Empathize

Problem

Coal Power:

1. It emits large amounts of pollution and greenhouse gases.
2. Damages land and water during mining.

Nuclear Power:

1. Produces dangerous, long-lasting radioactive waste.
2. Risk of accidents can be severe.

Common Issue: Both provide energy but cause environmental, health, and safety problems.

Users

Households, businesses, and transportation would benefit from free/clean energy by:

1. Cutting costs.
2. Reducing pollution.
3. Powering remote areas.
4. Improving public services and boosting innovation.
5. Fighting climate change globally.

Interview Insights (AI Perspective)

- Power Outages: Disrupt homes, hospitals, businesses, and schools → economic loss + health risks.
- High Electricity Costs: Burden families, affect studying, and disrupt daily life.
- Worker Challenges: Hazardous conditions, long hours, physical strain, exposure to pollutants, lack of training, mental stress.

Impact Example

- Environment: Energy production causes pollution, climate change, deforestation, and habitat loss.
- Communities: Soil and water pollution affect people living nearby.
- Workers: Unsafe conditions due to extraction and power plant operations.

Define

Problem Statement

- Need for reliable 24/7 energy supply to ensure smooth operations.
- Backup electricity systems are crucial to prevent disruptions.
- Industries, malls, and large facilities face major problems during outages.

How Might We Question

- How might we help people save fuel and switch to cleaner options in daily life?
- With fuel running out and pollution rising, we must find simple, smart ways to reduce usage and adopt clean energy.

Theme Connection

- Connects to “Environment, Waste and Circular Economy – EcoSync”.
- Benefits of cheap, clean electricity:
    - Reduces dependency on polluting fuels.
    - Less environmental damage and emissions.
    - Wider access to renewable energy.
    - Supports sustainable living with reduced waste.

Ideate

Explored Options

1. Biogas Production
2. Thermoelectric Generation
3. Piezoelectric Energy
4. Bicycle-Powered Generators
5. Hydrogen-Powered Electricity Generation

Selected Idea

- Hydrogen-Powered Electricity Generation
- Why:
    - Cheapest among explored options.
    - Capable of generating large amounts of electricity.

Technology Approach:

- Renewable Energy Technologies
    - **Hydrogen & Fuel Cells**: Electrolyzers, fuel cells for electricity generation.

PROTOTYPE

Solution Overview:

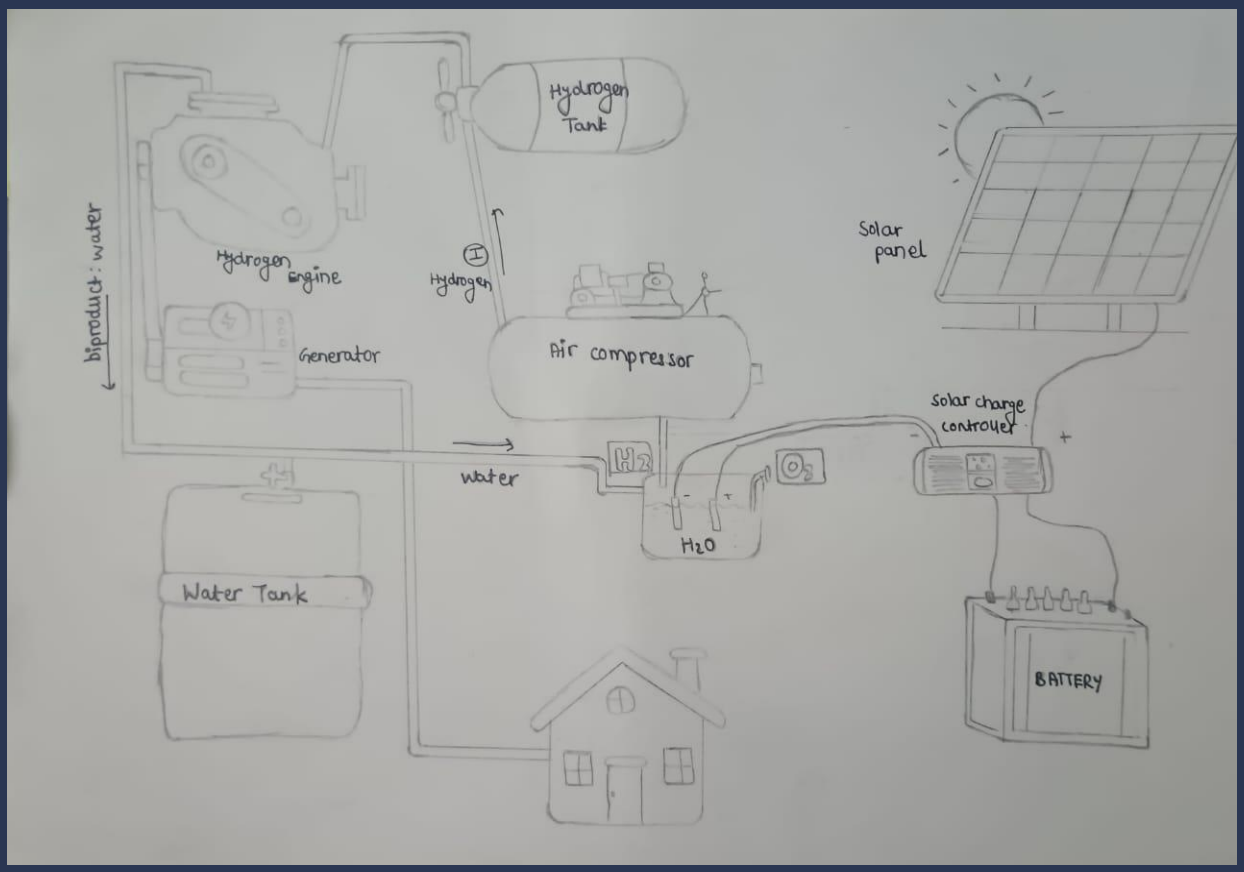
Eco-Friendly Hydrogen Engine Generator System

Innovative **hydrogen engine project** offers a sustainable and eco-friendly solution for generating electricity to power a city. This system utilizes hydrogen as fuel and operates similarly to traditional power generation sources, such as nuclear power plants or power generated by coal, but without harmful emissions. Here's a detailed description of its design, working, and environmental impact.

Technical Implementation:

1. **Water Tank**:
    - Stores water to serve as the source for hydrogen production.
2. **Electrolyzer**:
    - Splits water (H_2O) into hydrogen (H_2) and oxygen (O_2) using electrolysis, powered by solar panels(and then on its generator or if sunlight is not much).
3. **Air Compressor**:
    - Compresses the hydrogen gas and stores it efficiently in a hydrogen tank.
4. **Hydrogen Tank**:
    - Safely stores compressed hydrogen for use in the engine.
5. **Hydrogen Engine**:
    - Functions like a traditional diesel engine but uses hydrogen as fuel, making it eco-friendly. It is connected to **generator**.

6. **Byproduct Water Tank**:
    - Collects the water produced as a byproduct of the hydrogen engine. This water is fed back into the system, creating a **closed loop**.



How It Will Be Made

1. **Assembling the Components**:
    - Set up the **water tank**, **electrolyzer**, **air compressor**, and **hydrogen tank** in a centralized area.
    - Install the **hydrogen engine** with the generator to supply electricity.
2. **Electrolyzer and Solar Integration**:
    - Use **solar panels** to power the electrolyzer, ensuring a renewable energy source for hydrogen production.

3. **Engine Configuration**:
    - Modify a traditional diesel engine to use **hydrogen fuel**, adapting fuel injectors and ignition systems for hydrogen combustion.
4. **Closed-Loop System**:
    - Connect the engine's byproduct water output to the **water tank**, creating a **recyclable water loop**.

How It Works

1. **Water Collection**:
    - Water is stored in the tank and fed into the electrolyzer.
2. **Hydrogen Production**:
    - The electrolyzer, powered by solar energy, splits water into hydrogen and oxygen through electrolysis.
3. **Hydrogen Compression**:
    - The hydrogen is compressed using the air compressor and stored in the hydrogen tank.
4. **Fuel Supply to Engine**:
    - The hydrogen is fed into the modified hydrogen engine, which burns it to produce mechanical energy.
5. **Byproduct Recycling**:
    - The engine produces water as a byproduct of hydrogen combustion, which is collected and sent back to the water tank, completing the loop.

Environmental Impact

1. **Green Source of Electricity**:
    - The system uses **solar energy** for electrolysis and **hydrogen fuel** for the generator, eliminating the need for coal or thermal electricity.
2. **No Pollutants**:
    - The only byproduct is water, making it a **zero-emission system**.
3. **Renewable Energy Integration**:
    - Combines **solar power** and a **hydrogen engine**, ensuring nearly **100% renewable energy usage** in the city.

Some Calculations:

Production of Hydrogen

The engine runs 400 km on 1 kg of hydrogen.

At a speed of 60 km/h, it takes 6.67 hours to consume 1 kg of hydrogen.

RPM = 3000.

Step 1: Hydrogen consumption per hour

If the engine consumes 1 kg of hydrogen in 6.67 hours, then the amount consumed in 1 hour is:

Hydrogen consumption per hour= 1/6.67 is around 0.15 kg per hour

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Step 2: Electrolyzer power required

To produce 0.15 kg/hour of hydrogen, we calculate the required electrolyzer power using the known efficiency:

A 50 kWh electrolyzer produces 1 kg of hydrogen/hour.

For 0.15 kg/hour:

Power required=50 kWh×0.15=7.5 kWh and we use 8.00 kWh because some more hydrogen to store

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Step 3: Generator power requirement

If the generator operates at 3000 RPM, the power needed to support the electrolyzer is 8.00 kWh.

Final Answer:

Hydrogen consumption: 0.15 kg/hour (150 grams/hour).

Electrolyzer power required: 8.0 kWh.

Generator requirement: The generator must produce 10kWh(for another purpose like electrolyzer, etc.)and 80 kWh for electrical power to supply to 20 houses.

Key Features:

1. **Water-to-Hydrogen Conversion**
    - Uses an **electrolyzer** to split water into hydrogen and oxygen.
    - Hydrogen acts as clean fuel, producing only water as exhaust—**zero pollution**.
2. **Solar-Powered System**
    - A **solar panel** powers the electrolyzer and battery.
    - Ensures renewable, sustainable energy supply, reducing dependence on the grid.
3. **Battery Storage Integration**
    - Stores electrical energy from solar panels.
    - Ensures continuous operation even when sunlight is insufficient.
4. **Clean Water Supply for Electrolysis**
    - Uses a **solar-powered distillation system** and **ion exchange** to produce purified water.
    - Prevents damage to the electrolyzer and improves hydrogen production efficiency.
5. **Eco-Friendly & Cost-Effective**
    - Reduces reliance on fossil fuels.
    - Minimizes environmental impact by avoiding emissions and hazardous waste.
    - Hydrogen generation is cheap compared to other clean energy alternatives.

TEST

Testing Strategy

User Type 1: Households

- **Testing Activity:** Use electricity generated from hydrogen system for daily needs (lighting, appliances) for 1 week.

- **Learning Objective:** Understand if the system provides reliable and consistent power for homes.

User Type 2: Small Industries / Businesses

- **Testing Activity:** Connect hydrogen-powered electricity system to machines and devices during operating hours for 1 week.
- **Learning Objective:** Evaluate efficiency, stability, and cost-effectiveness compared to conventional energy sources.

User Type 3: Remote Area Communities

- **Testing Activity:** Install the system in areas without grid electricity and monitor power availability for 2 weeks.
- **Learning Objective:** Assess the practicality of providing sustainable electricity to off-grid locations.

User Type 4: Utility Engineers / Operators

- **Testing Activity:** Monitor system performance, battery storage, and hydrogen production for 1 month.
- **Learning Objective:** Test ease of operation, maintenance requirements, and safety protocols.