ADVANCED TECH

G.S.D. Group Final Report

Photovoltaic Panels, In-Floor Water Heating and Wind Turbine

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PHOTOVOLTAIC PANELS

Goal:

The G.S.D. groups goal for this section of testing was to ensure that the fourteen available photovoltaic panels were as effective as they could be. This was important from the start as we already had doubts concerning the first semester wind turbine and would intending to rely solely on P.V. panels for our energy demands.

In order to accomplish our goal we had to test our panels for effectiveness. This meant sitting down as a group and asking ourselves "what variables will affect our panels energy production?" As a response to this question we determined that: a) the angle of installation would determine exactly how much sun light was able to directly hit our panels, b) the directionality of our shed would determine when the sun would reach us and, c) the light intensity and would be directly comparable to how much current we could produce. Once we had gathered these basic assumptions, we were ready to begin our testing.

Photovoltaic Testing Station:

Luckily for the G.S.D. group, all of our P.V. panel testing could be done from the same set-up. This was ideal for us because it meant the least amount of lugging materials to and from our station as well as consistent surrounding conditions for easily comparable results.

The G.S.D. Photovoltaic Panel testing station (Figure 1.1) was located on the top of the Sussex Regional High School roof, making it possible for testing periods to extend well beyond our one hour of class time.

Figure 1.1: G.S.D. Photovoltaic Panel testing station.

Our set-up consisted of three P.V. panels, all at different angles, a temperature probe, and a light intensity probe all connected to three GLX data loggers which tracked the current going through each panel, the light intensity at a central point and the outside temperature.

Test 1.1: Best Angle of Installation:

The first variable that our group decided on testing was the angle of installation. As a group, we decided that we would test three P.V. panels each at a different angle. After some discussion and research we came to a decision to test the angles of 35°, 45° and 60° (all with the horizontal), 35° because it is the recommended angle for our location, 45° because we felt it to be an average, and 60° to include a steeper slope for data purposes.

Once we had decided on the three angles to test, we positioned our panels accordingly and began collecting data. Our testing period was over the course of four days during which we experienced sunny, cloudy and overcast days. Upon completing our 96 hour testing period, we extracted the data from the loggers and used excel to create a graph comparing the current going through all three panels.

Test 1.1: Results:

Once we had organized a graph comparing all three panels (Figure 1.2), we were faced with the task of analyzing our information. Despite our hypothesis that the 45° panel would be most efficient, we were looking at graphs that showed 35° to be not only to reach higher peaks, but to be more consistent.

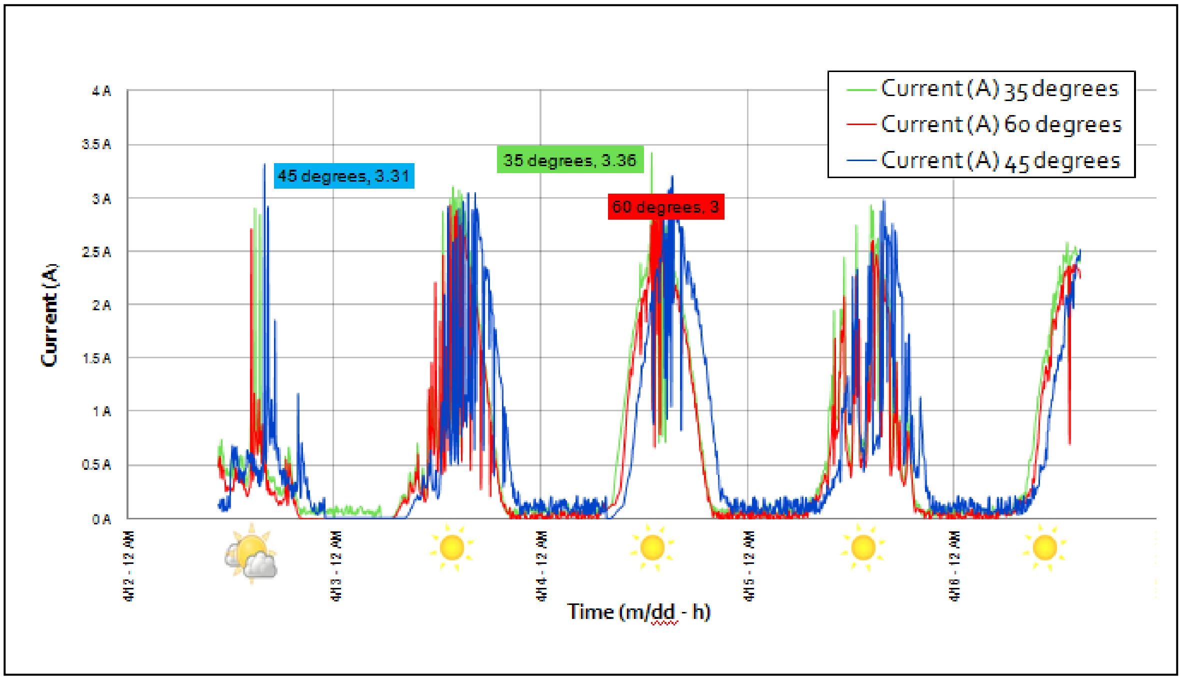


Figure 1.2: Current Comparison Graph.

Under further examination of our graph, we began to notice the trend of the 35° angled panel providing current before any other, and the 45° angled panel always provided current long after the other two had stopped (**Figure 1.3)**. Realizing this, our group decided that in order to maximize our current production, we would install panels at two different angles.

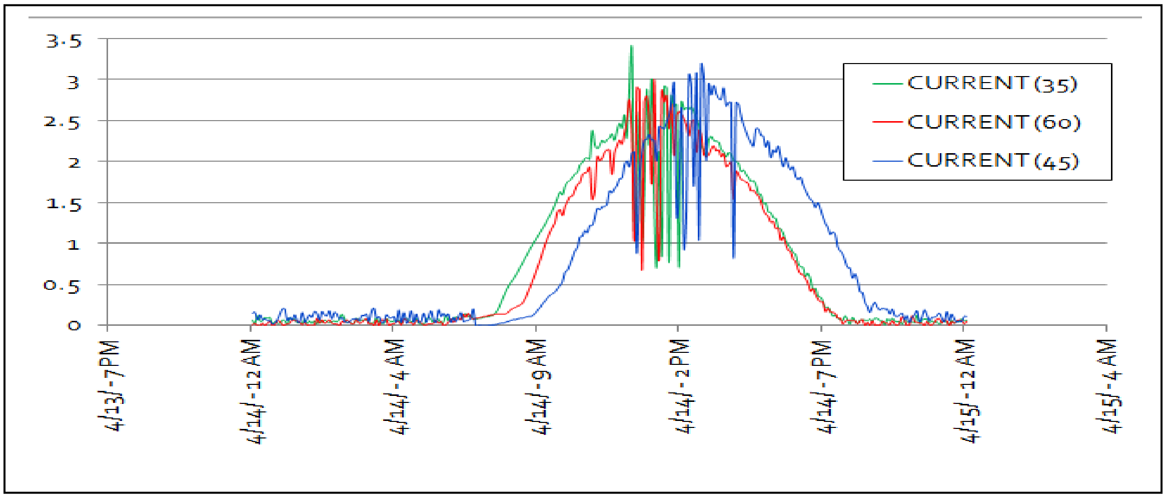


Figure 1.3: Comparison graph displaying trends in current production times.

Sunlight Intensity:

The second test that the G.S.D. group did was based around the average sunlight intensity. With this test our goal was to find out how much sun we were exposed to on average. Our group decided that this was an important test to undergo because when we presented our initial shed designs we were all guessing the amount of sunlight hours that were available to us. In order to eliminate guessed number and present estimates or "educated guesses" we came to the conclusion that we needed to look into sunlight intensity in greater detail.

This test was very simple and consisted of a Sunlight Intensity probe and a GLX data logger. By fastening or Sunlight Intensity probe to the center of our roof testing station (**Figure 1.1**) due South, we were able to leave it on the roof of the school for a period of 96 hours and track the Sunlight patterns over the course of varied weather conditions.

Test 1.2: Sunlight Intensity Trends:

By doing this test the G.S.D. group was able to determine that on average we receive sunlight for approximately 7 hours per on a sunny day (**Figure 1.4**). Looking at our results we were also able to conclude that the patterns are fairly similar on a daily bases (note: the weather consists of only cloud and sun).

Test 1.2: Results:

To finalize this test, we chose to organize our data in a fashion that would compare the light intensity, outside temperature and angle of our panel. The following graph represents our results.

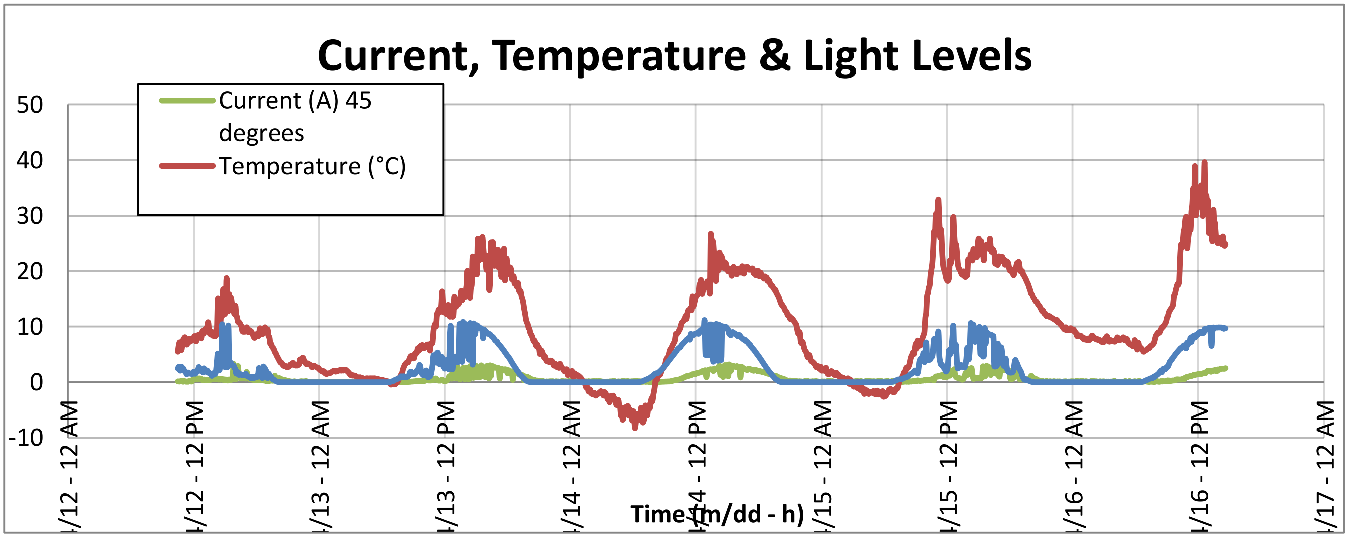


Figure 1.4: Results of the Sunlight Intensity test

Conclusion:

As a conclusion to our Light Intensity tests, we determined that on average we have 7 hours of sunlight to our exposure so long as our panels are facing southward. An additional conclusion that we were able to make through examining our results, is that the outside temperature has no effect on the light intensity of any given day. We were able to determine this by comparing the shapes of the red and blue line graphs above (**Figure 1.4**).

IN-FLOOR WATER HEATING

Goal:

The goal of this section of testing began as "designing a semi-self sustaining In-Floor Water Heating System" but due to lack of supplies and a shortage of time, ended on a slightly different note. All in all, as the end of the semester snuck up on the G.S.D. group and we only had one In-Floor Water Heating test completed, our goal morphed into supplying the next semester with a partially built design and plan so that they are able to carry on where we have left off.

Insulation Test 2.1: Gravel v.s. Air :

The single test that we were able to conduct during this phase of our project was based on the insulation of our In-Floor Water Heating System's pipes, to be located beneath the floor of the actual building. One day as Vanessa was visiting, it was asked of us "how we planned on keeping the heat in our in-ground pipes?". From this question, we were able to sit and plan a test to determine whether or not pipe insulation was an asset or only a further expense.

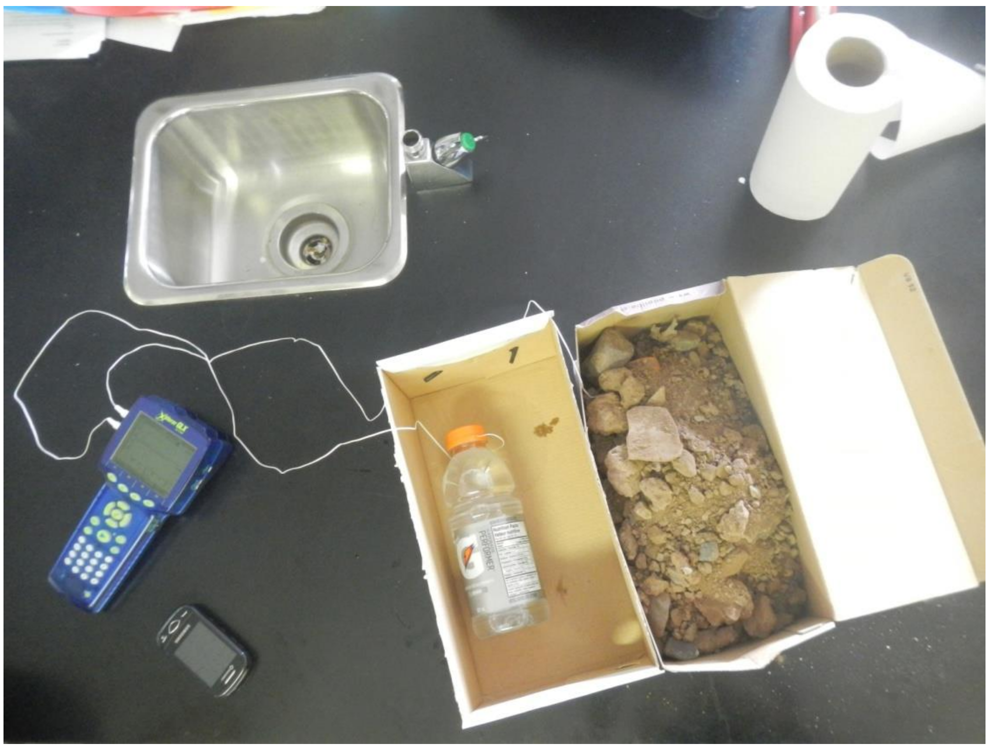


Figure 2.1: Testing which medium, air or dirt, serves as a better insulator

This test, although one of our more simple experiments, was able to definitively prove that insulation was certainly more than just an expense. Our In-Floor Water Heater test used two identical water bottles, two testing mediums and a GLX data logger hooked up to two temperature probes (**Figure 2.1**). By filling up both bottles with the same amount and temperature of water and placing each bottle in its "insulation" or testing medium, we were able to track the rate at which the temperature decreased, and as a result determine which medium was more effective in terms of retaining heat.

Test 2.1: Results:

As our group had initially assumed, we were able to prove that insulation, in our case dirt, retains heat more effectively than no insulation or "air". We determined this through a graph of our data that illustrates the rate at which each bottle loses its heat (**Figure 2.2**). By examining this graph we are able to visually see that although both mediums appear to begin decreasing in temperature at the same rate, the red line, symbolizing gravel, holds onto its heat longer than air.

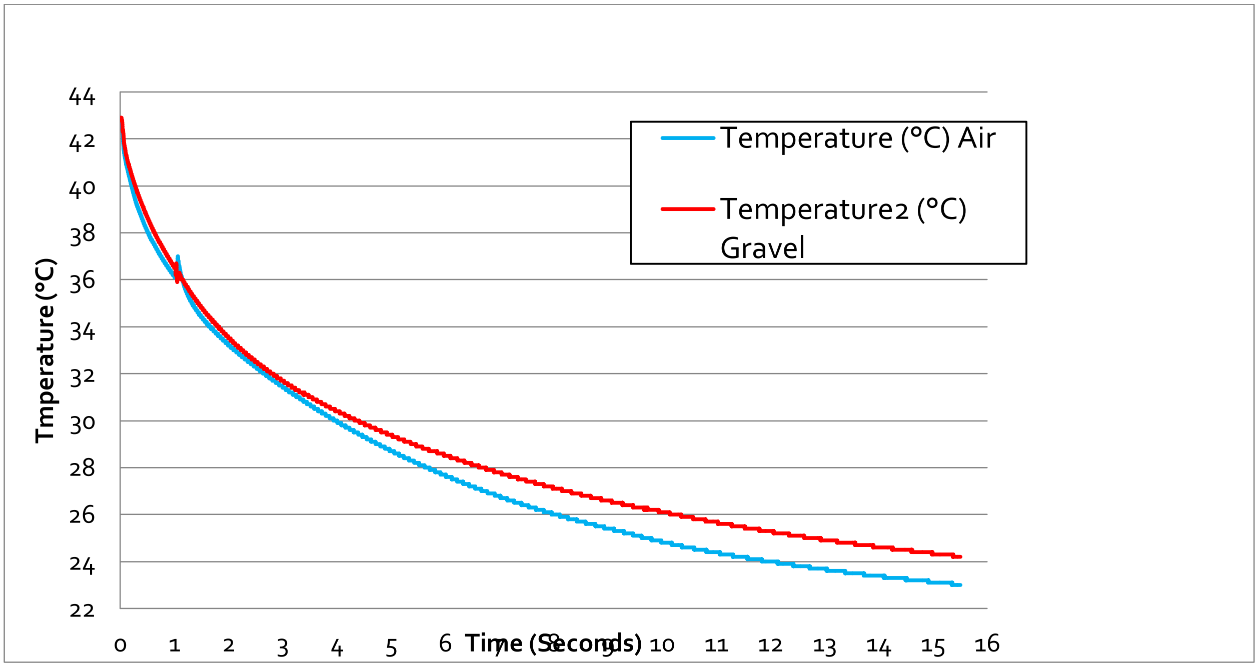


Figure 2.2: Results of test 2.1 Water V.s Air

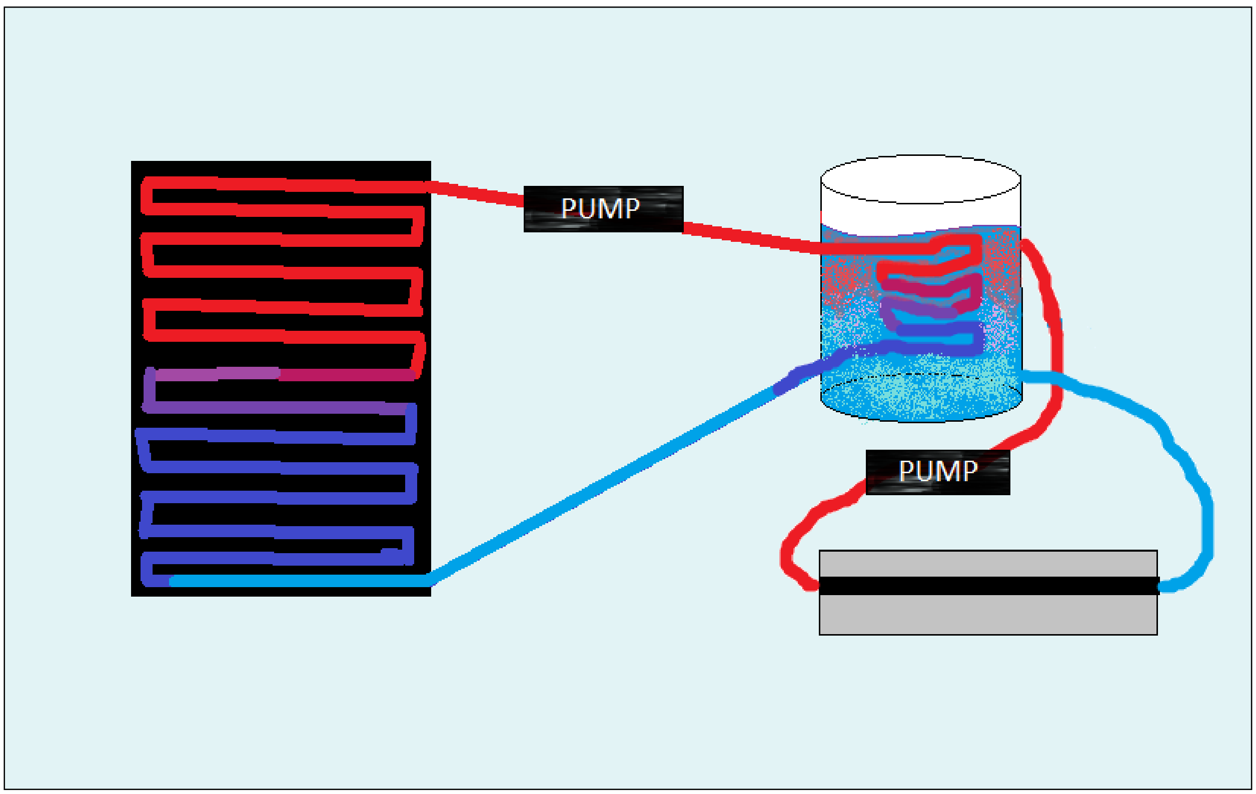
Conclusion:

Although the G.S.D. group was unable to come to as many conclusions in this section as in the Photovoltaic Panel section, we are confident in the one fact that we have concluded; our In-Floor Water Heating System *must* have an insulation of sorts surrounding it's in ground piping. By finding dirt to work as a better insulator than air, we can determine that only air is not enough to prolong the heat of our piping.

While the G.S.D. test was based on dirt as an insulator, we would highly recommend to the next group that they look into the possibilities connected to cement. it is understood that if a pipe were to burst, cement would prove incredibly difficult to get around in terms of repair, however; there may be cement alternatives that we overlooked due to a shortage of time this semester.

G.S.D. In-Floor Water Heating Design:

Over the course of the semester the G.S.D. In-Floor Water Heating Design (**Figure 2.2**) has undergone numerous tweaks and changes but as we come to an end, we are confident in both our design and suggestions to the following Adv. Tech. class.



Our design consists of two main components, a heating station (On the right of **Figure 2.2**) and the floor heating loop (One the left of **Figure 2.2**). By dividing this system into two parts, we can ensure that the heated water being pumped through the floor never leaves the inside of our building therefore reducing the risk of freezing and/or bursting pipes during the colder winter months.

WIND TURBINE

Goal:

Our goal for the Wind Turbine section of testing was to test the pre-existing Wind Turbine and see if there was any justification to continuing on with the first semester design.

Test 3.1: Wind Turbine Effectiveness

The test that we preformed for the wind turbine, although informal, was able to definitively answer the questioned asked when posing our goal statement: "*Will this Turbine produce enough power to be worthwhile?*". As a test, with the help of Vanessa and Mr. Gaunce, we took the wind turbine outside, hooked up a Multi Meter in order to track the current it was producing.

Test 3.1: Results

Unfortunately, while the wind turbine was spinning as fast as we could possibly make it go the multi meter produced a reading of only .11 milliamps, certainly not enough to power a building. Although it is entirely possible, and most likely, that with a few tweaks to the first semester design we would be left with an successful wind turbine, we felt that due to a limited time frame focusing on the In-Floor Water Heating System would be more beneficial.

Conclusion:

Concluding our final area of testing, the G.S.D. group has labeled the first semester wind turbine as ineffective, however; we do have suggestions regarding the Wind Turbine for the following Adv. Tech. class.

Our first suggestion would be to mount the Wind Turbine on the roof or side of the building simply due to the surroundings, traffic and location, behind the school. Our secondary suggestion, is in terms of the height at which the Wind Turbine should be mounted. After extensive research we have found that the turbine should be mounted at a height that is 150% of the buildings height, this is to ensure that the turbine is clear of any wind turbulence from the roof yet high enough that it will be able to capture optimal wind flow without snapping your support pole.