Prince Mohammad University
Department of Electrical Engineering

SELF MAINTAINED SOLAR TRACKING

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OUTLINE

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- Project Objectives
- Project Specifications
- Project Architecture
- Background
- Previous Projects
- Summary & Comparison
- Planning
- Design Subsystem 1,2 and 3
- Team Work
- Completed / Remaining
- Budget estimate
- References

PROJECT DEFINITION

To design a photovoltaic tracking system that has a self-cleaning sub-system, for increasing the efficiency of converting sun's energy to electricity.

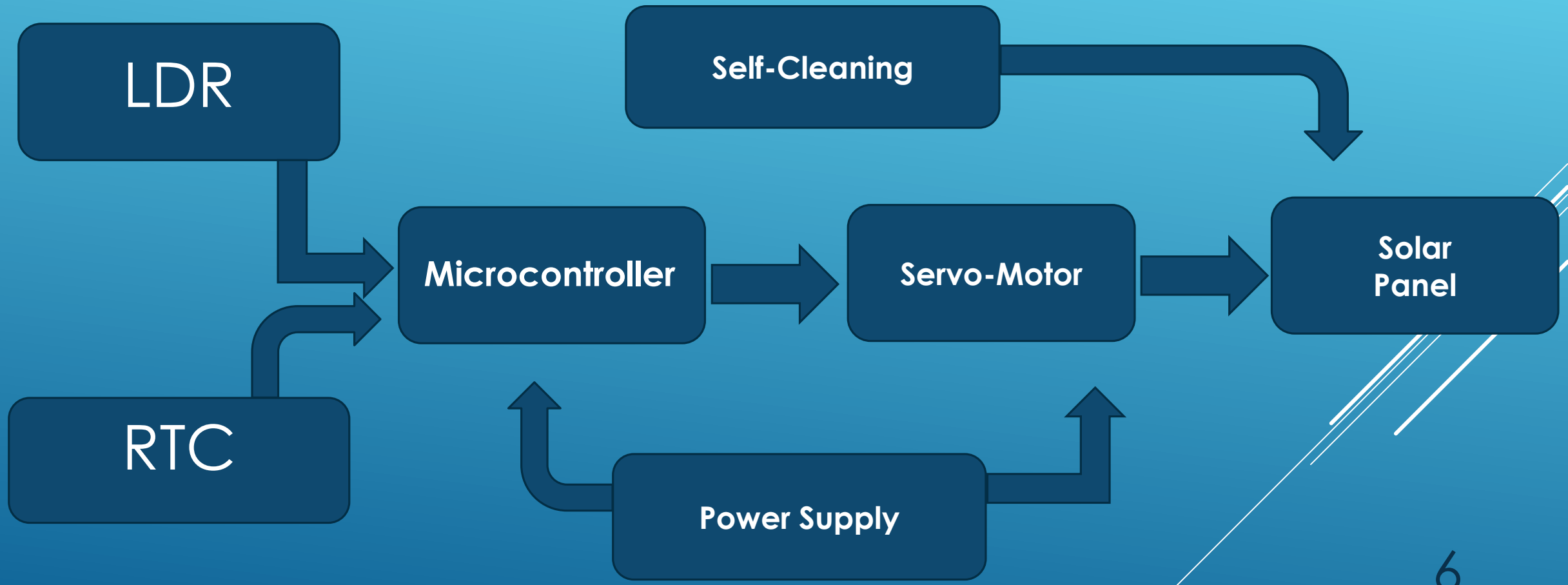
PROJECT OBJECTIVES

- To show that tracking systems are more efficient that fixed ones.
- To show that self cleaning will improve the solar reliability and efficiency.
- To make the solar panel automatically controlled by RTC to follow Sun's trajectory during the day (in case of LDR failure).

PROJECT SPECIFICATIONS

- Solar tracker using RTC and LDRS.
- Self-Cleaning Mechanism.
- One-axis motion.

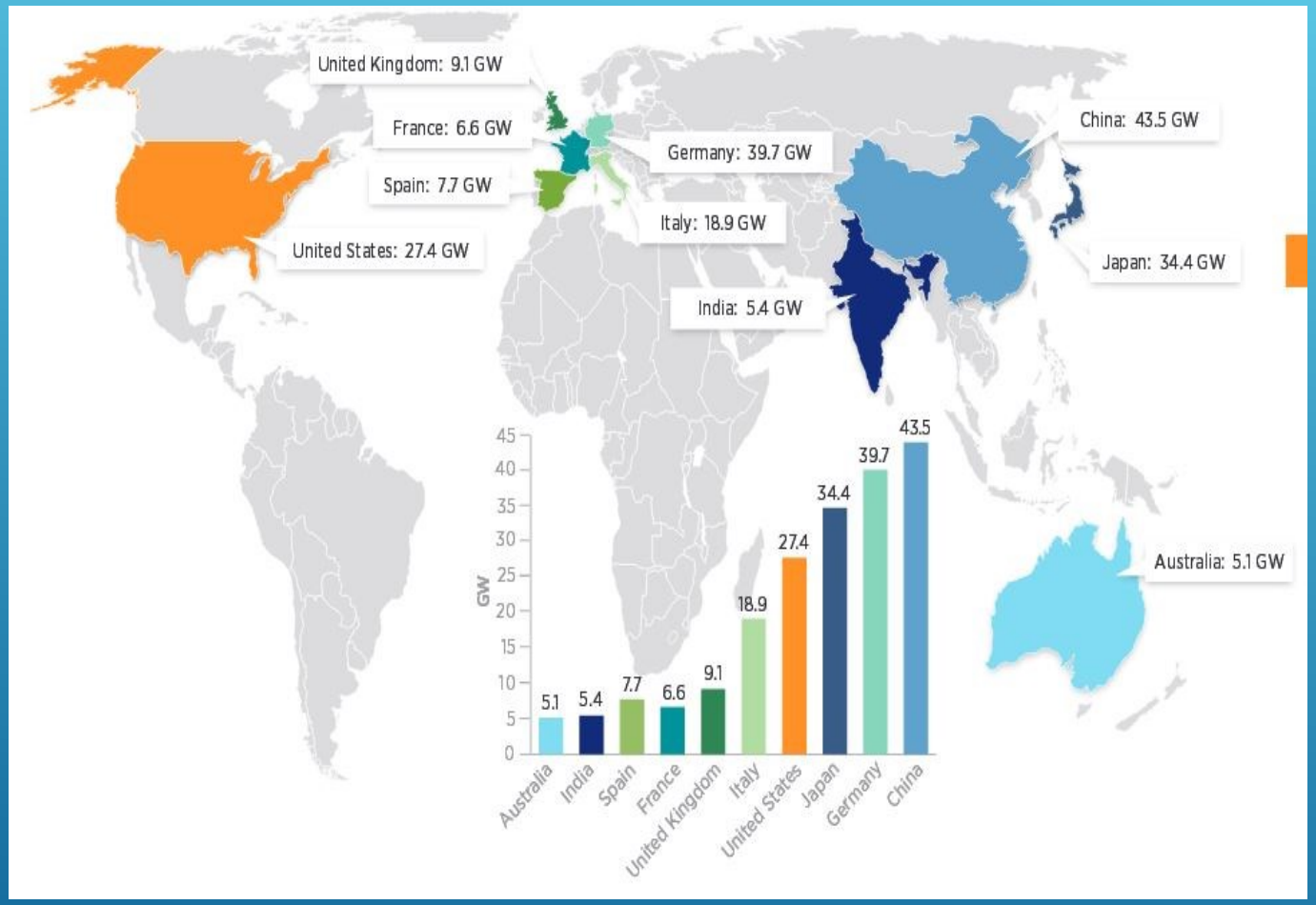
PROJECT CHART



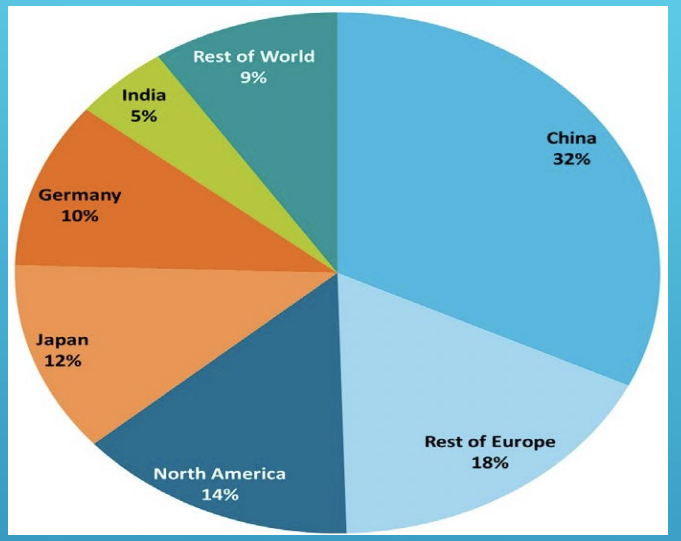
Planning

Design feasibility	Material and equipment availability	PMU Labs
The design can be implemented due to: • Research done • Advisor view	Most of the material are available in the local market which can be available within a reasonable amount of time.	PMU labs are reliable to implement and test the design

TOP COUNTRIES FOR INSTALLED PV CAPACITY



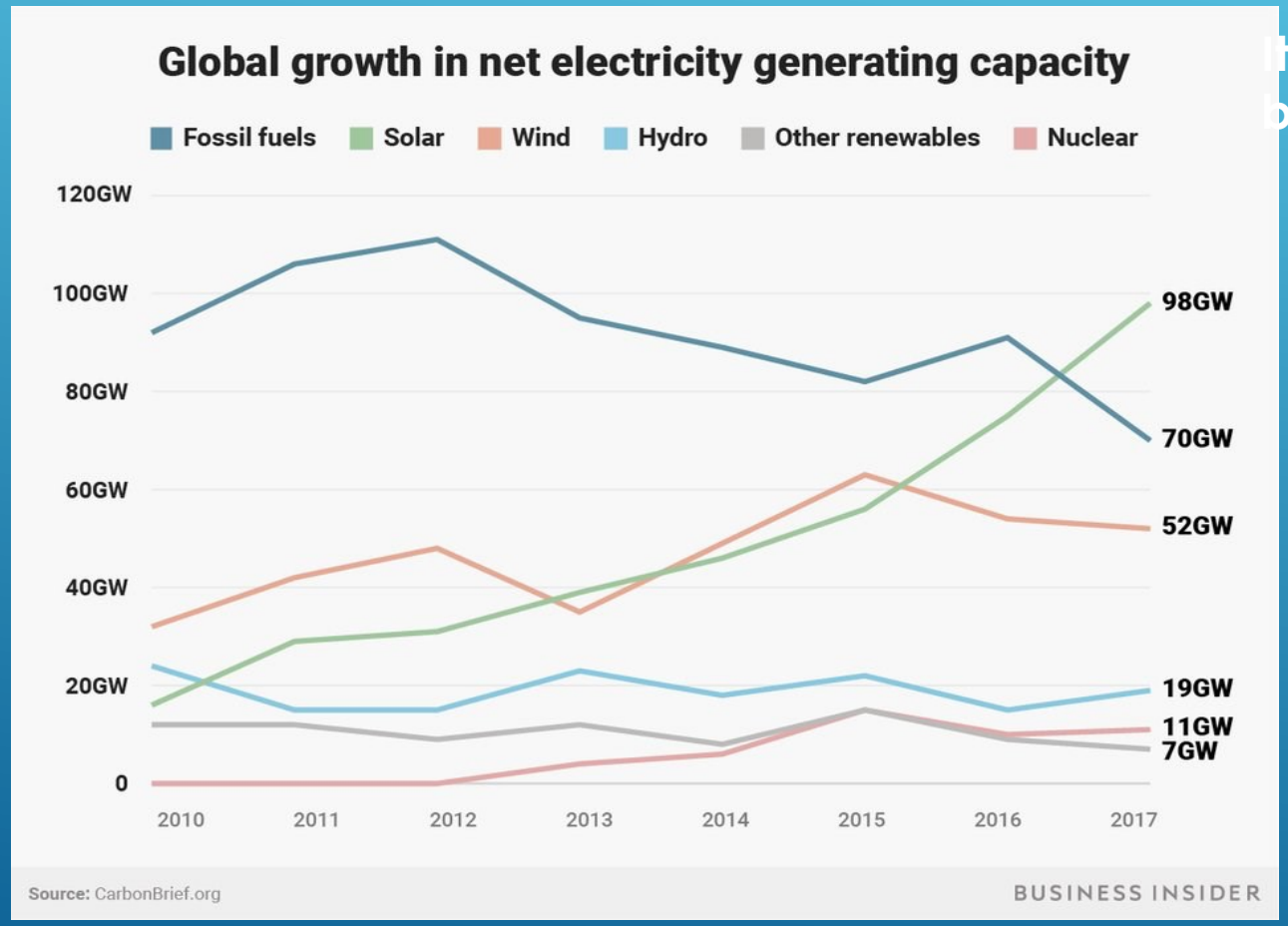
US Department of Energy, NREL 2015 Renewable Energy Data Book



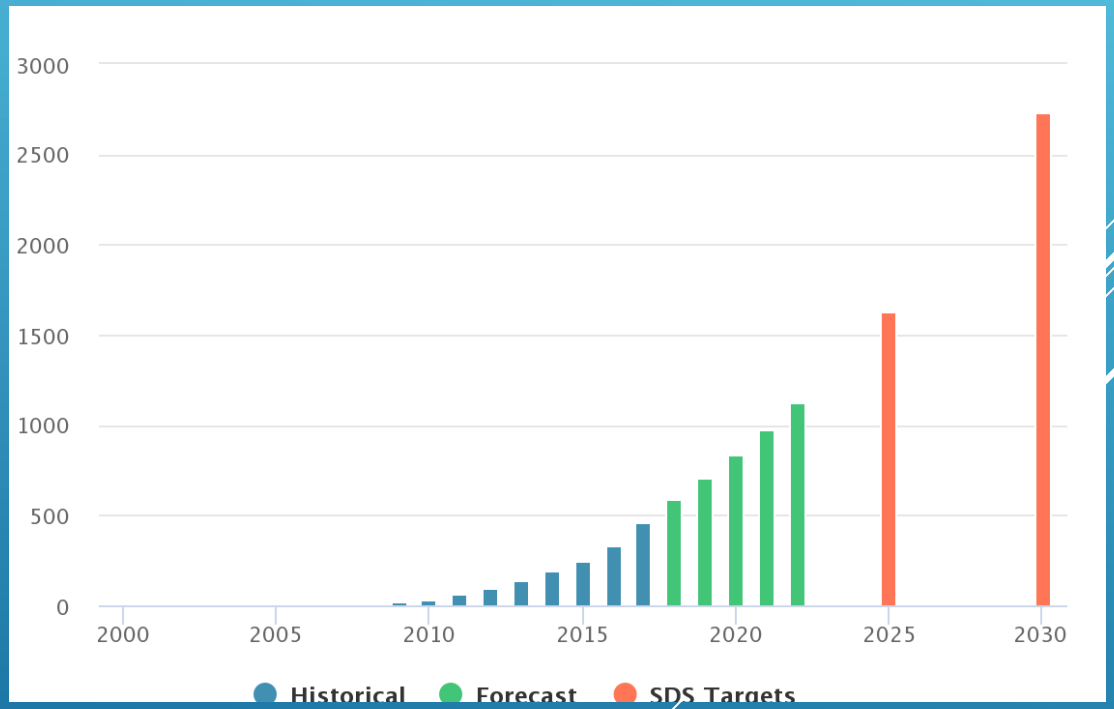
The total cumulative installations amounted to 415 GWp at the end of year 2017.

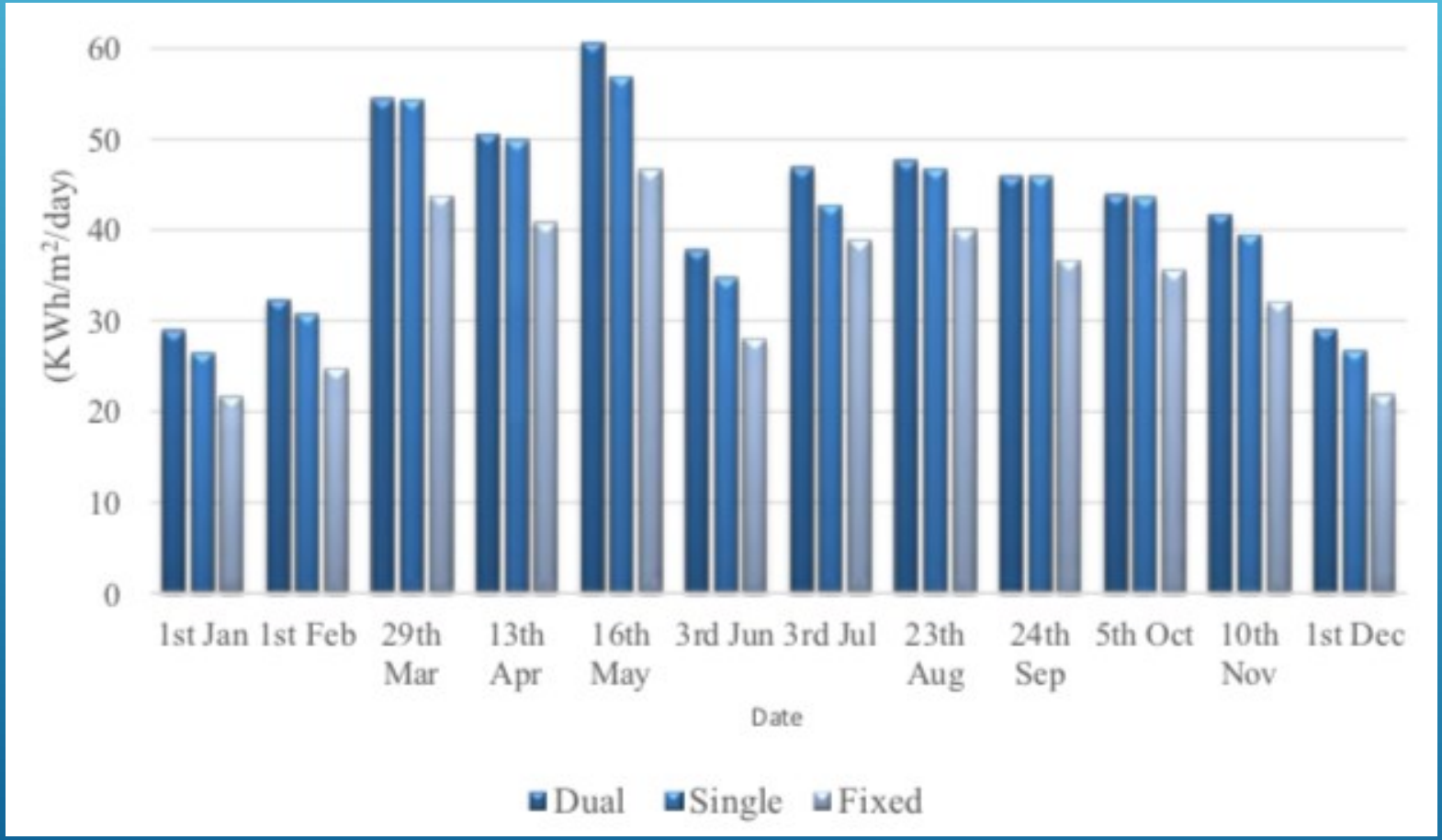
42% of installations around the world in china and Germany

SOLAR ENERGY GROWTH



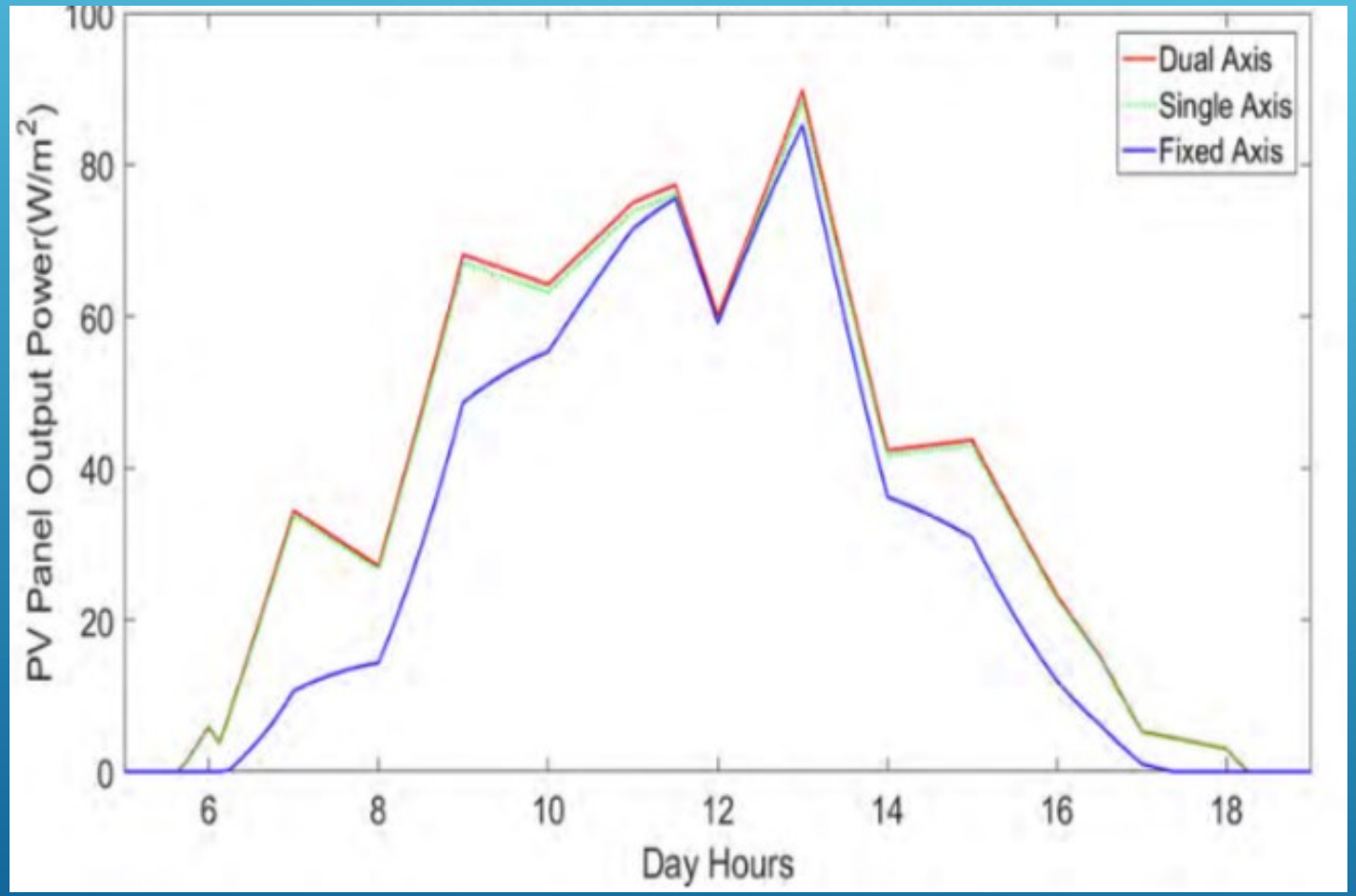
It estimates that solar PV capacity could reach between 1,760 and 2,500 gigawatts (GW) by 2030





Difference between fixed and single axis varies in different months

FIXED VS SOLAR TRACKER

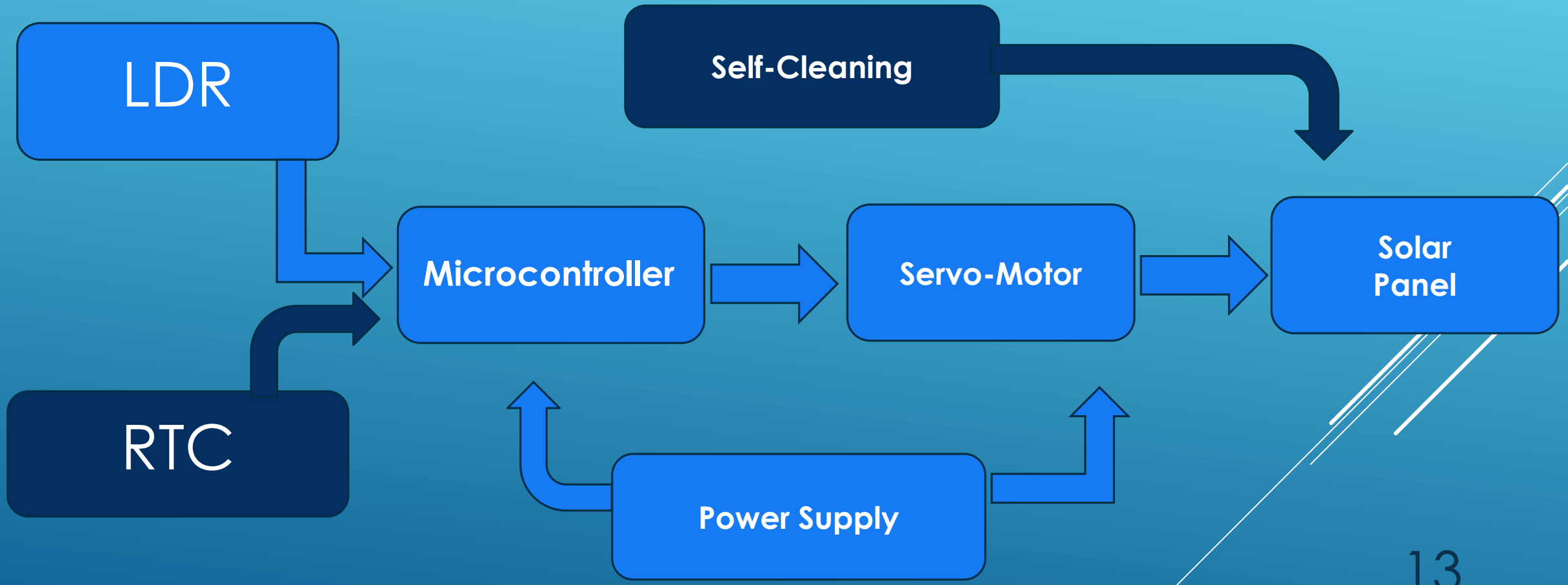


PV panels are almost at the same position in the graph at noon. Due to low declination angle, the output power values of single axis PV Panel and dual axis PV Panel almost always remain nearer.

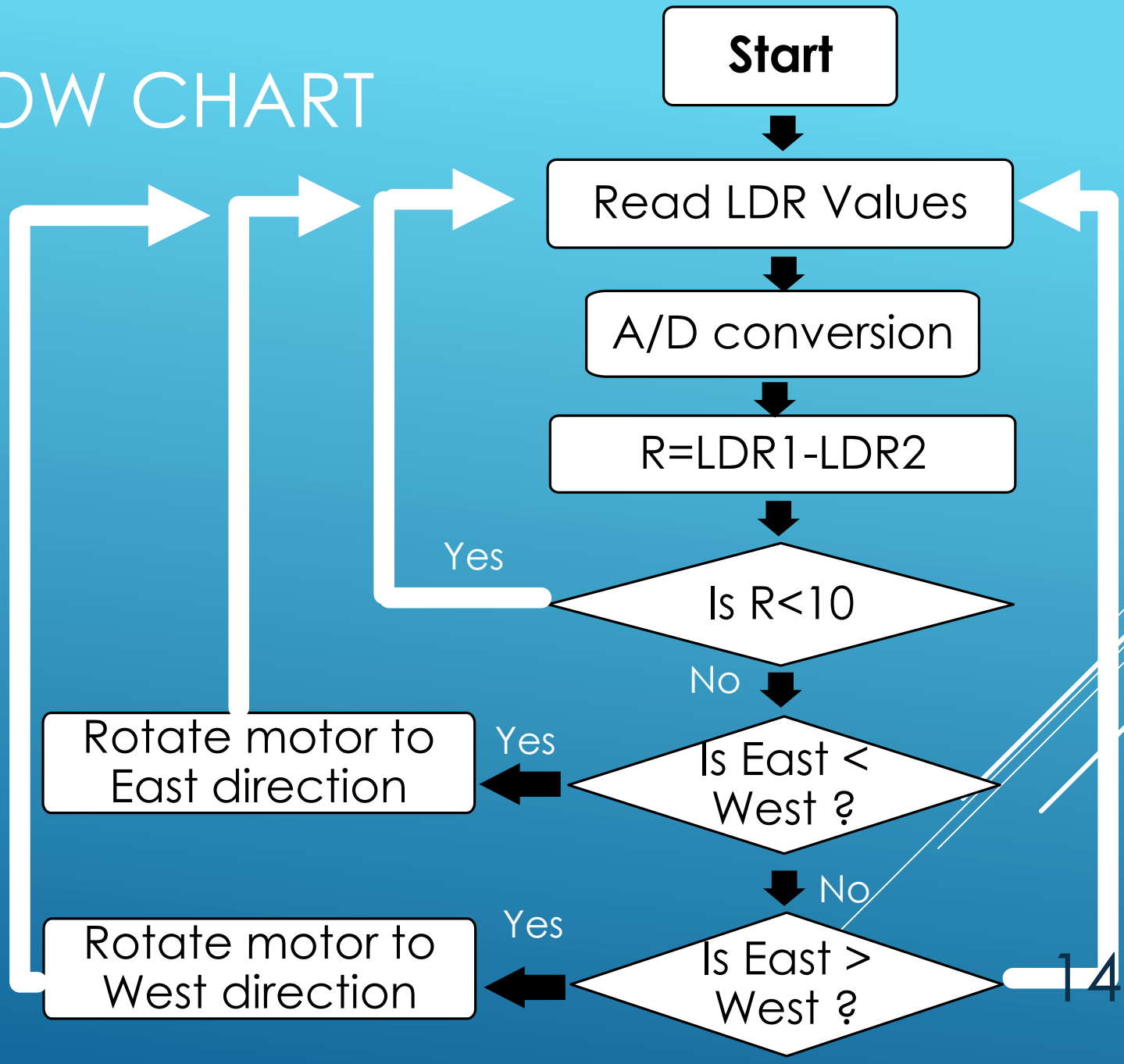
BACKGROUND: SMART SOLAR PANEL ADVANTAGES

Fixed, Without tracking	Solar tracking
Low efficiency	Higher efficiency
Un effective tracker	Effective tracking
No dust resistive	Dust resistive
No water resistive	Water resistive
	Time based (season)

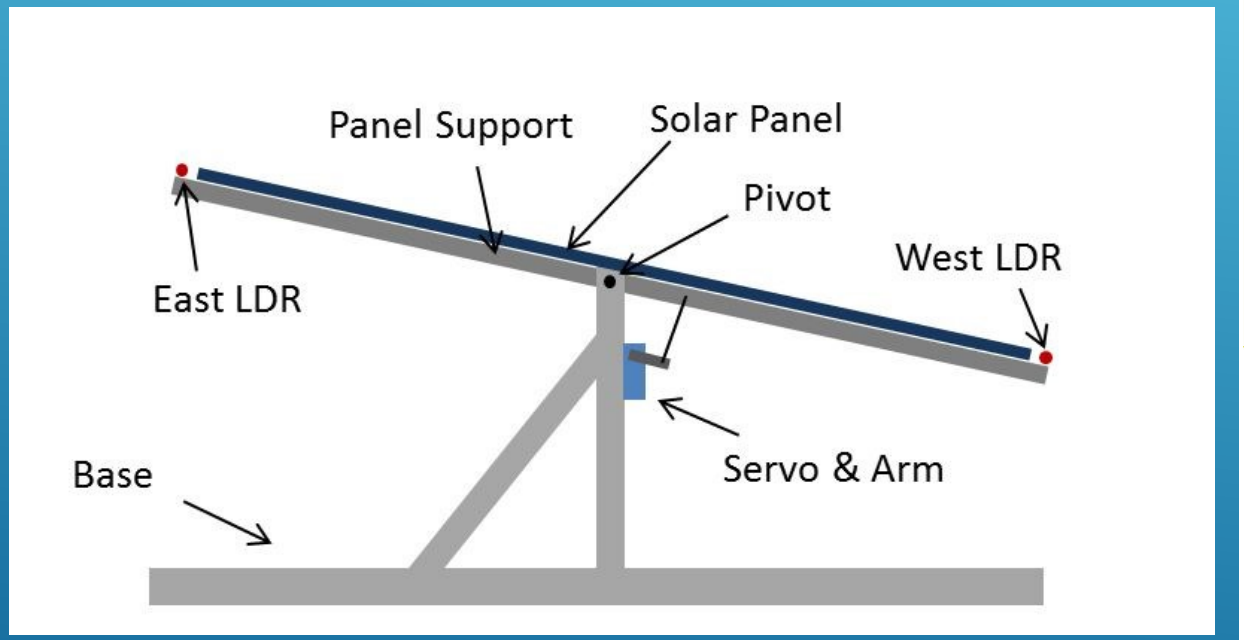
SUBSYSTEM 1: TRACKING BY LDR

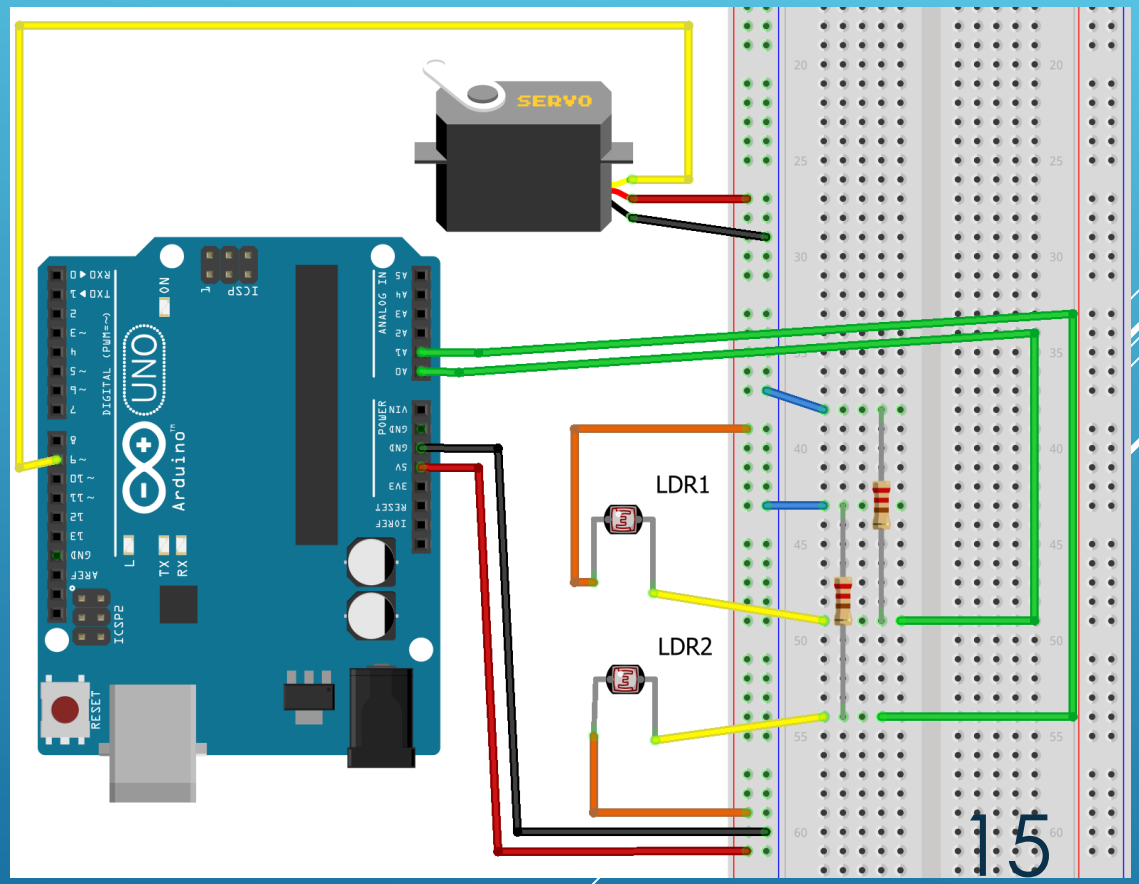


SUBSYSTEM 1: FLOW CHART

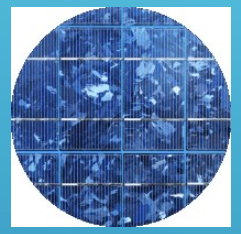


SUBSYSTEM 1: STRUCTURE AND CIRCUIT DIAGRAM

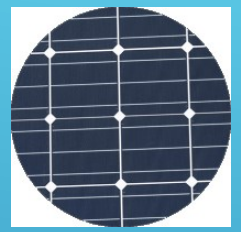




SOLAR PANEL TYPES



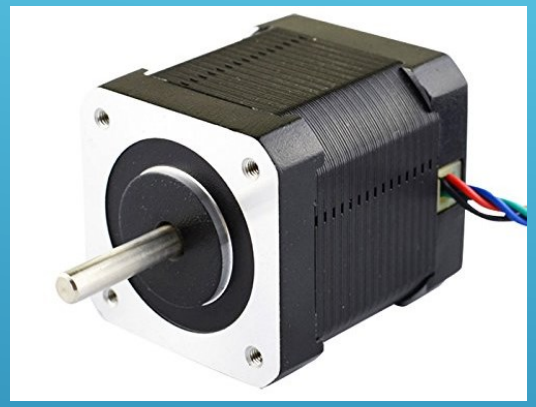
Polycrystalline Solar Panels (Poly-SI)



Monocrystalline Solar Panels (Mono-SI)

Solar Cell Type	Efficiency-Rate	Advantage	Disadvantage
Monocrystalline Solar Panels (Mono-SI)	~20%	- highest efficiency rates - high power output - Longest lifetime - lowest effected to temperature	Expensive
Polycrystalline Solar Panels (p-Si)	~15%	- Not Expensive - Good Efficiency rate	- Lower Efficiency
Thin-Film: Amorphous Silicon Solar Panels (A-SI)	~7-10%	- Very cheap - Flexible	-Lowest Efficiency - Short lifetime - Effected by temperature

DESIGN: MOTOR OPTIONS

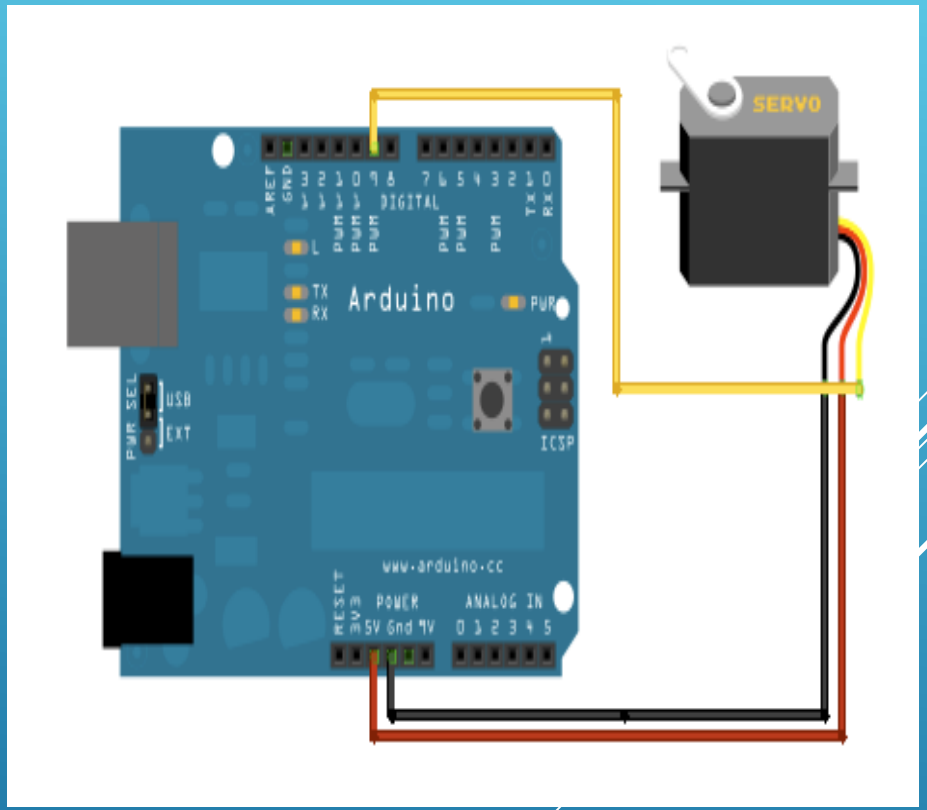


Stepper Motor	Servo Motor
Cheaper	Expensive
Smaller	Larger
Used for high torque applications	Used for high speed applications

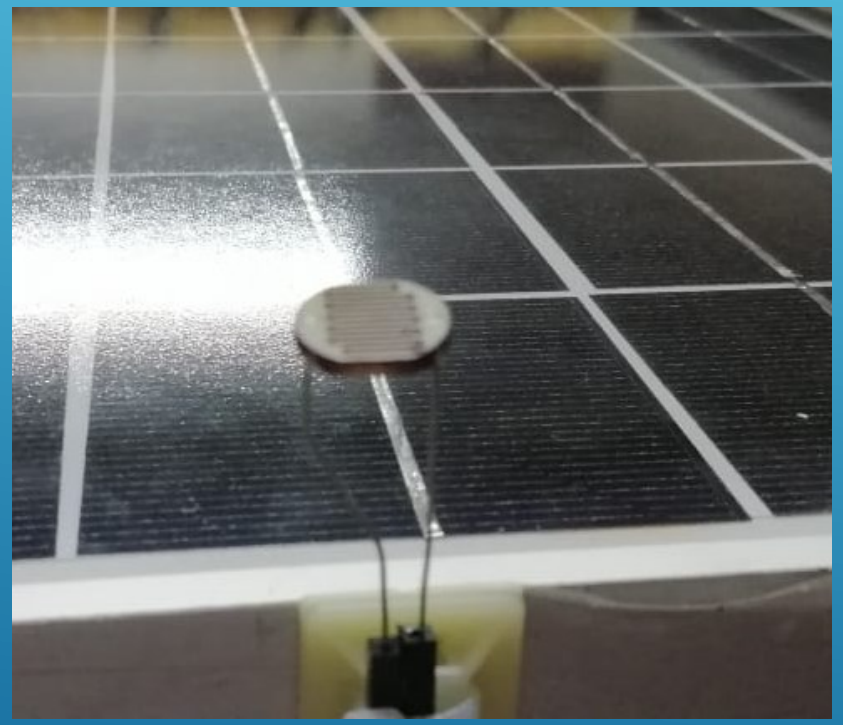
DESIGN: MOTOR SPECIFICATIONS

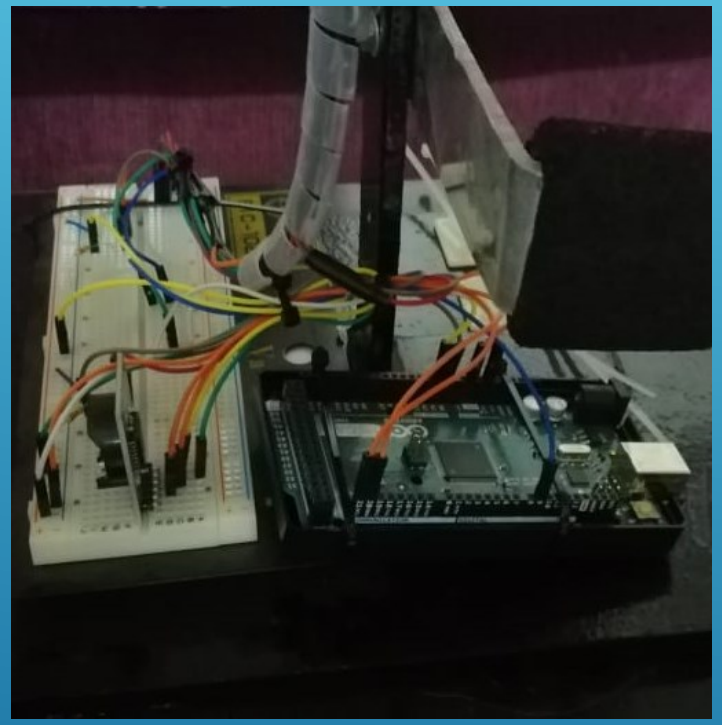
Features:

Net Weight:	60g (Servo only)
Dimension:	40×20×40.5mm
Stall torque:	15kg/cm（6.6v); 17kg/cm(7.4v)
Operating speed:	0.16 sec/60°(7.4v)
Control Angle:	180 degree
Operating voltage:	6-7.4v
Gear Type:	Metal gear
servo wire length:	30cm



DESIGN: STRUCTURE





SUBSYSTEM 1: RESULTS

Time	Tracking system	Fixed angle/ position
10:30 a.m.	21.5 V	20.92 V
12:00 p.m.	20.19 V	19.8 V
1:30 p.m.	19.82 V	18.62 V
2:00 p.m.	18.80 V	15.81 V
3:25 p.m.	19.61 V	14.55 V
5:15 p.m.	10.13 V	5.82 V

TESTING CURRENT OUTPUT RESULTS

Time	Tracking system	Fixed angle/ position
10:30 a.m.	1.01 A	0.95 A
12:00 p.m.	1.13A	1.06 A
1:30 p.m.	1.09 A	0.91 A
2:00 p.m.	1.00 A	0.77 A
3:25 p.m.	0.89 A	0.32 A
5:15 p.m.	0.75 A	0.22 A

POWER PRODUCED TEST

Time	Tracking System	Fixed angle / position
10:30 A.M	21.715 W	19.874 W
1:30 P.M	21.6038 W	16.9442 W
2 P.M	18.8 W	12.1737 W
3:25 P.M	17.4529 W	4.656 W
5:15 P.M	7.5975 W	1.2804 W

POWER EFFICIENCY

Power produced (Average Tracking) by the solar = 18 W
Power consumed by the solar for rotation for single rotation for 3 Sec = 1.575 W

Net power Gain = Power produced – Power consumed
Net power Gain = 18 – 1.575 = 16.425

η = 91.25 % for solar tracking System

SUBSYSTEM 2: TRACKING SYSTEM BY RTC

WHY Real time clock?

1. Due to test and study of sun's trajectory in the sky, solar panel will shift angle based on time
2. In case of LDR sensor detection failure the solar tracking System can operate with RTC data implemented and will keep the system running with the same efficiency designed for the System

SUBSYSTEM 2: TRACKING SYSTEM BY RTC

Testing:

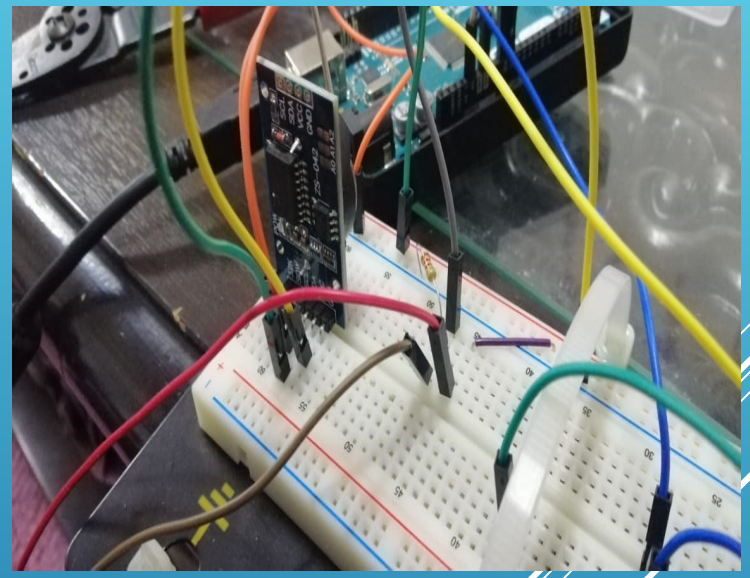
I. SCL pin of DS323 is to be plugged Arduino Mega

II. The SDA pin plugs into the port

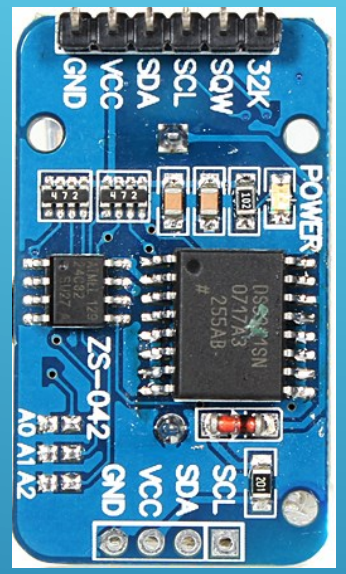
III. The VCC pin plugs into the 5V port of the Arduino

IV. GND plugs into the GND port.

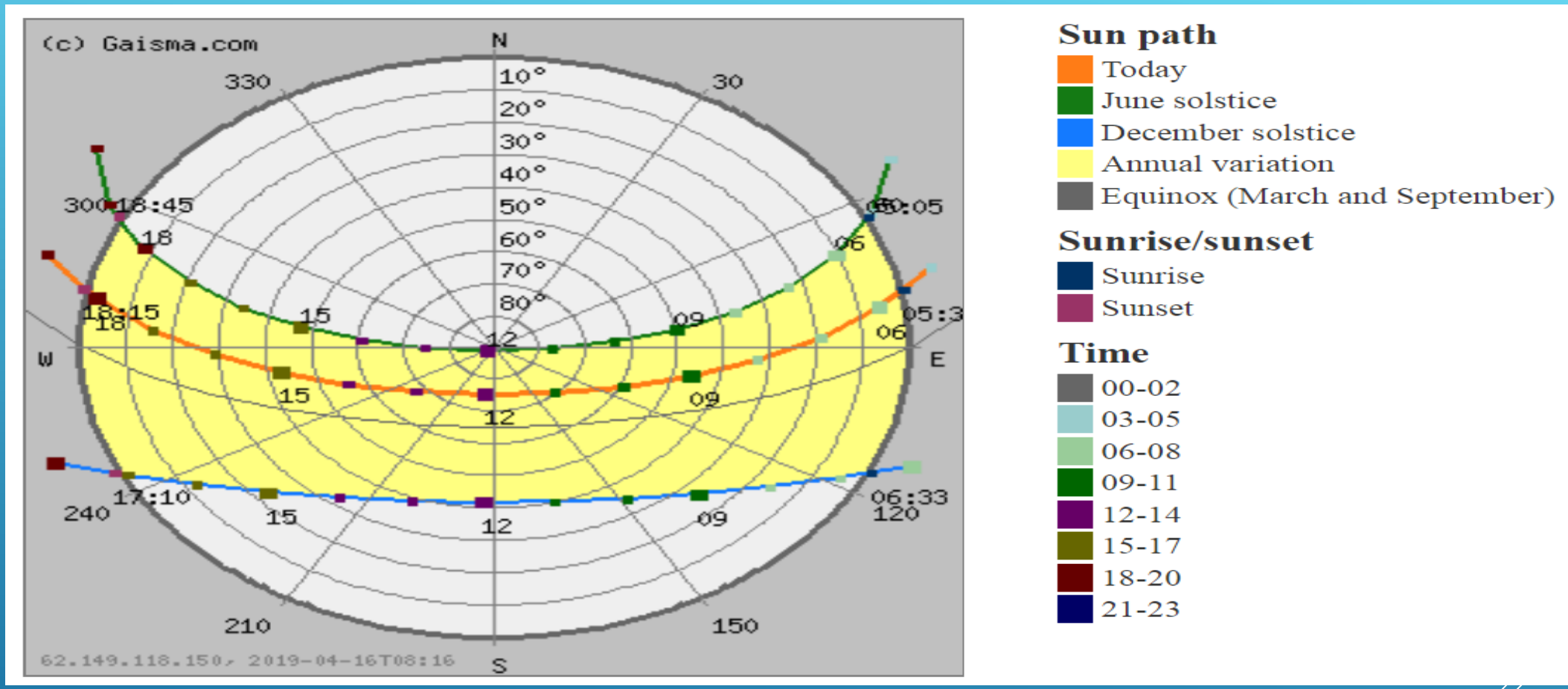
V. Calibration



REAL TIME CLOCK TYPES



DS_1307	DS_3231
Lower Accuracy	Most Accuracy
Expensive	Cheaper
Complex	Easier to implement
Affected to external temperature	Not Effected to temperature
No Backup Battery	Backup Battery

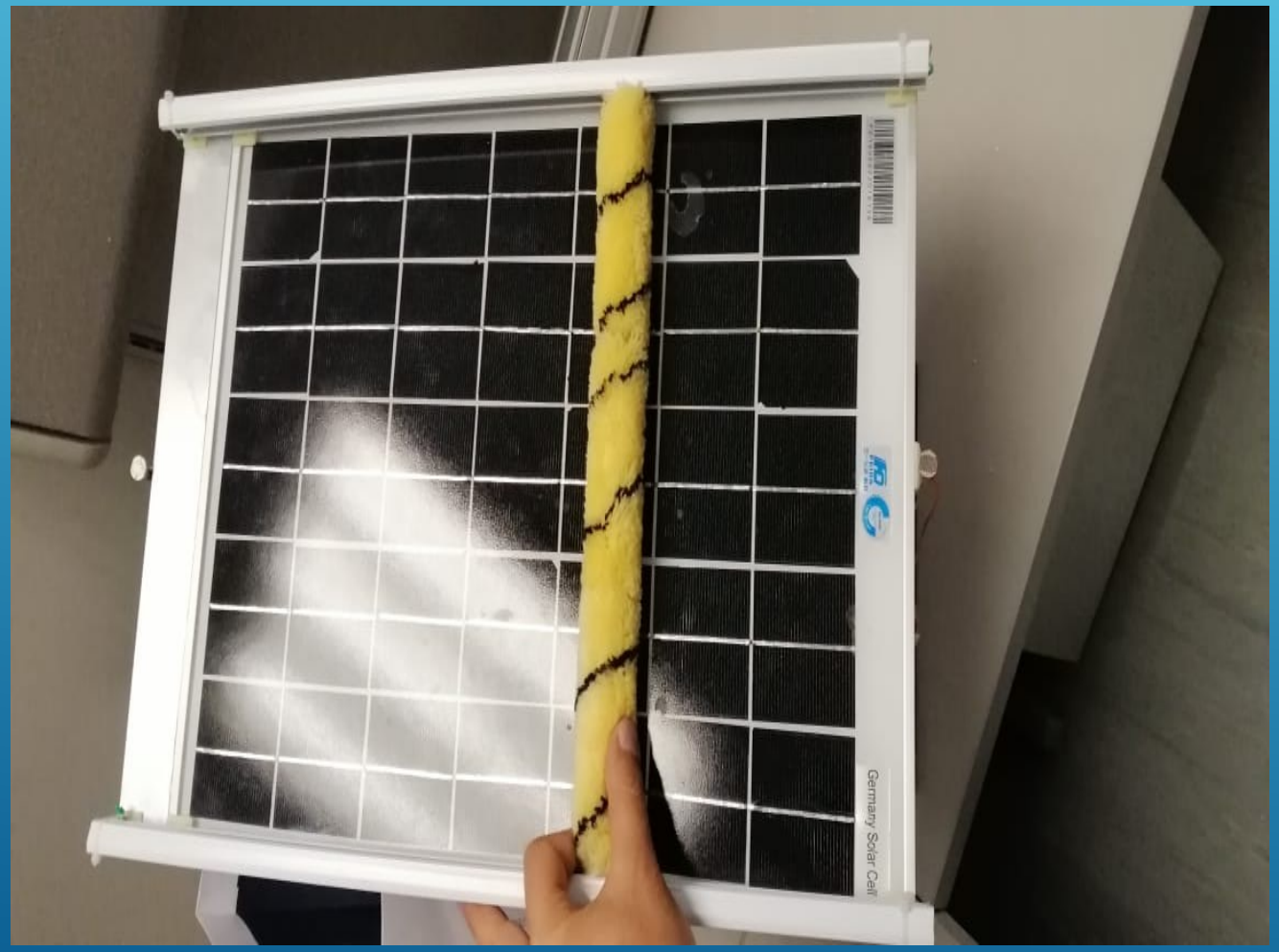


SUN PATH OF DHAHRAN

SUBSYSTEM 3: SELF-CLEANING

Mechanical self-maintained System	Electric System
No power required	Consume power
Higher efficiency	Lower the efficiency of the project

DESIGN: SELF-CLEANING



COMPLETED

Completed :

- Design and implement the ALL subsystems
- writing diagram
- Collect Components
- Build the project
- Test subsystem 1
- Test Subsystem 2
- Test Subsystem 3

DESIGN CONSTRAINTS

The main characteristics differentiating the solar tracker system are as follows:

- Sustainability.
- Environmental.
- Economic

FUTURE WORK & RECOMMENDATIONS

- Adding an MPPT as separate system will consume more power and decrease the efficiency
- However , adding an MPPT with an RTC will be a new good idea to increase efficiency.
- Dust sensor
- Irradiance sensor implement rather than LDR it gives more accurate readings than the LDR
- Adjust cleaning schedule.

PROJECT MANAGEMENT & TEAM WORK

Phase one

1 - project selection
2 - motor selection
3 - components selection
4 - design implantation
5 - design test

Phase two

1 - design implantation of subsystem 2 and 3
2 - Complete Test of all Systems

Project Management & Team Work

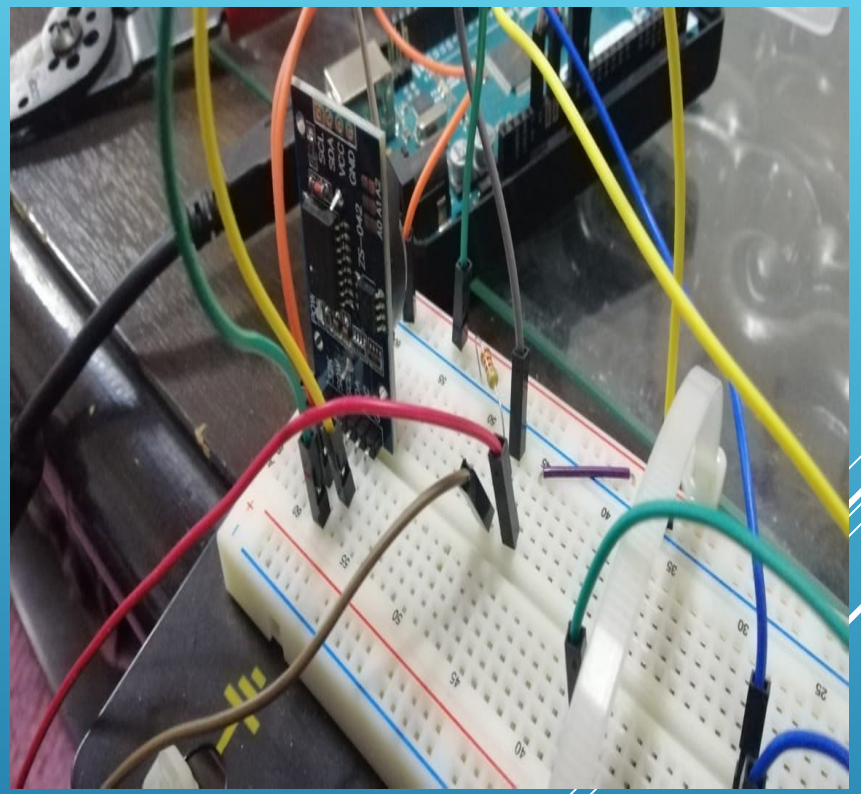
- Team work task division

Task	Ahmad	Faisal	Abdulaziz	Mohammad	Hussain
Search & acquire components	30%	40%	35%	35%	40%
Design & Implement Subsystem 1	40%	35%	30%	30%	40%
Design & Implement Subsystem 2 & 3	20%	20%	25%	25%	25%
Testing	50%	30%	40%	55%	60%
Write Reports & Presentations	45%	50%	40%	35%	45%

Project Management & Team Work

- Decision Making
- Design the Solar system
- Find the project components with many martials
- Challenges
- Solve the problems with servos
- build and try with codes.

Team Work



Budget Estimate

Item	Quantity	Unit Cost (SR)	Subtotal
Microcontroller	1	250	150
Solar Panel	1	360	360
Motor	1	140	140
Servo	2	60	60
Chips & components		200	200

REFERENCES

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