Project Proposal: Innovating for Sustainability

Project Title: Smart Appliances for Sustainable Resource Management

Team Name: TEAM NYRA

College Name: Anurag University

IUCEE Student Chapter: Anurag University IUCEE Student. Chapter

Submission Date: June 30, 2025

1. Chosen SDG Target

SDG 6: Water-use efficiency via optimized usage in appliances

SDG 7: Energy efficiency in home appliances

2. Problem Statement

Household appliances like refrigerators, air conditioners, and washing machines contribute significantly to energy and water resource inefficiency, leading to environmental degradation and higher utility costs. This project addresses these challenges by developing IoT-enabled, AI-driven systems to optimize appliance efficiency and promote sustainable resource usage.

3. Detailed Description of the Problem

The main causes of resource inefficiency in home appliances include outdated technologies, lack of smart systems for optimized resource use, and limited consumer awareness about sustainable practices. These factors lead to higher household costs, increased greenhouse gas emissions, and stress on local water supplies, especially in urban and water-scarce areas.

Stakeholders impacted include homeowners, utility providers, manufacturers, and the environment.

4. Proposed Solution & Objectives

Develop smart, affordable, resource-efficient systems for home appliances that integrate IoT-based monitoring and AI-driven optimization.

Visualize the real-time usage of any device, predict its energy consumption, and estimate the monthly electricity bill based on usage patterns.

Objectives:

- Reduce energy consumption of appliances by 20% through smart technology.
- Reduce water usage in washing machines and desert air coolers by 15%.
- Increase consumer awareness and sustainable habits.
- Ensure scalability for urban and rural households.

5. Detailed Explanation of the Solution

How it works:

- IoT sensors gather real-time data (temperature, power usage, water levels).
- AI algorithms predict and adjust appliance operation for optimal efficiency.
- Data is processed via local devices (Raspberry Pi) or low-cost cloud services.

Technical Details:

- Sensors: Temperature, water level, energy usage
- Microcontrollers: Arduino or ESP32
- Communication: MQTT protocol for lightweight data exchange
- AI: Python-based predictive models

Design Thinking: User-focused design with iterative prototyping and testing to ensure usability and impact.

6. Proof of Concept

To validate the solution, a cost-effective prototype will be developed that combines an IoT model and AI system to interact with a chosen home appliance (e.g., washing machine, refrigerator and AC).

Prototype Description:

- IoT sensors collect real-time data.
- AI model analyzes data and sends optimized control signals.
- Data flows through MQTT protocol, processed locally or via free cloud tiers.

Real Example:

- Washing machines: Typically use 60–90 liters per cycle, totaling 15,000–23,000 liters/year for a household. The prototype aims for 15% water savings, saving ~3,000

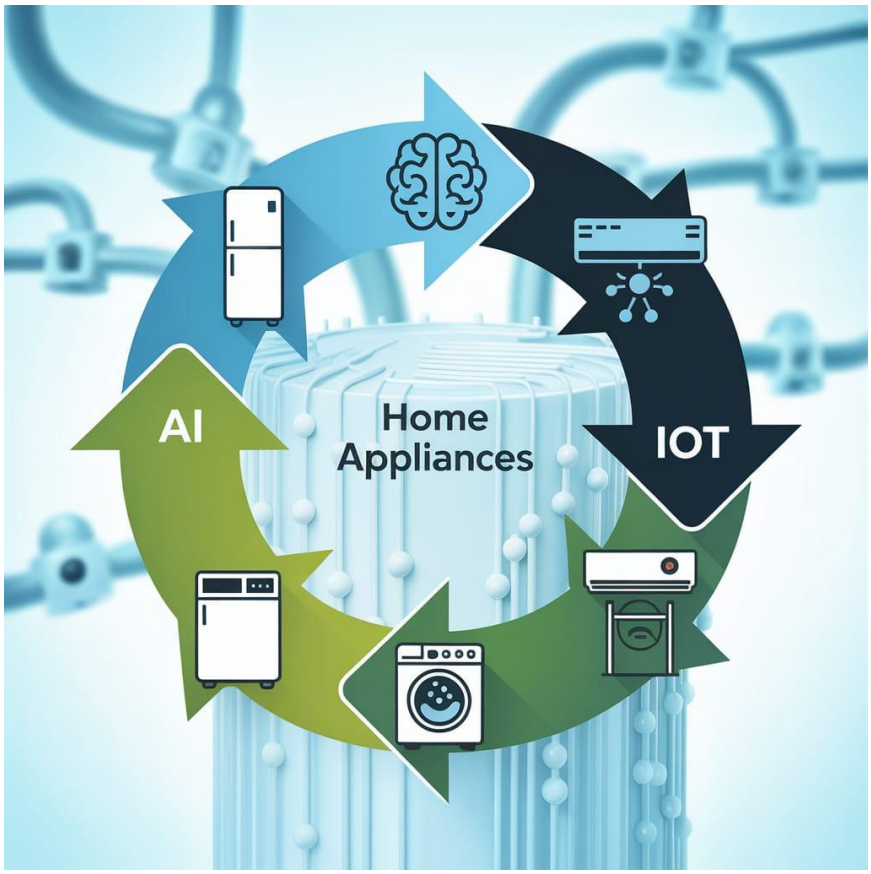
liters/year.
• Refrigerators: Consume ~300–400 kWh/year. The smart system can reduce this by 10%, saving 30–40 kWh/year.

Technologies Used:
• Arduino/ESP32, sensors, Raspberry Pi (optional)
• Python AI scripts
• MQTT communication

Expected Result:
Clear demonstration of energy and water savings using low-cost, replicable tech.

7. Expected Outcomes

Short-Term: 10–15% utility bill savings per household.
Long-Term: Broader adoption contributing to global sustainability targets, lower carbon emissions, and water conservation.
Environmental, Social, Economic Impact: Reduced emissions, greater resilience in water-scarce areas, savings for families, and increased sustainability awareness.



8. Resources Required

Materials & Equipment:

• IoT sensors (temperature, water level, energy meters)
• Arduino/ESP32, Raspberry Pi (optional)
• Power supplies, wires, breadboards
• Basic appliance setup for testing

Budget-Friendly Version:

Item	Description / Purpose	Approx. Cost (INR)
ESP32 Board	Wi-Fi + Bluetooth IoT microcontroller	₹350 – ₹500
DHT11 Sensor	Temperature & humidity sensing	₹80 – ₹120
Water Level Sensor	Tank/overhead water monitoring	₹100 – ₹150
Energy Monitoring Sensor	Appliance energy usage (e.g., HLW8012)	₹200 – ₹350
Relay Module (2/4-channel)	Controls appliances (lights, fans, pumps)	₹150 – ₹250
Breadboard + Jumper Wires	For prototyping and circuit connections	₹100 – ₹150
Power Supply (5V or USB adapter)	Provides power to ESP32 + sensors	₹150 – ₹300
Basic Home Appliance (Test Setup)	Light bulb, fan, or water pump (demo)	₹300 – ₹800

Total Estimated Budget: ₹1,500 – ₹2,500

Budget: Estimated at ₹1,500 – ₹2,500

Mentorship: Needed for IoT design, AI development, and sustainability impact assessment.

9. Benefits Over Existing Systems

• **Retrofittable:** Works with older appliances.
• **Dynamic:** Real-time optimization instead of static preset modes.
• **Affordable:** Uses open-source hardware and free-tier tools.

• **Behavior Change:** Gives households feedback for better usage habits.
• **Utility Integration:** Supports smart grid and load balancing.

10. End Users & Impact

Primary: Everyday households use common appliances.

Secondary: Manufacturers, smart home companies, utility providers who can integrate or promote the solution for wider impact.

The project empowers households to save resources and costs, while manufacturers and utilities can scale the solution for broad sustainability benefits.

11. Team Details

Name	Department	Year	Role
M. Rajith Rao	Artificial Intelligence	3rd year	Lead
P. Neeraj Kumar Yadav	Artificial Intelligence	3rd year	Member
T. Vaishnavi chowdary	Information Technology	4th year	Member
P. Jahnavi Dora	Information Technology	4th year	Member
B. Akshay	Artificial Intelligence	3rd year	Member

12. Faculty Mentor

Name: Narender Singh
Department: ECE
Email: narendarsinghece@anurag.edu.in
Mentor's Statement of Support:

13. Optional Images & Proofs

S. No	Description of the Appliance	Qty	Wattage (KW)	Working Hours in a day	Energy Consumption (KWH) per day	Working Days in a Year	Annual Energy Consumption (KWh)
1	LED Tube	2	0.01	3	0.06	365	21.9
2	LED Tube	1	0.02	5	0.1	365	36.5
3	LED Bulb	5	0.007	1.5	0.05	365	19.16
4	LED Tube	3	0.018	5	0.27	365	95.55
5	Electric Water Heater	1	0.032	0.25	0.008	210	1.68
6	Mixer Grinder	1	0.75	0.5	0.375	175	65.625
7	Fan	1	0.065	8	1.12	365	408.8
8	3 Star Frost Free Refrigerator	4	-	-	-	-	276
						Total	928.22

S. No	Description of the Appliance	Qty	Wattage (KW)	Working Hours in a day	Energy Consumption (KWH) per day	Working Days in a Year	Annual Energy Consumption (KWh)
1	Fluorescent Tube	2	0.02	3	0.12	365	43.8
2	LED Tube	1	0.02	5	0.1	365	36.5
3	LED Bulb	5	0.007	1.5	0.05	365	19.16
4	Fluorescent Tube Light	3	0.04	5	0.6	365	219
5	Electric Water Heater	1	0.032	0.25	0.008	210	1.68
6	Mixer Grinder	1	0.75	0.5	0.375	175	65.625
7	Fan	1	0.065	8	2.08	365	759.2
8	3 Star Frost Free Refrigerator	4	-	-	-	-	276
						Total	1420.97

Existing Electrical Appliances Rating at home