



# Solar and Wind Driven Electrolysis System

By Mark Oxley and James Robeson



# Introduction

- ▶ More than 85% of the energy used in the United States is supplied by fossil fuels [1].
- ▶ Our project's goal is to create a portable and renewable energy source to reduce the consumption of fossil fuels.



[2]

# Hydrogen

- ▶ Having portable and renewable energy can be a difficult task to achieve. Attaching a solar panel or wind turbine to a vehicle would be impractical.
- ▶ An example of a portable and renewable energy is hydrogen.



[3]

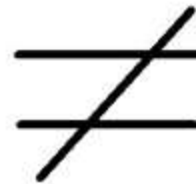
Problem: hydrogen is not a natural occurring element on Earth, but it can be created from water!

# The Dilemma

- ▶ A common belief is there is a way to harness “free fuel” from water – there’s not. It takes energy to create energy. To create a clean portable fuel such as hydrogen, we need to use an outside energy source.



[3]



# The Solution

- ▶ The good news is that we can create portable hydrogen fuel using an alternative energy source such as solar or wind.



[4] [5]

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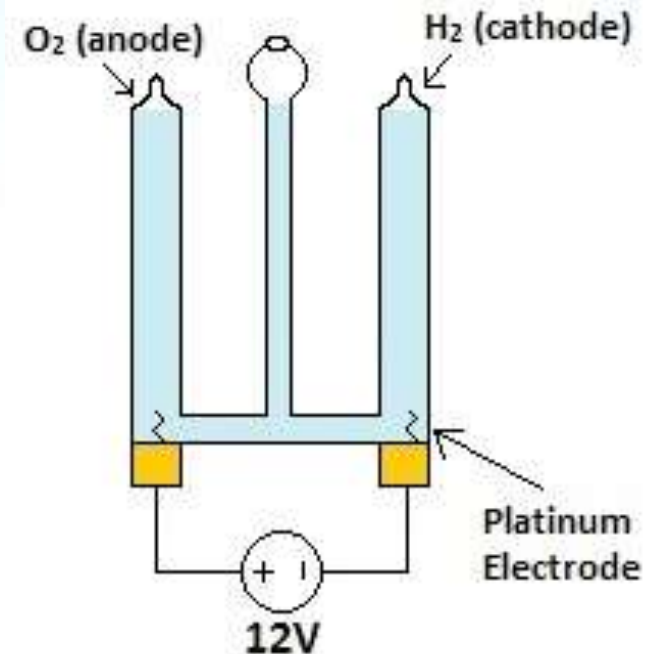
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# Our Project

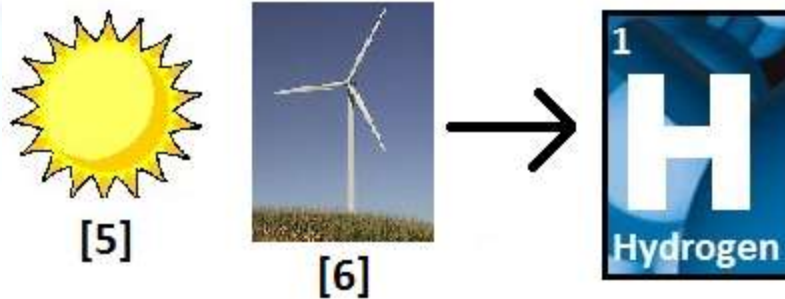
- ▶ Our project uses a process called electrolysis to separate water ( $\text{H}_2\text{O}$ ) into its hydrogen and oxygen components. The hydrogen can then be stored and used as fuel!
- ▶ Electrolysis is the process of electricity passing through water to form hydrogen and oxygen. This is accomplished easily using a 12V battery.





# Renewable and Clean

- ▶ The electricity to power the electrolysis process comes from a solar panel and wind turbine rather than the power outlet.



- ▶ In effect, we use renewable energy sources to create hydrogen: an environmentally clean fuel.

# Problems

- ▶ Distilled water isn't a very good electrical conductor on its own. A salt, base, or acid can be mixed with the water to fix this.
  - Table salt can be used
  - Prefer potassium hydroxide (careful!)
- ▶ Batteries cannot be directly connected to the solar panel or wind turbine without designing a charge controller first.
- ▶ Storage
  - Gas
  - Liquid
  - Hydrides



# Features

- ▶ Two batteries for hydrogen production day and night.



[5] [7]



[8] [9]

- ▶ Charging controllers for healthy battery charging by the solar panel and wind turbine.

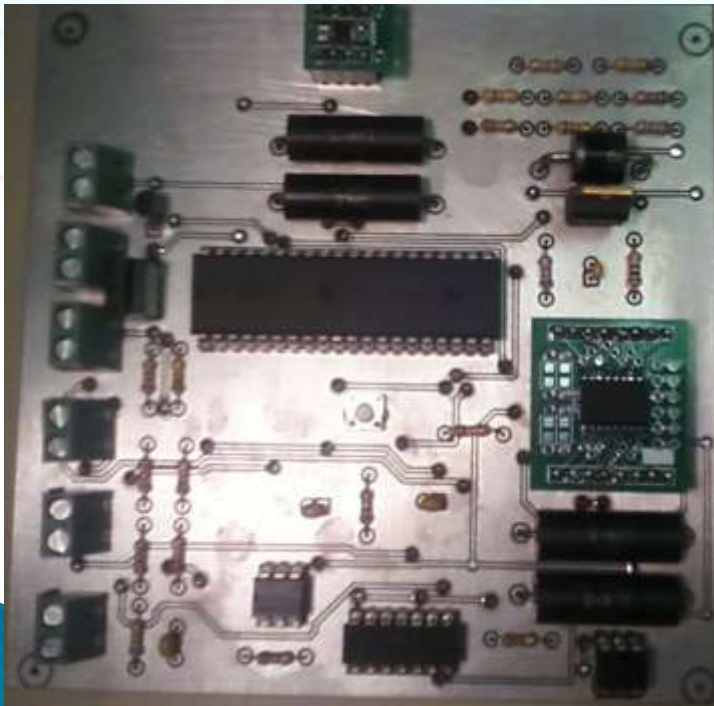
# Features (cont)

- ▶ Automatic System shutdown at critical battery levels.
  - Batteries become unusable if discharged too far.
- ▶ Monitoring System – LCD displays important characteristics to monitor by the user.
  - Source voltages
  - Which battery is currently being used
  - Electrical current used
  - Battery levels
  - On-board temperature

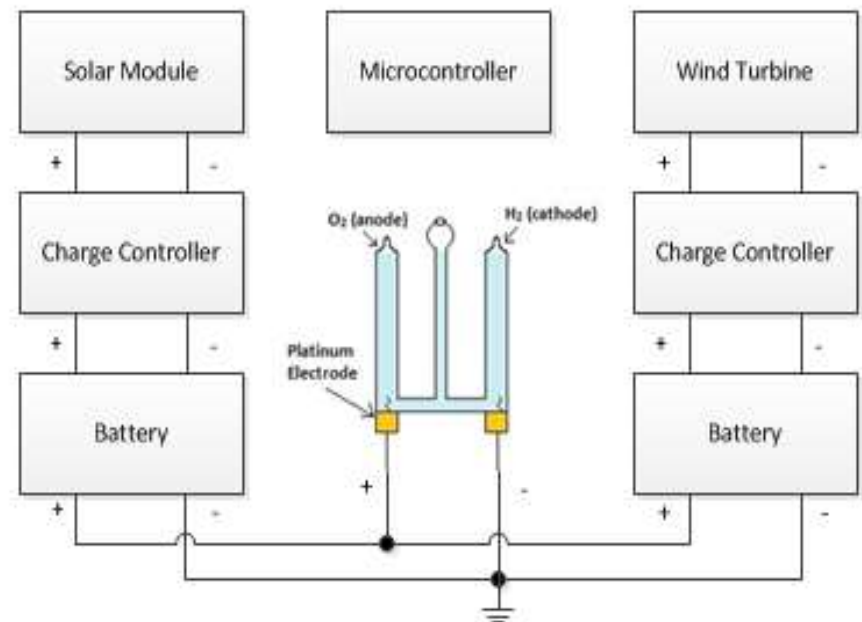


# The System

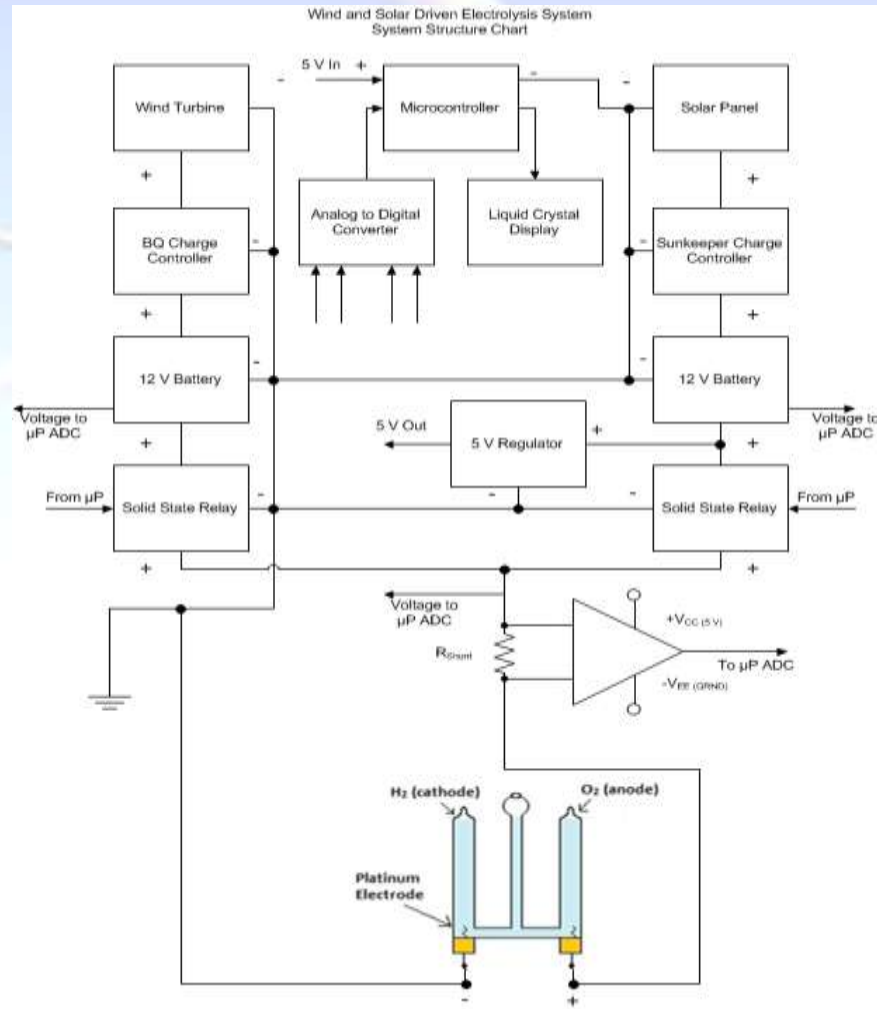
- ▶ The features mentioned are controlled and monitored using a microcontroller and other components needed.



Wind and Solar Driven Electrolysis System  
Basic System Diagram



# Structure Chart



# Design Process

- ▶ Major components researched and selected
- ▶ Components tested and characterized
- ▶ Subsystems interfaced to the control system individually until entire system functioned properly
- ▶ System tested in breadboard to verify functionality
- ▶ Printed circuit board developed
- ▶ Final prototype developed



# Results

- ▶ Solar Panel Experimentation
  - Determine charging characteristics of the solar panel and charge controller to provide optimal charging for the solar battery.

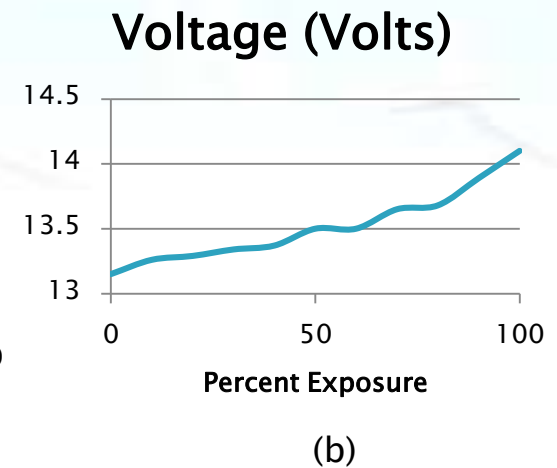
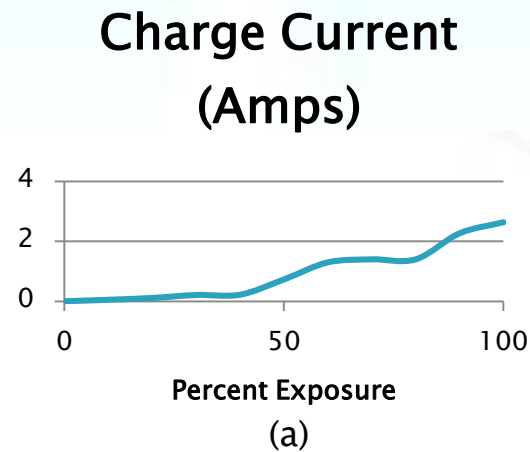


Figure 3. (a) Voltage and (b) current measurements versus the surface area of solar panel exposed to light.

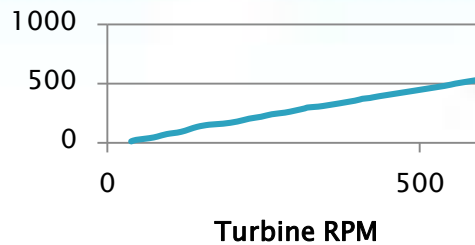


## ▶ Wind Turbine Experimentation

- Determine charging characteristics of the wind turbine to develop a charge controller for the wind battery.

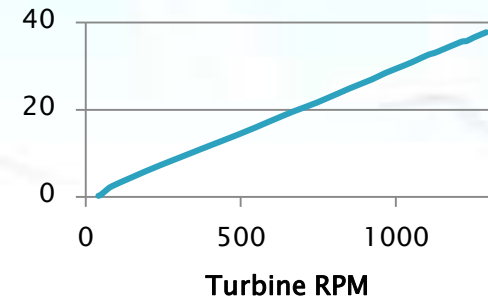


Charge Current  
(mA)



(a)

Voltage (Volts)

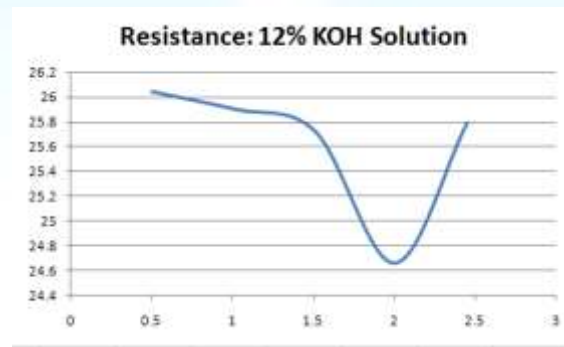


(b)

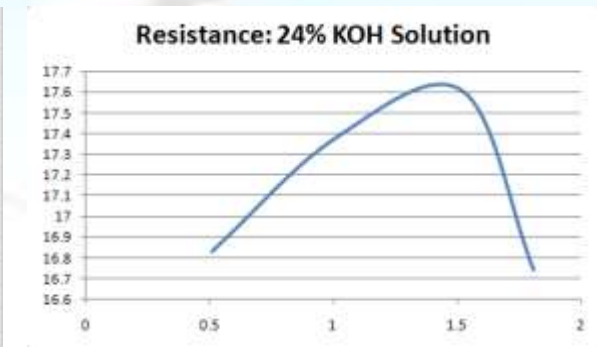
Figure 4. Wind turbine (a) current and (b) voltage measurements versus rotational speed in RPM.

## ▶ Electrolysis Experimentation

- Determine the amount of potassium hydroxide to mix in the solution to increase the conductivity of the distilled water to an optimal level.



(a)



(b)

Figure 5. a) Resistance (ohms) of solution at 12% KOH concentration across varying voltages. b) Resistance (ohms) of solution at 24% KOH concentration across varying voltages.

# Conclusions

- ▶ Development of a small-scale system that utilizes renewable energy to produce hydrogen provides evidence that an alternative fuel source is both viable and readily available.
- ▶ Further developments of the system would allow consumers to produce fuel on-site eliminating the need for costly infrastructure changes
- ▶ Larger capacity for hydrogen production and storage and increased control over user safety would make the system easy to use and increase consumer demand for the system

# Future Work

- ▶ Further development of the system:
  - Increase hydrogen output
  - Automatically controlled hydrogen storage system
  - Controllable wind turbine
    - Pitch and yaw control
    - Rotor brake
  - Automatically controlled solution storage system
  - Improved battery storage
    - Higher capacity
    - Multiple batteries
    - 24 Volt batteries

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  - Vic Bershinsky and George Janack
  - College of Engineering Machine Shop
  - Dax Crum

# Questions?





# References

- ▶ [1] – Department of Energy (<http://www.energy.gov>)
- ▶ [2] – Prison Planet.com (<http://www.prisonplanet.com>)
- ▶ [3] – Cleantechnica (<http://www.cleantechnica.com>)
- ▶ [4] – Finroo.com (<http://www.finroo.com>)
- ▶ [5] – WorthingtonPools.com ([www.worthingtonpools.com](http://www.worthingtonpools.com))
- ▶ [6] – Carleton College (<http://apps.carleton.edu>)
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(<http://ecuadorupdate.wordpress.com>)
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