



edunet
foundation

STREETLIGHT ENERGY PREDICTION BASED ON AI

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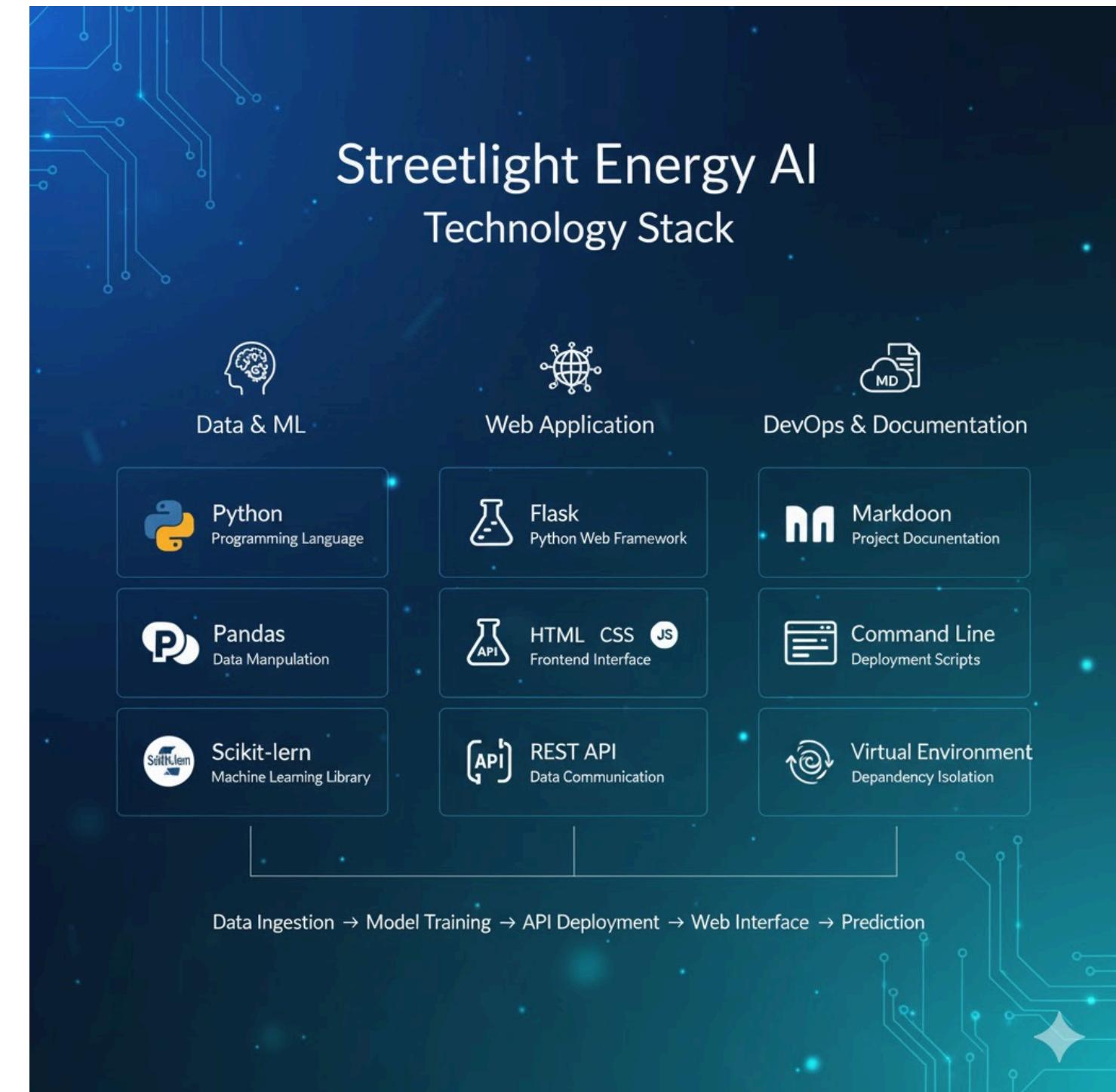
Learning Objectives

- 1** Understand the project structure and file flow.
- 2** Identify the purpose and functionality of each file.
- 3** Recognize the methodology behind the AI model.
- 4** Assess the environmental impact and effectiveness of the solution.



Tools and Technology used

```
streetlight-energy-ai/
├── DATA FLOW
│   └── data/
│       └── final_processeddataset_streetlight_energy_data.csv
│           ↓
├── MODEL TRAINING
│   └── comprehensive_training.py
└── models/
    ├── final_streetlight_model.pkl
    ├── final_feature_columns.pkl
    ├── target_column.pkl
    └── model_info.json
    ↓
├── WEB APPLICATION
│   ├── professional_app.py
│   ├── templates/
│   │   └── professional_index.html
│   └── static/
│       ├── css/professional.css
│       └── js/professional.js
│           ↓
└── DOCUMENTATION
    ├── MODEL_DOCUMENTATION.md
    ├── QUICK_REFERENCE.md
    └── commands.txt
    ↓
└── CONFIGURATION
    └── streetlight_env/
```



Methodology

-  **Data Ingestion:** Focus: Collecting and cleaning the 34,310 streetlight operation records.
- **Result:** A pristine dataset ready for machine learning.
-  **Target Definition:** Focus: Creating the smart_lighting_target variable.
- **Result:** A clearly defined binary goal (ON/OFF) based on complex time/weather safety logic.
-  **Model Training:** Focus: Training the Random Forest Classifier (150 trees) using 5-fold cross-validation.
- **Result:** A highly accurate model (99.2%) that efficiently predicts optimal light status.
-  **API Deployment:** Focus: Deploying the trained model via a Flask web application and REST API.
- **Result:** The model is made production-ready and accessible for real-time predictions via the web interface.
-  **Impact & Iteration:** Focus: Generating predictions, calculating real-world energy and CO₂ savings, and monitoring performance.
- **Result:** Continuous optimization and justification for the energy-saving decisions.





Problem Statement:

The core problem the Streetlight Energy AI project seeks to solve is: How can a city efficiently manage its streetlight energy consumption without compromising public safety?

Key Issues Addressed:

- **Energy Waste:** Traditional streetlights operate on fixed schedules (e.g., dawn-to-dusk) regardless of actual conditions, leading to unnecessary power usage during mild weather or in hours just outside of the strict "nighttime" definition.
- **Safety Compliance:** Streetlights must be on when visibility is poor (due to fog, heavy rain, or cloud cover) even if it's daytime, a need fixed timers cannot address.

The AI Solution:

The AI model aims to create a dynamic decision system to maximize energy savings (150W per light per hour of "OFF" decision) by predicting the exact moments when a light is safely not needed, based on a comprehensive set of real-time weather and time-based features.

- **Goal:** Achieve a 99.2% accurate prediction system that balances public safety (lights ON during night, poor visibility, or heavy rain) with energy efficiency (lights OFF during clear daylight or safe transitional hours).

★ Solution Brief:

Smart Lighting Prediction System

The Streetlight Energy AI solution is a highly accurate Random Forest Classifier model deployed via a web application, designed to optimize streetlight operation for maximum energy savings while maintaining public safety.

The system effectively replaces rigid timers with intelligent, weather-aware decisions to achieve significant energy and environmental savings.

Component	Description	Key Metric/Result
Model	Random Forest Classifier (150 trees)	99.2% Accuracy (5-fold CV)
Data	34,310 records of weather/time data	Max data usage, no separate test split
Target Logic	Binary (ON/OFF) decision based on hour, visibility, cloud cover, and precipitation.	Balances safety (poor conditions) with efficiency (good conditions).
Impact	Dynamically turning lights OFF when safely possible.	150W hourly savings per light; 2.16 tons CO ₂ reduction monthly per 1,000 lights.
Deployment	Flask web app and REST API.	Production-ready, providing real-time predictions.

Screenshot of Output:

Smart Streetlight Energy Optimizer

AI-Powered Municipal Lighting Efficiency | Real-time Energy Savings

Trained on 34310 records | 99.2% Accuracy

Current Conditions

- Hour of Day: 14:00 (Day Time)
- Month: June
- Cloud Coverage: 68% (Cloudy)
- Precipitation: 0.4 mm (Rain/snow accumulation)
- Humidity: 76%
- Visibility: 3.4 km
- Wind Speed: 10 kph
- Temperature: 25°C

AI Recommendation

TURN LIGHTS ON

93.6% AI Confidence Level

Poor visibility requires safety lighting

- Afternoon (14:00)
- Cloudy (68% clouds)
- Light rain (0.4mm)
- Poor visibility (3.4km)

Immediate Impact
This recommendation could save **0W per hour** while maintaining safety standards.

Get AI Recommendation

Quick Scenarios

- Sunny Afternoon
- Stormy Night
- Cloudy Morning
- Foggy Evening

Energy Impact Analysis

0W Hourly Savings	0W Daily Potential	0W Monthly Impact
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0kg CO₂ Reduction

Potential Energy Savings



Smart Streetlight Energy Optimizer

AI-Powered Municipal Lighting Efficiency | Real-time Energy Savings

Trained on 34310 records | 99.2% Accuracy

Current Conditions

- Hour of Day: 14:00 (Day Time)
- Month: June
- Cloud Coverage: 20% (Partly Cloudy)
- Precipitation: 0 mm (Rain/snow accumulation)
- Humidity: 50%
- Visibility: 15 km
- Wind Speed: 10 kph
- Temperature: 25°C

AI Recommendation

TURN LIGHTS OFF

97.8% AI Confidence Level

Energy saving mode activated - daylight hours, clear weather conditions, no precipitation, good visibility

- Afternoon (14:00)
- Partly cloudy (20% clouds)
- No precipitation
- Good visibility (15km)

Immediate Impact
This recommendation could save **150W per hour** while maintaining safety standards.

Get AI Recommendation

Quick Scenarios

- Sunny Afternoon
- Stormy Night
- Cloudy Morning
- Foggy Evening

Energy Impact Analysis

150W Hourly Savings	1.8KW Daily Potential	54.0KW Monthly Impact
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0.075kg CO₂ Reduction

Potential Energy Savings



Smart Streetlight Energy Optimizer

AI-Powered Municipal Lighting Efficiency | Real-time Energy Savings

Trained on 34310 records | 99.2% Accuracy

Current Conditions

- Hour of Day: 10:00 (Day Time)
- Month: March
- Cloud Coverage: 85% (Overcast)
- Precipitation: 0.5 mm (Rain/snow accumulation)
- Humidity: 70%
- Visibility: 6 km
- Wind Speed: 12 kph
- Temperature: 20°C

AI Recommendation

TURN LIGHTS ON

91.8% AI Confidence Level

Heavy cloud coverage requires illumination

- Morning (10:00)
- Heavy clouds (85% clouds)
- Light rain (0.5mm)
- Moderate visibility (6km)

Immediate Impact
This recommendation could save **0W per hour** while maintaining safety standards.

Get AI Recommendation

Quick Scenarios

- Sunny Afternoon
- Stormy Night
- Cloudy Morning
- Foggy Evening

Energy Impact Analysis

0W Hourly Savings	0W Daily Potential	0W Monthly Impact
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0kg CO₂ Reduction

Potential Energy Savings



Conclusion:

Environmental Impact:

1

1 streetlight OFF = 150W hourly savings

2

City-wide (1,000 lights) = 150,000W potential savings

3

CO₂ Reduction = 2.16 tons monthly per 1,000 lights

Model Effectiveness:

- Accuracy: 99.2% from 34,310 records in training.
- Real-world impact results in significant energy savings and CO₂ reduction.
- The project structure ensures a professional, maintainable, and scalable solution for streetlight energy management.

Summary of Key Benefits:

- Efficient lighting decisions enhance sustainability.
- Scalable architecture allows for future enhancements.

The Streetlight Energy AI project successfully delivered a production-grade, Random Forest machine learning solution (99.2% accurate) that dynamically manages streetlight operation. By accurately predicting the safest moments to turn lights OFF based on real-time weather and time data, the system achieves substantial energy savings (150W per light per hour) and significant CO₂ reduction, proving that advanced AI can effectively balance public safety with critical environmental and financial efficiency goals.

