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MOUNTAIN HOME GEOTHERMAL PROJECT - A DIRECT GEOTHERMAL APPLICATION TO AN INTEGRATED LIVESTOCK COMPLEX IN IDAHO

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ABSTRACT

The engineering and economics of the direct application of a geothermal hydrothermal resource to a vertically integrated livestock complex was studied under DOE Contract DE-AC07-78ET28442. The study was conducted by a team of industry firms and supported by an Idaho Advisory Board. A system of feed production, swine raising, slaughter, potato processing and waste management was selected for study based upon market trends, regional practices, all commercial hardware, resource characteristics, energy and biological cascading considerations.

The 160 acre complex has a 115 million Btu/hour (34 MWt) peak geothermal load; has an installed capital of $35.5 million with a payout of owner-invested capital of just over three years and a total debt payout in 12 years. The yearly production amounts to 150,000 hogs, 28 million lbs. of processed potatoes, 7300 tons of fertilizer, and on the order of 1000 continuous horsepower from methane. The total effluent is 200 gpm of irrigation water. The study is presented in DOE Report DOE/28442-1, February 1979.

SELECTION OF APPLICATION

The project addressed the problem of the need for more efficient use of capital and the need for a local source of lower cost, high quality feed in the livestock industry. The means of addressing these needs through the direct use of geothermal hot water was specifically studied.

The Bostic 1-A well, located southeast of Mountain Home, in Southcentral Idaho, was selected based upon the characteristics in Table 1. The well was being re-entered by Magma-Union during the study, hence, recent data were not available. The study had to rely upon previously published information, (Table 1).

Table 1. Bostic 1-A Well Data (Ref. 1)

<table>
<thead>
<tr>
<th>Location:</th>
<th>SE1/4 SW1/4 Sec. 25 T4S R8E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Depth:</td>
<td>9,678 Feet</td>
</tr>
<tr>
<td>Casing:</td>
<td>10 3/4&quot; to 1,063 Feet</td>
</tr>
<tr>
<td>Shut In Press:</td>
<td>3,752 p.s.i.</td>
</tr>
<tr>
<td>Max. Temp:</td>
<td>371.6°F @ 8,898 Feet</td>
</tr>
<tr>
<td>Flow Rate:</td>
<td>1000 gpm, Artesian</td>
</tr>
<tr>
<td>Water Quality:</td>
<td>800 ppm T.D.S.</td>
</tr>
<tr>
<td>Damage:</td>
<td>Wellbore skin damage, suspect cause of loss of flow</td>
</tr>
</tbody>
</table>

A matrix approach was used to select the processes and types of livestock for the study. The process area considered included: feed production from both locally grown and regionally purchased constituents; the raising of cattle, swine, sheep and small animals; slaughter and by-product processing; and a comprehensive waste management system. Market trends, regional practices, use of all commercial hardware and processes, resource characteristics, considerations of thermal cascade and biological mass flow and economic factors were used to select the elements for the study. Consideration of vertical integration of the livestock complex at one site resulted from consideration of the logistics and cost of feed; the losses through transport to slaughter of finished animals; improved capital utilization; waste handling environmental requirements; current trends to vertical integration in the industry; and the most efficient means of utilization of hydrothermal direct energy.
From these considerations and the matrix study the core of the system was selected to include:

- An environmentally controlled, sprouted grain growing system for the production of fresh enzymes and vitamins as a minor but important constituent of feed.
- A feed milling facility capable of producing 165 tons per day of multiple formulae, high quality feed using regional supplies, the sprouted grains and potato by-products.
- A modular, totally confined swine raising facility capable of producing 150,000 hogs per year.
- A slaughter, by-product processing and marketing facility capable of processing at least 60 head per hour of swine.
- A potato dehydration and processing facility producing 67 tons of processed potatoes per day and 16.5 tons per day of by-products for the feed mill.
- A total waste management facility handling over 300 tons per day of animal, human and process wastes; producing on the order of 0.4 million cu. ft. of methane per day (1000 HP), and less than 200 gpm of irrigation water effluent.

The facility has a peak geothermal energy demand of 115 million Btu, (34MWt) and, through cascading, utilizes temperatures from 300°F down to 70°F at re-injection. The required peak geothermal flow of 350°F fluid, through a primary heat exchanger is nominally 1000 gpm. This energy is equivalent to an average annual consumption of 4.5 million gallons of oil. The complex requires 100 acres for $35.5 million in capital facilities, Figure 1. Another 60 acres are used for storage and waste treatment irrigation lands.

The geothermal energy is used extensively throughout the complex. Of the peak flow of 1000 gpm, 800 gpm at 300°F is required for absorption refrigeration for temperatures to +10°F; (compression refrigeration is used for colder temperatures). The slaughter processes use 1000 gpm over a cascade of 300°F to 130°F and a similar flow and cascade is used in potato processing. Space and process conditioning for the mill and sprout growing uses 800 gpm at temperatures from 290°F to 280°F and 200 gpm from 130°F to 120°F. The major energy demand is space conditioning of the hog facility, requiring 800 gpm at temperatures from 280°F to 120°F. Biogas operations cascade the entire 1000 gpm from 120°F down to 90°F and the ponds utilize the residual heat.

The "fit" of the application in the thermal cascade, at peak demand, is illustrated in Figure 2. The peak energy loads are summarized in Table 2.

There are no known environmental or institutional impediments to commercial implementation. However, it should be noted that replication to other sites may require special consideration for site dependent requirements. The magnitude of the facility and its internal fluid flow requirements dictate a concerted approach to design for human, animal and environmental safety. Unique effort is required to affect the integration and balance of the energy and mass flow streams of the subsystems.

The profitability of the operation returns the owner's invested cash (25% of the capital) in 3.15 years. Total debt, at 11% per year interest, is paid out in 12 years. The internal rate of return on owner cash flows was calculated to be 62.4%. The maximum owner cash investment requires just over $10 million at the end of the second year. This can be reduced through postponement of the first interest payment until the end of the ninth quarter.
CONCLUSIONS & OBSERVATION

The more significant conclusions include:

- Swine raising is an ideal application of geothermal direct energy. A strong market, confined raising technology, efficient feed conversions, and waste that can efficiently generate methane contribute to this fit.

- Vertical integration of swine raising with local production of competitive feeds is the major factor affecting the attractive economics.

- Hog slaughter at a minimum commercial size of 60 head/hr is a key criteria that sizes the large complex.

- Potato processing contributes to feed production, increased methane yields and greater efficiency in the thermal cascade.

- A well integrated and carefully designed waste management system is the key to elimination potential environmental and institutional impediments.

- The commercial-sized modular elements of the system permits consideration of a dispersed subset, certainly for start-up purposes. This would lead to some economic penalties accrued to the integrated system.

An independent observation reached after the study should be mentioned. When one realizes that a $35.5 million, multi-business complex is required to efficiently utilize 1000 gpm of hot water from one well, and that the well is a by-product of geothermal-electric exploration, one begins to recognize that such a project is more economic development oriented than energy development oriented. While the complex is made possible by the unique economic and cascading characteristics of a hydrothermal geothermal resource, the orchestrations of such a development requires financing, institutional, business development and management talents on a large scale.

This may be one of the most important results of the study.

REFERENCES AND BIBLIOGRAPHY


