Theme 1: Intelligent Energy & Power Systems

Innovative approaches to energy generation, conversion, storage, and distribution

E01 Smart Microgrid Load Balancer

Problem Statement:

Design an AI-powered dashboard that simulates real-time load balancing for a residential microgrid with solar panels, battery storage, and EV charging stations. The system should optimize energy distribution based on demand predictions and renewable availability.

Domains: AI/ML | Energy Systems | IoT

Expected Outcome: Working prototype with visualization showing load distribution and optimization decisions

E02 Predictive Solar Panel Maintenance

Problem Statement:

Build a machine learning model that analyzes weather data, panel age, and historical performance to predict solar panel degradation and maintenance needs. Create an alert system for optimal cleaning and repair scheduling.

Domains: Machine Learning | Renewable Energy | Predictive Analytics

Expected Outcome: ML model with web interface showing maintenance predictions and cost savings

E03 Household Energy Footprint Analyzer

Problem Statement:

Develop an application that uses smart meter data patterns to disaggregate total household energy consumption into individual appliance usage without requiring separate sensors. Provide personalized energy-saving recommendations.

Domains: Data Science | Consumer Tech | Sustainability

Expected Outcome: App prototype showing appliance-level breakdown and actionable insights

E04 Peer-to-Peer Energy Trading Platform

Problem Statement:

Create a blockchain-inspired ledger system for neighborhoods to trade excess solar energy. Design the matching algorithm, pricing mechanism, and user interface for prosumers to buy/sell energy locally.

Domains: Blockchain | Energy Markets | P2P Systems

Expected Outcome: Simulation platform with trading interface and transaction history

E05 Wind Farm Output Forecaster

Problem Statement:

Build a hybrid model combining weather APIs and historical turbine data to forecast wind farm output 24-48 hours ahead. Include uncertainty quantification for grid operators to plan reserve capacity.

Domains: Weather Analytics | Forecasting | Grid Management

Expected Outcome: Forecasting tool with confidence intervals and accuracy metrics

E06 Smart Battery Degradation Optimizer

Problem Statement:

Design an algorithm that optimizes charging/discharging cycles for lithium-ion batteries to maximize lifespan while meeting user energy needs. Consider temperature, depth of discharge, and charge rate impacts.

Domains: Battery Tech | Optimization | Embedded Systems

Expected Outcome: Simulation showing battery life extension under different strategies

E07 Industrial Energy Waste Detector

Problem Statement:

Create a system that analyzes industrial facility power consumption patterns to identify energy waste from idle equipment, inefficient processes, or equipment malfunction. Generate automated alerts and ROI calculations.

Domains: Industrial IoT | Anomaly Detection | Process Optimization

Expected Outcome: Dashboard identifying waste sources with potential savings calculations

E08 Dynamic Electricity Pricing Advisor

Problem Statement:

Build an app that tracks real-time electricity prices, forecasts price trends, and automatically schedules flexible loads (dishwasher, laundry, EV charging) to minimize bills while respecting user constraints.

Domains: Smart Home | Economics | Scheduling Algorithms

Expected Outcome: Working scheduler with cost comparison against baseline usage

E09 Campus Energy Digital Twin

Problem Statement:

Develop a simplified digital twin of a university campus that models energy flows between buildings, renewable sources, and storage. Allow users to simulate scenarios like adding solar panels or changing HVAC schedules.

Domains: Digital Twin | Simulation | Building Energy

Expected Outcome: Interactive 3D visualization with scenario comparison tools

E10 Power Outage Prediction System

Problem Statement:

Create a model that combines weather forecasts, historical outage data, and grid topology to predict outage risks by area. Help utilities pre-position crews and alert consumers to prepare backup power.

Domains: Predictive Analytics | GIS | Emergency Management

Expected Outcome: Risk map interface with outage probability scores and alerts

E11 EV Fleet Charging Optimizer

Problem Statement:

Design a scheduling system for a delivery company's electric vehicle fleet that optimizes charging times based on route schedules, electricity prices, grid capacity, and battery health constraints.

Domains: Fleet Management | Optimization | EV Technology

Expected Outcome: Scheduling interface with cost and time optimization metrics

E12 Renewable Energy Certificate Tracker

Problem Statement:

Build a transparent system for tracking renewable energy certificates from generation to retirement. Enable businesses to verify their green energy claims and consumers to validate sustainability reports.

Domains: Sustainability | Verification Systems | Data Integrity

Expected Outcome: Tracking platform with certificate lifecycle visualization

E13 Smart Grid Cyber Threat Detector

Problem Statement:

Develop an anomaly detection system for smart grid data that identifies potential cyber attacks by analyzing unusual patterns in meter readings, control signals, or communication traffic.

Domains: Cybersecurity | Anomaly Detection | Critical Infrastructure

Expected Outcome: Detection system with simulated attack scenarios and alert mechanisms

E14 Demand Response Gamification App

Problem Statement:

Create a gamified mobile app that incentivizes users to reduce energy consumption during peak hours through challenges, rewards, and social competition while educating them about grid stability.

Domains: Gamification | Behavioral Science | Mobile Development

Expected Outcome: Mobile app prototype with reward system and leaderboards

E15 Hybrid Energy System Optimizer

Problem Statement:

Build a tool that helps rural communities design optimal hybrid energy systems combining solar, wind, batteries, and diesel backup. Consider local weather, load profiles, and budget constraints.

Domains: System Design | Rural Electrification | Optimization

Expected Outcome: Configuration tool with cost-benefit analysis and reliability metrics

E16 Building HVAC Energy Optimizer

Problem Statement:

Design an AI system that learns building thermal dynamics and occupancy patterns to optimize HVAC settings for comfort and efficiency. Include override capabilities and comfort feedback loops.

Domains: Building Automation | Thermal Modeling | AI Control

Expected Outcome: Control algorithm demo with energy savings projections

E17 Solar Installation Site Scorer

Problem Statement:

Create an application that uses satellite imagery and GIS data to automatically assess rooftop solar potential, considering shading, orientation, available area, and local regulations.

Domains: Computer Vision | GIS | Solar Assessment

Expected Outcome: Scoring tool with detailed installation recommendations

E18 Energy Poverty Identifier

Problem Statement:

Develop a data-driven tool that identifies households at risk of energy poverty by analyzing consumption patterns, payment histories, and demographic data. Connect them with assistance programs.

Domains: Social Impact | Data Analytics | Public Policy

Expected Outcome: Risk scoring system with intervention recommendations

E19 Grid Frequency Stability Monitor

Problem Statement:

Build a real-time monitoring dashboard that tracks grid frequency deviations and correlates them with renewable generation, demand changes, and grid events. Provide early warning for stability issues.

Domains: Power Systems | Real-time Monitoring | Signal Processing

Expected Outcome: Live dashboard with frequency analysis and alert system

E20 Carbon-Aware Computing Scheduler

Problem Statement:

Design a job scheduler for data centers that delays non-urgent computational tasks to times when the grid's carbon intensity is lowest, reducing the carbon footprint of cloud computing.

Domains: Cloud Computing | Carbon Accounting | Job Scheduling

Expected Outcome: Scheduler prototype with carbon savings calculator