# Smart Centralized Renewable Energy Management

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## Project Discerption

The project develops a scalable, renewable energy system combining wind and solar power with smart management and monitoring to ensure reliable and efficient performance. It integrates contributions from multiple engineering disciplines to promote sustainability.

## Constraints

- Environmental impact
- Noise
- Scaling
- Maintenance
- Photovoltaic power potential (solar irradiance)
- Transmission losses

## Target Specifications

- Cut-in Wind Speed: 3 m/s
- Rated wind speed: 10m/s
- Rated wind turbine power: 100 W
- Rated solar panel power: 10 W
- Availability and Monitoring: 99.9%
- Diameter of the dome: 50cm
- Height of the dome: 24cm
- Deliver 12 DC voltage

## Important Equations

Dead Load: $DL = w \times A$

Live Load: $LL = w \times A$
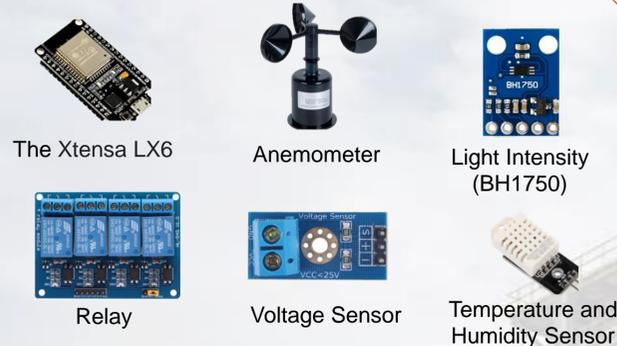
Surface Area: $A = 2\pi R^2$

Volume: $V = \dfrac{2}{3}\pi R^3$

Wind Power $= \dfrac{1}{2}\rho A V^3$

Power Output

$$P = VI_L - VI_o\left[\exp\left(\dfrac{e_0 V}{kT}\right) - 1\right]$$

## Controller

The Xtensa LX6  Anemometer  Light Intensity (BH1750)

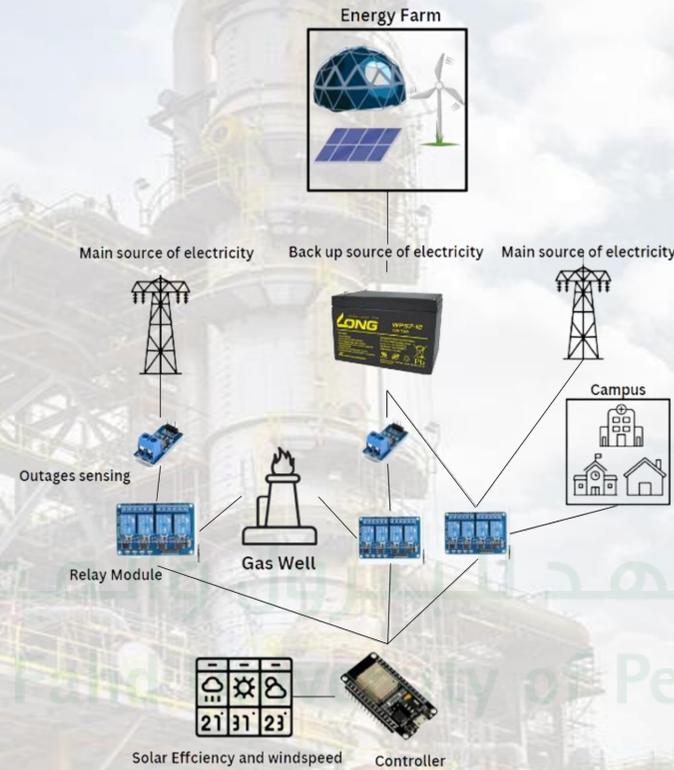Relay  Voltage Sensor  Temperature and Humidity Sensor

The Xtensa LX6 microcontroller managed data from sensors (DHT22, BH1750, anemometer) and controlled relays to switch between main and backup power during outages, ensuring continuous load operation. Real-time processing was implemented in C++.
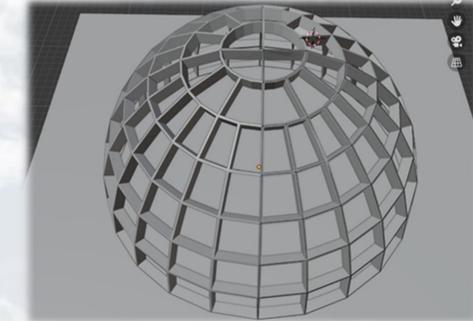
## Electric Circuit
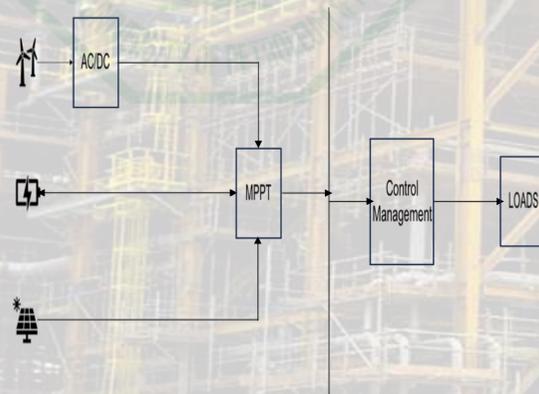
Varying Voltage from sources
MPPT : Provide fixed 12 DC voltage
Battery charger : 12V 5A

## Prototype Design

Energy Farm

Main source of electricity  Back up source of electricity  Main source of electricity

Campus

Outages sensing

Relay Module  Gas Well

Solar Effciency and windspeed  Controller

## Flowchart of The Controller's Logic

Is there a power outage?
- No → Campus will operate normally by backup battery → Main grid on standby for campus → Gas-well is operating by main grid
- Yes → Number of power outages

Priority 1 = Housing
Priority 2 = schools
Priority 3 = Hospitals
Higher number = Higher priority to be powered

Outages count =< 2 → Divert some power from backup battery to gas well → Priority 1 and 2 will operate by main grid

Outages count > 2 → Divert all power from backup battery to gas well → Priority 3 will operate by main grid

the outages Gas wells will operate by backup battery

## Solar Dome Design

The solar dome features a mirrored roof that scatters and reflects sunlight onto solar panels installed at its base.

Real Concept:
- Diameter: 32m
- Height: 16m
- Materials: Steel for frame and mirrors

Scaled Down:
- Diameter: 50cm
- Height: 24cm
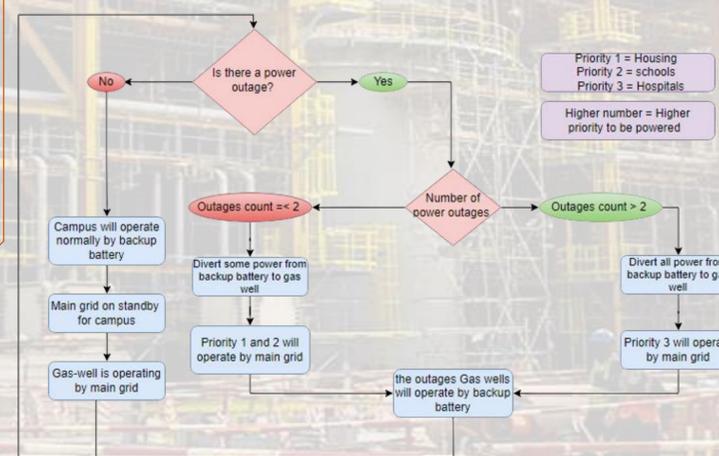- Materials: 3D printing with PLA for frame and mirrors

## Wind Turbine Design

NACA 4418 airfoil blades 3d & 2d:
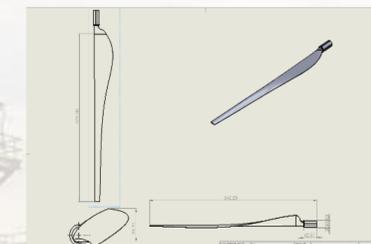
- Wheel diameter: 1.15m
- Rated power: 100W
- Rated Voltage: 12V
- Rated wind speed: 10m/s
- Blade material: PETG

The blades were 3D printed with heat-resistant, sun-proof material to prevent malfunctions.
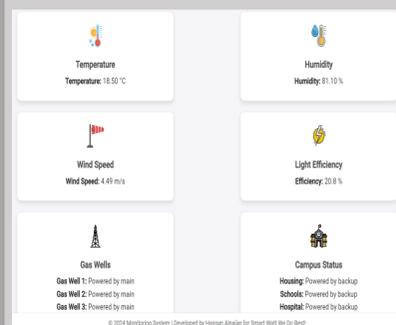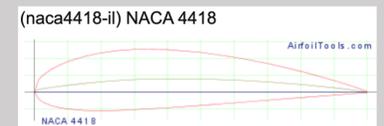
## Solar Panel

10W - 12V – 833mA
24 × 35 × 1.7 cm

## Monitoring Dashboard

Temperature  Temperature: 18.50 °C
Humidity  Humidity: 81.10 %
Wind Speed  Wind Speed: 4.49 m/s
Light Efficiency  Efficiency: 20.8 %
Gas Wells
Gas Well 1: Powered by main
Gas Well 2: Powered by main
Gas Well 3: Powered by main
Campus Status
Housing: Powered by backup
Schools: Powered by main
Hospital: Powered by backup

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## Blade Profile

(naca4418-il) NACA 4418  AirfoilTools.com

NACA 4418

## Total Analysis

BUDGET
- Controller Parts 15%
- Complementry 8%
- Solar Dome (3D Printing) 5%
- Wind Turbine (3D Printing) 65%
- Electrical Circuit 4%
- Reamining 3%

King Fahd University of Petroleum & Minerals