PM SURYA GHAR: MUFT BIJLI YOJANA

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(An Innovation Challenge on Climate, Energy & Sustainability)

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Automated Rooftop Solar Verification Using YOLOv8 (Detection, Segmentation, Area Estimation & QC Automation)

BY

Akash M
(240769.it@rmkec.ac.in)
Mohan Kumar H
(230549.it@rmkec.ac.in)

SUBMITTED BY	SIGNATURE
Akash M **Mohan Kumar** **team: Health Coder** Year: **2025–2026**	**EcoInnovators 2026 Hackathon Committee** Ministry of New & Renewable Energy Government of India

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Abstract:

The rapid expansion of rooftop solar installations under the PM Surya Ghar: Muft Bijli Yojana requires fast, accurate, and scalable verification mechanisms. Manual field inspections are slow, expensive, and prone to human error. To address this problem, SolarSight AI was developed — an automated AI pipeline that detects rooftop solar panels using satellite imagery.

The system uses two YOLOv8 deep-learning models: (1) Detection model to identify presence of solar panels, (2) Segmentation model to generate polygon masks and estimate solar panel area.

The pipeline fetches satellite images, classifies solar presence, estimates surface area, performs QC verification, and generates audit-ready JSON outputs. The solution reduces verification time from days to seconds and provides transparent digital evidence for government auditing workflows.

1.Overview

SolarSight AI is a two-model deep learning system designed for automated verification of rooftop solar photovoltaic (PV) installations under the PM Surya Ghar Yojana initiative.

The system uses high-resolution satellite imagery and performs the following key tasks:

- Detect solar panels
- Generate polygon segmentation masks
- Estimate rooftop solar area
- Provide transparent, audit-ready verification outputs

The model ensures scalable, automated, and governance-friendly verification suitable for large national deployments.

1.Intended use

Intended For:

- Large-scale rooftop solar installation verification
- Government and DISCOM auditing workflows
- Utility provider monitoring
- Remote assessment dashboards and digital inspections

NOT Intended For:

- Real-time drone inspections
- Facial recognition or identity inference
- Legal, medical, or safety-critical decision making

2. Model Architecture:

Model 1: YOLOv8 Detection (best_detect.pt)

- Task: Solar panel presence detection
- Output: Bounding box + confidence score
- Used in: CLASSIFY stage

Model 2: YOLOv8 Segmentation (best_segment.pt)

- Task: Pixel-level polygon mask segmentation
- Output: Mask + estimated solar panel area
- Used in: EXPLAIN and QUANTIFY stages

Together, both models generate interpretable and verifiable outputs suitable for audits.

3.Training Data

The models were trained using three merged Roboflow datasets, containing:

- Urban & rural rooftop solar installations
- Solar farms
- Roof types (cement, tin, metal, tiles)
- Various weather/lighting conditions

Annotations:

- YOLO bounding boxes
- Polygon segmentation masks

Dataset Size: ~3,000 images

Preprocessing:

- 640×640 resizing
- Normalization
- Augmentations: rotation, flip, brightness variation

4.Training Details

Common Training Setup

Setting	Value
Framework	Ultralytics YOLOv8
Image Size	640
Epochs	200
Optimizer	Adam
Learning Rate	1e-3
Hardware	Google Colab T4 GPU
Loss Function	YOLO Multitask Loss

Both models were trained independently to optimize detection and segmentation performance.

5.Performance Metrics

Detection Model (best_detect.pt)

- F1 Score: ~0.82
- Precision: ~0.80
- Recall: ~0.85

Segmentation Model (best_segment.pt)

- mAP@50: ~0.78
- RMSE (area estimation): Moderate

These results indicate strong suitability for national-scale solar verification.

6. Strengths

- High-accuracy solar detection
- Works across diverse Indian rooftops
- Bounding box + polygon mask outputs
- Lightweight, fast inference
- Produces audit-friendly JSON outputs

7.Limitations

- Low-resolution or outdated imagery reduces accuracy
- Metal roofs, water tanks may cause false positives
- Strong shadows or clouds affect segmentation

10. Ethical Considerations

- No personal data or biometric information
- Designed for public-benefit use
- Ensures privacy and minimal data dependency
- Not intended for surveillance

  Uses only satellite imagery