

## Introduction/Background

- Saudi Arabia still relies on diesel generators for remote sites and backup power—driving high CO<sub>2</sub>/NO<sub>x</sub> emissions, volatile fuel costs, and heavy maintenance. Stand-alone solar PV cuts emissions but suffers from intermittent supply and short-lived, expensive batteries. Our project bridges this gap with a **solar-powered hydrogen fuel-cell generator** engineered for the Kingdom’s sunny climate.
- Solar panels feed a PEM electrolyzer that splits tap water, stores hydrogen, and later drives a fuel cell for on-demand electricity—while recycled waste heat boosts overall efficiency. The result is a scalable, zero-emission alternative to diesel that advances Vision 2030’s sustainability.

## Problem statement:

- The widespread use of diesel generators in Saudi camps leads to higher operating cost and increased greenhouse emissions, highlighting the need for a mobile, sustainable, and environmentally friendly energy system.

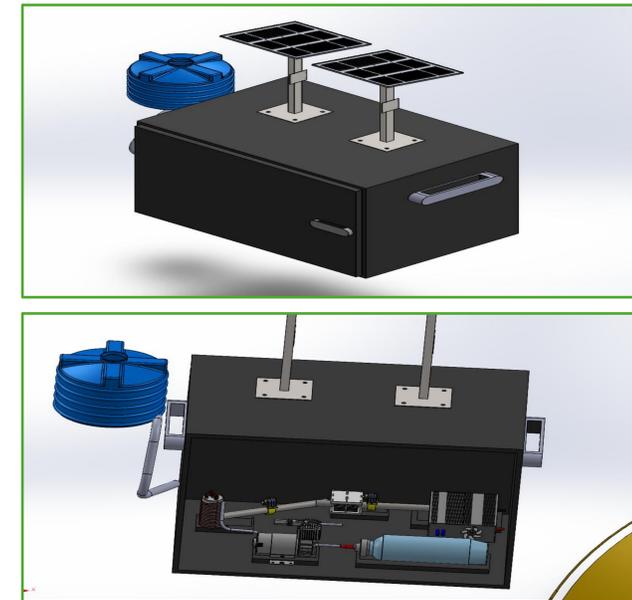
## Constraints

1. The power input from the solar panel 500 W **Met**
1. Minimum hydrogen production of 100 ml/min at STD **Met**
2. The operations temperature is 350K and the operations pressure is less than 30 bar **Met**
3. The system must be lesser than 30 kg for transportation **Met**
4. Based on several suppliers, I will set up criteria to make sure the cost < 6,000 riyals **Met**
5. Electrolyzer cells > 10 **Met**

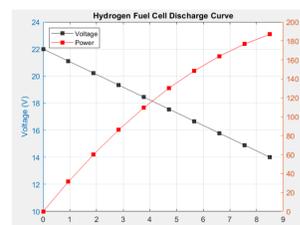
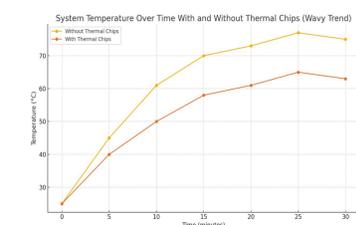
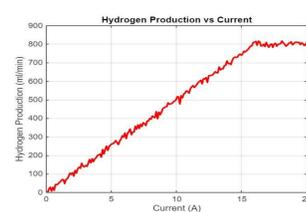
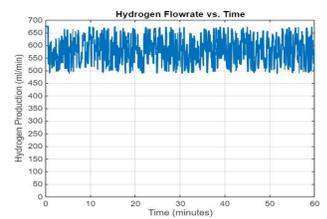
## Specifications

1. The system must produce a 456 Wh output power **Met**
2. Ensures grounding and isolation for safety. **Met**
3. purity of H<sub>2</sub> greater than 99.5%
4. Achieving an overall system efficiency of 50% **Met**
5. Tanks must operate at a pressure of 350–700 bar **Met**
6. withstand wild conditions. **Met**
7. All quality control charts must ensure that the process remains between the Upper Control Limit and the Lower Control Limit.
8. The error rate in my training model is < 5%. **Met**

## Prototype Design Development



## Validation of Constraints and Specifications



- All constraint and specifications were achieved: hydrogen purity reached 99.5%, enabling efficient fuel cell performance. System efficiency reaches between 44% and 49.4%, and the output reached 227 Wh. Safety standards were met through grounding, leak detection, and structural stability. Control processes remained within limits, and the model error rate was under 5%.

## Conclusion

- The solar-powered hydrogen fuel cell generator supports Saudi Arabia’s renewable energy goals by converting solar energy into clean hydrogen power. It uses a PEM electrolyzer and fuel cell, with thermoelectric coolers for efficiency and safety features for hydrogen handling.