system operations will greatly improve in efficiency, sustainability, reliability, and resilience [11]. The future power supply will be in the form of microgrids or nanogrids which are based on renewable energy resources.

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## ABOUT THE AUTHORS

**Matthew N.O. Sadiku** is a professor emeritus in the Department of Electrical and Computer Engineering at Prairie View A&M University, Prairie View, Texas. He is the author of several books and papers. His areas of research interest include computational electromagnetics and computer networks. He is a fellow of IEEE.

**Philip O. Adebo** is an instructor at Texas Southern University. He completed his PhD in Electrical and Computer Engineering, Prairie View A&M University with emphasis on power systems. His research interests include power systems, renewable energy, microgrids, smart-grid systems, restructuring power system and optimization of power systems.

**Abayomi Ajayi-Majebi** is a professor in the Department of Manufacturing Engineering at Central State University in Wilberforce, Ohio. In 2015 he was honored by the White House as a Champion of Change for his significant contributions to the engineering education of minority students. He is a senior member of both the Society of Manufacturing Engineers and the American Society for Quality.

**Sarhan M. Musa** is a professor in the Department of Electrical Engineering at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow. His research interests include computer networks and computational electromagnetics.

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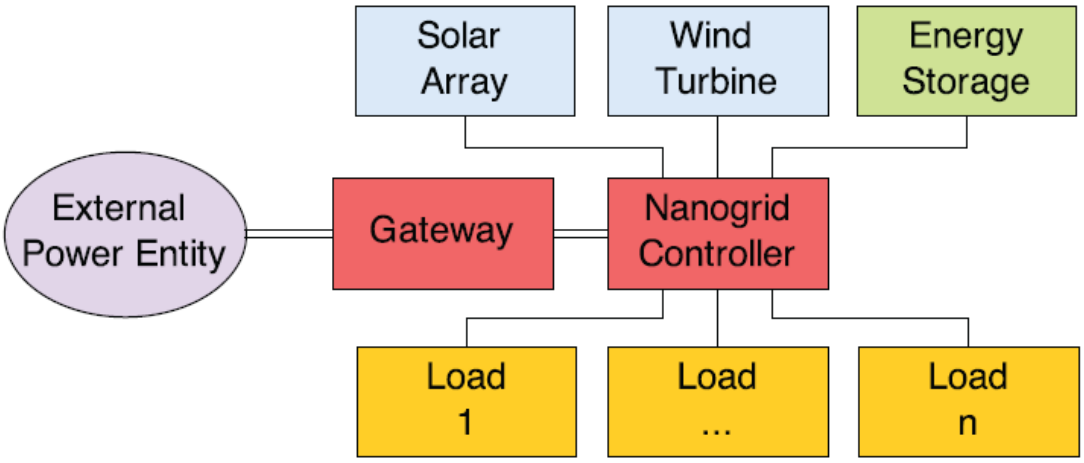


Figure 1 Structure of a nanogrid [3].

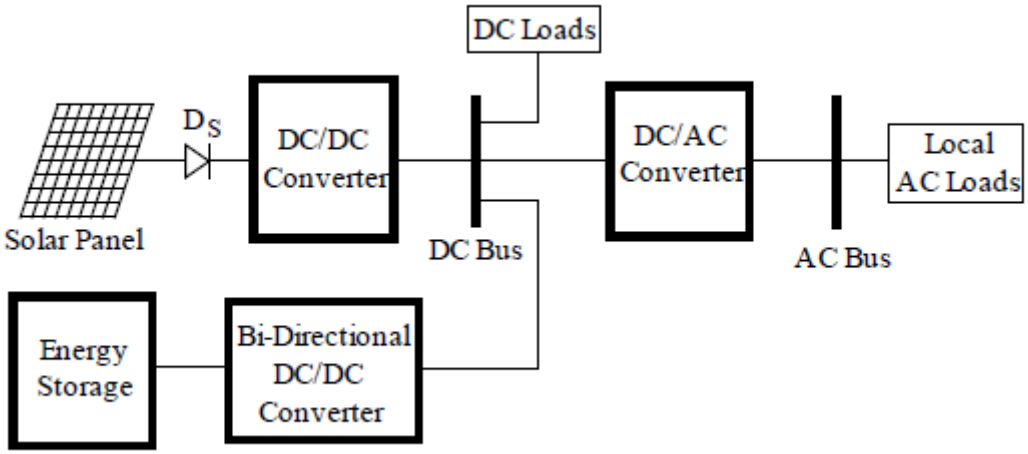


Figure 2 A typical DC nanogrid [7].