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Experimental study for a micro smart grid to meet the energy demand of a household

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Abstract

In this research, a smart grid using renewable energy and energy storage unit is studied. The system's storage units applies novel supercapacitor technologies to work with traditional batteries. This study aims at satisfying the dynamic demand of a household and evaluate the performance of the smart grid. The system design and the control strategy design is expressed in the paper combined with the discussion of the system's operation theory. The control panel of the system use SIEMENS S7-200 PLC as the core chipset. Digital software is an auxiliary tool for monitoring the system's operation process. The controlling method is divided into two situations, with renewable energy source and without renewable energy source, and both the operation processes are presented in detail in the results discussion part. After analysing the operation details of the system, the controlling strategy is proven to be useful for the operation of the smart grid system. Future work for the system is combining the electrical smart grid with other energy source. This system is potentially to be developed as electrical part of a multi energy system.

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Keywords: Max 6 keywords Smart grid， bio-oil engine, wind turbine, solar power, energy storage units, supercapacitors

1. Introduction

A challenging future faced by the UK make the smart grid to be researched as a tremendous opportunity for solving energy crisis. Large amount of fund has been spend on the researching of the power generation networks [1]. For accessing higher efficacy of energy consuming, the power plant needs to be more flexible and more adaptable. Smart grid technologies combined with novel energy storage technology is a solution to the uncertainties of the power demand from the domestic energy demand.

With the ability of enabling new sources and new forms of energy demand to be integrated into one system, the smart grid is regarded as an efficient, timely and low carbon approach of energy supplying[2].

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Encouraged by the official supports and attracted by the smart grid's future benefits, lots of researches accelerate the development of smart grid.

The smart grid technologies also refers to self-sufficient systems which are always prepared for an accident problem with corresponding solutions. Quickly response for the problems make the system to be more sustainable, reliable and stable. Lots of technological applications are applied in the smart grid by the researches and investor these days. Ali presents a control strategy for wide area smart grid architectural model. A time-variant load patterns was posted as complex problem for the model and a technical overview of data metering was surveyed in the research [3]. The results suggested the wide area smart grid model is a method to control and to operate similar systems.

Another key component of smart grid studies is the renewable energy [1]. Eltamaly shared an idea of optimal sizing of hybrid renewable energy systems [4]. In the research, the control problems and the optimization problems were considered with applying the renewable energy sources. By dividing the load into high priority load and low priority load, the system adjust its operation process to satisfy the load with different working patterns. As a result, the Matlab simulation confirmed that the size of the system could be reduced.

Many articles have researched the topic of smart grid. However, these articles lacked a comprehensive research on a small smart grid for varying domestic load. No research combined the renewable energy with the novel energy storage unit together with a smart grid system. This article addressed on the test process of a novel smart grid system. The controlling system is designed based on the SIEMENS S7-200 PLC model. Software has the function of measuring the performance of the system. The energy source of this system includes the generator sets, a wind turbine and solar panels combined as the energy source of this system. This system contains the function of DC energy transfer and AC energy supply that was different from a normal micro-scale energy generation. With a parallel energy source, the system has a serial of functions such as electricity generation, energy storage, transmission, control and protection, which guarantee the stability of this system. The inverters and converters are all connected with the data collector. With the connection of RS-485, the control centre could ensure the capacity of resisting disturbance. The results of the experimental tests indicate a high efficiency performance and a stable ability of supplying load.

2. System design and modellin

Figure 1 Configurations of system design