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HEATPLAN: A Microcomputer Program for Geothermal District Heating Assessment

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ABSTRACT

A microcomputer program for preliminary assessment of geothermal district heating favorabilities is described. The program is based on the premise that a community's ability to effectively use its geothermal resources to meet heat demands can be significantly influenced by land-use measures in the community development process. The program is intended for use by local government planning officials as an aid in: documenting community heat supplies and demands; prompting detailed technical investigations of district heating; and establishing land-use plans and regulatory standards that are responsive to, and supportive of, geothermal energy and district heating opportunities.

INTRODUCTION

HEATPLAN is a microcomputer program designed to provide a neighborhood-level inventory of community heat demands by type of land-use; and a preliminary assessment of geothermal district heating favorabilities for the neighborhoods. It is designed for use by local planning officials for purposes of:

- o Establishing a basis for heat supplies and demands as determinants in the community development process, where land-use planning can be used to optimize geothermal energy use and district heating development.
- o Identifying areas in communities where detailed engineering and economic assessments of current geothermal district heating opportunities may be warranted, and other areas where land-use incentives should be focused to improve long-term conditions for geothermal district heating.

HEATPLAN is an account of work for the Washington State Energy Office, which intends to use the program in connection with its local government technical assistance projects. HEATPLAN is written in C/BASIC language, is available on 5 1/4 or 8-inch floppy disk, and runs on microcomputers with CP/M operating systems.

A Land-Use Planning Approach to Geothermal District Heating

HEATPLAN approaches geothermal district heating from the premise that a community's heat supplies and demands should be important determinants in the community development process. In northern climates space and water heating can account for a major portion of a community's total energy consumption. A community's land-use framework presently embodies the conventional sectors of industry, housing, transportation, etc. By adding heat supplies and demands to this list of development determinants, it is suggested that a community can create a land-use planning process that is ultimately more energy-efficient.

Community heat loads are a direct function of land-uses. The types, locations, densities, and mixes of land-uses in a community will control its suitability for district heating; moreover, land-use relationships to geothermal resource sites will determine in large part the suitability of such a heat source for district heating. Thus, a community's land-use scheme must create sufficiently high densities and diversities of heat loads, in close proximity to heat sources, in order for geothermal district heating to be feasible; with appropriate land-use incentives this feasibility can be considerably improved upon.

Beyond the basic design and economic prerequisites of geothermal district heating, land-use planning can also be used in conjunction with geothermal district heating to achieve other community objectives, such as neighborhood renewal or economic diversification.

HEATPLAN determines favorability for district heating on the basis of heat demand per unit of land area, and the cost effectiveness of serving such demand through geothermal district heating. The intent of this land-use approach is to: 1) identify areas where heat demands presently make geothermal district heating favorable and worthy of detailed study; and 2) identify areas where land-use changes and/or incentives need to be applied to improve geothermal district heating favorabilities in the future, e.g. increased densities, greater diversity of uses, and better proximity to heat sources. In this way communities may develop land-use plans, and zoning and subdivision standards that are consistent with, and supportive of, geothermal district heating development.

Description of HEATPLAN

HEATPLAN is comprised of seven major steps or subroutines summarized as follows:

Step A. Subject and Climate Information

The user enters information identifying the community and service area being evaluated; local climatic conditions which affect building heat loads; and a discrete case number to allow for sensitivity analyses, which the program is also designed to provide.

Step B. Land-Use Thermal Inventory and Assessment

The user divides the community, or portion thereof, into study areas, i.e. neighborhood district heating zones. In most cases these study areas will be blocks or groups of blocks. The user collects and enters the amount of building floor space in each study area according to land-use types provided by the program. The program uses the floor space data to estimate heat loads for each study area using a modified degree-day method (expressing peak and annual space heating loads, and average hourly and annual water heating loads). The program also allows the user to enter any actual load data that may be readily available for a study area, e.g. from a major institution or industry. The program then estimates the heat load density and load factor for each study area; and with a user-supplied estimate of expected market penetration rates, it then calculates the total load of all study areas aggregated into a single community-wide district heating system. The program allows the user to override calculated values for purposes of sensitivity analyses, or to account for unique local conditions.

Step C. Determination of System Design & Estimation of Capital Costs

The user enters the distance from the most favorable geothermal resource site to the most favorable heat load site in the evaluated service area; and is given a choice of selecting a district heating system supplied completely by geothermal energy, or by a hybrid system using geothermal base heat and conventionally-fueled peaking. The user enters data on the geothermal resource to be used for the system, including correction factors to account for the reliability of resource estimates when actual data is unavailable. The program estimates the required number of geothermal wells, amount of transmission and distribution pipeline, and type of central heat exchange or boosting equipment, and their capital costs. The user is again allowed to override calculated values for each system component for sensitivity purposes or to account for unique local conditions.

Step D. Estimation of Operation and Maintenance Costs

Based on previously calculated capital costs, and user-supplied costs for electricity and peaking fuel (if applicable), the program estimates operation and maintenance costs for the system. Again, the user is allowed to override calculated values for sensitivity purposes or to account for local conditions.

Step E. Estimation of Life-Cycle Costs & Minimum Sales Per Land Area

The user enters the following economic and financial parameters for the project: expected inflation rates over the life of the project; the amount of capital cost to be debt financed, and interest rate for the debt; the proposed sales price for geothermal heat, based on local competing fuel prices; and the choice of either public or private ownership for the system. The program calculates life-cycle costs for the system, solving for the minimum amount of annual heat sales necessary to break-even under a public ownership scenario, or achieve a 20% return on equity under a private ownership scenario. The resulting minimum amount of first year heat sales necessary for successful operations is then expressed in terms of minimum heat sales needed per unit of land area in the community.

Step F. Estimation & Mapping of Geothermal District Heating Favorabilities

The program then estimates district heating favorability for each study area by calculating the ratio of minimum community-wide heat sales per unit of land area, to the previously estimated heat load density and load factor in each study area. Study area favorability ratios are ranked in five increments of favorability, depending on the positive relationship between study area load and the community-wide minimum. A complete print-out of all previous computations along with study area ratings are provided. With a user-supplied diagram of the community, the program will also generate two maps of the study areas: 1) a map depicting current thermal load densities, i.e. the best picture of existing heat loads in the community for long-range land-use planning purposes; and 2) a map depicting the favorability ratings for each study area, i.e. the best picture of current district heating potential, where detailed engineering and economic feasibility assessments may be warranted.

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