

TEAM 109

GREEN HYDROGEN PRODUCTION UNIT VIA ELECTROLYZER FOR INDUSTRIAL APPLICATIONS



PROJECT OVERVIEW:

PROBLEM: CONVENTIONAL HYDROGEN PRODUCTION RELIES HEAVILY ON FOSSIL FUELS AND CENTRALIZED INFRASTRUCTURE, LIMITING ITS SUSTAINABILITY AND ACCESSIBILITY, ESPECIALLY IN OFF-GRID OR RESOURCE-CONSTRAINED REGIONS.

SOLUTION: A COMPACT, OFF-GRID UNIT POWERED BY WIND AND SOLAR THAT INTEGRATES WATER PURIFICATION, PEM ELECTROLYSIS, ENERGY MANAGEMENT, AND MODULAR HYDROGEN STORAGE- ALL WITHIN A 6 M² FOOTPRINT.

SPECIFICATIONS & CONSTRAINTS:

CONSTRAINTS:

- TOTAL PROTOTYPE COST \leq 6,000 SAR
- MUST BE COMPLETED WITHIN 3 MONTHS
- INPUT WATER CONDUCTIVITY $<$ 5 μ S/CM
- TOTAL SYSTEM AREA \leq 6 M²
- BLADES MUST WITHSTAND WIND UP TO 100 KM/H
- H₂ STORAGE MUST MEET ISO 19880 STANDARDS
- FULLY AUTOMATED ENERGY SWITCHING REQUIRED
- WIND + SOLAR MUST SUPPLY \geq 200 W COMBINED

SPECIFICATIONS:

- PRODUCTION RATE 30 G/DAY (PURITY \geq 99.999%)
- SOLAR: 50 W | WIND: 100 W @ 10 M/S
- OPERATES FROM -10°C TO 50°C, WIND \leq 100 KM/H
- SYSTEM AREA \leq 6 M²

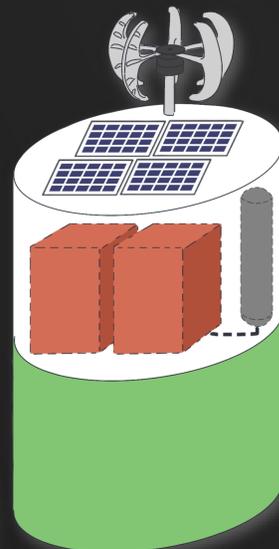
ABDULAZIZ KHALAWI, MOHAMMED ALQURAINI, AHMED YAHIA WALEED ALHARBI, MOHAMMED ALSHAMMARI, SULIAN MAZEED

COACH: DR. FAHAD ALAM

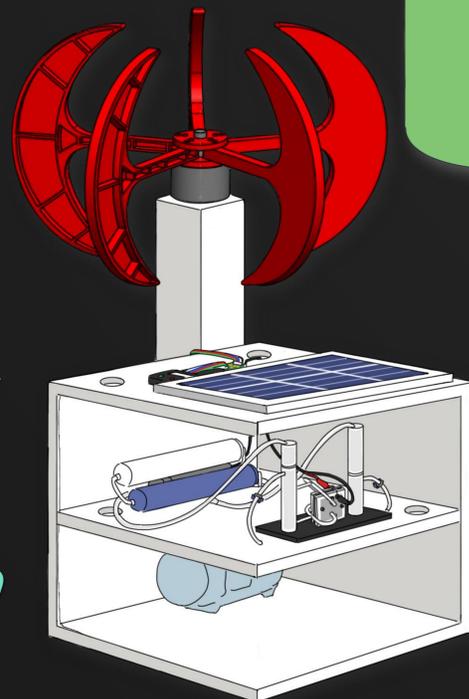
PROTOTYPE DEVELOPMENT:



CONCEPT DESIGN:



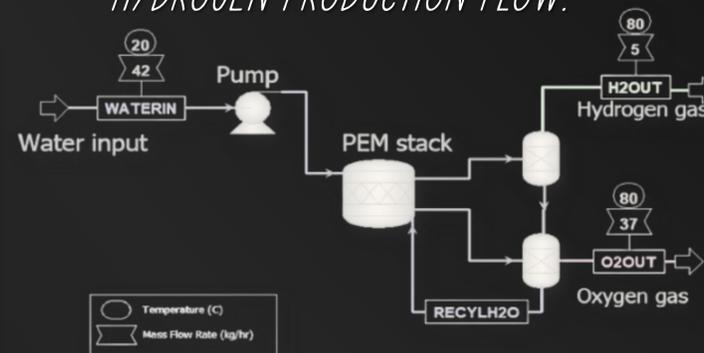
FINAL PROTOTYPE:



WORKFLOW OVERVIEW:



HYDROGEN PRODUCTION FLOW:



ARDUINO-BASED HYBRID SOURCE MANAGER:

```

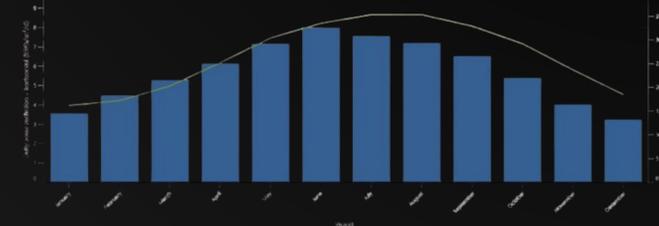
1 // Hybrid Source Manager - V3
2 Dual-Channel Voltage, Current & Power Monitor with Source Labels
3 + Channel-1 : SOLAR - ACS712 on A0 + voltage divider on A1
4 + Channel-2 : WIND - ACS712 on A2 + voltage divider on A3
5 + Decision : Chooses Solar + Wind + Fuel-cell based on TOTAL power
6 and prints the selected source at the end of each line.
7
8
9
10 // --- Pin assignments
11 // Channel-1 = SOLAR
12 const int PIN_CURRENT1 = A0; // ACS712 #1 OUT
13 const int PIN_VOLTAGE1 = A1; // Divider #1 midpoint
14 // Channel-2 = WIND
15 const int PIN_CURRENT2 = A2; // ACS712 #2 OUT
16 const int PIN_VOLTAGE2 = A3; // Divider #2 midpoint
17
18 // Source-control relays (active-HIGH)
19 const int PIN_SOLAR_RELAY = 3;
20 const int PIN_WIND_RELAY = 4;
21 const int PIN_FUEL_RELAY = 5;
22
23 // Availability inputs (HIGH = source available)
  
```

CONCLUSION & RECOMMENDATION:

THE SYSTEM MET ALL PERFORMANCE GOALS WITHIN FOOTPRINT, COST, AND EFFICIENCY LIMITS. FUTURE IMPROVEMENTS MAY INCLUDE REAL-TIME MONITORING, ENHANCED MODULARITY.

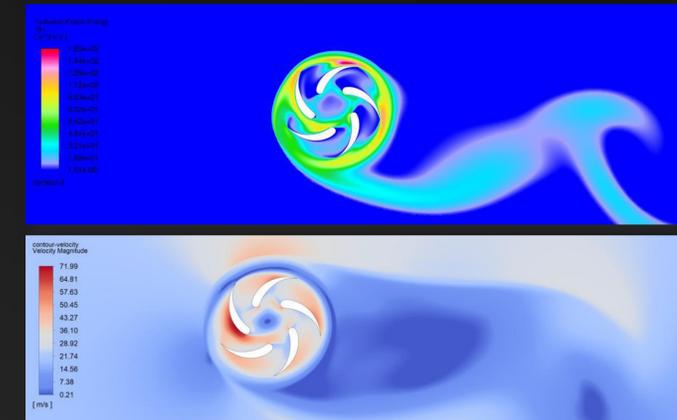
TESTING & VALIDATION:

SOLAR PERFORMANCE ANALYSIS:



SOLAR AVAILABILITY ACROSS MOST MONTHS EXCEEDS SYSTEM REQUIREMENTS, SUPPORTING STABLE HYDROGEN PRODUCTION.

WIND TURBINE PERFORMANCE ANALYSIS:



THE VAWT PRODUCES UP TO 50 W AT 10 M/S, WITH STABLE PERFORMANCE VALIDATED BY CFD AND FEA. SIMULATIONS CONFIRM EFFICIENT AIRFLOW, LIFT GENERATION, AND SAFE STRUCTURAL BEHAVIOUR.

MECHANICAL STRESS TESTING:

