FINAL REPORT

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GROUP MEMBERS

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ABSTRACT

This project develops a dual-axis solar tracker to maximize PV (photovoltaic) energy capture by maintaining perpendicular alignment with sunlight. Inspired by R2D2, it features an Arduino Uno, solar cell, servo motors, and 3D-printed PLA (polylactic acid) components. This presentation addresses solar panel inefficiencies and our dual-axis tracker solution, covering design, challenges, and planned optimizations.

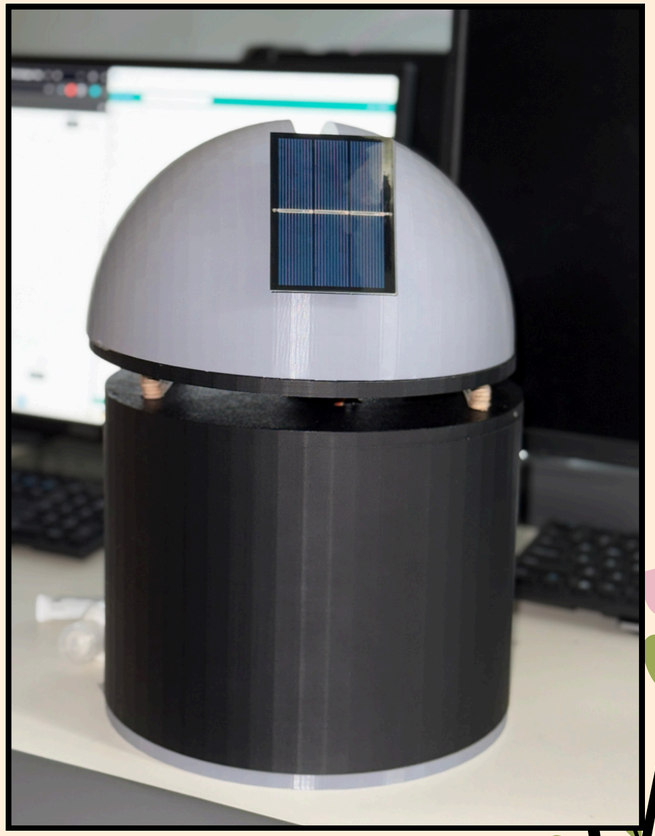
UPDATES

Assembly Updates:

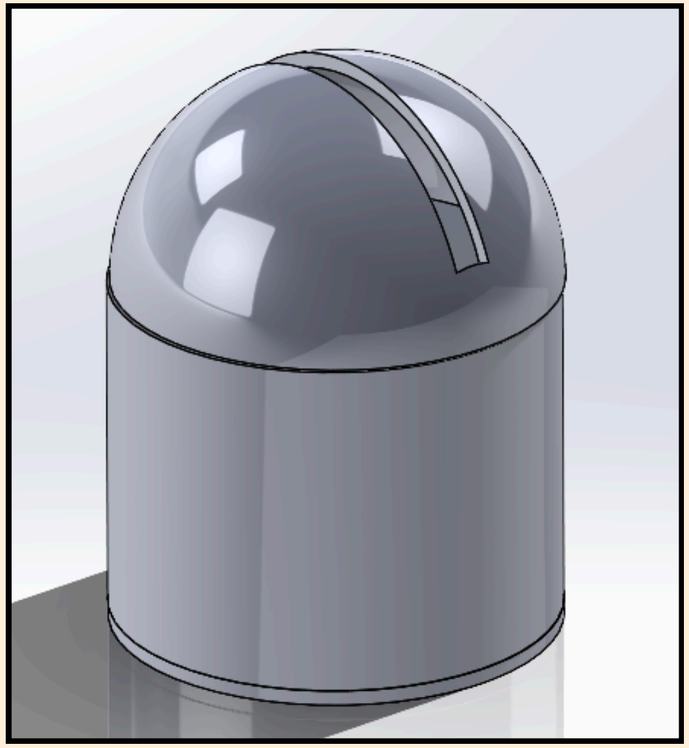
- Printed everything
- Alignment issues

Functionality Updates:

- R2D3 tracks light through full scan and locally



BUILD: OVERVIEW

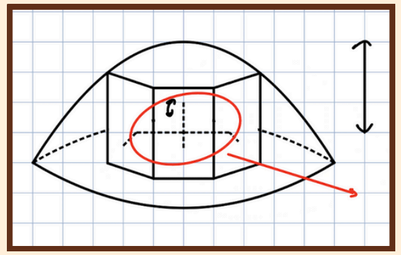


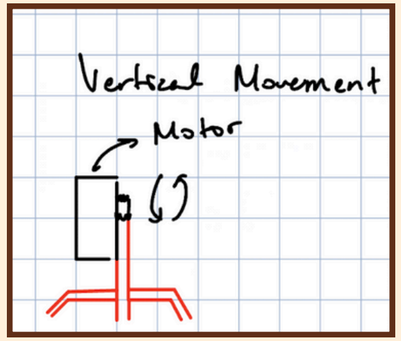
This rendering shows the 3D-printed housing for the dual-axis solar tracker, inspired by R2D2's dome-like head. The transparent shell reveals the main sections of the assembly:

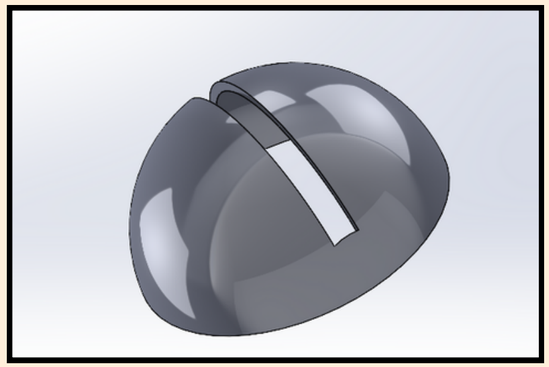
- **Dome Section** – Houses the solar cell and the tilt servo mechanism.
- **Base Section** – Contains the Arduino Uno and the horizontal rotation servo.
- **Internal Frame** – Provides support for wiring, sensors, and motors, ensuring each component is securely mounted.

Together, these parts allow the tracker to pivot horizontally and vertically, orienting itself to the brightest light source for optimal detection and data collection.

UPPER HOUSING





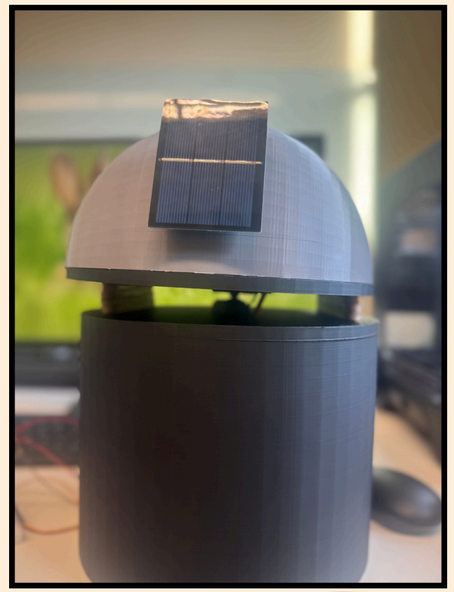


Upper Housing: Finished Product

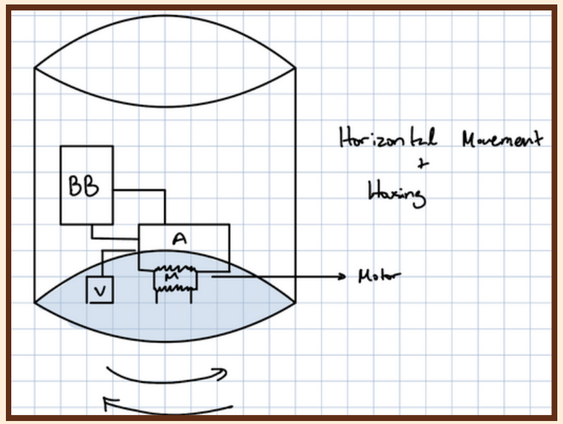
- Narrow slit has been added
- Servo arm can pivot freely
  - Made extended armature

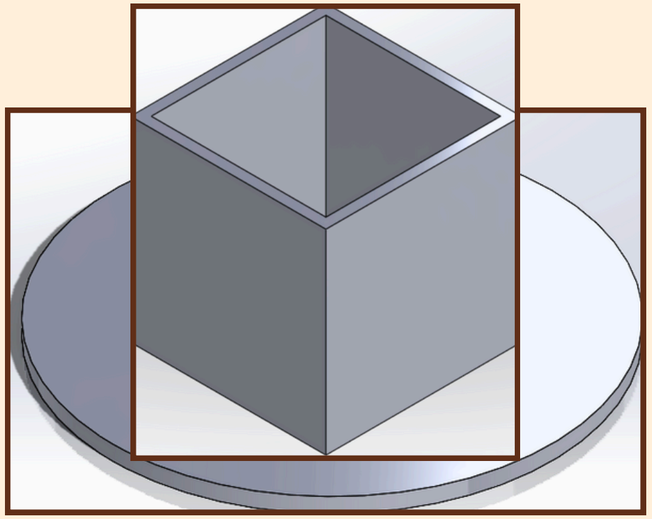
Adjustment

- Added popsicle stick braces for support
- Hot glue for a more secure adhesive



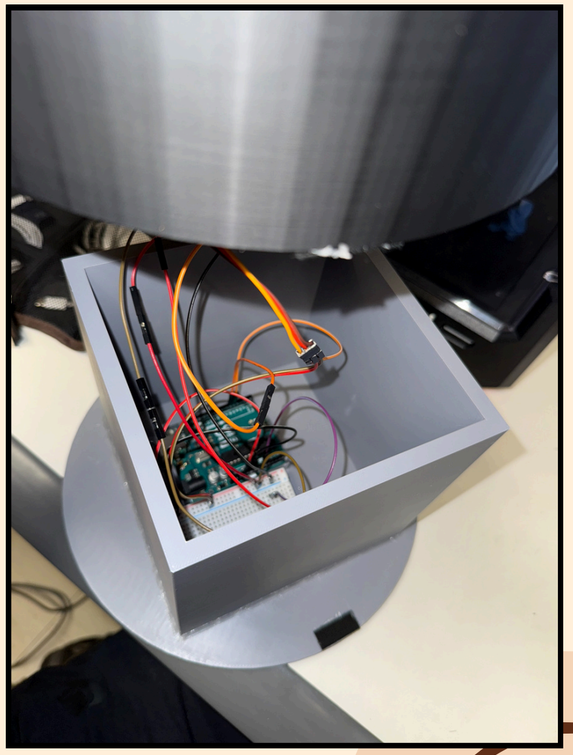
LOWER HOUSING



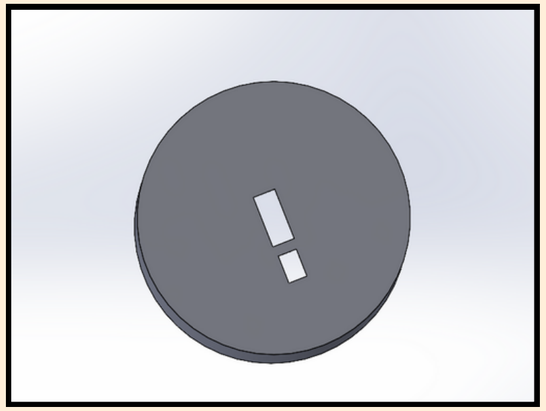


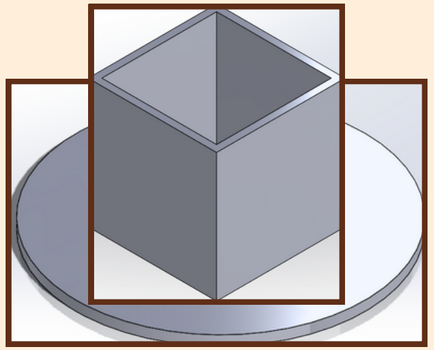
Lower Housing: Model vs. Initial Drawings

- Base aligns with original sketches
- Provides ample space for the battery pack and Arduino
- Velcro strips on the base to provide resistance during transport



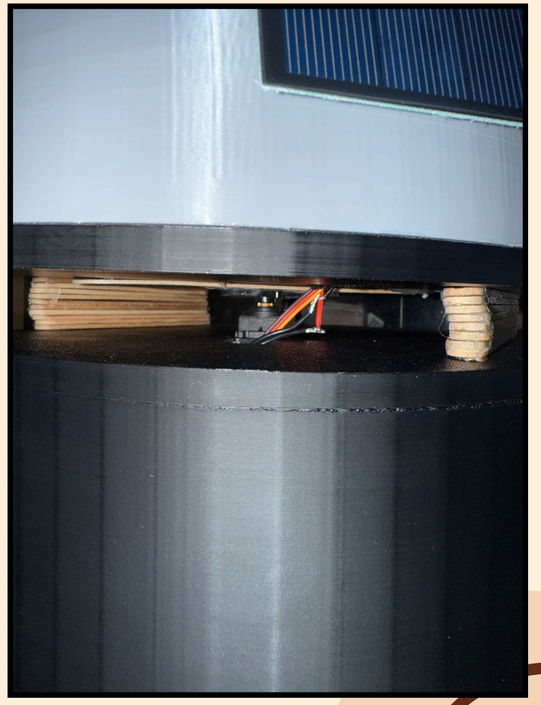
MOVEMENT MECHANISM





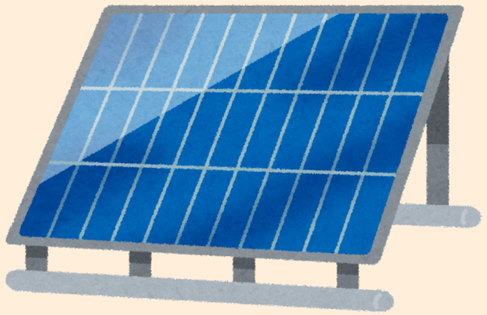
Movement Mechanism: Horizontal Rotation

- Housing lid slides onto storage cube
- Extrusions for horizontal motor and wires from upper model
  - Wires from the panel and vertical motor
- Additional base piece on top of horizontal motor
  - Horizontal motor not centered

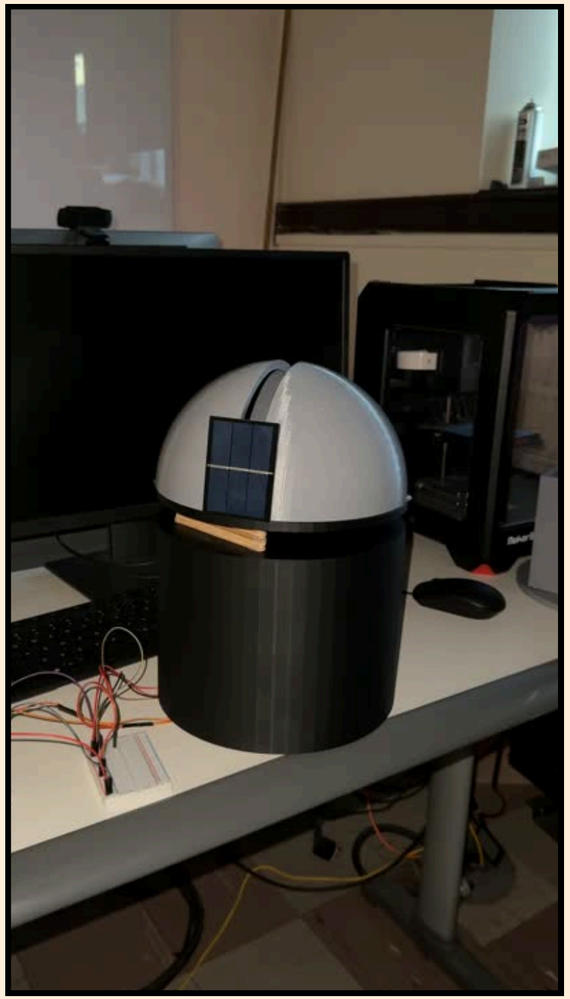


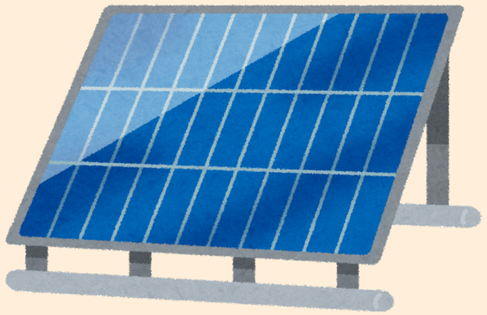
INITIAL LIGHT DETECTION

```
/**
 * Performs a full 0–180° sweep on the specified servo to find the angle
 * with the maximum voltage (i.e., brightest light).
 */
int findMaxPosition(Servo &servo, int sensorPin) {
  float maxVoltage = 0.0;
  int bestAngle = 25;

  for  int angle = 25; angle <= 180; angle++) {
    servo.write(angle);
    delay(50); // allow servo to move
    float voltage = readVoltage(sensorPin);

    if (voltage > maxVoltage) {
      maxVoltage = voltage;
      bestAngle = angl
    }            e;
  }

  return bestAngle;
}
```



FIRST ITERATION

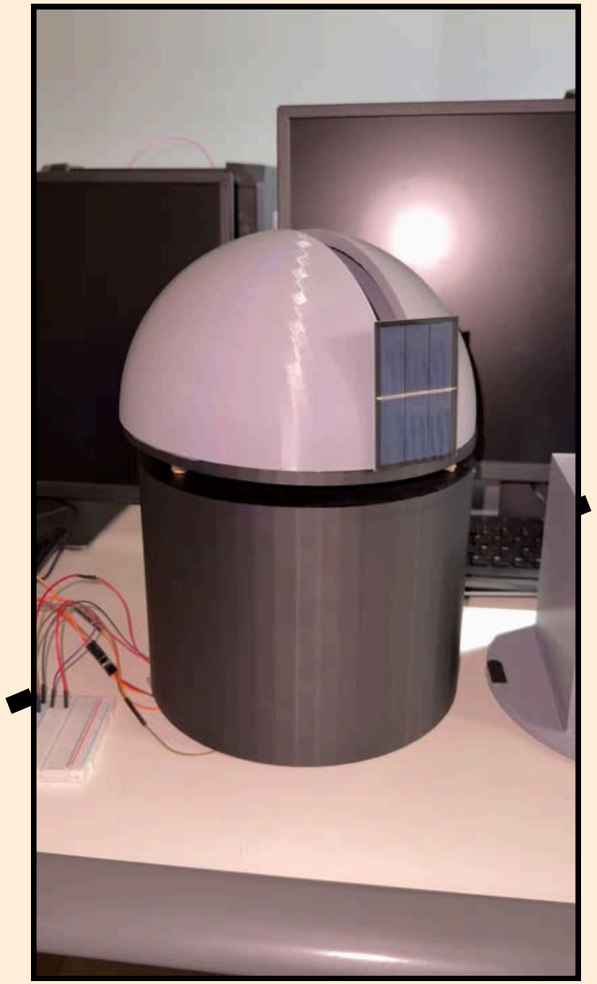




LOCAL TRACKING FUNCTION

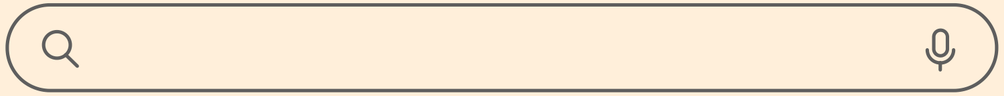
```
int trackLightLocally(Servo &servo, int sensorPin, int currentAngle, int step, int range) {
  // Read the voltage at the current angle
  servo.write(currentAngle);
  delay(30);
  float bestVoltage = readVoltage(sensorPin);
  int bestAngle = currentAngle;

  // Check angles around the current angle
  for  int offset = -range; offset <= range; offset += step) {
    int testAngle = currentAngle + offset;

    // Keep angles within valid bounds
    if (testAngle < 25)   testAngle = 25;
    if (testAngle > 180) testAngle = 180;

    servo.write(testAngle);
    delay(30);
    float voltage = readVoltage(sensorPin);

    // If we find a better voltage, update bestAngle and bestVoltage
    if (voltage > bestVoltage) {
      bestVoltage = voltage;
      bestAngle = testAngle;
    }
  }

  // Move servo to the best angle in the local region
  servo.write(bestAngle);
  return bestAngle;
}
```

LOCAL TRACKING FUNCTION



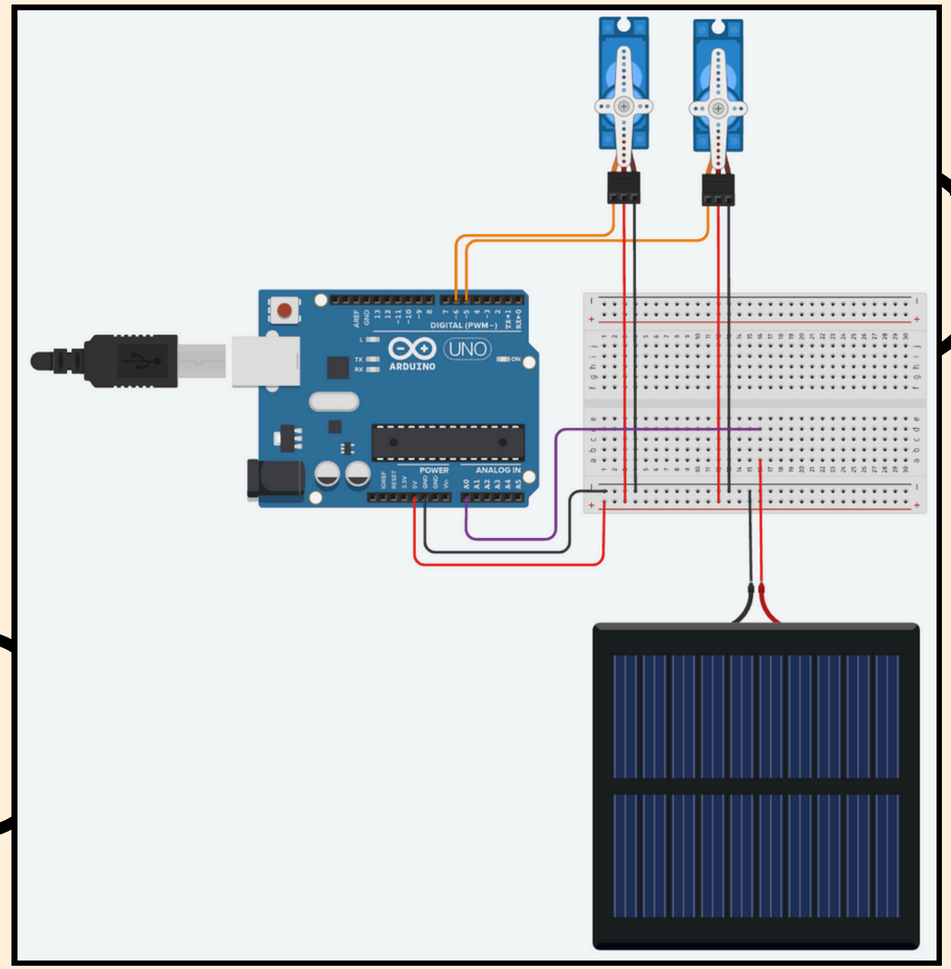
CONTINUOUS SEARCH

```
void loop() {
  // Continuously refine horizontal angle around the current position
  currentHorizontalAngle = trackLightLocally(
                             horizontal_servo,
                             A0,
                             currentHorizontalAngle,
                             1,   // Step size
                             20   // Range around current angle
                           );

  // Continuously refine vertical angle around the current positio
  currentVerticalAngle = trackLightLocally(
                           vertical_servo,
                           A0,
                           currentVerticalAngle,
                           1,   // Step size
                           20   // Range around current angle
                         );

  // Short delay before checking again
  delay(1000);
}
```



```
/**
 * Helper function to convert the raw analog reading to a voltag
e*/
float readVoltage(int sensorPin) {
  int rawValue = analogRead(sensorPin);
  return rawValue *  5.0 / 1023.0);
}                   (
```

ELECTRICAL DESIGN



NEXT STEPS

- Tune Speed
- Decorate!
- Wireless Control
- Stabilize

REAL WORLD IMPACT

DUAL-AXIS TRACKERS

ADVANTAGES

- MAXIMIZE POWER OUTPUT BY CONTINUALLY FOLLOWING THE SUN
- HELP MANAGE GRID POWER LIMITATIONS
- REQUIRE LESS LAND AREA TO PRODUCE MORE TOTAL ENERGY
- GENERATE 45-50% MORE ANNUAL POWER THAN FIXED PANELS
- QUICKER PAYBACK ON INVESTMENT COSTS

DISADVANTAGES

- MORE PRONE TO TECHNICAL GLITCHES DUE TO COMPLEXITY
- SHORTER LIFESPAN AND LOWER RELIABILITY
- HIGHER MAINTENANCE COSTS

SOURCE: HTTPS://RATEDPOWER.COM/GLOSSARY/SOLAR-TRACKERS/

THANK YOU