IPRO 301: IIT's Solar Hydrogen Project

What we are doing:

- The objectives of this project are to design, assemble and demonstrate a stand-alone distributed power generation system, which utilizes clean energy to power an LED sign. The sole purpose of the sign is to promote solar energy and other clean energy technologies via daily messages to the Chicago highway commuters.

- Our specific project goal for this semester was to integrate the pieces we already have into a single, autonomous, off-grid power system.

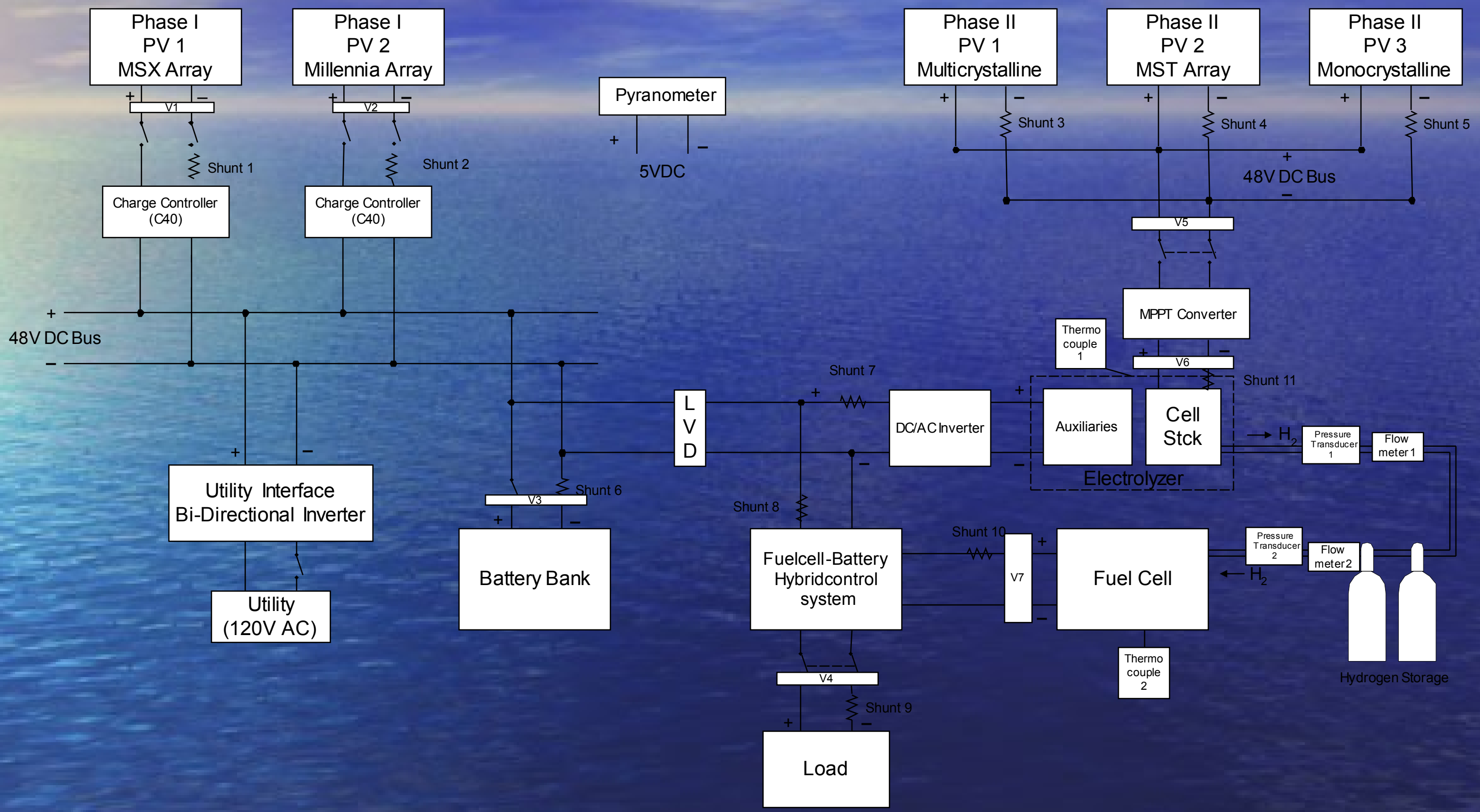
How are we doing this:

Our project works toward accomplishing these goals in the following manner:

- We generate power to run the sign from Solar Panels mounted on the roof of the building where the sign will be.

- We are also running a hydrogen fuel cell to provide power for the sign to demonstrate another clean energy technology.

System Layout



Electrical System

- The electrical design of the system was reconfigured this semester to help isolate the system from the power grid, and to facilitate the goals of the project.
- This meant re-designing the system so that the Hydrogen Electrolyzer would run off of PV-Array Power rather than grid power.

What was required:

- We needed to find a new network topology that would allow us to migrate our current equipment to running from DC Power from the PV Array's.
- After weeks of evaluating current equipment, and researching new equipment, we finally arrived at a feasible solution for the system layout.

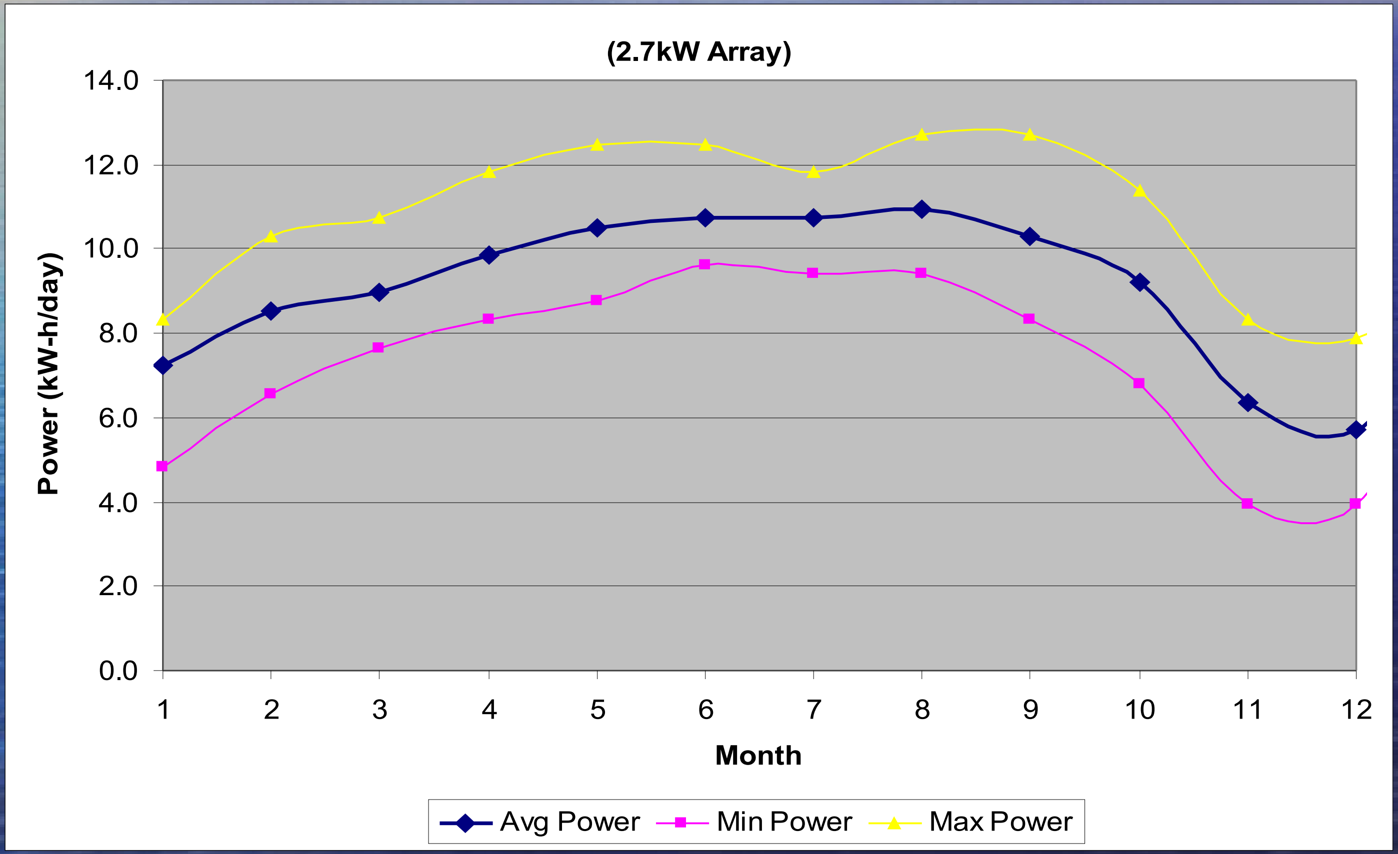
What is the new electrical layout?

- PV Array’s will power the hydrogen hlectrolyzer cell stack through a DC/DC voltage converter.
- A different set of PV Array’s will be powering the battery bank, which will then provide power for the electrolyzer auxiliaries and also will provide power for the sign.

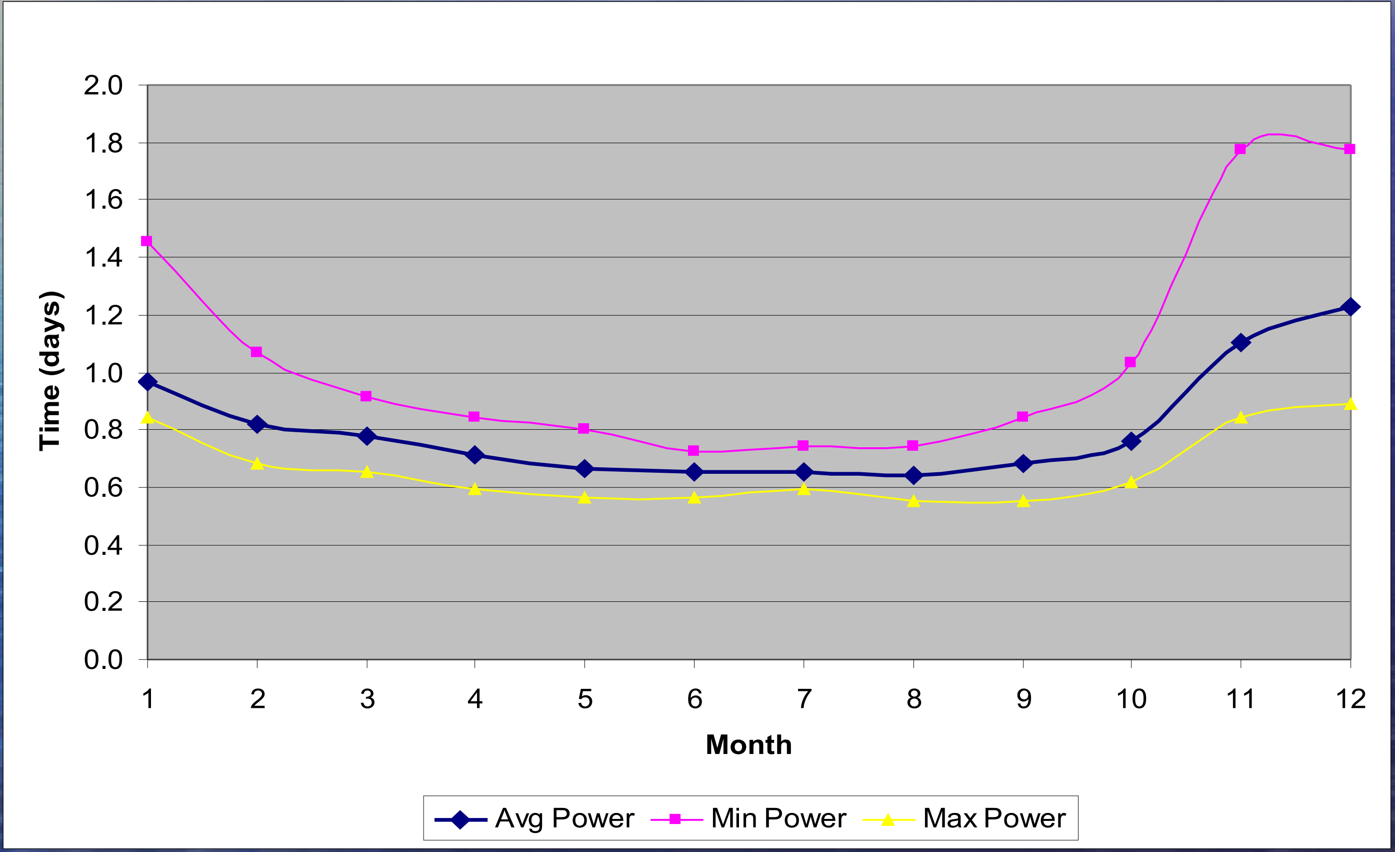
Hydrogen System

- The hydrogen system consists of two parts: the hydrogen electrolyzer, and the hydrogen fuel cell.
- To make these parts run, we must provide them with adequate power.

Yearly Power Graph



Time Required to Fill Tanks



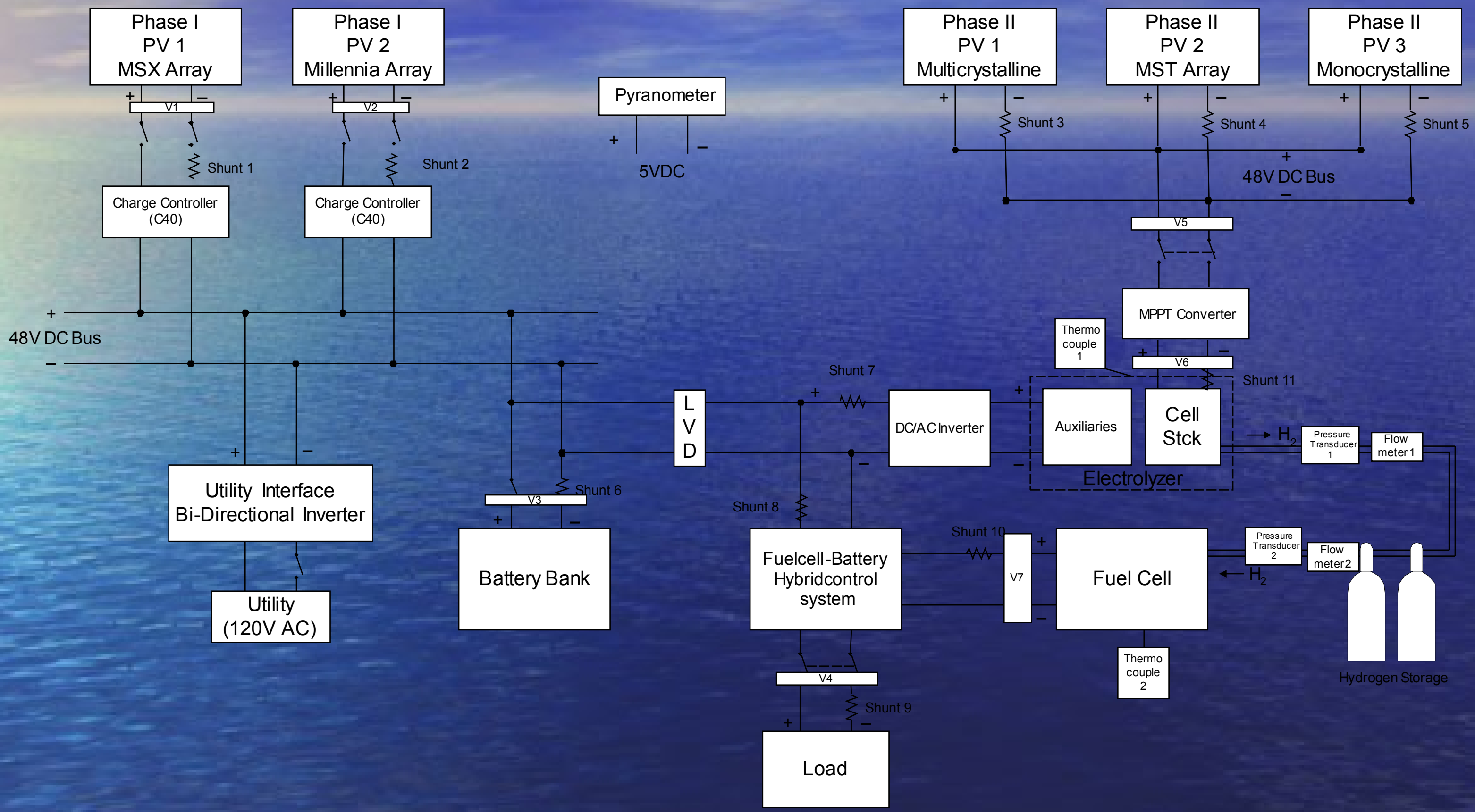
Calculations

Tank and Electrolyzer Calculations		
Power from MSX	5.99	Kw-h/day
Power from Milennia	21.16	Kw-h/day
Power from BP	13.67	Kw-h/day
Total Power to Stack	8.98	Kw-h/day
H_2 Production Rate	38	ft^3/h @200psi
Energy Consumption	7.00	Kw-Hour
Daily insolation data	4.1	Kw-h/m^2/day
Number of Days Needed to Fill the Tanks	0.780	Days
Fuel Cell Calculations		
Load	250	Watts
Running Time	24	hrs
Mass of H_2 Required	288.00	grams
Mass of H_2 in Tanks	1307.51	grams
Time Fuel Cell Can Run on Full Tanks	69.73	hrs

Data Acquisition

- Outlines the measurements, reading, signal and instruments required for designing a lab view program to monitor the solar hydrogen system performance.
- The program will measure voltage, current, pressure, temperature, mass flow rate and solar insolation of the part of the system under investigation.
- The program can also provide us information about power and efficiency of each part of the system and the system in general using conversion factors.
- The data will be collected in different time intervals corresponding to the intervals of change for that measurement.
- The data obtained can be analyzed using different computer programs - Excel is one example.

System Layout



Measurements and Signals

- Current signals will be collected from PV1, PV2, PV3 (Phase I and Phase II), battery, load, electrolyzer cell stack, battery auxiliaries, battery load and fuel cell.
- Voltage signals will be collected from PV1, PV2 (Phase I and Phase II), battery, load, electrolyzer cell stack, and fuel cell.
- Mass flow rate signals will be collected from fuel cell and electrolyzer.
- Pressure signals will be collected from fuel cell, electrolyzer and hydrogen tank.
- Temperature signals will be collected from fuel cell and electrolyzer.

Problems Encountered

There were four basic types of problems encountered this semester:

- System Maintenance
- Component Functionality
- Personnel
- Decision Making

System Maintenance:

- Electrolyzer was not maintaining purge pressure
- Fuel cell pipes leaking hydrogen
- Batteries not holding charge.

Component Functionality:

- Web-cams were not functioning properly.
- DC/DC converter lacked proper documentation, thereby making it difficult to ensure proper functionality.

Personnel Problems:

- There were some minor communication issues throughout the semester.

Decision Making:

- Deciding upon the direction of the project and the layout of the system took a longer than expected period of time.

Next Steps

- Complete Purchase of, Verification of, and Installation of Components.
- Complete Data Acquisition Installation.
- Sign Installation.
- Refinement and Optimization of system.

Conclusion

- Our project’s goals were furthered by our efforts. We have redesigned the system to isolate it from the power grid, and started implementation of our design. Progress on the project will continue during the summer, and our project should come closer to completing its objectives.