

## Model Card: Solar Panel Instance Segmentation Model (Eco Innovators Hackathon 2025)

### 1. Model Overview

This model performs **instance segmentation** of rooftop solar panels using a **fine-tuned Mask R-CNN** architecture.

It was developed as part of the **Eco Innovators Hackathon** to support automated solar panel detection from satellite imagery.

The model identifies individual solar panel installations and produces pixel-level masks for each instance.

### 2. Model Architecture

- **Base Model:** Mask R-CNN
- **Backbone:** ResNet (fine-tuned)
- **Training Epochs:** 20 epochs
- **Task:** Instance segmentation
- **Input Resolution:** 640×640 pixels
- **Output:** Pixel-level instance masks and bounding boxes

### 3. Data Sources

#### Imagery Providers

- **ESRI ArcGIS World Imagery:** High-resolution satellite and aerial imagery.
- **Google Maps Static API:** 640×640 pixel static satellite imagery for diversity in rooftop structures.

#### Dataset Composition

- Combination of labeled and unlabeled rooftop imagery
- Urban, semi-urban, and rural building diversity
- Variations in roof materials, angles, lighting conditions, and shadows

### 4. Training Approach

#### Self-Supervised Pseudo-Labeling

- Generated mask annotations from unlabeled data to reduce reliance on manual labeling.

#### Multi-Method Fusion

Integrated cues from:

- Color information
- Edge detection
- Shape priors resembling solar panels

### **Conservative Filtering**

- Multi-stage quality checks to remove noisy, incomplete, or low-confidence pseudo-labels.

### **Augmentation Handling**

- All transformations applied consistently to images and instance-level annotations to maintain mask integrity.

## **5. Model Performance**

- **Overall Accuracy:** ~60% after 20 epochs
- Performance influenced by dataset variability, pseudo-label noise, and limited high-quality annotated samples.

## **6. Intended Use Cases**

- Identification of rooftop solar installations
- Renewable energy potential mapping
- Sustainable urban planning support
- Preprocessing for large-scale environmental analytics

## **7. Limitations**

- Lower performance on small or low-contrast solar panels
- Reduced accuracy in shadowed or reflective rooftops
- Sensitivity to region-specific architectural differences
- Not optimized for ultra-high-resolution imagery

## **8. Ethical Considerations**

- Must comply with Google Maps Static API and ESRI ArcGIS imagery terms
- Not intended for surveillance or private property analysis
- Designed strictly for sustainability, research, and environmental applications

## **9. Licensing**

- Model code/weights: Insert license (MIT / Apache 2.0 / CC-BY).
- Imagery licensing governed by respective API providers.