Electrical design of a photovoltaic power station research proposal example

Environment, Electricity

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FOR ADDITIONAL POWER GENERATION

Introduction

Power shortage in the globe has been one of the major problems our world is experiencing today. One solution to this crisis is through resorting to clean and renewable energy which lets us harness a source of energy that can replenish itself over and over again.

Fossil fuels such as coals, diesel, oils, etc. are used worldwide in generating the energy the world needs such as electricity. Electricity is now one of the basic needs the world needs in order to function. Everybody needs electricity, in big industries up to small households, in lighting our light bulbs at home, in charging our cellular phones etc. But these fossil fuels are finite, they can be depleted. What are we going to use then if fossil fuels reservoir are depleted? Not only these kinds of fuels depletes but it cause air, water and soil pollution and it also produces greenhouse gasses that contributes to global warming.

The conventional electrical energy generation is facing environmental issues

like the release of pollutants in the air like Sulphur Dioxide (SO2) and Oxides of Nitrogen (NOx), which both contribute to acid rain, as well as particulates which may contain trace metals such as Cadmium, Mercury and Lead. Another unavoidable consequence of burning any fossil fuel is that the process generates greenhouse gases, mostly Carbon dioxide (CO2) but also Sulphur dioxide (SO2) and Methane (CH4), all of which contribute to global warming (World Nuclear Association, no page). These are just some of the many reasons why people should resort to renewable energy sources in power generation.

There are many factors that need consideration when it some to the construction of a Solar Photovoltaic Power plant. Some of these factors are shading, array orientation, array construction, array mounting methods, Balance-of-System (BOS), Solar cells, PV modules, Solar PV parameters, grounding, inverters, transformers and cables and wiring system (Wood, no page).

Literature Review

The Department of Energy (no page) defines Solar power as the direct conversion of electromagnetic light for example sunlight into direct current which is a form of electricity electricity. This method either directly converts sunlight to electrcricity through the use of photovoltaics (PV), or indirectly converts sunlight through concentrated solar power or CSP. CSP systems utilize mirrors or lenses as well as tracking systems in order to focus and harness the rays of light to a small beam. Photovoltaic on the other hand is the conversion of electricity when a material is exposed to light or also

known as the photovoltaic effect.

The intensity (or power) of sunshine is called irradiance and is measured in watts per square meter (W/m2). The amount of solar radiant power that hits the earth’s outer atmosphere is a nearly constant 1, 360 W/m2. On a clear day, approximately 70% of this radiation makes it through to the earth’s surface. The amount of solar energy received on a given area over time is measured in kilowatt-hours per square meter (kWhr/m2) and is called insolation (one kilowatt equals 1, 000 watts). Insolation (energy) differs from irradiance (power) because of the inclusion of time. (Wood, no page)

Previous studies regarding the Photovoltaic Technology are being done by SME which is a private organization that utilizes renewable energy resources as a source of power and electricity.

Tipler (no page) claims that the power density of the solar energy hits the Earth’s surface at sea level is 1. 353 kW/m2. This is a large amount of energy if it can be fully utilized though only 20% of it in reality can be converted into electrical energy since photovoltaic cells have limitations and can be affected by a number of factors.

Ryan Jose Sumaya (p 73), an engineer who conducted a feasibility study regarding the electrical system design of a Solar Photovoltaic Power Station in a province in the Philippines found out that we should find first the best site for installation of the solar farm. Attributes such as solar resource, land use, topography, accessibility, grid connection and socio-political acceptability was used in evaluating the prospected sites. Other factors were also considered studied are done regarding the components of a Solar Photovoltaic Plant like the capacity of the plant, brand and specifications of

the solar modules, number of modules and panels, length of cable wires, electrical design was made and the total project cost was estimated. Grid impact study regarding the insertion of the plant to the grid was also made. Adrian Timbus (page 1) studied the benchmark networks for grid integration impact studies of large Photovoltaic Plants. He found out that this renewable energy way of generating electricity is now ranked third next to hydro and wind power plants. Having renewable energy power plants connected to the grid led to the concerns of the grid's stability, reliability and the stability.

Methodology

Site inspection is the first part of this project. A round trip around places should be made and possible sites for the solar PV plants should be listed and marked on the map. After initial site inspection has been conducted, prospected sites have been evaluated. The method of multi-attribute decision analysis was used in selecting the site. Initially, local climate, land area, and water availability were included in the attributes to be evaluated. Other attributes must also be evaluated like the solar resource, land use, topography, accessibility, grid connection, and socio-political acceptability. If the place is finalized, data regarding that place should be gathered. Data like over-all load demand and load forecasting of the place should be done. The design of the plant depends on the orientation of the area. After the designing process, project cost estimate as well as the load flow analysis should also be made before executing the building process. Other grid impact study includes the short circuit analysis of the grid where the plant

will be connected as well as the protection and coordination of the devices when this solar PV plant is operational.

Possible Problems and Recommended Solution

It is highly recommended that a thorough and detailed design and estimate of the PV plant should be made. The design made was just an electrical design considering the main components of the plant such as modules, inverters, cables and transformers. A detailed design would contain the protective devices that would be incorporated in the plant, the control system, the metering system, etc.

The cost estimate of this project was limited to the plant only not considering the transmission lines and other electrical equipment that would be used in tapping the plant to the existing electrical system of the desired location. It is highly suggested that a substation should be designed for the PV plant.

In conducting the load flow, short circuit analysis as well as the protection and coordination analysis of the electrical system of the site that you wish to install the Solar PV Plant, it is recommended that a manual solution of this analysis should also be presented as supplement to the computer software used.

It is also recommended that a thorough study should be conducted on this project about the licensing, permits and incentives from the government.

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