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PRICING OF GEOTHERMAL ENERGY

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This opportunity to discuss pricing concepts with the utility industry is one that is needed. The utility fuel purchasers may discuss together how much they will pay for fuel. The fuel finders cannot discuss among each other how much they will charge nor how they will develop a price to charge. Federal law will allow us individually to discuss these questions with our customers. My presentation will be limited to that which is a part of the formal testimony given before the State of California Geothermal Task Force of 1977.

The price of any fuel is the amount of money a willing buyer and a willing seller can agree upon. Posted prices for commodities are a visible gauge of a seller's desired price, and reports on fuel costs by the utility are evidence of the final fuel costs. To derive the actual price for the fuel at the producing facility requires a careful analysis of fuel transportation, preparation, and handling charges. In a free economy the fuel producer, in establishing his price, has strong constraints established by his costs, the price of competing fuels, and the desire of potential customers to use his fuel. The supplier and user of geothermal energy has to consider carefully if the price provides a reasonable return on investment. A company with limited funds to invest must select the investment opportunities with the best chance of having the most favorable return from these finite funds. The customer must select the fuel to buy that will reliably provide a product at an attractive price. The amount of money needed to construct and operate plants to use the fuels is a strong component of how much the customer will pay per unit of fuel.

The pricing system used in the past at The Geysers was directly related to the number of kilowatthours of electricity produced. The disadvantage of pricing energy by the kilowatt produced is that there is no incentive for the utility to invest money in making its plants more efficient. An increase in efficiency, resulting in more kWh per kilogram (pound) of steam, results in the steam producer, not the utility, being paid more. The dry steam system of The Geysers is relatively low-cost, so an increase in efficiency is not needed to be strongly competitive. Dry steam reservoirs are at a nearly constant temperature so there is little incentive for the producer to conduct research and explore new depths for higher-temperature reservoirs.

The costs in the hot water systems that will be developed in California are of such magnitude that incentives must be provided to encourage increased efficiency in generation and increased search for hotter water reservoirs at depth. Both are necessary if these systems are to compete successfully (commercially) with other fuels.

A way of structuring price is shown below.

PRODUCT PRICING CONCEPTS

SALE OF GEOTHERMAL ENERGY TO BE BASED ON COST PER KILOJOULE (PER 10^6 BTU) OF "USEABLE HEAT" DELIVERED TO PLANT INLET OR PLANT'S PIPELINE.

"USEABLE HEAT" IS THE TOTAL ENERGY DIFFERENCE BETWEEN THE DELIVERED FLUID MIXTURE AND THE FLUID RETURNED TO THE PRODUCER AT A SPECIFIED TEMPERATURE FOR DISPOSAL.

ENERGY SALES AGREEMENT SHOULD INCLUDE CLAUSES THAT PROVIDE FOR ENERGY SALES AT A FAIR MARKET VALUE WITH ESCALATION DETERMINED BY NEGOTIATIONS BETWEEN BUYER AND SELLER.

The pricing concept for geothermal energy includes the price and the structuring of the price, as this may be a strong template for future generating units in the field. The basic structure of price must provide an attractive rate of return to the prospector. To achieve this, the prospector's capital investment must be minimized.

PRICING CONCEPT

DEVELOP METHOD TO COMPETE WITH FOSSIL FUELS

1. ENVIRONMENTAL ACCEPTABILITY
2. LOWER CAPITAL REQUIREMENTS
3. BUSBAR PRICE

The utilities participate in the lowest risk segment of the business. The lower risk segments should require a lower rate of return on investment than the higher risk. Therefore, the busbar price for each kilowatt generated will be more competitive if equipment to transport and convert the geothermal energy to electricity is built by the utility. The fuel price should provide for delivering fuel to a productive site manifold and receiving the fluid at a disposal well island site.

PRICING CONCEPT

DELIVER FUEL TO:

A. MANIFOLD AT PRODUCTION SITE
B. A PLANT SEPARATOR

RECEIVE SPENT FLUID AT:

A. DISPOSAL ISLAND SITE
B. PLANT CONDENSER

PLAN "A" IN EACH, RESULTS IN LOWER FUEL COST AND BUSBAR PRICE.

It is good business to consider the revenue stream for the producer as being composed of two parts. The first is money for providing useful heat to the utility, and the second is money for disposing of the fluid after the useful heat utility, and the second is money for disposing of the fluid after the useful heat has been extracted by their machines. By buying fuel on a kilojoule (Btu) basis, incentive is provided for continued improvement in the electricity generating system. The more kilowatts produced per kilojoule (million Btu), the more competitive the geothermal busbar price becomes.

FUEL PRICE

(BASIC CONCEPT PAY FOR USEFUL KILOJOULES [BTU])

A. PAY ON BASIS OF ALL KILOJOULES (BTUS) DELIVERED ABOVE A "REFERENCE" TEMPERATURE
B. PAY FOR KILOJOULES (BTUS) DELIVERED AND DISPOSAL AT X DOLLARS PER KILOGRAM (MILLION POUNDS) DISPOSED

The producer of fuel is stimulated to find and produce the highest heat content fluid from his system. This lowers his operating costs for production and disposal, since volumes of fluids to be moved are minimized.

The joules (Btu) provided should be priced on joules (Btu) delivered above a reference temperature. These will be known as "useful joules" ("useful Btu"). A useful kilojoule per kilogram of brine (Btu per pound) is the remainder of the difference between the enthalpy of the fluid at delivery temperature and the enthalpy of the fluid at a reference temperature such as 93°C (200°F). (Reference temperature depends upon agreement with purchaser and is limited by composition of the geothermal fluid.)

USEFUL JOULE (BTU)

DELIVERY TEMPERATURE	C	185°	171°	166°
	(F)	(365°)	(340°)	(330°)
ENTHALPY (INLET)	KJ/KG	784.5	723.1	698.9
	(BTU/LB)	(337.5)	(311.1)	(300.7)
ENTHALPY @ REFERENCE TEMPERATURE	93°C	390.5	390.5	390.5
	(200°F)	(168)	(168)	(168)
ΔH = USEFUL KJ/KG OF BRINE		394	332.6	308.4
	(BTU/LB)	(169.5)	(143.1)	(132.7)

BRINE KG (LB)

DELIVERY TEMPERATURE	C	185°	171°	166°
	(F)	(365°)	(340°)	(330°)
FLOW FOR 50 MW	KG/S	955	913.4	1285.1
	(10^6 LB/H)	(7.58)	(9.25)	(10.2)
NET MW PRODUCED		45.5	45.2	45.0
BRINE REQUIRED:	KG/NET KWH	75.7	93	103
	(LB/NET KWH)	(167)	(205)	(227)
USEFUL KJ/NET KWH		29,826	30,932	31,765
	(BTU/NET KWH)	(28,300)	(29,300)	(30,100)

(CALCULATION: BRINE REQUIRED TIMES USEFUL KJ/KG [BTU/LB])