Design of Solar PV/Fuel Cell Hybrid Micro-Grid Power System

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Abstract

University of Sharjah spent around 80 million Dirhams on energy consumption in 2016. Our objective is to reduce the energy consumption from the grid, increase the renewable factor and reduce the carbon emission. Using Renewable resources can diminish the problem of CO2 emissions and supply a green source of energy such as Photovoltaic (PV) technology. However, PV systems have problems of fluctuation in the power output which will cause shortages of electricity. This calls for the need of Hybrid renewable power systems that combine different sources together. In this phase of our project we are compensating for the availability of solar energy by combining it with the fuel cell technology. A small-scale PV/Fuel Cell/Electrolyzer Off-Grid Hybrid System of a capacity of 550 W was designed and built. The performance of each component in the system was tested and studied. The results show that the designed system supplied the load fully with a minimum shortage. Moreover, the results that were obtained validated the simulation that was done using HOMER software. There was a similar behavior in the graph that showed the performance of the whole system, however, there were few differences. This was due to the losses in the prototype as the experiments were conducted. Overall, the final results helped us conclude that HOMER is a reliable software that can be used to build larger scale systems.

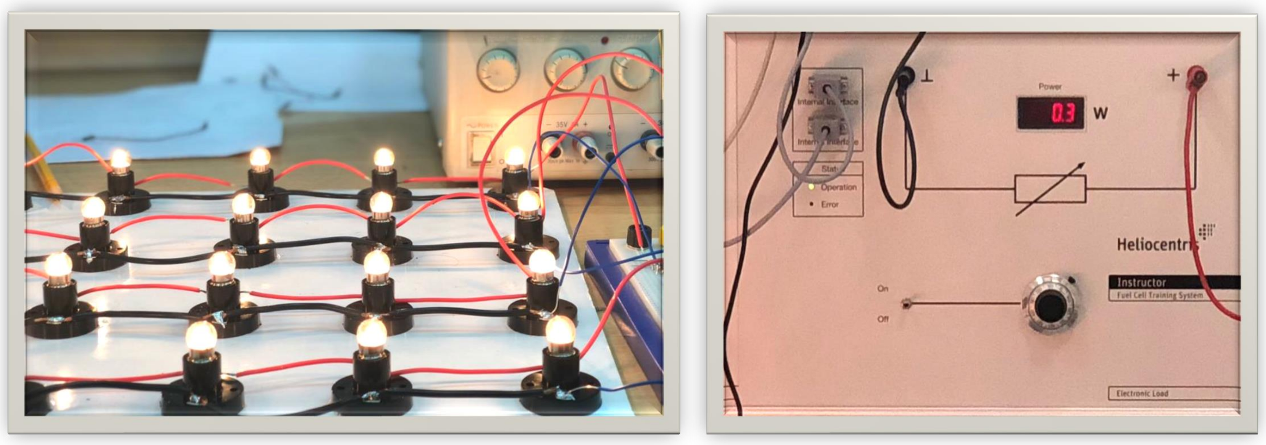
Methodology

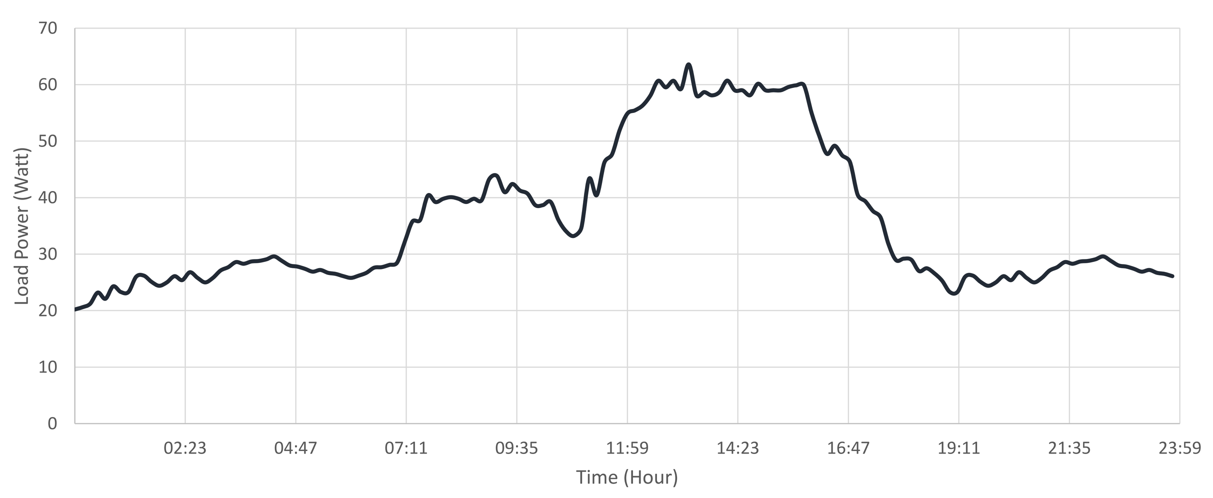
In order to achieve our target of this project, the following steps had been followed:

- **Identify the need and Constraints.**
- **Research the Problem .**
- **Develop possible solution.**
- **Select a promising solution.**
- **Build a prototype Test and evaluate the prototype.**
- **Redesign as needed .**

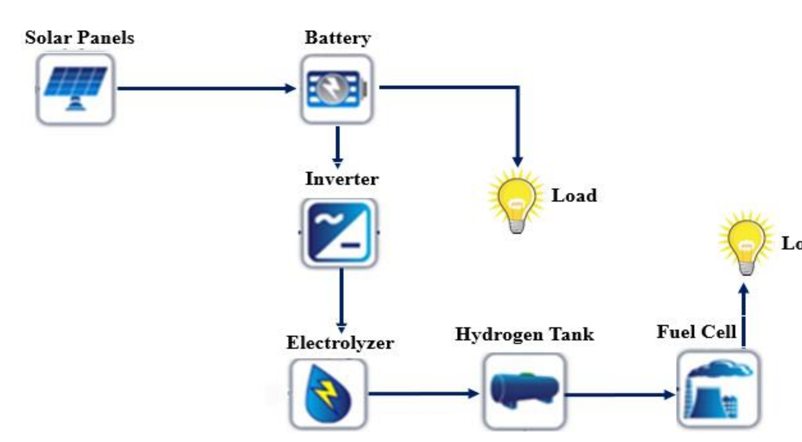
Experimental Setup

❖ Loads

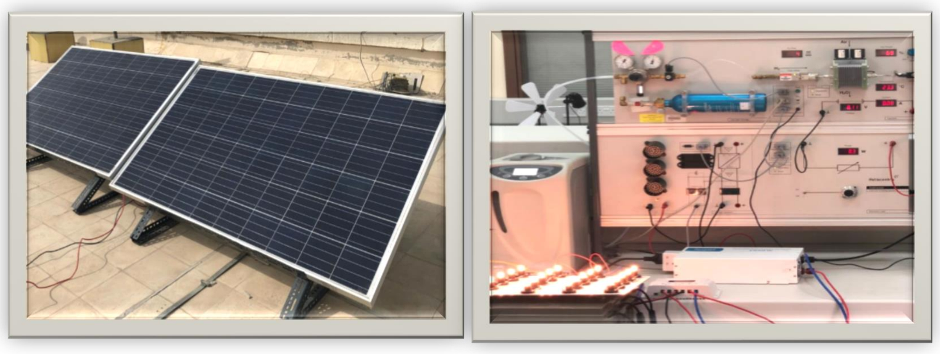




❖ Schematic diagram of the system



❖ Prototype

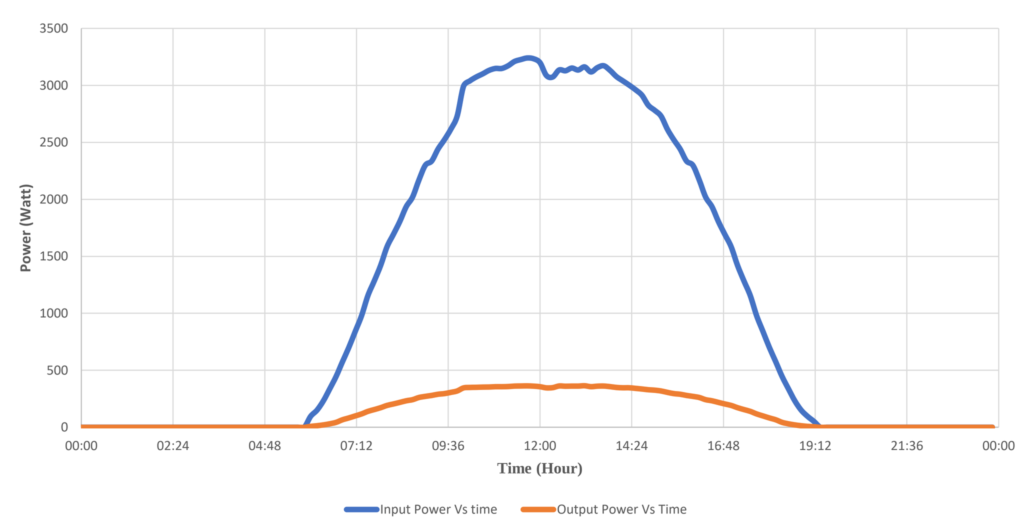


❖ Summary of the System Components that were used

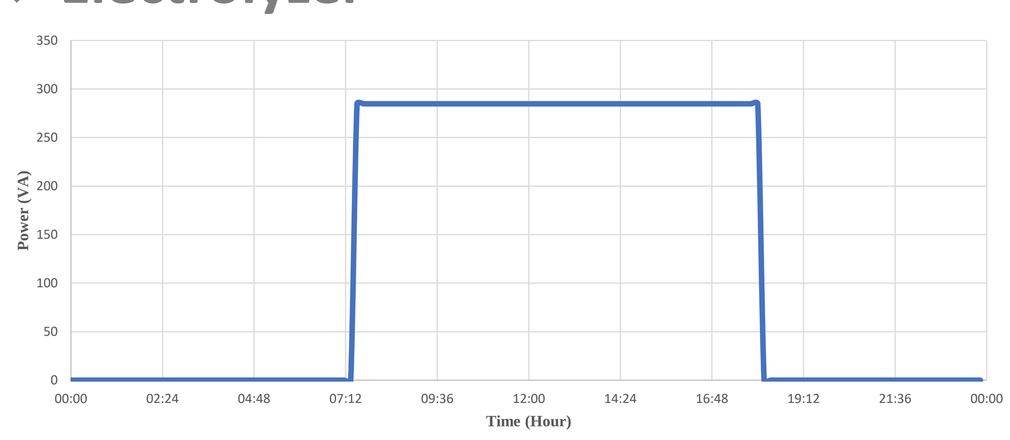
System Components	Description
Solar PV	• Type: RT250P polycrystalline solar cell • Efficiency: 16% • Rated Power: 250W • Rated Current: 8.39A • Rated Voltage: 36.6V • Short Circuit Current: 9.22A • Open Circuit Voltage: 39.8V • Life time: 25 years
Electrolyzer	• Type: hydrogen generator (HG 30|60) • Efficiency: 50% • Power consumption: 300 VA • Hydrogen purity: 6.0 (99.9999 % vol.) • Life time: 15 years
Hydrogen Tank	• Type: Pressurized Hydrogen Tank • Storage Capacity: max: 265 standard liters. Approx. 150 standard liters. • Life time: 25 years
Fuel Cell	• Type: PEMFC • Rated Power Output: 50 W • Rated Current: 8A • Rated Voltage: 5V • Life time: 50,000 hours
Battery	• Type: ROCKET • 2 Batteries in Series • Voltage: 24 V • Nominal Capacity: 65 Ah • Life time: 15 years
System Inverter	• Type: POWERED (FPI series) • Efficiency: 98% • Rated Power: 1000W • DC Input voltage: 24V • AC Output Voltage: 220VAC ±3% • AC Output Frequency: 50Hz • Life time: 15 years

Results

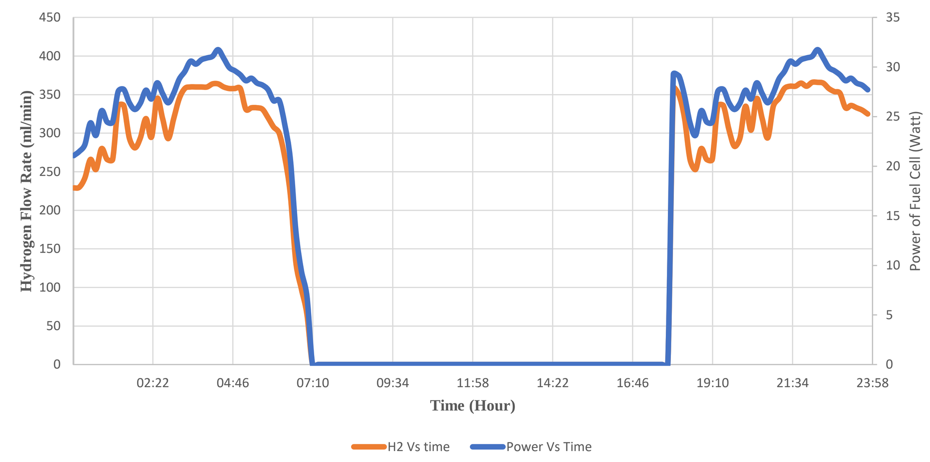
❖ Solar PV

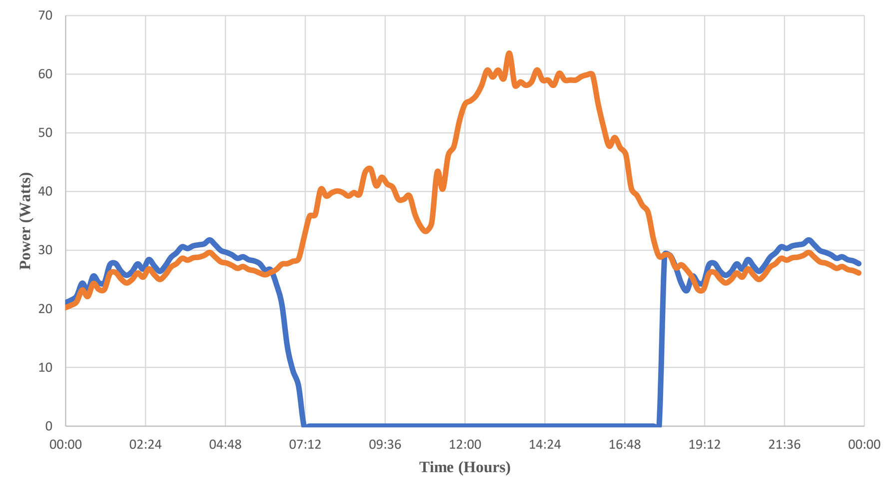


❖ Electrolyzer

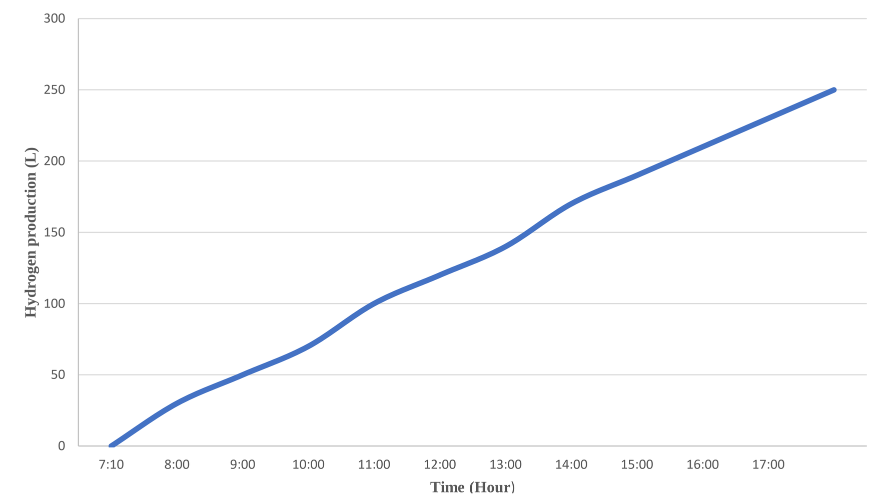


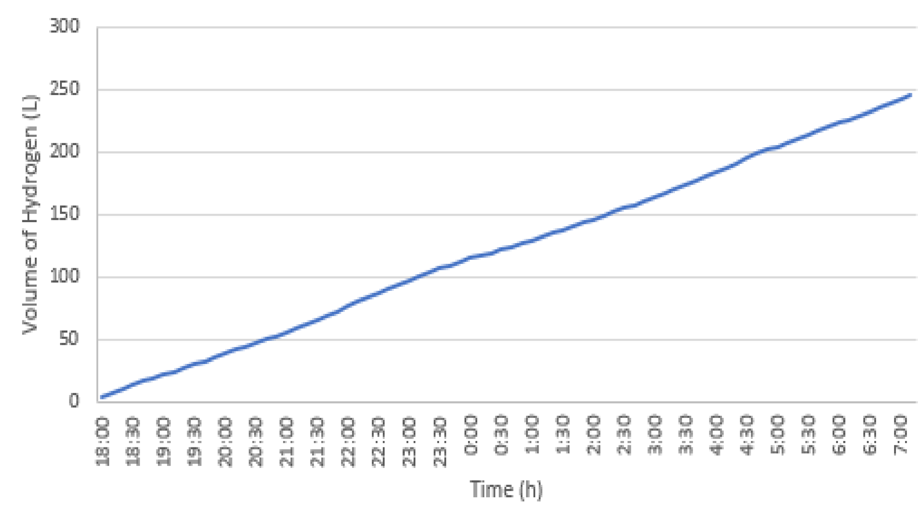
❖ Fuel Cell



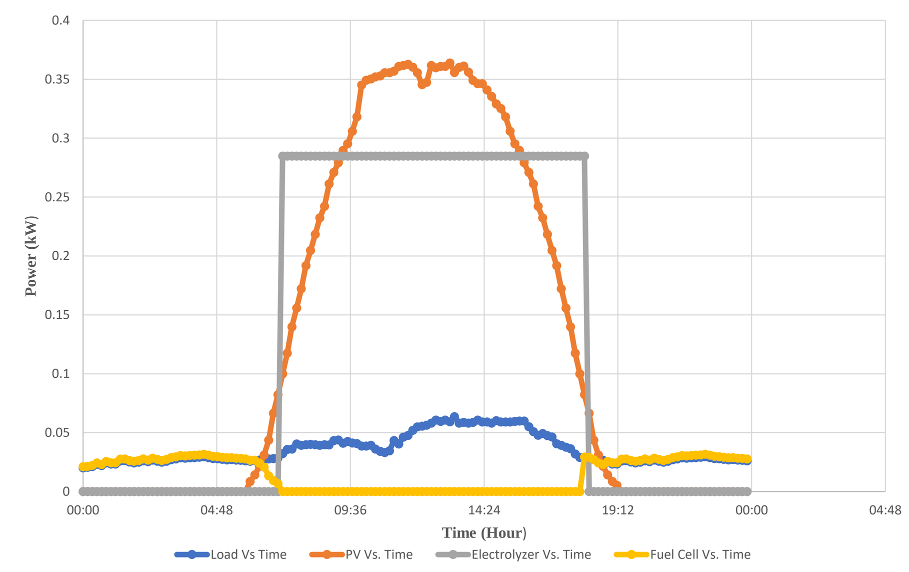


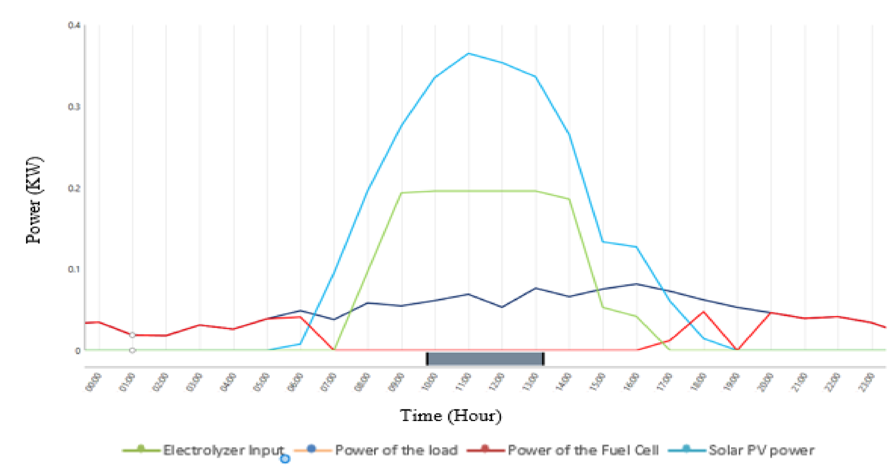
❖ Hydrogen Tank





❖ HOMER Validation





Conclusion

To conclude, our objectives for senior design project II were met. We were able to get a renewable fraction of 100% as our design is completely Off-Grid Hybrid System and due to this, the carbon emission is reduced. By building and sizing the prototype, we studied the performance of each component in the designed prototype. Validation of HOMER was done. We found that the experimental result follows a similar trend to HOMER and by this we can conclude that HOMER is a reliable software to be used for large scale systems

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