A Survey on Solar Inverters

Duc Hoai Tran; Masahiko Taniguchi
Masters
Dr H. G. Yeh
CSULB
t_hduc@yahoo.com

In the present global energy and environmental context, the aim of reducing the emissions of greenhouse gases and polluting substances has become of primary importance. The sun is certainly a renewable energy source with great potential and is environmentally friendly. It is sufficient to think that the surface of the terrestrial hemisphere exposed to the Sun gets a power exceeding 50 thousand TW; therefore the quantity of solar energy which reaches the terrestrial soil is enormous: about 10 thousand times the energy used all over the world. However, photovoltaic cells supply dc power while the present power grid accepts ac power. Therefore, dc-ac grid-connected inverters are necessary for power conversion. In order to avoid introducing additional distortions to the power grid, the generated currents from these inverters should have low harmonics. Ideally, the inverters should have high power quality, high efficiency, high reliability, low cost, and simple circuitry. It is a fact that the production of electricity from photovoltaic (PV) systems is still expensive when compared to conventional production methods. This necessitates the careful selection of each individual part of a grid-connected PV plant in order to achieve maximum energetic and economic performance. Sizing the optimum inverter in order to reach a consumer's electrical needs is one of the most important things that have to be considered. These days, many brands and options are available to consumers. The correct choice depends on how consumers intend to use the inverter. Options range from small mobile power units to mid-sized stationary inverters for powering home in either remote off-grid or urban on-grid location, to large inverters and groups of inverters networked together to run large businesses and even small communities. In this project, an investigation on inverter efficiency will be performed; the efficiency curve of a given PV inverter can be described by a function based on three parameters that can be easily determined from the data provided by the manufacturer. Then an analytical method for the calculation of the optimum inverter size in grid-connected PV plants in any location, which can be a valuable tool for comparing different inverters without having to perform multiple simulations, is presented.

VAR Control for Distribution Circuits with Photovoltaic Generators in a Dynamic (Time-Varying) Setting

Son Doan
Ph.D.
Dr. Henry Yeh
California State University, Long Beach
sonproee@gmail.com

There has been a growing interest to find ways to replace fossil fuel based power generation with renewable energy resources, which are desirable not only for environmental reasons but also because someday we will run out of fossil fuel. Due to that reason, the California Renewables Portfolio Standard (RPS) has been mandated to require 33% of the energy consumption to come from renewable sources by 2020. This recent legislation has stimulated a boom in the construction of generation facilities that are eager to deliver renewable energy to consumers. The integration of renewable resources generally happens at the transmission level in the forms of large generation such as wind and water-based power plants. Integration of renewable resources can also take place at the distribution level where the installations are generally small commercial and/or residential, typically in the form of photovoltaic (PV) solar panels.

With the installation of PV's throughout a distribution circuit, real power is being injected into the system from these PV's. When the number of PV generators on a distribution system is small, the impact it has on the system is small and can be neglected. When the penetration level gets high enough, the distribution system might encounter various problems such as loss of proper voltage regulation. Reactive power (VAR) control can be used for the purpose of mitigating some of these problems. Historically, utilities used capacitor banks at the substations to control the voltage level and maintain the level of VAR draw. The problem with capacitors is that they're not fast enough to respond to the fast random fluctuations of renewable generation. Several studies have shown that DC/AC inverters that connect PV to the grid can be used to as a VAR controller since they can inject or draw VAR at a much faster timescale than capacitors.

Biodiesel synthesis and analysis using Fourier transform infrared spectroscopy and gas chromatography

Leidy Palomec
Undergraduate
Sergio Mendez
Chemical Engineering CSULB
pliracema@yahoo.com

The worldwide demand for petroleum, a limited resource, is increasing rapidly each year. The remaining accessible reserves are becoming more difficult to extract therefore more expensive. The increasing shortage of petroleum reserves makes alternative energy more advantageous and desirable. The creation and usage of biofuels also reduces pollution, global warming and the dependence of non-renewable foreign fuels imported to the United States. Biodiesel, a type of biofuel, is a renewable alternative fuel can be made from fresh or recycled vegetable oils.

Biodiesel is synthesized by a process called transesterification. In this process, soybean oil (a triglyceride) is reacted with methanol (an alcohol) by using sodium hydroxide as a catalyst to produce biodiesel (fatty acid methyl ester) and glycerol (a by-product). The quality of biodiesel is pivotal to the performance and acceptance by industry. One major dilemma of making biodiesel is the presence of unwanted by-products after biodiesel synthesis. Our first objective is to study the synthesis of biodiesel to track the reaction over time. A second objective is to test the biodiesel sample for by-products based on the ratio of free fatty acids to triglycerides present in the reactants. An analysis of the Fourier transform infrared spectroscopy (FTIR) results was used to determine the percentage of biodiesel to soybean oil in mixture and to create a calibration curve. Gas chromatography (GC) measurements were monitored to measure the levels of glycerin plus unreacted mono-, di-, and/or triglycerides in the biodiesel. In the analysis of biodiesel and oil mixture, it was concluded that the majority percentage was made by the first 10 minutes of biodiesel synthesis. The GC tests demonstrated that the impurities presented in the reactants proportionately affected the products contents of impurities. The glycerin and unreacted glycerides (or by-products) can cause soap formation and can clog the injectors of an engine, therefore it is crucial to produce high quality biodiesel.

Currently, we are experimenting with algae and its growth. Future analysis will be made on the development of algae as a biodiesel synthesis source. Algae can prove to be a much better source of biodiesel as opposed to vegetable oils because it does not compete with food sources, and it grows much faster and has more energy per unit of weight.

Experimental and Computational Simulations to Maximize Power Output of Polymer Membrane Fuel Cells

Lisa AungYong and Michael Tran
Undergraduate
Sergio Mendez
Chemical Engineering CSULB
lisa.aungyong@student.csulb.edu

As the world's fossil fuel reserves become depleted, we must find alternative sources of energy. The ideal replacement fuel will emit less environmental pollutants and green house gases. Hydrogen fuel cells are a promising source of electrical power since the input fuel can be from renewable green sources and the exhaust emission is simply water. Because fuel cells convert chemical energy to electrical energy, chemical engineers play a central role in the development of this technology. At the fuel cell anode, hydrogen gas is flowed past a polymer membrane where the molecule is split into protons and electrons. The electrons flow through an external circuit and thus produce electric power. The protons travel across a proton exchange membrane to the cathode where oxygen is flowed. The protons react with the oxygen to produce water. In this work, we have experimentally measured the effect of hydrogen gas flow rate and fuel cell temperature on maximum electrical power output. We observed that there is a saturation point where the power plateaus and increasing the hydrogen gas flow rate has no effect. The goal of this research is to maximize the power output by developing improved polymer membranes. To understand the fundamental transport properties of the membranes, we utilized COMSOL Multiphyics, a finite element solver that has been documented to accurately model a wide array of physical systems. We performed computer simulations to model the effect of gas flowrate and temperature on the permeability of the membrane, and the electrical power of the fuel cell. Our vision is to use the results of COMSOL simulations to guide our future efforts to fabricate polymer membranes that can maximize electrical power output from fuel cells.

GOBO Hybrid

Danny Pham, Ketan Ranade
Undergraduate
Dr. Nour
CSULB
dannypham@ieee.org

In this poster, a design for a practical and cost effective electric vehicle is presented. The 3-wheel plug-in hybrid architecture includes a 50-kW, 3-phase ac induction motor driving the front 2-wheel axle and an independent small internal combustion engine (ICE) coupled to the rear wheel. The battery-pack is sized for an average daily commute without the need for the ICE. However, the on-board light-weight ICE provides extended driving range when needed. This vehicle is built and currently being tested at the college of Engineering, California State University, Long Beach as a graduate research project. An overview of the performance of the vehicle on the road is described. Tests carried out on the vehicle include evaluation of acceleration and speed characteristics in addition to the overall powertrain efficiency. The additional gain in efficiency and range, accomplished via the 3-wheel aerodynamic configuration is also discussed. The components of this vehicle were carefully selected to achieve significant reduction in the overall cost compared with that of traditional plug-in hybrid vehicles.