Geothermal

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{youtube}67F_tNtqiRI{/youtube}

A brief video showing how the RET process uses geothermal heat.

It is known that the temperature of the earth's crust increases downward at a rate of about (10 C) for every 30 meters. The temperature of the earth's mantle is about 2000 C at a depth of about 5 kilometers. A limitless supply of steam may be obtained with only a loose requirement of proper well depth. This technology is commercially available today. The calculated useful heat content of HDR (Hot Dry Rock) under the United States has been estimated to be about 10 million quads (1 quad = 1.0X1018 joules). In energy content, this is equivalent to about 1,700 trillion barrels of oil, or approximately 60,000 times the energy in the proven US reserves of crude oil. That represents about 35 million trillion cubic feet of hydrogen. On a weight basis, that comes out to 207,000 trillion pounds of hydrogen. Other sources of geothermal heat include geo-pressured reservoirs. Geo-pressured reservoirs such as those found along the northern shore of the Gulf of Mexico in the region from Brownsville, Texas, to New Orleans, Louisiana contain hot water at temperature from 150 C to 180 C under extremely high pressures (270 to 400 bars). The hot water under pressure from the geo-pressured zones can be used to produce hydrogen because of the hydraulic energy of the high pressure water and also the geothermal heat of the water. The figure below illustrates the various geothermal resources in the United States.

An integration of geothermal steam and electricity generation can be used to produce hydrogen and oxygen from the waste steam of the turbine, representing both resource mining and refining at the same location. This concept is called "hydrofining", and the integration of the geothermal well/electricity generation/waste steam cracking to hydrogen and oxygen, a "hydrofinery". This is illustrated below for an "unassisted" hydrofinery well at 80% thermal efficiency. It is unassisted because there is no external electricity source. If there is a cheap external source of electricity, the hydrofinery can produce over 6 times more hydrogen. Local economics will dictate the choice of technology options.

Economics for hydrogen generation utilizing RET technology compare very favorably with commercial steam methane reforming technology even when favorable economic assumptions are made for the SMR (steam methane reforming) process technology. In addition, CO2, an off-gas from a geothermal steam well can be processed with the generated hydrogen to produce a variety of chemicals such as methanol or methane. RET Technology is also ideal for geothermal RET hydrogen production/ power plant integration.

It is important to compare rates of energy production of fossil fuel sources such as oil with RET production of hydrogen from a typical geothermal source. Below is a table illustrating typical and peak oil production rates from two sources using horizontal drilling technology and heavy oil.

Location
Production of oil in (barrels/day/well)

Heavy oil Western Canada (avg.)
200

Horizontal oil drilling, Brazos, Tx (peak)
475

Geothermal well with RET (unassisted)
3162*

Geothermal well with RET (assisted)
18,824*

* energy equivalent of hydrogen produced (51 kilograms of hydrogen/barrel of oil)

In order to give a perspective on rates of oil production in various countries versus equivalent energy production of hydrogen from a geothermal RET well, the following table was compiled (SOURCE: Oil and Gas Journal, December 23, 2002) in order of increasing efficiency.

Country	Producing Wells	Production (barrels/well/day)
United States	521,070	11
Canada	54,061	41
China	72,255	47
Venezuela	15,395	157

Russia
41,192
179

Iraq
1,685
1,204

Kuwait
790
2,025

Iran
1,120
3,080

Geothermal w/RET (unassisted)
1
3,162

Norway
833
3,782

Saudi Arabia
1,560
4,730

Geothermal w/RET (assisted)
1
18,824

One question that arises is: How many hydrofinery wells do you need to be equivalent to today's U.S. production of oil? Due to the high productivity of the hydrofining wells, the number of wells needed is greatly reduced in order to produce an equivalent amount of energy. The low efficient oil wells in the U.S. are not economic compared to hydrofineries. Only 1,813 hydrofinery wells are needed compared to 521,070 oil wells. Oil pumped from wells still need to be refined and transported via tankers and trucks to distribution sites and retail stations resulting in additional expense. Hydrogen can be sent via pipeline to the end user without intermediate refining.How many hydrofineries are needed so that the U.S. can be energy and fossil fuel independent?We consumed a total of about 98 Quads of energy in 2003 according to the Energy Information Administration. That is equivalent to about 17 billion barrels of oil. In order for us to be totally energy independent (every sector of the economy) as well as fossil fuel free we would need about 14,700 unassisted hydrofinery wells. That number is still an order of magnitude smaller than the current number of production oil wells in the U.S. today. If there are assisted hydrofinery wells in the mix of energy sources, that number would be even less.

The following link shows an interactive map of a section of Nevada (Great Basin) that has enormous potential for the production of hydrogen using the RET technology. The thermal gradients and profiles exhibited by this interactive map satisfy the requirements of the RET technology. Both flash steam and binary modalities can be used depending on the temperature of the geothermal fluid source. It is interesting to note that this one section of Nevada can satisfy a large part of our (United States) energy needs for the foreseeable future.

http://pubs.usgs.gov/of/1999/of99-425/webmaps/GB%20map.html