

Research on the Hybrid Energy Storage based Photovoltaic Piconets and the Isolated Net Running Comprehensive Control System in the Campus Environment

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Abstract. In this paper, we conduct research on the hybrid energy storage based photovoltaic piconets and the isolated net running comprehensive control system in the campus environment. Piconets flexible operation mode and the efficient power supply without perfect stable control. Micro the early stage of network development related to micro network operation concepts are modeled on the control of large power system. Our proposed approach is proven to be effective and feasible through the numerical simulation and theoretical analysis which will be meaningful.

Keywords: Hybrid Energy Storage; Photovoltaic Piconets; Isolated Net; Control System.

Introduction

With the rapid development of renewable energy technologies, for photovoltaic piconets system island mode, its electricity is intermittent, volatility and randomness, general equipped with energy storage device in the system. Energy storage device with battery and super capacitor has the high density characteristics of super

capacitor can realize the instantaneous power absorbed or released, but not for a long time to load power. Battery can provide power for load for a long time, but it is recycling low service life, low power density of faults, the hybrid energy storage system has become a research hotspot. The aging of power system structure, the bottleneck of environmental protection, energy efficiency and user to the high standard requirement of the power quality, makes the exploitation and utilization of renewable energy, build a sustainable energy system become the consensus of countries with the inevitable development trend. Piconets flexible operation mode and the efficient power supply without perfect stable control. Micro the early stage of network development, related to micro network operation concepts are modeled on the control of large power system, the concept of design. In fact, due to the type of micro power, micro network and the load characteristics of power quality condition such as constraints, micro network control and operation strategy in concept and is essentially have great different with the traditional electric power. Because the basic cells can directly produce direct current, battery and super capacitor energy storage device is also

suitable for dc output, this paper adopts dc micro mesh.

	PV-Diesel-Batteries	PV-Wind-Batteries	PV-Wind-Diesel-Batteries	Wind-Diesel-Batteries	Optimization of components	Optimization of control strategy
Borowy and Salameh, 1996		×			×	
Chedid and Saliba, 1996			×		×	
Kaiser et al., 1997	×				×	×
Morgan et al., 1997	×				×	
Seeling-Hochmuth, 1997			×		×	×
El-Hefnawi, 1998	×				×	
Protogeropoulos et al., 1998		×			×	
Kellogg et al., 1998		×			×	
Elhadidy and Shaahid, 1999				×	×	
Dufo-López and Bernal-Aguistin, 2005	×				×	×
Koutroulis et al., 2006		×			×	
Shaahid and Elhadidy, 2006	×				HOMER	
Ashok, 2007			×		×	
Yang et al., 2007, 2008		×			×	
Diaf et al., 2008		×			×	
Dalton et al., 2008			×		HOMER	
Himri et al., 2008				×	No batteries	
Shaahid and El-Amin, 2008	×				HOMER	

In the above table, we show the existing research on the issues. The economic operation is an important aim of power system. Piconets contains the type of generating unit and the permeability, load characteristic and power quality constraints, micro network operation mode, and energy policy taken by the power market, and the traditional power system is put in bigger difference. To make the micro network successfully incorporated into existing power system operation and to promote its economy, environment friendly is the key. Therefore, in ensuring piconets and provides the security and stability, on the basis of micro network economy optimal operation become the integrated control and an important content in the study of energy management.

In this paper, we conduct research on the hybrid energy storage based photovoltaic piconets and the isolated net running comprehensive control system in the campus environment. In this paper, a detailed study of photovoltaic piconets island operation system based on hybrid energy storage structure of photovoltaic cells, battery and super capacitor circuit model of the three energy unit, according to the purpose of control respectively designed three energy unit control circuit and control method. In order to improve the service life of the battery, optimize system operation state and design the battery and super capacitor energy storage system, battery based on energy

management more than current hysteresis control strategy which will be shown in the next sections.

The Proposed Methodology

The System energy management and control.

In this paper, design of photovoltaic micro network system to run in island mode, no large power grid with voltage and frequency, so the micro network must have ability to maintain its voltage and frequency. According to the micro mesh and interaction between the main energy, micro DER whether to enjoy the right of priority scheduling in the grid, interaction between piconets and main operation can be divided into the following several kinds of control strategies. (1) The network can and the free two-way exchange between main powers. (2) Preferred to use micro network internal DER to try our best to meet the demand of the network load, can absorb the power from the main, but not to the main power output. (3) Piconets DER with individual participation within the system operation optimization, but is still only can absorb power from the main, cannot to the main power output. For renewable energy generation systems especially photovoltaic power generation systems, although the environmental benefit is very high, the running cost is low, but for a long time to install cost has been high and the comprehensive economic benefit is unable to compete with other forms of power generation.

Therefore, at present China's electric power industry management mode is renewable energy power generation to enjoy priority rights and power dispatching is a full purchase discount. In this paper, the research also premises. Based on centralized control microcontroller net system, on the micro level network central controller shall be provided by the operation optimization of function is studied, with the power output of each DER, interaction between piconets and main power as optimization variables, the establishment of a micro network run active optimization scheduling model. The formula one expresses the objective function.

$$\min F_1(P_i) = \sum_{i=1}^N (C_f(P_{it}) + C_{OM}(P_{it})) + C_{PEt}(P_{gridt}) \quad (1)$$

Compared with ac micro grid, dc micro power grid because of the distributed power supply and dc bus voltage with only between primary transformation equipment, reduce the construction cost of the entire system, on the control are more likely to achieve; At the same time without considering the synchronization issues between the distributed power, in the circulation between different distributed power inhibition has more advantages. The limiting conditions are shown below. Regardless of the network loss and power electronic converter power loss, system runtime needs to satisfy the basic constraint conditions are as follows.

$$\sum_{i=1}^{N_d} P_{it} = P_{lt} - \sum_{j=1}^{N_{nd}} P_{jt}; \quad N_d + N_{nd} = N + 1 \quad (2)$$

When run micro grid island, as from the controller of the distributed power supply unit is commonly PQ control, the change of load mainly as a main control module of the distributed power supply to follow, so its power output should be controlled within a certain scope, and able to follow the load fluctuation and change fast enough. In the application of master-slave control strategy of power grid, when the micro grid work in parallel operation mode, all of the distributed power are usually applied PQ control,

but once in a lonely island operation mode, you need to as main control module of the distributed power supply controlled by PQ mode quickly converted to control mode, and the main controller can meet the fast switching between two different control modes. In the following figure one, we show the flowchart of the proposed control system.

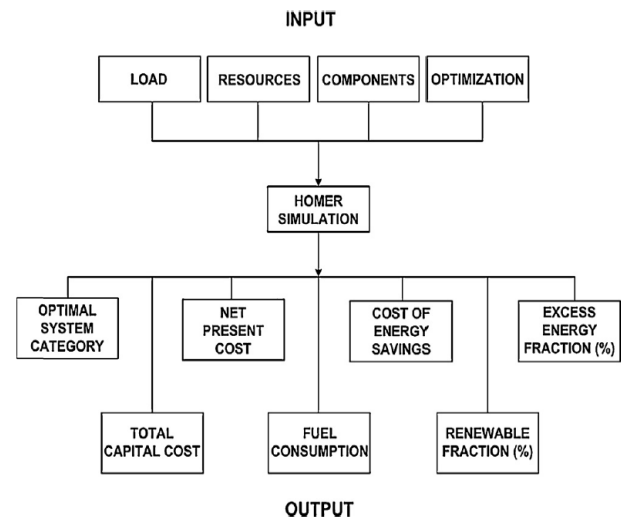


Figure 1. The Flowchart of the Proposed Control System

The Hybrid Energy Storage and Applications. Energy is the fundamental driving force of the development of the society. Solar energy as an inexhaustible, inexhaustible clean energy, safety, no pollution, renewable and the characteristics of wide distribution, it is an ideal renewable energy and green energy, is the source of all fossil fuels, and a variety of renewable energy, is the most sustainable way to relieve the energy crisis. It is the application of solar photovoltaic power generation and the building integration of a new concept which is the solar energy photovoltaic phalanx installation outside the building maintenance structure surface to provide power supply. This system can integrate solar power generating set perfect on the walls of buildings or roof, the principle and general of photovoltaic power generation systems are exactly the same, the difference is solar module generator is used as a system, and used as building materials. Combined with construction

of the photovoltaic system, can the independent power supply or power supply in interconnection manner.

The micro grid access will inevitably impact on power grid. Micro grid can absorb energy from the power distribution network, at the same time also can send energy to power distribution network, so a single energy flow, changed the traditional power grid when energy was obtained from the distribution of micro power grid, the grid power grid is a relatively concentrated load,

can adopt the traditional methods for operation and control; But when a large number of micro power grid through the distribution network to penetrate to the large power grid, the access point and the whole trend of the distribution of the distribution network will be a major change, will likely voltage stability and transient stability of power grid caused by the influence of different and the analysis of these effects is needed based on the new method. The following figure shows the comparison.

	HOMER	HYBRID2	HOGA	HYDROGEMS + TRNSYS	HYBRIDS	INSEL	HYBRIDS	ARES	RAPSIM	SOMES	SOLSIM
Free download and use	×	×	×								
PV, Diesel, Batteries	×	×	×	×	×	×	×	×	×	×	×
Wind	×	×	×	×	×	×	×		×	×	×
Mini-Hydro	×	×	×	×							
Fuel cell; electrolyzer and hydrogen tank	×	×	×	×							
Hydrogen load	×	×	×	×							
Thermal load	×			×							
Control strategies	×	×	×								
Simulation	×	×	×	×	×	×	×	×	×	×	×
Economical Optimization	×		×	×							
Multi-Objective optimization, Genetic Algorithms			×								

The System Structure and Simulation.

Micro grid parallel operation, power grid for micro power grid load fluctuations, frequency and voltage disturbance, grid inverter in the power grid frequency and voltage support, not participate in power grid frequency control and voltage regulation, mainly adopts PQ current source control method, which adjust the output active and reactive current control to track the reference current, through coordinate transformation, realize the active and reactive power decoupling control. For grid inverter is mainly have two kinds of control mode: the first is through a set of micro power active power reference value for power regulation. The second is the inverter control function, according to a

given reference value for active power and reactive power output.

For grid control delay and filter inductance changes will affect the system response speed, stability and grid current distortion rate, this paper proposes a power feed-forward robust forecast no beat control strategy. Control strategy of the whole nonlinear prediction method was adopted to realize the voltage and current double closed loop control, improved climbing method was adopted to realize maximum power tracking, by introducing feedforward control power to speed up the response of the system, in order to meet the demand of the grid inverter. In the following figure two, we demonstrate the simulation result for the photovoltaic piconets and the isolated net running system.

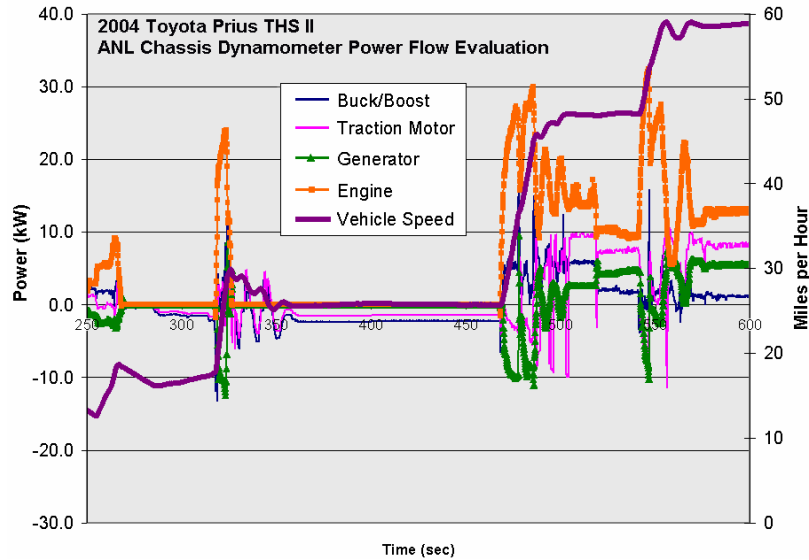


Figure 2. The Simulation Result for the Photovoltaic Piconets and the Isolated Net Running System

CONCLUSIONS

In this paper, we conduct research on the hybrid energy storage based photovoltaic piconets and the isolated net running comprehensive control system in the campus environment. For photovoltaic energy intermittent and volatility of nets, proposed by adopting the combination of battery and super capacitor hybrid energy storage system. Because of the hybrid energy storage system combines the advantages of battery and super capacitor, ensure the quick formation of the piconets instantaneous power balance, maintain the system voltage and frequency constant, guarantee the stability of the isolated net running. On battery control strategy is proposed in this paper the power trace hysteresis current control, real-time tracking the change of power demand, flexible adjustment of the storage battery charging and discharging current, to avoid the battery often switch between charge and discharge, and high power battery charging and

discharging. This method is helpful to improve the service life of the battery. The experimental simulation proves the effectiveness of the approach.

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