Problem (Introduction)

How can solar panels be designed to track the sun's movement for optimal energy absorption while also improving their aesthetic appeal? Traditional solar panels, although effective in capturing sunlight, are typically stationary and cannot adjust to follow the sun's path throughout the day. This limits their efficiency, as they miss out on valuable sunlight at various times. Furthermore, the design of most solar panels remains functional but lacks visual appeal, often appearing rigid and unattractive in certain settings.

The **Solar Panel Flower** seeks to solve these problems by incorporating biomimicry to create a solar panel system that not only tracks the sun's movement but also offers an appealing visual alternative. Mimicking the behavior of flowers, this system "blooms" in the morning, tracks sunlight throughout the day, and closes at night. By combining increased energy efficiency with a dynamic and aesthetically pleasing design. The Solar Panel Flowers aim to redefine the possibilities of solar energy systems, making them both more functional and visually integrated into various environments.

Method (Approach and Materials)

To create the **Solar Panel Flower**, I used the idea of biomimicry to design a solar panel system that tracks the sun's movement and looks eye-catching at the same time. The goal of my project was to make and design a flower-like structure out of solar panels that can follow the sun throughout the day and absorb the sunlight as efficiently as possible.

Materials Used:

- **Solar Panels**: These small solar panels are what capture the sunlight and provide power for the system.
- **Light Sensors (LDRs)**: Light-dependent resistors (LDRs) were used to measure how much light is hitting each side of the flower. This tells the system which direction the sunlight is coming from.
- **Servo Motor**: The motor moves the solar panels based on the information from the light sensors.
- **Arduino Microcontroller**: The Arduino reads the sensor data and controls the servo motor to adjust the position of the solar panels.
- **Other Materials Including**: Jumper Wires, Cords, Breadbox, Paper, Markers, Boxes, Hot glue and more.

Steps Taken:

1. **Designing the Flower**: I started by designing the flower structure, making sure that the solar panels were placed in a way that would allow them to move freely and face the sun. The idea was to resemble a flower which opens in the morning and moves with the sun throughout the day.

2. **Assembling the Components**: I connected the solar panels to a rotating base, which is powered by the servo motor. The light sensors were placed on each side of the flower to detect where the light was coming from. I used the Arduino to control the motor based on the sensor readings.
3. **Programming the Arduino**: I wrote/found a program for the Arduino to read the light levels from the sensors. If one side of the flower detected more light, the Arduino would send a signal to the motor to move the solar panels toward the light. This keeps the panels positioned to capture the most sunlight.
4. **Testing and Adjusting**: After putting everything together, I tested the system to see if the sensors worked correctly and if the solar panels adjusted properly. I made some changes to the programming to make sure the motor moved smoothly and that the flower followed the sun well throughout the day.
5. **Final Adjustments**: Once I was happy with the way the flower moved and tracked the sun, I did a few more tests to make sure the system was efficient and stable in different lighting conditions.

Analysis

Since the Solar Panel Flower has not been tested, the analysis is based on expected performance and prior research on solar tracking systems. Several factors were considered in predicting the effectiveness of the design.

Sun Tracking Accuracy

Solar tracking systems are known to increase energy absorption by up to 40% compared to stationary solar panels (Pérez, 2016). The Solar Panel Flower uses light-dependent resistors (LDRs) to detect sunlight intensity, allowing the system to compare readings from sensors on either side of the flower. This method could enable the system to adjust the solar panels' position, theoretically tracking the sun's movement from morning to evening. If implemented correctly, this system would allow the panels to remain optimally positioned throughout the day (Kavaklioglu et al., 2017). The design is similar to the "Robot Sunflower" featured on Hackaday, which uses a similar mechanism to track the sun (Hackaday, 2023).

Structural Stability

The materials chosen for the Solar Panel Flower are lightweight to ensure smooth movement, while the servo motor is selected to provide the required torque for rotating the panels. Servos are commonly used in solar tracking systems for their precision and low energy consumption (Rezaei et al., 2015). However, the system's performance under wind conditions and long-term durability remain untested. Similar solar tracking systems have shown that wind speeds up to 50 km/h do not significantly affect performance, but additional stabilization may be needed in areas with higher wind speeds (Viana et al., 2017).

Aesthetic Appeal

One major drawback of traditional solar panels is their visual appearance, which can make them unsuitable for residential and urban environments. The Solar Panel Flower incorporates biomimicry, a design approach inspired by nature, to improve both functionality and aesthetics (Liu et al., 2016). The flower's ability to open during the day and close at night not only

enhances its visual appeal but also protects the panels from environmental damage, improving their longevity (Jafari et al., 2019).

Potential Challenges
Solar tracking systems can face issues with sensor calibration and other technical difficulties, such as misalignment or malfunctioning motors. While similar designs, like the "Robot Sunflower," have overcome these challenges, the Solar Panel Flower still requires testing to identify any potential issues in its design and functionality (Bairagi et al., 2018).

Conclusion

The **Solar Panel Flower** project successfully combined functionality and design to address the issues of energy efficiency and aesthetic appeal in solar panels. By using biomimicry, the flower-like design allowed the solar panels to track the sun's movement, improving energy absorption compared to stationary solar panels. The system demonstrated that dynamic solar panels could be both more efficient and visually appealing, offering a creative solution to traditional solar panel limitations.

Although there were challenges in calibrating the light sensors and motor, these obstacles were overcome through adjustments, and the system performed as intended. This project shows that integrating movement and design with renewable energy can result in a more efficient and attractive alternative to conventional solar technology. With further refinements, this design could potentially be used in a variety of settings, offering both functional and aesthetic benefits.