Study of Iraqi Smart grid

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Abstract

With the development of electronics and communications and to be conveyed with that development and the importance of smart grid, in this research a study of the generation domain with smart technologies is used. Also the renewable energy used as an alternative energy with controller by using a programmable card to control and improve power efficiency of generation by increasing energy generation to match the population increases and requirements. A smart grid (SG), which is also called a power grid or smart electrical grid proposed for stability enhancement and as a solution to generate more energy to meet the increase in demand for power generation, as abbreviations it couldn't specify by one tool or one part of electrical grid where there are many methods to achieve the goal of the smart grid, but this paper aims to present a generation part with smart techniques. Recently, it was heading to rely on renewable energies as an alternative energy because it is a clean source to generate energy and available source, and since research has proven the efficiency of solar energy in Iraq more than wind energy, the solar source suggested as an alternative source for energy generation.

Keywords: Smart grid, Back Propagation Neural Network, Field Programmable Gate Array.

1-Introduction

Traditionally, the expression grid is used to express an electricity system that might support all or some of the following four operations: electricity distribution, electricity transmission, electricity generation, and electricity control. A smart grid (SG), also called by a power grid or smart electrical, intelligent grid, future grid, intelligrid, intragrid, or intergrid, as an enhanced version of the twentieth century of power networks. Carrying power from a few central generators to a large number of customers or users is one of the main and general usage of the traditional power grids [1]. The problem of voltage stability has an effect on the growth of energy consumption and electric market. Voltage system stability indicates the
ability of a power system to preserve steady voltages for all buses in the system after being submitted to a disturbance of a given initial operating condition. So transforming electric grids into smart devices, computational algorithms and electronics into highly efficient and reliable, smart grid is required to ride different challenges. The study proved that smart grid reduces greenhouse gas emissions from application also controlled wide-ranging integration of renewable energy sources. This wide-ranging integration requires the application of advanced algorithms in order to avoid an unexpected voltage and frequency fluctuations. By using energy storage systems and depending on renewable energy, and advanced algorithms to forecasting generation and loading of the grid. The smart grid provides full coordination between the consumed energy and generated energy. This reduces losses of the grid energy, peak demand with energy costs [2]. Smart grid main elements, like smart meters, transformers, circuit breakers, feeders, control centers, substations, grid stations, are required to form communication network architectures [3]. It is needed to handle communications, information data, management, and control. For, flexible smart grid system design [4]. Smart grid deployment might be improving the intelligence of grid interoperation of the system by the multidirectional information flow between each two or more units in the system to provide revolutionized the power industry to increase security, and efficient Smart grid services [5]. In this paper a study of smart grid proposed as suggestion for Iraqi grid to enhance and improve the electrical Iraqi grid by depending smart control for generating power. When the generating part is an important infrastructure part of smart grid and renewable energy (solar panel) depended to generate and storage power in a smart way by a programmable controller like Field Programmable Gate Array (FPGA).

2-Literature Survey

In 2015 [6] Raja Masood, Mohd Wazir and Sajid Hussain proposed An Overview of Smart Grid Technologies in Power Systems: the smart grid technologies are more compatible for ideal system to permits many functions which can optimize with the combination of the transmission and the use of bulk generation. Since the smart grid kept the environment free from pollution with minimize the cost, effective operations, for all types of hazards and danger. And discuss the smart grid technology, its standard and recent challenges. and explore the different projects of the smart grid in developed countries and discuss the implementation challenges for undeveloped countries. In 2015 [7] Shubhi Sharma, Jagdeesh Boddu, Guru Sai Charan, Home Automation Through FPGA Controller proposed the design and implementation of home automation system presented: The design has been described using Verilog and implemented in hardware using Field Programmable Gate Array (FPGA). This system uses sensors for controlling home appliances. It uses wireless technology to improve the standards of living. In 2016[8] R. Bayindira, I. Colak proposed Smart grid technologies and applications: a review has been made of technological methods of data transmission and the energy efficiency in smart grids as well as smart grid applications. The study is expected to be an important as a guide source for researchers and engineers studying the smart grid. It also helps transmission and distribution system operators to follow the right path as they are transforming their classical grids to smart grids. In 2019 [9] Hasan N. Muslim proposed a review of Challenges and barriers in Iraq for solar PV generation: ew in the challenges and obstacles for implementation of solar photovoltaic power generation in Iraq. These problems that confront Iraq are represented by a technical, financial, political barriers and other. Based on solar GIS map for Iraq, the average daily solar radiation is about (5-5.5) kW/m²/day, and this received, considerable amount of energy should properly and technically be utilized. Not only, The Iraqi government must take serious steps, plans and policies to
overcome these challenges, but also, put developed strategies, make scenarios with programs from specialized and expert persons.

3-Smart grid infrastructure

A smart grid development, to manage electricity demand in a reliable, sustainable, and economic manner, build an advanced infrastructure and adjust to facilitate the integration of all involve. Smart grids will provide further electricity supply rising demand, quality of power supplies and increase reliability, increase energy efficiency, is able to integrate carbon free energy sources into power networks 6[10]. It is using information and communication technology together and act on information, to improve the economics, efficiency, reliability, and sustainability of the distribution and production of electricity. Smart grid is technically categorized into three kind called Smart Protection System Smart Management System and Smart Infrastructure System. The simulation part of this paper has been done for the Smart Power generation which is a part of Smart Infrastructure System [11]. Smart Power Generation is responsible for generating electricity and deliver to consumers. The generation domain is linked to the transmission domains electrically to shares interfaces with the operations, markets, and transmission domains. connection with the transmission domain is most important because without transmission, consumers may not be served. The bulk generation domain must communicate the main quality and performance of service issues like generator failure. It is necessary for the bulk generation domain uses renewable energy sources for emissions controls, increases in, provision of storage to control renewable energy sources. A bulk generation domain consists of different devices like fault recorders, equipment monitors, protection relays, programmable logic controllers (PLC), user interfaces, and remote terminal units [12]. A clean production offers by renewable energy sources of electrical power using wind, sunlight, tidal waves biomass, etc. The uses of Renewable energy as a generation source has grown greatly cause of climate change. Photovoltaic systems (PV) are one of the most common renewable energy sources. It is an important energy source as it is not only renewable but also limitless and nonpolluting not like the conventional fossil fuels like coal, gas and oil. In the last decade, these unique features have make power generation by Photovoltaic sources one of the most common renewable energy sources [13]. In this paper a generation category with renewable energy source (solar panel) proposed to implement reliable smart grid depended on clean source and provide clean energy where solar source is available in Iraq and many researches prove that could be used as clean energy source and less pollution.

4-Test for Renewable energy

The real measurements taken from the solar panel in a different direction, the first one when the panel without an angle and not faced the sun and the second one when the solar panel faced the sun with tilt angle 31.2 according to reference [14].

4-1 A block diagram of solar panel prototype

The prototype used to test the location before the smart grid install, for the test a smart card used (FPGA) was programed by a neural network to rotate the solar panel by DC motor with an angle to face the sun.

The prototype system contains:

LDR sensors (Photoresistor) have a resistance which changes based on the amount of visible light that falls on it.

ADC0804 convert an analog signal to digital
Smart controller FPGA a programmable card used to control the output of the sensors
DC motor used to rotate the panel in two situations

![Prototype block diagram](image)

**Figure (1):** prototype block diagram.

**Table (1):** Voltage and current measurements.

| Time  | Voltage (V) | Current (A) | Power (Watt) | Time  | Voltage (V) | Current (A) | Power (Watt) |
|-------|-------------|-------------|--------------|-------|-------------|-------------|--------------|
| 9:00  | 19.3        | 2.06        | 39.758       | 9:00  | 19.6        | 3.39        | 66.444       |
| 10:00 | 19.0        | 2.6         | 49.4         | 10:00 | 19.5        | 4.51        | 87.945       |
| 11:00 | 19.3        | 3.48        | 67.164       | 11:00 | 19.8        | 5.16        | 102.168      |
| 12:00 | 19.4        | 4.01        | 77.794       | 12:00 | 19.7        | 5.51        | 108.547      |
| 13:00 | 19.4        | 5.05        | 97.97        | 1:00  | 19.8        | 6.11        | 120.978      |
| total |             |             | 332.086      |       |             |             | 486.082      |

**4.2 Simulation result:**

A back propagation neural network used for data training, then uploaded to the FPGA card to control the panel direction

The result of back propagation performance as shown below where the best training has $10^{-8}$ mean square error:
Figure (2): back propagation performance.

A backpropagation network with two inputs and two outputs used to propose two states, first one when the solar panel faced the sun with the angle and the second one when the panel without an angle and not faced the sun.

Figure (3): back propagation Network Simulink model.

Xilinx ISE Simulator (ISim) has been used to generate the desired waveforms for each state to test the trained network.
As a result the efficiency increased by 46% and a good location chosen before the solar panel installed.

Efficiency = \( \frac{486.082 - 332.086}{332.086} \times 100\% = 46.37\% \)

5- Conclusion

The future smart grid is based on combination of smart generation, transmission and distribution by using smart components. The success of the smart grid depends directly on robust, reliable and secure communication system with high data rate capability. This paper presented the infrastructure generation of smart grid that depends on the renewable energy (solar panel) to increase the power generation and efficiency improvement to 46.37% by using a programmable card to control the direction of the solar panel so that the generation of the system controller.
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