Hybrid Non-Renewable Resource System Reliability and Cost Optimization

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Abstract
In this paper, a hybrid energy system-based intelligent power flow control (IPFC) for consumers is suggested. With the help of this system, an algorithm is created for intelligent power management plans that connect distribution-based application grids with end users. When to take energy for consumption from the grid or the storage unit is determined by intelligent power management systems. The main goal of the IPFC is to shift the price of power from the grid from high-cost to low-cost times in order to lower customer expenses. In order to avoid overloading the grid, the second goal, which is connected to the IPFC, modifies the quantity of electricity drained from the system from times of high demand to times of low demand. The algorithm takes into account how the load demand relates to the load based on the type of application. The technique was evaluated using the Fuzzy Logic smart control application as a base. It was shown that the IPFC-based strategy worked successfully. More money was saved thanks to the clever technique than was anticipated or forecast.
Key Words: Intelligent Power flow Control (IPFC), fuzzy logic, Wind turbine, PV array, Energy Storage Unit

1. Introduction

The usage of energy at home and around the world has risen sharply in recent decades. According to the International Energy Agency's 2020 report, the United States' overall energy consumption depending on application type was 26.6 TWh in 2018 compared to 22.3 TWh in 2010. This rise is comparable to the 20% increase. Even more so, the size of the world's energy needs. From 102.3 TWh in 2010 to 142.3 TWh in 2018, the global demand jumped by 39%. Global energy consumption is increasing more quickly than American demand [1]. It is estimated that annual rate related to the energy consumption will increase to the tune related to the 5% from 2020 [2]. The increasing amount related to the energy consumption based application type is often due to various reasons that come along on the basis of rise related to the living standard. For industrialized countries, mostly in North America and West Europe, demand for energy steadily recovered from economic crisis related to the 2018. In the emerging countries like "BRIC" (Brazil, Russia, India and China), demand for all forms related to the energy continued to grow at a very fast speed. To avoid potential energy crisis, it is imperative to generate more energy and at the same time, increase the energy efficiency, so that we can do more work on the basis of less energy.

Common sources of conventional energy include coal, natural gas, fuel oil, and nuclear energy. The materials required to produce conventional energy are cheap, and the power plants that control these resources may be built practically anywhere. However, there are clear drawbacks to the typical energy solution. First off, the material required to produce conventional energy is scarce, and it could be expensive to cycle and regenerate these resources over a long period of time. Therefore, ultimately, access to these resources will cease. Second, the typical method for the generation-based application type itself commonly harms the surroundings and may cause additional harmful pollution. In 1986 the infamous nuclear leak disaster occurred in Chernobyl Nuclear Power Plant in Ukraine which caused at least 200,000 cancer cases in that area [3]. Scientists and consumers are aware related to the the pollution caused by conventional energy and environmental degradation related to these resources. Therefore, it is imperative to come up on the basis of alternative energy solutions which are sustainable and renewable and have lower carbon footprint on the environment.

1.1 Criteria related to the Energy Storage Technology

The technique of storing energy-related forms so they can be used later for particular tasks is known as energy storage [7]. Among the storage kinds are those for chemical, biological, electrochemical, electrical, mechanical, thermal, and application-based fuel conservation. The advancement of energy storage makes it possible for power suppliers and end users to balance supply and demand. The research on energy storage technology draws consistent attention based application type related to the government agencies and global corporations. The 2009 Stimulus Plan proposed an industrial standard for energy storage technology and its integration based application type on the basis of Smart Grid [8]. The utilization based application type related to the renewable energy requires the development on energy storage technology. Otherwise it would not be possible to utilize renewable energy in a reliable, stable and sustainable way. U.S. Department related to the Energy has funded a specified program which is concentrated in energy storage technologies. The program is named Energy Storage Systems Program [9]. Batteries are one of the approaches available for energy storage. Batteries are electrochemical storage devices. Until 2005, due to comparatively small capacity and high cost, the use related to the batteries has been very limited. In 2005, revolutionary development on battery technology is able to offer large capability related to the storage at a greatly reduced cost. In New York and California, companies are exploring to build tremendous electrical storage facility that allows "arbitrage", which implies buying electricity at a low price and selling it later at a higher price [10]. The in-house utilization based application type related to the energy storage devices has been advocated as one as associated to the primary methods to save energy and reduce cost. However, if thousands related to the in-house energy storage devices are charging at the same time, that will result in higher and sometimes peak demand for distribution based application type grid. Therefore, power suppliers have to develop redundant generation based application type capacity to feed the need. That will cause more carbon emissions, and in the worst case, can result in power outages due to over-demand. Therefore, the inhouse energy storage system on the basis as associated to a sophisticated strategy to relieve peak demand will benefit both power suppliers and end consumers. This thesis will propose a strategy based on intelligent approach to address this challenge. Power outage is caused by malfunctioning in power stations, damage to power transmission line and transmission overloading etc. A transient fault is a momentary loss related to the power typically caused by a temporary fault on transmission line. Power is automatically restored once the fault is cleared. Therefore, it is less harmful to the business owners and end consumers than a blackout. A brownout is a sudden decline in voltage at power supply. It often results in poor performance related to the business facilities and household appliances. A blackout implies a total loss related to the power in residential or commercial area. It is the most severe form related to the power outage [11]. In this thesis, a great concern is to improve stability and sustainability related to the the electrical grid, which will potentially reduce the chances related to the all forms as associated to outages.

2. Methodology

As has been discussed in previous chapter a sophisticated power flow management system for end consumer is supposed to have two crucial abilities. The first is to lower the overall cost. The second objective is to help the electricity company avoid overload or blackouts. To achieve these goals, a smart power control system is linked between the power distribution sources and end users. Through a communication-based application, the intelligent power flow control scheme has the capacity to link power suppliers and end users. Based on the real-time price and grid load provided by the power supplier, it informs the end user [26].

Power flow control is the core intelligent unit that plays the most significant role in proposed design. Firstly, it maintains an interactive connection based application type between end consumers and distribution resources. Through a two way feedback the system are able to get real time information based application type about power generation and load from. Power suppliers will be controlled with the power consumption records as associated to the consumer load, It is sometimes referred to as a fluctuating load. in order for power supply facilities to instantly address load-related problems at both ends. The power supply will have an exact load for a certain area based on how much it covers once all of these information-based applications have been gathered and organised. This information-based type will be extremely advantageous to the application types that are focused on grid management and price determination. Second, intelligent power flow control is solely responsible for controlling the power input from the distribution grid and redirecting it to home appliances and the Energy Storage Unit.

Rule 1. load appliances must be given needed power at any time.

Rule 2. Energy Storage Unit must stop charge immediately when the storage power hits its maximum capacity.

Rule 1 is easy to understand. No one wants the power to be cut off from their household appliances. A design that would not let climate control work in the hottest summer day is miserable. A valid design related to the power flow control must ensure uninterruptible and adequate power supply to all load end.

Rule 2 ensures that we do not charge the Energy Storage Unit beyond its maximum capacity. When the Energy Storage Unit hits the designated maximum capacity, it will not be able to charge anymore. In this situation, Smart Meter must switch the state of Energy Storage Unit to any other states but not "Charge".

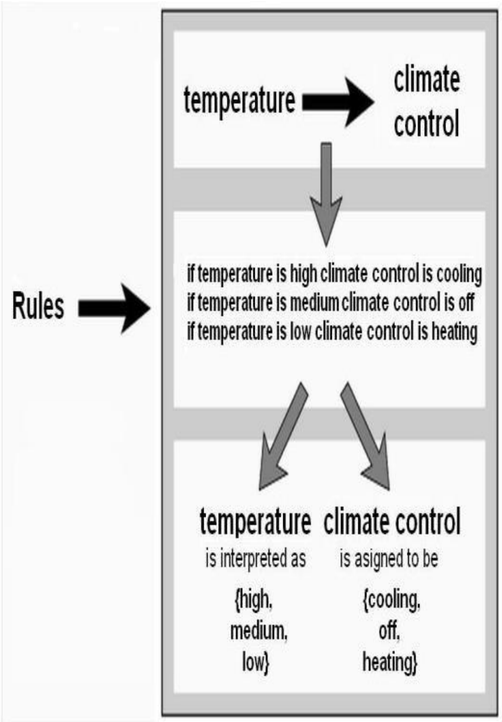

Figure 1: An example related to the fuzzy logic rule based inference system

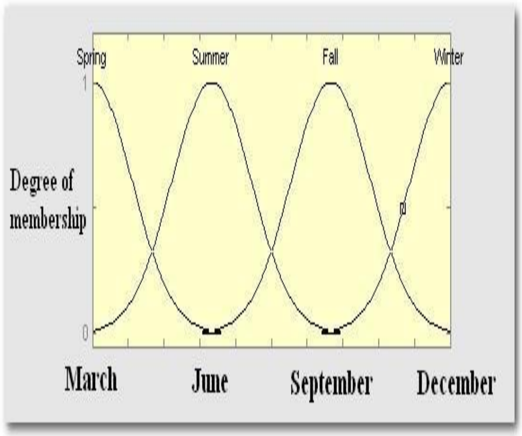

Figure 2: Fuzzy Membership Functions for depictions related to the seasons on the basis of respect to different months

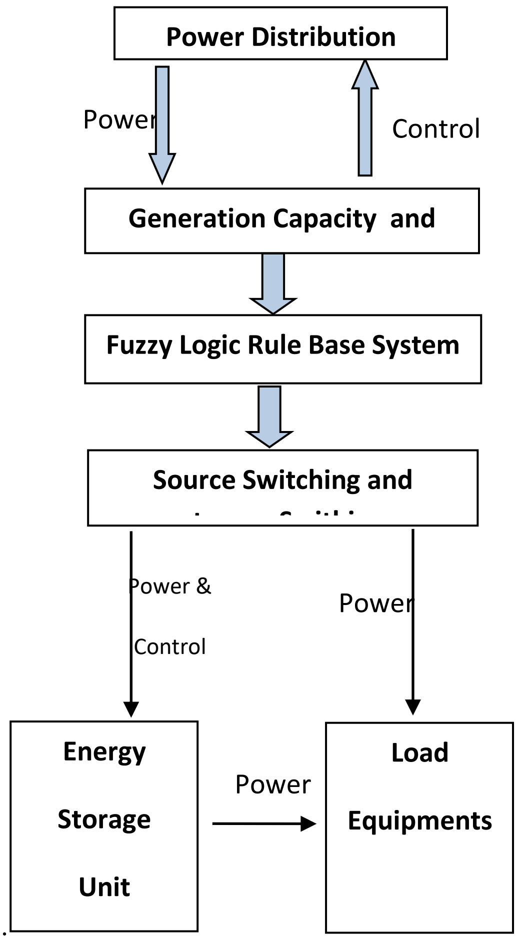

Figure 3: Framework as associated to a Fuzzy Inference System based Power Flow Management

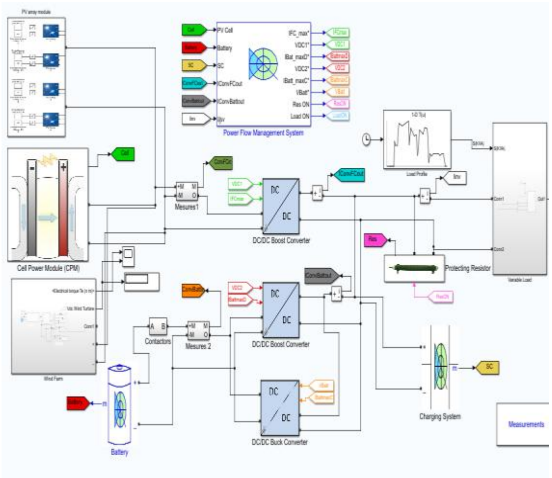

Figure 4: Simulink block model for power flow hybrid resource management system

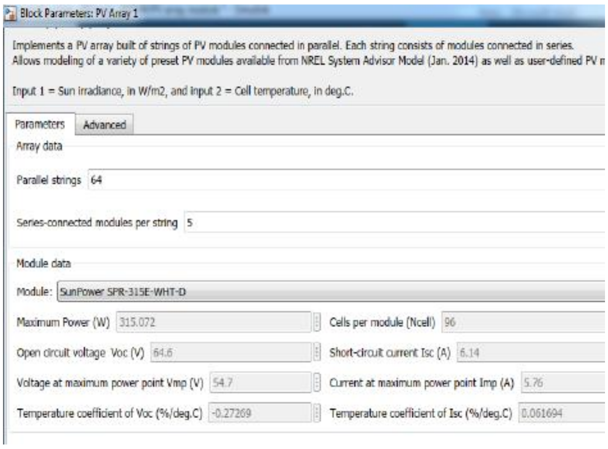

Figure 5 (a): PV array module parameter.

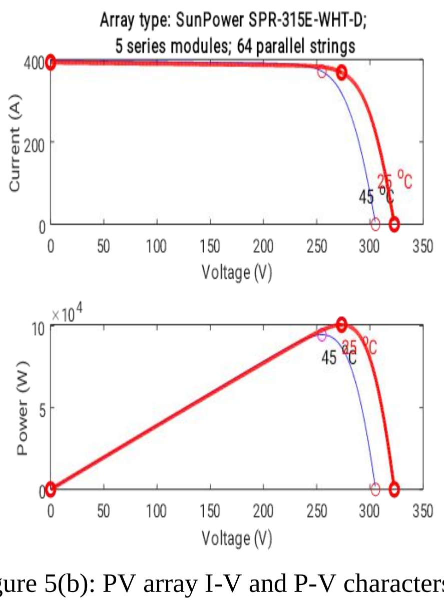

Figure 5(b): PV array I-V and P-V characterstics

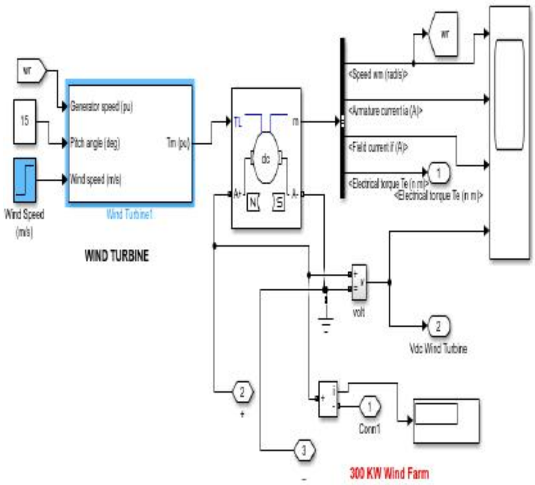

Figure 6 (a) :Wind Turbine subsystem simulink model

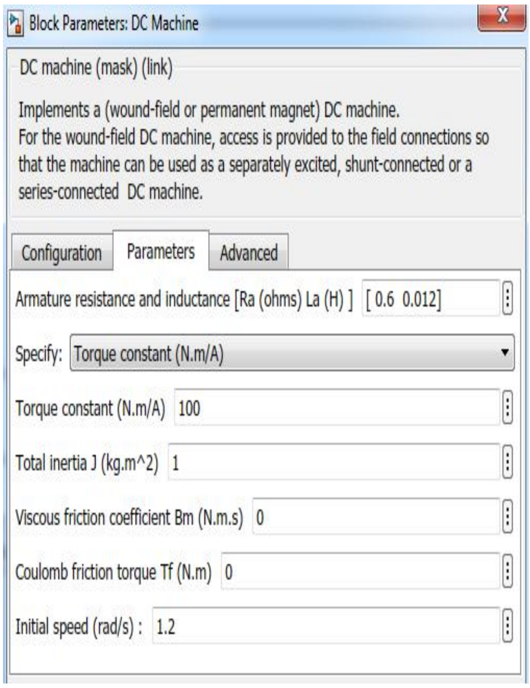

Figure 6 (b): Wind turbine coupled DC generator parameters.

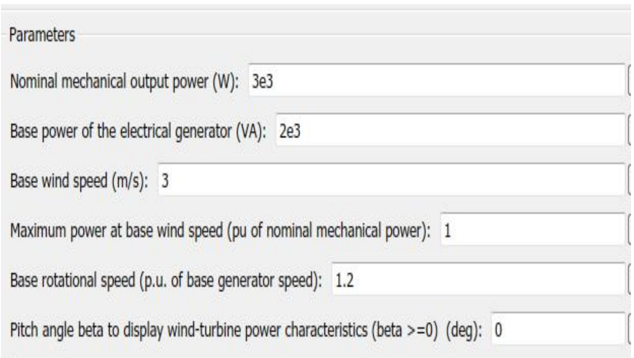

Figure 6 (c): Wind turbine coupled DC generator parameters.

3. Results and Discussions

This chapter describes the results shows power flow management systems for a hybrid electric sources.

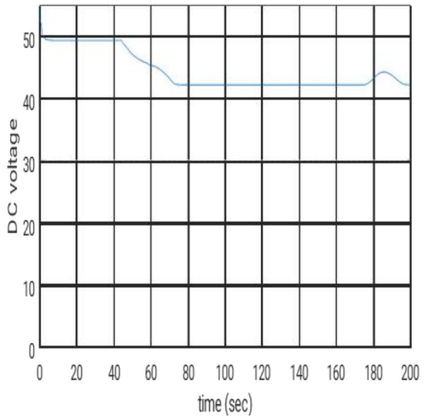

Figure 7: DC source voltage (Volts) with respect to time.

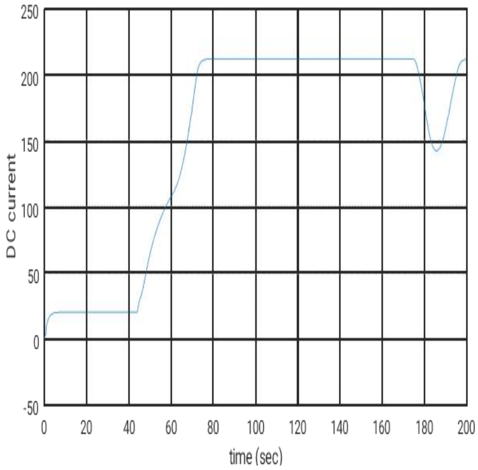

Figure 8: DC source current (Amp.) with respect to time.

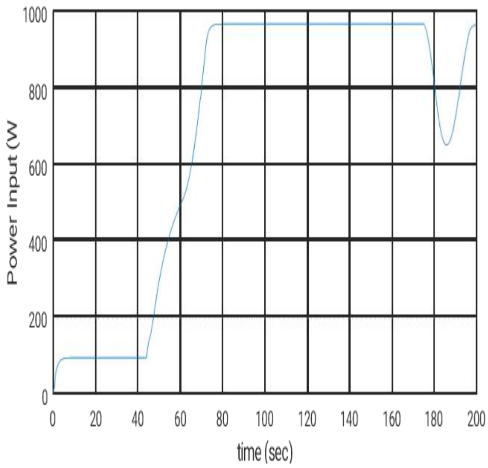

Figure 9: Power input to the PV solar modules with respect to time.

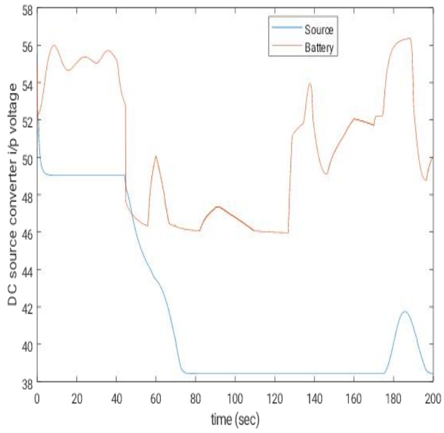

Figure 10: DC source input voltage (Volts) to the converter with respect to time.

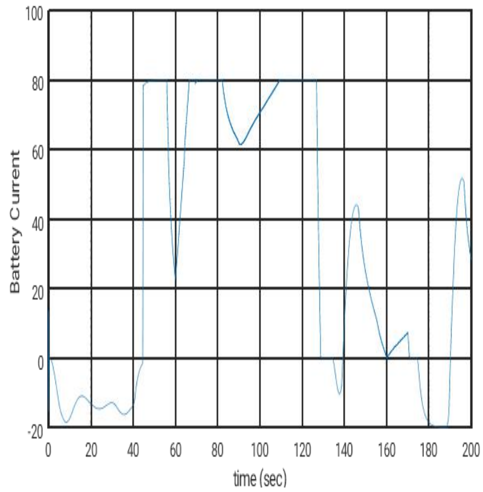

Figure 11: Battery current (Ampere) with respect to time.

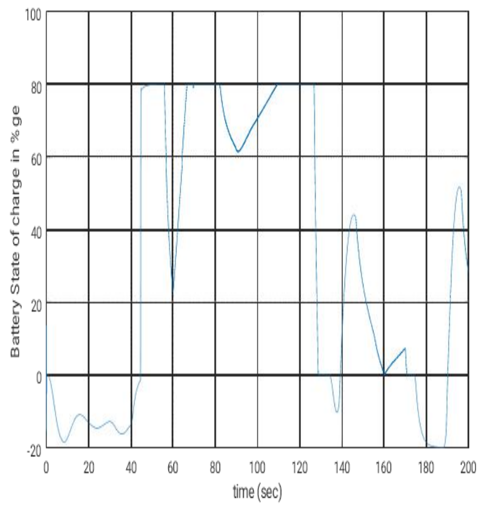

Figure 12:Battery state of charge ion percentage with respect to time.

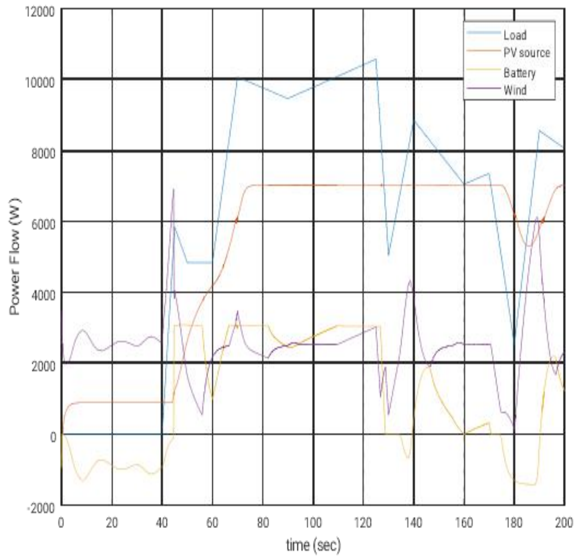

Figure 13: Net power flow from different sources, storage unit to load with respect to time.

4. Conclusions

This study makes a proposal for the infrastructure of an intelligent power flow management system. On the basis of the infrastructure, fuzzy logic-based methodologies are built and examined. The traditional Boolean technique has shown some potential for cost savings. In this study, Mamdani's FIS method consistently outperforms Classic Boolean in the majority of situations. When different loads were tested under diverse settings, this strategy was determined to be the best and most effective. A unique energy storage system planning that has been suggested and integrated to a household power flow control system is this work's major contribution. In this thesis, it has been shown that a smart mechanism developed utilising natural computing is a superior approach to the traditional approach for energy savings for end user load. Future study will concentrate on the most effective cost-saving rates for load consumption end and improved peak demand response for power suppliers utilising new heuristic algorithms on energy saving and power flow planning connected to the proposed architecture.

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