Senior Design Group: DEC1706

Travis Merrifield: Travism1@iastate.edu

Elika Korhonen: elika@iastate.edu
Joshua Pachl: jgpachl@iastate.edu
Noah Chartouni: noah.chartouni@gmail.com
Steve Ukpan: soukpan@iastate.edu

Extra Credit Homework

As a society moving towards the future it is important that we continue to research and implement renewable energies. Fossil Fuels have limits to their availability and are harmful to our environment. Part of continuing this process is making sure that future electrical engineers are educated about photovoltaic systems. While the DEC1706 group project is a stand alone PV system its primary purpose is to educate students that take the Motors and Power electronics course, EE 452, at Iowa state University about the main concepts of a photovoltaic system. These concepts can be related both for stand alone applications as well as grid connected technology. The main difference is converting the final result into 60 Hz three phase to connect to the grid and also that batteries are not necessarily required when connecting to the grid but can still be used.

While doing research on these different systems a project that was very similar to ours was a research paper that was presented at the 49th North American Power Symposium Hosted by West Virginia University. “Portable PV energy conversion system Suitable for Educational Purposes; Part 1 : Pollution Reduction Rate and Reactive Power Delivery Estimation”. They use a mobile cart with a PV panel, an inverter, a typical load, two MyDAQs, a computer, and a monitor. They use these tools to observe the output of the solar panel and the inverter. The primary objective of their project is suggested in the title. It is to observe the pollution reduction and also to estimate the reactive power that is generated by the inverter. These two concepts are both applicable when considering connecting a PV system to the grid. One would want to know the reactive power injected into the system as this affects the stability of the power grid as well as the voltage. In a distribution system where the PV system is large versus the load too much reactive power can cause high voltage problems for the utility.For example at Alliant Energy they have high voltage issues in areas with high PV penetration. Pollution has also been a huge topic in both politics and industry and although the current presidential administration is not as adamant about pursuing goals for reducing emissions many companies and States already put a huge amount of resources into reducing emissions.They also are more committed to protecting the environment.This highlights the importance of understanding how solar panels can help us in this manner. These companies and states will not want to see the large amount of resources put into these areas be wasted so it is unlikely that they will slow down their pursuits of this, thus putting more solar onto the grid. The way the paper proposes to measure how the solar panels could help reduce carbon emissions is they simply measure the amount of energy produced by the panels and then compare this to the amount of energy that would be used by an electric car. By making this comparison they can reach the conclusion that if the power produced is used by one of these cars then the amount of carbon produced by a car that produces emissions traveling a similar distance would be saved. I believe that comparison is a little bit of a reach because cars would generate carbon at a different rate than say a coal plant which is what the solar panel would more likely replace. Nonetheless it is a good way to get an Idea the impact the solar panel has. With the mobility as well as the measurement systems that are involved in the project described above It creates a good platform for students to observe and participate in the output of the solar panel.

There are some differences between our project and the one mentioned. The first one is the lack of an MPPT module. One of the core concepts of our project is to educate students about the importance of Maximum Power Point tracking. This is a tool that manipulates the voltage and current of the Solar panel to make sure that for a given Irradiance we are receiving the most power possible from the panel. Another significant difference is that our system is more designed to demonstrate a stand alone system. Our system uses batteries as well as the MPPT module to

manage output. This means that the MPPT module controls whether to use solar output or battery output based on the voltage of the solar panel and the batteries. We are also able to choose a load that is sized to the batteries so that theoretically it should be able to operate all of the time. Our project also has several different loads that can be tested. An induction motor, a DC motor, and also standard light bulbs. This allows us to derive and perform a few different educational experiments. The class is power electronics and motors so using the motors we can combine solar and motors and then the light bulbs allow for an easy way to observe the behavior of an inverter connected to a PV system. An inverter is a useful piece of power electronics that is also highlighted in the class. While the observable outcomes between the two projects are different the goal of educating students about emerging solar technology remains the same. While there are not many direct applications of stand alone PV it is a technology that could become more prevalent as good energy storage systems emerge.

An example of a stand alone PV project that has not been started yet but is worth keeping an eye on is being debated because of the recent tragedies in Puerto Rico. According to the BBC article *“Elon Musk says he can rebuild Puerto Rico's power grid with solar”* Elon Musk would like to rebuild Puerto Rico’s electric grid using solar panels and Tesla’s solar storage technology. The article also states that *”The company(Tesla) says it has powered small islands, such as Ta'u in American Samoa. There, it installed a solar grid which can power the entire island and store enough electricity for three days without any sun”* This has broad implications if this project is carried out. This would increase the relevance of our project because it would provide a direct application of the PV system that our project models on a much smaller scale. These kinds of applications again highlight the importance of educating students about PV systems in general which our project attempts to do.

With the emerging of PV systems throughout the power grid in the U.S. system and around the world it is important that Iowa State University educates its students about Solar panels and how they provide power to different loads and the various electronics that are involved with those systems.This is what DEC1706 aims to do with our project. While the concepts and methods that we choose to educate about are different from other ways of doing it. It can be seen that it is a useful and necessary task that can be adapted in the future as the future of this technology evolves because of the flexibility of our system.

Bibliography

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