17. Energy Management: Solar Power Forecasting

- **Problem Statement:** The integration of intermittent renewable energy sources like solar power into the electrical grid requires accurate forecasting. This project aims to predict short-term solar irradiance and power output by analyzing images of the sky. A CNN will be trained on a sequence of sky-camera images to learn cloud movement patterns and predict future cloud cover, which directly impacts solar panel generation. The forecasting model will be developed in Google Colab using TensorFlow and Keras.
- **Detailed Tasks:**
    1. **Data Sourcing:**
        - Find a dataset containing time-stamped images from a sky-facing camera and corresponding solar irradiance measurements (e.g., from a pyranometer).
    2. **Data Preparation (Sequencing):**
        - Create sequences of data. For example, an input sequence could be 6 consecutive sky images (taken every 5 minutes), and the target would be the solar irradiance value 30 minutes after the last image.
    3. **Model Architecture (ConvLSTM):**
        - This is a perfect use case for a **ConvLSTM2D** network. This type of layer can process sequences of images, learning both the spatial features (clouds) in each image and their temporal evolution (movement).
        - The architecture will consist of several ConvLSTM2D layers followed by Dense layers to regress to a single continuous value (the predicted irradiance).
    4. **Training:**
        - This is a regression task, not classification.
        - Compile the model with the Adam optimizer and a regression loss function like **Mean Squared Error (MSE)** or **Mean Absolute Error (MAE)**.
    5. **Evaluation:**
        - Evaluate the model using regression metrics like Root Mean Squared Error (RMSE) and MAE on a test set.
        - Plot the predicted irradiance values against the true values over time to visually assess the forecasting performance.