Millennium Reign Energy LLC

Understanding the fundamentals using hydrogen as part of a micro grid.

MRE uses the following information to make energy conversions to help formulate sizing and energy requirements for various micro grid projects.

- 423 standard cubic feet (scf) = 1 kilogram (kg) of hydrogen.
- It takes 2.3 gallons of water to create 1 kg of hydrogen.
- There are .0791 kilowatt hours of electricity in a scf of hydrogen.
- 1 kg of hydrogen is equal to 1 gallon of gasoline in btu equivalent.
- MRE electrolyzers require 48 kilowatt hours (KWH) of electricity to produce 1 kg of hydrogen. More energy is required to compress and purify the hydrogen ranging from 5 to 15 KWH per kg, dependent on size of system.
- A fuel cell's efficiency, on average, is about 55%.

An example of using the information above in a formula to find out how many kilowatt hours are in a kg of hydrogen:

423 scf x .0791 KWH per scf = 33.45 KWH of electricity in a kilogram of hydrogen.

In order to utilize this hydrogen in a fuel cell, you must multiply the 33.45 KWH by .55 (or the efficiency of an average fuel cell). You will arrive at 18.40 KWH of usable electricity available after running it through the fuel cell.

- The round trip efficiency from taking electricity and converting it to hydrogen with MRE's electrolysis process, then purifying it and compressing it, and then converting the hydrogen back to electricity in the average fuel cell, is approximately 35%. It is important to consider that in the case of over production from wind and solar, this excess energy produced represents a 35% increase in available energy, versus what some might think is a 65% loss.

Building a Micro Grid to be 100% off Grid;

There is a good bit to understand to build an off grid electrical power system or Micro Grid that would include hydrogen as a storage component of that system. It is not an either or proposition between batteries or hydrogen. Rather it is an all, working together, strategy.

Hydrogen generators consume electricity to turn it into hydrogen to store it for later use. They do not produce electricity. A fuel cell is what is used to take the hydrogen you stored with the hydrogen generator and turn it back into electricity. Fuel cells take in hydrogen you have stored and oxygen from the air and make electricity and water. Hydrogen generators take in electricity and water and make hydrogen and oxygen.

It takes Batteries to handle the main loads switching on and off constantly and heavy, the fuel cell provides back up to the batteries and is used this way because batteries would be too expensive and to many to allow for example, a five day window of time when the sun does not shine or the wind does not blow. Using both together provides the best of all worlds.

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To build an effective micro grid multiple elements are needed.

First is the renewable energy aspect. We call this the Origin of Energy. Some source of renewable onsite generation of electricity must be established, like wind, solar, hydroelectric, or geo thermal. Wind and solar work nicely together.

Whatever renewable energy source you select , the sizing of it is very important. It must be large enough to supply all the electrical demands or loads when running and in addition have enough extra power to recharge a battery bank of a specific size and then continue to supply power to the hydrogen generator after the batteries become fully recharged. Usually that is about two to three times the size renewable energy than what your loads for your house are. This will also depend on how many days of autonomy, or time you want to have enough energy stored to last through the down times when there is no wind or solar.

You will need Batteries to supply instant power to meet swings in power demand and last through the night on normal loads.

When the batteries deplete to for example 20% then you will need a fuel cell to take the hydrogen you have made and stored and turn it into electricity. This hydrogen storage is another important sizing issue. Hydrogen is the long term storage and the batteries are the short term storage and load control system. The more kilograms of hydrogen you have in store the longer time you can still supply power to your personal micro grid when no wind or sun is available.

All of this will run thru the inverters for your wind or solar that will take the DC electric power the renewables make and turn to AC power for all the things in your home and other buildings will need.

You should still include a minimal backup generator system that runs on diesel or gas.

Finally you will need a good logic control system to manage the power company you now own and turn things on and off at the right time.

As you can see there is much to consider. MRE has a team of professionals with partnerships that have built systems like this and can assist in the engineering and installation of a complete packaged system.

All in total ball park cost to make a private property completely off grid could range between $90,000 and $200,000 dependent on size and location. This would be for being completely off grid and still be like you are on the grid in town.

List of components,

Renewable electricity source, Wind, solar, hydroelectric, geothermal.

Invertors sized to handle renewables and storage electrical flows.

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Batteries sized to handle all loads and last overnight.

Hydrogen generator to make hydrogen after batteries are recharged daily if renewables are available.

Hydrogen storage sized to store enough H2 to last the desired time past the one day battery life.

Extra storage will be needed if you intend to also use the H2 for transportation, heating or cooking in addition to storing it for electricity.

A fuel cell sized to handle all loads after the batteries get depleted to 20% and be able to recharge the batteries.

Standard Back up Gas, Diesel or natural gas powered generator sized to handle loads.

A logic control system designed and capable of managing the power in and out and to switch sources of power from all renewable and storage options and power demands. It might also be smart logic that would delay power demands till a later time when the demand might be better supplied by the renewables. Example the clothes might be washed later when power is more available.

To properly size all of this you will need to look at your electrical consumption history in Kilowatt hours over the last few years, found on your current electrical bill. For new builds you must estimate your potential consumption in Kilowatt hours per day, month and year.

Finally you must be involved on a level that you will understand how to monitor your systems and be able to identify challenges so you can correct them yourself or pay a professional to do It.

Freedom With Responsibility!!