COLORADO GREENHOUSE GROWERS ASSOCIATION, INC.

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PLANNING AHEAD FOR GREENHOUSE HEATING: 1980s-1990s PART II: EVALUATING THE OPTIONS

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Costs and sources of information on various fuel options such as waste heat, coal, natural gas and geothermal. At this time, coal, up to and above $75.00 per ton appears to be the cheapest option in terms of usable heat. See Part I (Bul. 383) on a more complete discussion of alternative fuel supplies.

Before we can draw any conclusions for heat sources in the 1990s, we must analyze the heating costs of present day systems. By doing a little "pencil farming" with heating costs in the Rocky Mountain area, a picture begins to develop. It appears that the average greenhouse operator, with little or no double layered covers, paid approximately $1.00 per sq.ft. of greenhouse area for natural gas in the 1981-82 heating season. If all greenhouses had a double layered cover or thermal blankets for night use, the cost should have dropped at least 20% or to 80¢ per sq.ft. The electrical costs approximated 15¢ per sq.ft.

At our request, a fuel comparison chart (Table 1), using December, 1982, commercial-industrial rates was developed by Jim Slagle, a Public Service Company of Colorado engineer, in order to verify a similar table which appeared in Ohio State Assoc. Bul. 630, April, 1982. From the table, a grower can determine his fuel bills if he had been using other fossil fuels. Based on coal prices ($50/ton), which are 61% cheaper than natural gas, he would have paid 39¢/sq.ft. and with a double layer cover 31¢/sq.ft. There are questions concerning coal. How long will the coal companies keep the wholesale prices 60% below natural gas? What will it cost to convert to coal? If the new coal boilers can effectively burn slack-dry-run coal, directly from the mines, the costs could be cut another 10 to 15%. Another savings could be obtained if the cooperative or association could pool the orders and go directly to the coal companies for quantity prices.

[1]Professor, Colorado State University.

Slagle suggested that the following formula be used in conjunction with Table 1 to compute costs of various fuels from local suppliers:

$$\text{Cost for 1 million (1,000,000) usable BTUs} = \frac{\text{1,000,000 BTU X Fuel price}}{\text{BTU content X efficiency}}$$

Example for coal:

$$\text{Cost} = \frac{\text{1,000,000 BTU X \$50/ton}}{\text{25,000,000 BTU/ton X 70\%}} = \frac{50{,}000{,}000}{17{,}500{,}000}$$

Cost per 1,000,000 usable BTUs = $2.86

Today, many people are equating the THERM with the fuel used to operate home heating equipment. One *THERM* is 100,000 BTU or 1/10 of 1 million BTUs and would, therefore, cost 28¢ in the above example.

The use of electric generating power plant waste heat has its problems. First, there has to be an interest by all involved parties. As of 1977, the Public Service Company of Colorado has not been interested in selling waste heat. An in-depth study of the feasibility of using the waste heat from the new Commanche Power Plant in Pueblo, CO, was conducted between 1975 and 1978 (2,3). A food production greenhouse complex of approximately 200 acres was proposed for the Fort St. Vrain Nuclear Power Plant site in Platteville, CO, as early as 1970 (1). The end results, according to Public Service: "We are in the business of selling electricity not heat".

A second problem associated with any waste heat project is the need to supply adequate energy throughout the

Table 1. Industrial/commercial heating fuel comparisons, 1982-83.[z]

Fuel	BTU Value
Coal	25,000,000 BTU per ton
Natural Gas	894,000 BTU per MCF (1000 cubic feet)
No. 2 Oil	140,000 BTU per gallon
Propane	91,065 BTU per gallon
Electric	3,413 BTU per KWH (1000 watt hours)
No. 6 Oil	150,000 BTU per gallon

Fuel		% Boiler Efficiency[y]	Cost to Purchase 1,000,000 BTU's	Cost for 1,000,000 Usable BTU's	Cost 1 Usable Therm[w]
Coal	@ $50/ton	70	$ 2.00	$ 2.86	$ 0.29
	@ $55/ton	70	2.20	3.14	0.31
	@ $75/ton	70	3.00	4.29	0.43
Natural Gas @ $4.57/MCF (Commercial gas-1 rate)		70	5.11	7.30	0.73
No. 2 Oil	@ $1.00/gal	70	7.14	10.20	1.02
	@ $1.05/gal	70	7.50	10.71	1.07
	@ $1.10/gal	70	7.86	11.22	1.12
Propane	@ $0.50/gal	70	5.49	7.84	0.78
	@ $0.55/gal	70	6.04	8.63	0.86
	@ $0.60/gal	70	6.59	9.41	0.94
	@ $0.80/gal	70	8.78	12.54	1.25
Electric @ $0.05931/KWH[x] (E060 rate)		99	17.38	17.55	1.75
No. 6 Oil	@ $0.65/gal	70	4.33	6.19	0.62

[z]Developed by Jim Slagle, Public Service Co. of Colorado, Fort Collins office.

[y]This is a figure for converting potential fuel energy to usable energy. It can vary between 60-80%, depending how "tuned" the burners are.

[x]Single phase value. Three phase costs are based on demand, and KWH costs will be greater than for single phase. The investment is less for three phase.

[w]One Therm = 100,000 BTU.

greenhouse heating season. Some power plants have to close down for periods of time, or the water is relatively cold in the winter. If two power plants are side by side, similar to the Astoria, NY, system, availability is of little concern. Otherwise, a standby heating system must be incorporated, which adds to the capital investment.

The low temperature water problem has been overcome at the Ploesti, Rumania, Power Plant (3). There is a 325 acre greenhouse complex next to the power plant, and water reaching the greenhouses ranges between 195 to 300°F with pressures from 149 to 200 psi. A heat exchanger was located in the steam line between the last turbine and the main power plant condenser. American power plant/greenhouse complexes use the water which circulates between the condenser and cooling towers, a completely separate system from the high temperature steam system used to turn the turbines.

The aspects of using geothermal water to heat greenhouses presents problems also i.e. water temperature, water quality and water availability. The geographical location can also complicate transportation of floral products. To aid the interested growers who want to do a little geothermal "pencil farming", the following information will be helpful.

Map Series 14. Geothermal Resources of Colorado. R.H. Pearl.

1979. Known geothermal resource areas, thermal springs and well characteristics, thermal areas, brief description of selected thermal areas, heat-flow values. Free, over-the-counter; $1.50 rolled or $1.00 folded for mailing.

Colorado Geographical Survey
1313 Sherman Ave., Rm. 715
Denver, CO 80203

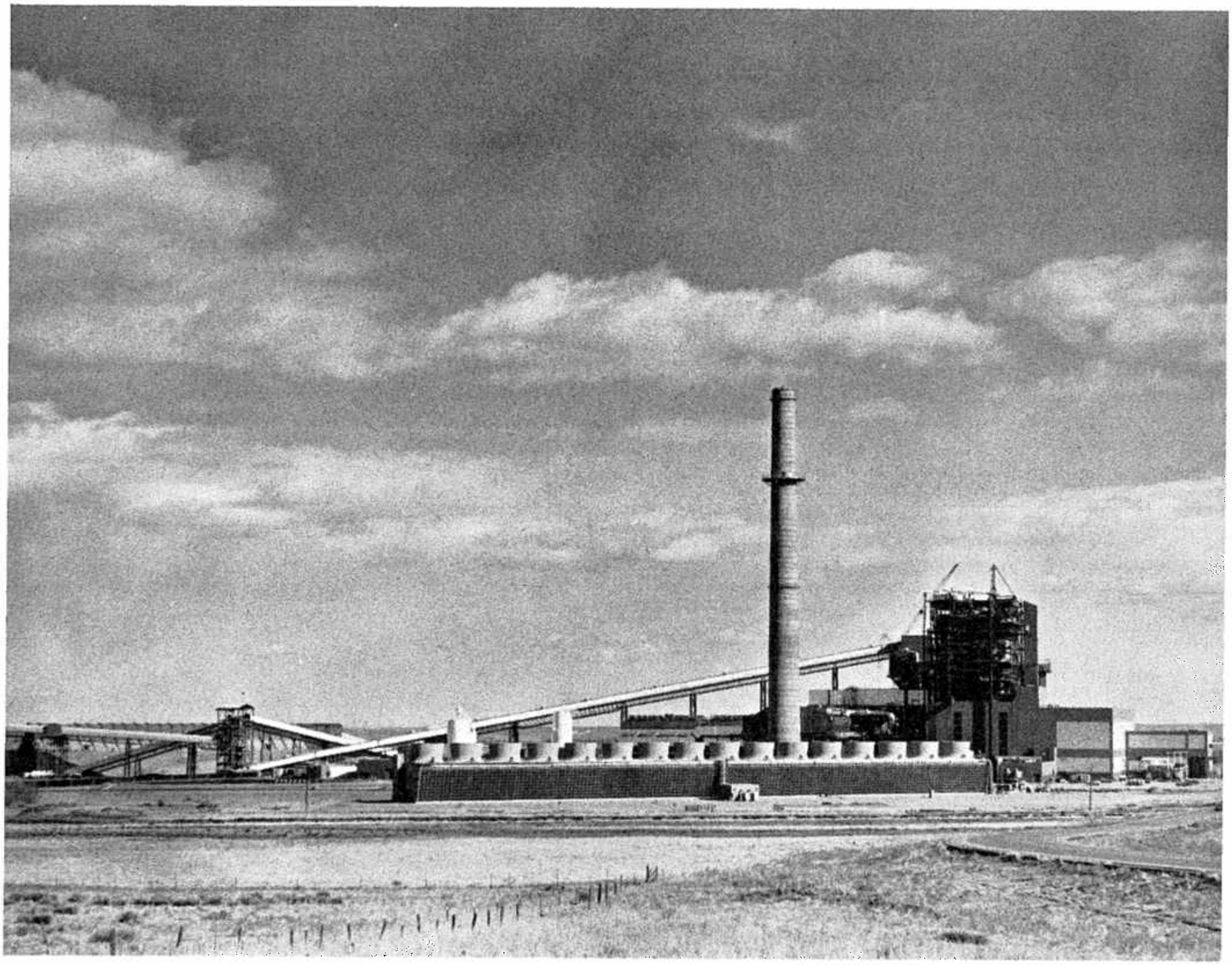
<u>Assessment of Geothermal Resources of the United States - 1975</u>

Geological Survey Circular 726 and the 1978 supplement to it, Geological Survey Circular 790. Sources for these free publications are:

U.S.G.S.
Branch of Text Products
604 S. Pickett St.
Alexandria, VA 22304

In Colorado: U.S.G.S
1961 Stout
Denver, CO 80294

One definite recommendation has been made regarding geothermal water — start with a water lawyer and a hydrologist. Water rights, replenishing, pollution, etc. must be considered and every state has different laws.



Public Service Company's Pawnee power plant, 91 miles from Denver. If heat was available, how many Colorado growers would take advantage?

Final Thoughts

For the short term, Colorado growers need to analyze their individual costs of output. The cost of present fuel sources will continue to climb. Growers affected by the "Blizzard of 82" will not have time to make any large changes if they plan on being in business by spring. However, they can consider such energy saving installations as Infra-red heat (for certain crops) and the new Bio-Therm system for heating benches. It would also be an excellent time for most of them to develop a good cost accounting system and know what their inputs are for every product that goes out of the door.

On a long term basis, even within two to five years, the grower had better do some in-depth planning. Should a move be considered? Change fuel sources? Growers with unit heaters really have a big decision to make. Perhaps the greenhouse manufacturers will have a new/old design that will meet your needs, which can be incorporated into a move.

The less than a dollar per sq.ft. cost of utilities in the future is appealing. How can the Colorado grower best achieve it? Will those that accomplish lower fuel prices reflect it in their selling prices and drive other growers out? Colorado is blessed with the most important aspects of energy for plant growth — SOLAR RADIATION. With foresight, they can perhaps capitalize on other opportunities.

Literature Cited

1. Beall, S.E. and G. Samuels. 1971. The use of warm water for heating and cooling plant and animal enclosures. Ornl-tm-3381. June.
2. Feasibility analysis of vegetable greenhouse project utilizing waste heat from Commanche Power Plant. 1978. Public Service Company. Pueblo, CO. Dec. 29, 1978. Pueblo Development Commission.
3. Goldsberry, K.L. 1975. Literature review on the utilization of thermal discharge water from electric generating plants. Progress Report I. Demonstration Project FCRC No. 252-336-083. Four Corners Regional Commission, Suite 238, Petroleum Plaza Building, 3535 East 30th St., Farmington, New Mexico 87401.