OUTDOOR PERFORMANCE STUDY OF POLY AND MONO CRYSTALLINE PHOTOVOLTAIC MODULES UNDER VARYING ENVIRONMENTAL CONDITIONS

A Project and Thesis submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this project and thesis entitled "OUTDOOR PERFORMANCE STUDY OF POLY AND MONO CRYSTALLINE PHOTOVOLTAIC MODULES UNDER VARYING ENVIRONMENTAL CONDITIONS" is done by the following student under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 31 October 2020.

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The project and thesis entitled **"** Outdoor Performance Study Of Poly And Mono Crystalline Photovoltaic Modules Under Varying Environmental Conditions **"** submitted by **Shah Isteak Mahmud**, ID No:153-33-2853, Session: Fall 2015 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** on 31 October 2020.

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This thesis is dedicated to my parents & teacher's

For their endless love, support and encouragement…

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List of Abbreviations

PV	Photovoltaic
LCA	Life Cycle Analyses
EPBT	Energy Pay Back Time
Isc	Short Circuit Current
Voc	Open Circuit Voltage
Rs	Series Resistance
Rsh	Shunt Resistance
V	Volt
Amp	Ampere

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ABSTRACT

This study investigates the environmental impact on poly Si and mono Si Photovoltaic module in outdoor condition. Two sun oriented modules with similar qualities have been utilized to do the effects of the ecological boundary for example temperature, moistness and wind speed on the sun based PV module. The ambient temperature and the module surface temperature around the solar PV module was recorded at the same time with the output current to assess the impacts of the temperature on the PV module performance. Additionally the overall dampness and wind speed for the investigation region information acquired by a moistness sensor and an anemometer individually. Results show that the temperature has the best effect on the presentation of the PV module followed by relative mugginess and overcast spread. In this investigation, poly Si module shows higher rate estimations of short out current concerning mono Si module for the vast majority of the days. It shows the poly Si module performs in a way that is better than the mono Si module all through the examination in outside condition

CHAPTER 1
INTRODUCTION

1.1 Introduction

In this 21stcentury overall sun oriented photovoltaic (PV) is one of the quickest developing sustainable power source innovation. The purpose for is the fast consumption and unfavorable ecological effect of petroleum derivatives. With a yearly increment of over 47%, the worldwide yield of the PV segment has surprisingly expanded from 0.26 GW in 2000 to 41.7 GW in 2013.Past life cycle investigations (LCA) of photovoltaic (PV) frameworks have made a delegate information base of the creation steps of this quickly creating industry. These past investigations have brought a superior comprehension of the basic boundaries affecting the aberrant sunlight based power ecological effects. Regardless of whether innovative enhancements are a significant objective to both limit the expense and natural effects of sun powered power there are other critical boundaries those are stamped liable for the effect on pv framework. Force is made in Bangladesh basically from oil and coal likewise, little part of vaporous petroleum. The essentialness usage is by and large from the oil gas (76.6%), oil (23.0%), hydropower (2.3%) and coal (1.7%). Bangladesh's all out force age limit was 13,555 MW in June 2017 that gives a passage to control among 77.9% populace. The Renewable Energy has a little offer on the all out power age and is the most minimal on the planet. Regardless of the explanation as Bangladesh has now made a dream to offer capacity to the majority of the people by 2020, to achieve this target the council articulated a clean manageable imperativeness approach. The prospects of sun-situated essentialness is a remarkable for Bangladesh everything thought about orchestrated inside 20.30◦ and 26.38◦ north degree, 88.04◦, and 92.44◦ east longitude that is altogether sensible for the production of sun arranged imperativeness. [1]. It was viewed a biggest sun-based radiation, 4 to 6.5 kWh/m2 got in the extended length of March to April and least on December to January. Notwithstanding having expanded force age regular huge measure of hurtful items and harmful gases are delivered from the energy plants in our eco framework, where sparing the climate is one of the most significant obligation for us. To secure the livings and our hereditary qualities the best thought for the world currently is to rely

increasingly more upon sun powered energy as it is both inexhaustible and clean, it doesn't emanate any poisonous gases or items into our current circumstance. Other than the assets oils, coals, and so forth which are expected to create power are going to terminated in not so distant future. Presently our lone expectation is this sustainable type of energy that will consistently be there to help us for quite a while.

1.2 Literature Review

As sun oriented energy is a center subject now numerous explores and ventures have been done through everywhere on the world. Researchers and understudies have analyzed various activities hypothetically and basically. Numerous papers and postulation books have been distributed in various diaries and gatherings. We have experienced diverse proposal papers and exploration papers to gather an immense information about others' examination works. So as to accomplish our motivation, bunches of hypothetical examination has been finished.

Three specialists A Singla, K Singh and V K Yadav from India in their paper "ecological impacts on execution of sunlight based pv module" [2] examined about the temperature consequences for the sun powered execution. Therefore, they found that the yield power has a contrary connection with the temperature. The higher temperature rises the yield intensity of the boards gets lower. High obstruction additionally has negative impact on yield power, however the yield power is relative with the shunt opposition of the framework.

In another exploration paper distributed in "24th European Photovoltaic Solar Energy Conference, Hamburg: Germany (2009)"[3] scientist looked at the aftereffects of a day to day existence cycle affectability investigation with values from past explores.

'Execution investigation of mono-translucent and poly-glasslike silicon sun powered cells comprehend distinctive atmosphere conditions: a relative report' [4] a proposal from BRAC college dependent on the presentation of mono and poly glasslike sun oriented module in various seasons under various natural and indoor condition. They concocted an outcome that the energy yield is distinctive among indoor and outside investigation. They found the sun based module more productive in outside examination and most extreme energy is acquired in the period of March and April.

A gathering paper "Execution Analysis of PV Cells under Monsoon Climate" which introduced in the IAPE'19 Oxford University. [5] They discovered that the radiation power of winter is around 54% of that force of summer, additionally the most noteworthy radiation force at the early afternoon (around 12 pm). The yield current of mono translucent (m-Si)

cells is higher than that of poly glasslike (p-Si) cells consistently in a day in the period of September and January. From 11 am to 12 pm, the estimation of current expanded up to 37% in September and 15% in January. There is no recognizable variety seen in 11 am to 12 pm even the pinnacle irradiance esteem saw around then.

The genuine natural effects of translucent silicon pv modules: an investigation dependent on cutting-edge produces information. [6] It tells that along with various pv organizations a broad exertion has been made to gather life cycle stock information that speaks to the current status of creation innovation for translucent silicon modules. Based on this new information it is indicated that pv frameworks based on c-Si innovation are in a decent situation to contend with other energy advances.

1.3 Objective

The primary objective of this work is to examine the exhibition of two distinct kinds of modules for example poly Si and mono Si under various climatic conditions in open air. Natural boundary, for example, temperature, dampness and wind speed is thought about for this examination. A climate station is set up to gather the ecological information. Short out current is considered as yield boundary of PV module to comprehend the presentation.

1.4 Thesis Outline

This Thesis is organized as follows:

Chapter 1 Gives an overall presentation followed by the foundation and the targets of the work.

Chapter 2 Exhibits the hypothetical foundation of this investigation.

Chapter 3 Presents the fundamental trial set up.

Chapter 4 Limitation and Recommendation.

Chapter 5 Conclusion and Future Works.

CHAPTER 2
THEORETICAL BACKGROUND

2.1 Single Diode Model

A PV module comprises of numerous PV cells wired in corresponding to stretch out current and in arrangement to give a superior voltage. The module is typified on the front with treated glass and a defensive and water-safe material on the back. The edges are fixed, and an aluminum outline holds everything together in a mountable unit. At the rear of the module, an intersection box holds all the electrical associations. A proportionate circuit of PV cell is portrayed in Fig.

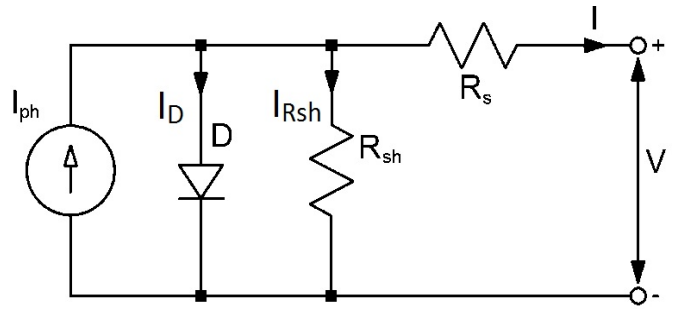

Figure 2 1: Equivalent circuit of solar cells

Where a steady current source Iph speaking to the light-instigated current produced in the cell is in corresponding with the p-n intersection diode. Rs speaks to arrangement opposition and *Rsh*representsthe shunt protections of the cell. The yield current (I) of the PV module can be communicated as [7]

$$I = I_{ph} - I_D - I_{Rsh} = I_{ph} - I_s \left(e^{\frac{q\left(\frac{V}{N_s}+IR_s\right)}{nkT}} - 1 \right) - \frac{\frac{V}{N_s}+IR_s}{R_{sh}} \quad (1)$$

2.2 Types of Solar Panels

There are 7 different types of solar modules which are categories in three generations [8].

2.2.1 1st Generation Solar Module

These are the customary kinds of sun based boards made of mono translucent silicon or poly silicon and are most usually utilized in ordinary environmental factors.

Both mono glasslike and polycrystalline sun powered boards have a similar usefulness in the general sunlight based PV framework. They catch energy from the sun and afterward transform it into power. They are both produced using silicon, which is utilized for sun based boards since it is a plentiful, truly solid component. The two kinds of sun based board is depicted beneath-

(A)Mono crystalline solar panel

Mono glasslike sun based boards are typically considered as a top notch sun based item. The fundamental favorable circumstances of mono glasslike boards are higher efficiencies and sleeker feel. So as to deliver sun powered cells for mono glasslike sun oriented boards, first silicon is framed into bars and cut into wafers. These sorts of boards are classified "mono translucent" to demonstrate that the silicon used to deliver the board is single-gem silicon. As the cell is made out of a solitary precious stone, the electrons that create a progression of power have more space to move. Along these lines, mono translucent boards are more productive than poly glasslike boards.

(B)Poly crystalline solar panel

Regularly polycrystalline sunlight based boards have lower productivity than mono translucent sun oriented boards, yet their preferred position is that their cost is similarly lower. Moreover, polycrystalline sunlight based boards have a blue tint where mono glasslike boards have dark tone. Polycrystalline sun based boards are likewise produced using silicon. Nonetheless, rather than utilizing a solitary precious stone of silicon, numerous pieces of silicon are liquefy together to frame the wafers for the board. Polycrystalline sun oriented boards are otherwise called multi-translucent or many-precious stone silicon. This is on the grounds that in every cell there are numerous precious stones that gives less opportunity to the electrons to move. In this manner, polycrystalline sunlight based boards have lower effectiveness than mono glasslike boards.

2.2.2 2nd Generation Solar Panel

These cells are different types of thin film solar cells and are mainly used for photovoltaic power stations, integrated in buildings or smaller solar systems.

A) Thin-Film Solar Cells (TFSC)

B) Amorphous Silicon Solar Cell (A-Si)

2.2.3 3rd Generation Solar Panels

Third era sun based boards incorporate an assortment of slender film innovations yet the majority of them are still in the. Some of them produce power by utilizing natural materials, others utilize inorganic substances (CdTe for example).

A) Bio hybrid Solar Cell

B) Cadmium Telluride Solar Cell (CdTe)

C) Concentrated PV Cell (CVP and HCVP)

2.3 How do solar panels work to generate electricity?

A standard sun oriented board (otherwise called a sun powered module) comprises of a layer of silicon cells, a metal edge, a glass packaging, and different wiring to permit current to spill out of the silicon cells. Silicon (nuclear #14 on the intermittent table) is a non-metal with conductive properties that permit it to ingest and change over daylight into power. At the point when light connects with a silicon cell, it makes electrons be set into movement, which starts a progression of electric flow. This is known as the "photovoltaic impact," and it depicts the overall usefulness of sunlight based board innovation. [9]

The general photovoltaic process, as described above, works through the following steps:

1. The silicon photovoltaic solar cell absorbs solar radiation
2. When the sun's rays interact with the silicon cell, electrons begin to move, creating a flow of electric current
3. Wires capture and feed this direct current (DC) electricity to a

solar inverter tube converted to alternating current(AC)electricity

2.4 Effect of various environmental parameters on the performance on PV solar module

Sunlight based is the most effective characteristic fuel hotspot for the world at the present time. In spite of the fact that its characteristic force come began from the sun, there are sure ecological boundaries which have huge effect on the result of the sun powered module. In this way we lamentably don't get the expected force result from the sunlight based, or the outcome fluctuates all around or time to time.

For a long time it's one of the most important and attractive trial for researchers to work with this theme. There are distinctive ecological boundary which have sway on sun oriented module. For instance, Solar Irradiance, The surrounding temperature, the surface temperature of the module, the breeze speed, the dampness, Dust, stature and so on. Among all these boundary, sun powered irradiance and Temperature are the key job players here.

2.4.1 Effect of Temperature

In semiconductor, temperature measures the amount of movement of the electrons and the holders for those electrons. Let’s think and compare the situation with the shelf and the bin of balls, when a semiconductor is hotter, we can think it as if the balls are churning and bouncing around in the bin and for that the shelf above is vibrating up and down.

Like that in a hot solar cell, the balls bounce around, so it’s become easier for the sunlight to pick them up and put them on the shelf. As the shelf is vibrating up and down, for the balls it's also become easier to get onto the shelf, but as they aren't that high, they don't roll as fast. Thus when a silicon solar cell gets hotter, it generates more current but less voltage (Figure 2.2). Actually, the change in current is little but the change in voltage is quite more, so in result the power decreases.

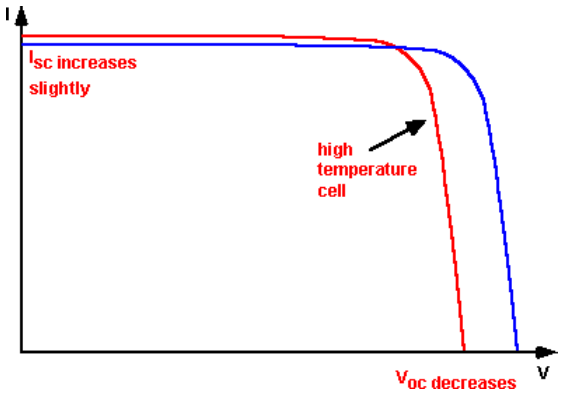

Figure 2 2: Effect of temperature on module short circuit current and open circuit voltage

This implies the effectiveness of sun powered cells diminishes with the expanding of cell temperature or the surrounding temperature and Voc is more touchy to temperature where the Isc isn't a lot of delicate to temperature.

From estimations we can see that the connection among voltage and temperature is contrarily relative for silicon cell and (dVoc/dT) is roughly equivalent to - 2mV/ºC, which implies that the effectiveness of the cell drops by about 0.4 % for the expansion of each 1 degree Celsius. [10] A silicon cell of 20% productivity at 20ºC will decrease to 16% at 30ºC.

2.4.2 Effect of relative humidity

The air humidity means the amount of water content in the air. The water content of the air can be expressed in several ways. Relative humidity is one of those ways to indicate the air humidity.

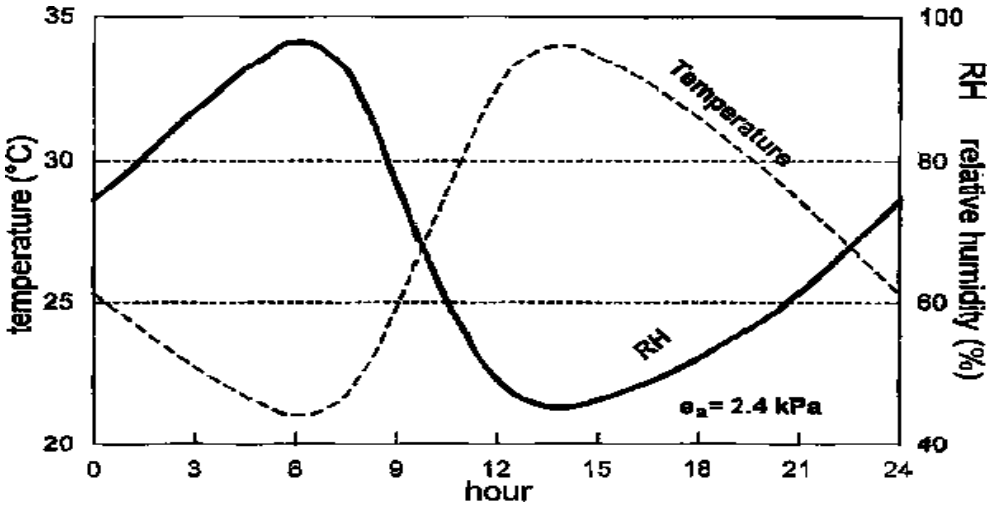

Figure 2 3: Variation of the relative humidity over 24 hours for a constant actual vapor pressure of 2.4 kPa

Relative dampness essentially arbitrators to the proportion between the measure of water the encompassing air really, holds at a specific time and the sum it can hold at an equivalent temperature. It is dimensionless. Its unit is given as a rate. The general moistness for the most part changes between the time-frame of a greatest close to dawn and a base dawn around promptly in the early evening (Figure 12). As the temperature changes during the day, the overall stickiness likewise changes appropriately. [11]

The relative humidity (RH) expresses the degree of saturation of the air as a ratio of the actual ($e_{a.}$) to the saturation ($e°$ (T)) vapor pressure at the same temperature (T)

Measurement:

Relative mugginess is estimated legitimately with hygrometers or utilizing moistness sensor. The estimation depends on the idea of some material, for example, hair, which changes its length if comes in dash of the adjustments in air dampness. It's likewise can be estimated utilizing a capacitance plate, where the electric capacitance changes with RH

The RH is the amount of moisture in the air, which can be found by dividing the moisture amount by the maximum amount of moisture that could exist in the air at a specific time.

$$RH = \frac{E}{E_S} * 100\%$$

This changing in dampness affects PV sun powered cell productivity. A decline in relative mugginess brings about higher yield current. Low relative stickiness implies there is low water fume in the climate which offers ascend to a high sun oriented transition and along these lines upgrade the creation of the ebb and flow or power. As the current creation increments with a low mugginess in the climate, so it's ridiculous that the productivity of the sun based module is better in low relative dampness condition. [12]

Effect of wind speed*:*

Solar panels are installed with an angle equal to the latitude of the site. Many studies have shown that as wind impinges on an inclined solar panel, it flows around it inducing an unequal pressure on its two surfaces. Thereby the surfaces of the solar panels experience the drag force in the direction of the wind flow and lift force in the direction perpendicular to the wind flow. These forces produce the torque.

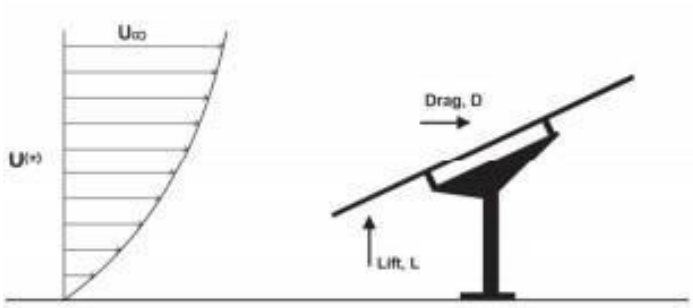

Figure 2 4: Vertical profile of wind approaching a solar panel

It may not be a right idea to state that sun oriented PV effectiveness is straightforwardly influenced by wind speed, anyway it has a significant task to carry out in PV age. At the point when the breeze doesn't give the daylight beams any additional oomph while fueling boards, the impact of twist at that point functions as a lift in sunlight based productivity. At the point when a sun powered board is excessively blistering, its proficiency diminishes because of the science behind the age of power. Then again, if there should be an occurrence of cooler sun based board its proficiency improves. So, the impact of temperature on sun based cell execution is this way: cooler boards permit more energy to overcome like an electric flow than blistering boards do. [Fig2.4]

At the point when the breeze streams essentially temperature of sun oriented cell drops. The breeze cools the sunlight based boards bringing about delivering less vibration of the electrons so the electrons can convey more energy while moving to upper state. Sunlight based boards cooled by 1 degree Celsius are 0.05 percent more effective. This rate includes after some time.

2.5 Science behind a Solar Panel Generating Electricity

Inside a hot sunlight based cell, the particles vibrate at a quicker rate than the atoms in the sun oriented cell when is cool. Normally the electrons within the atoms are energized to a higher level with the sunlight, and thus generate electricity. When the electrons move from one energy state (rest) to a higher one (excited) the cells produce power. When a solar panel is hot, the distinction between the rest state and the energized energy state is more modest, so the cells produce less energy. The opposite happens when a solar panel is cooler. Inside a cool solar cell, the electrons are still getting excited by the sunlight and they’re easily able to move up to the higher level of energy. This is because the atoms aren’t vibrating. Despite the fact that the electrons move more slow, the ones that endure conveying more energy than the electrons in a warmed state.

CHAPTER 3

EXPERIMENTAL SETUP

3.1 Introduction

So as to play out the investigation in open air condition an exploratory set up is vital. For this we need to pick a spot without shadow. There are two 20 watt PV modules; one is poly Si and another is mono Si. To gauge the short out current ammeter is utilized. To gather the ecological information a few sensors are utilized. For these a climate station is planned with temperature, wind speed and stickiness sensor. All the sensors information are gathered progressively and put away in a PC. We have utilized ongoing clock to gather the continuous information. For temperature sensor we have utilized Dallas DS18B20 temperature sensor to gather the module surface temperature. To acquire the encompassing temperature and moistness we have utilized DHT 11 sensor. To gather the breeze speed we have utilized Anemometer.

3.2 Weather Station

The main controller is an Arduino Mega. The Dallas, DHT and Anemometer along with the real time clock are connected with the Arduino. Arduino controls the sensors and display the real time data on the computer screen. All the sensors connection and performance is discussed below.

3.3 Dallas Temperature Sensor: DS18B20

Temperature sensor is a device; to measure the temperature through an electrical signal it requires a thermocouple or RTD (Resistance Temperature Detectors). The thermocouple is

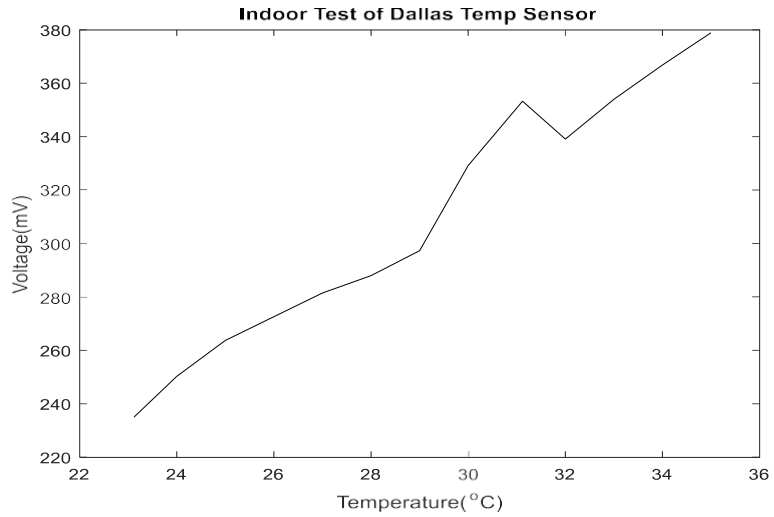

Figure 3.1: Output voltage of temperature sensor versus temperature reading

prepared by two dissimilar metals which generate the electrical voltage indirectly proportional to change the temperature. The RTD is a variable opposition, it will change the electrical obstruction in a roundabout way corresponding to changes in the temperature in an exact, and almost direct way. The estimation of the temperature sensor is about the hotness or coolness of an article. The working base of the sensors is the voltage that read over the diode. In the event that the voltage expands, at that point the temperature rises and there is a voltage drop between the semiconductor terminals of base and producer, they are recorded by the sensors. On the off chance that the distinction in voltage is enhanced, the simple sign is produced by the gadget and it is straightforwardly corresponding to the temperature [13]. Following the data from above, we tried our Dallas sensor and its voltage expanded relatively with the temperature expanding shows in Figure 3.1. Figure 3.2 shows the commonplace association graph with the Arduino.

DS18B20 Sensor Specifications are as follows.[14]

- Programmable Digital Temperature Sensor
- Communicates using1-Wiremethod

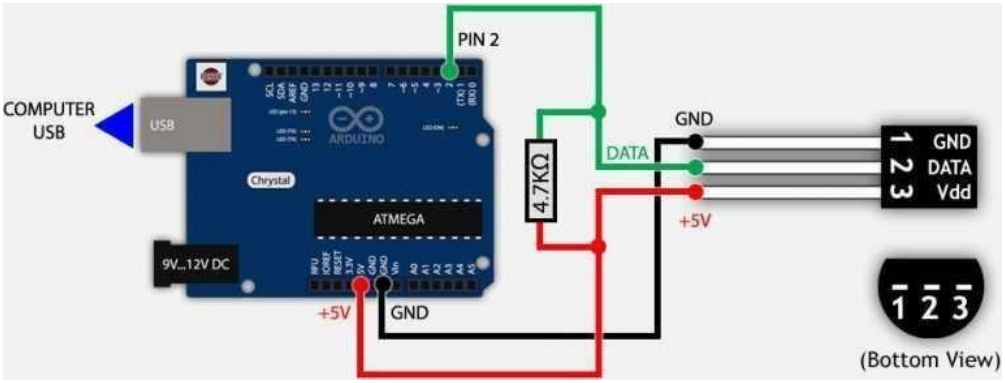

Figure 3.2: Connection Diagram of Dallas Temperature sensor with Arduino.

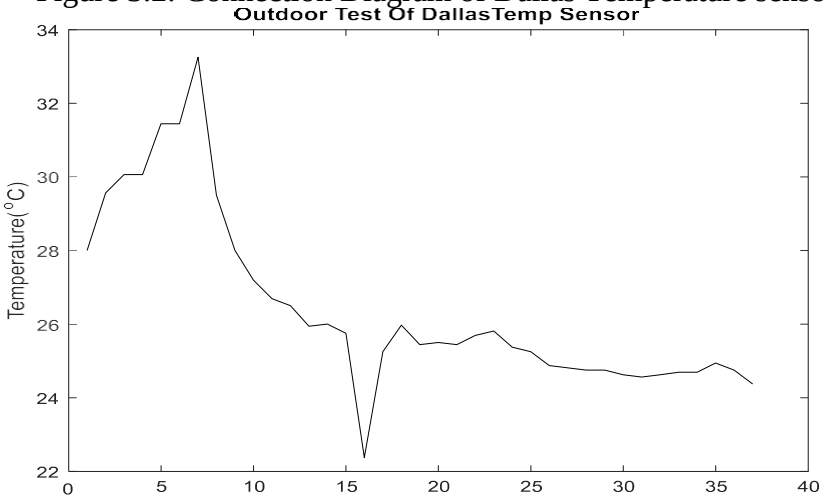

Figure 3.3: Outdoor test of Dallas temperature sensor

- Operating voltage: 3Vto5V
- Temperature Range: -55°C to+125°C
- Accuracy:±0.5°C
- Output Resolution: 9-bit to12-bit(programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750msat12-bit
- Programmable alarm options

- Available as To-92, SOP and even as a water proof sensor

3.4 Humidity sensor DHT11

Dampness is one of the most normally estimated physical amounts and is vital in a wide assortment of business and mechanical applications. Dampness is characterized as a proportion of the water fume present in a gas. Two basic boundaries in related with moistness estimation are total mugginess and relative stickiness.

Table: 3.1. Technical specifications of DHT 11

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 °C	±5%RH	±2°C	1	4 Pin Single Row

For estimating dampness they utilize the moistness detecting segment which has two terminals with dampness holding substrate between them. Figure 3.4 shows the electrodes. Thus, as the mugginess changes, the conductivity of the substrate changes or the obstruction between these cathodes changes. This adjustment in obstruction is estimated and handled by the IC which prepares it to be perused by a microcontroller. Figure 3.5 shows the commonplace association graph with Arduino. Table 3.1 shows the specialized details of the sensor utilized in this investigation. The humidity sensor is tested which shows inverse relationship with the temperature

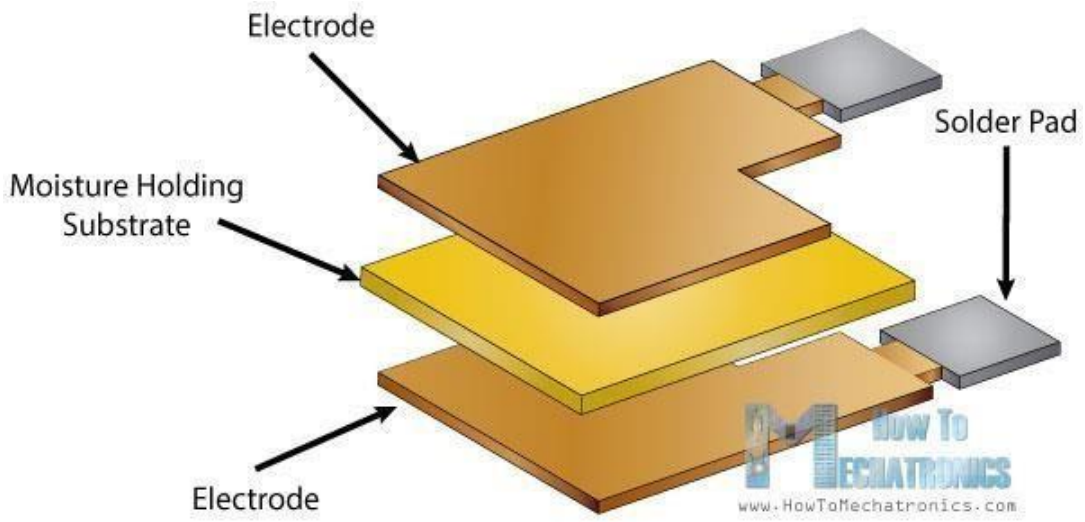

Figure 3.4: Electrodes of Humidity sensor

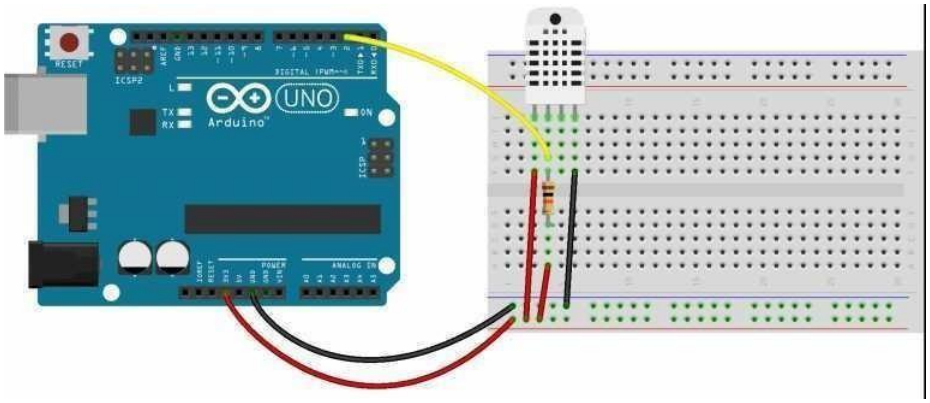

Figure 3.5: Connection Diagram of DHT 11 sensor with Arduino

Reading shows in Figure 3.6. It shows almost 2% change in relative humidity percentage per degree Celsius temperature.

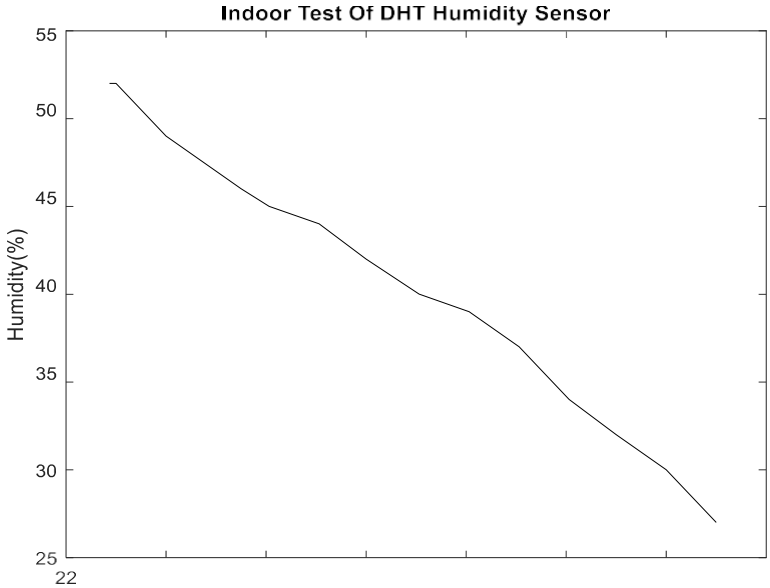

Figure 3.6: Relative humidity versus temperature reading

3.5 Anemometer

An anemometer is a gadget utilized for estimating wind speed, and is additionally a typical climate station instrument. The term is gotten from the Greek word anemos, which means wind, and is utilized to portray any wind speed instrument utilized in meteorology. Anemometer quantifies the breeze speed from a simple sign it gets when the cups of the anemometer turn. At the point when cups pivot the bar twists and estimating the bar's turning esteem engine gives a simple incentive by which voltage is estimated by utilizing a recipe and dependent on a datasheet following the voltage esteems anemometer gives the estimation of wind speed

Formula: V=6*U

Table 3.2 shows the Anemometer datasheet value of wind speed and corresponding voltages

.Figure 3.7 shows the testing data which shows the linear relationship and follows the standard data from datasheet. The connection diagram is shown in Figure 3.8.

Table 3.2: Relation between wind speed and output value

Wind Speed	Value	Wind Speed	Value
1	0.17	11	1.83
2	0.33	12	2
3	0.5	13	2.17

4	0.67	14	2.33
5	0.83	15	2.5
6	1	16	2.67
7	1.17	17	2.83
8	1.33	18	3
9	1.5	19	3.17
10	1.67	20	3.33

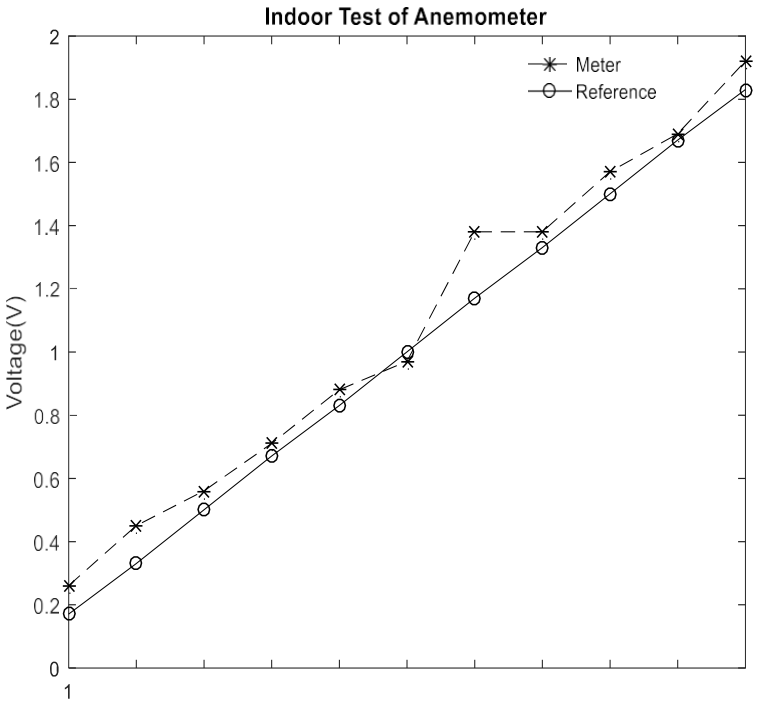

Figure 3.7: Anemometer testing data

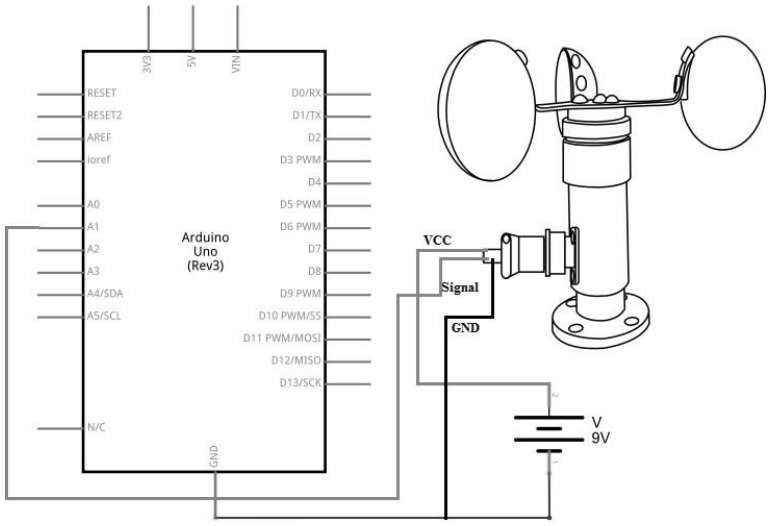

Figure 3.8: Connection diagram of Anemometer

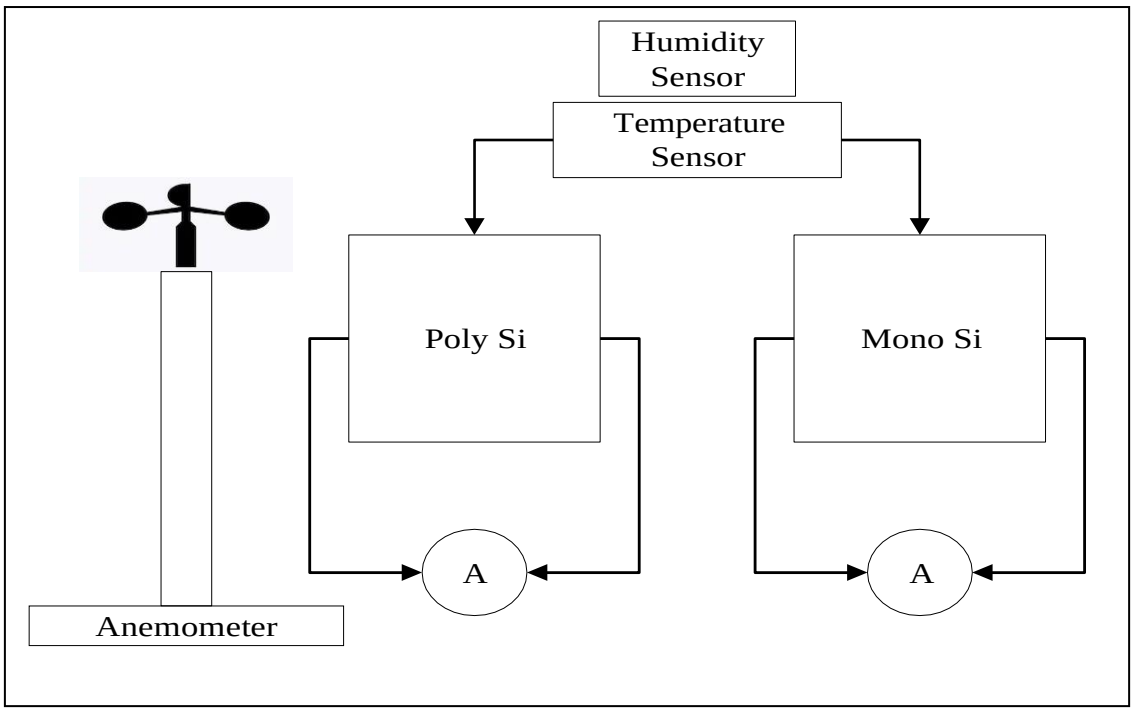

Figure 3.9: Experimental setup diagram of PV module with sensors

CHAPTER 4

RECOMMENDATION & LIMITATION

4.1 Recommendation

As sun oriented energy is a center subject now numerous explores and ventures have been done through everywhere on the world. A sun oriented cell is an electrical gadget that changes over the energy of light legitimately into power (DC) by the photovoltaic impact. Sun oriented cells made with silicon appear to be the most broadly utilized today, yet numerous organizations and researchers have been in the lab attempting to create a more effective cell, and at last, sunlight based board framework. The essential material utilized for creation of the sun based cells is silicon. Sun oriented Cell is a gadget that converts light legitimately into DC (direct flow) power. Sun based Cell can be recognize in three cell types as indicated by the kind of precious stone i.e., mono crystalline, polycrystalline and amorphous.

4.2 Limitation

Air dust transport is a characteristic marvel and can happen for long reach separation with the impact of weight contrasts and winds. Sun oriented boards can be broken by tree limbs or by objects conveyed by a solid breeze.

CHAPTER 5

CONCLUSION & FUTURE WORKS

This examination explores the outside exhibition of two photovoltaic modules. The performance measured based upon the short circuit current. The main outdoor parameters which were considered as follows; temperature, humidity and wind speed. There are a ton of interesting points when you're hoping to introduce a sun powered board framework, one of which being what sort of sunlight based boards to get. A large portion of the sun based boards available today for private sunlight based energy frameworks can find a way into three classifications: monocrystalline sun oriented boards, polycrystalline sun based boards, and slim film sun based boards. Monocrystalline sun oriented boards normally have the most elevated proficiency and force limit out of a wide range of sunlight based boards. Because monocrystalline solar cells are made out of a single crystal of silicon, electrons are able to flow easier through the cell, which makes the PV cell efficiency higher than other types of solar panels. Polycrystalline panels, sometimes referred to as multi crystalline panels, are popular among homeowners looking to install solar panels on a budget. The numerous silicon gems in each sun based cell makes it harder for electrons to stream. This gem structure makes the productivity pace of polycrystalline boards lower than monocrystalline boards. The performance of poly Si module is good enough than the mono Si module throughout the study.

In this study we have considered temperature, humidity and wind speed as environmental parameter which affects the PV module. In future dust impact can be analyzed.

CHAPTER 6

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