FLAT-RATE vs. BTU METERS
WARREN ESTATES AND MANZANITA ESTATES
RESIDENTIAL GEOTHERMAL DISTRICT
SPACE HEATING
RENO, NEVADA

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INTRODUCTION

Warren Estates and the adjoining Manzanita Estates, located in southwest Reno, Nevada, (Figure 1) comprise the largest residential geothermal space heating district in Nevada. Nevada Geothermal Utility Company (NGUC), a privately-owned utility, has operated the district since 1983 when it served only 10 homes. Today, the NGUC 130-acre service area includes approximately 160 residences; about 100 of those are currently under contract for geothermal space and water heating, and other related applications.

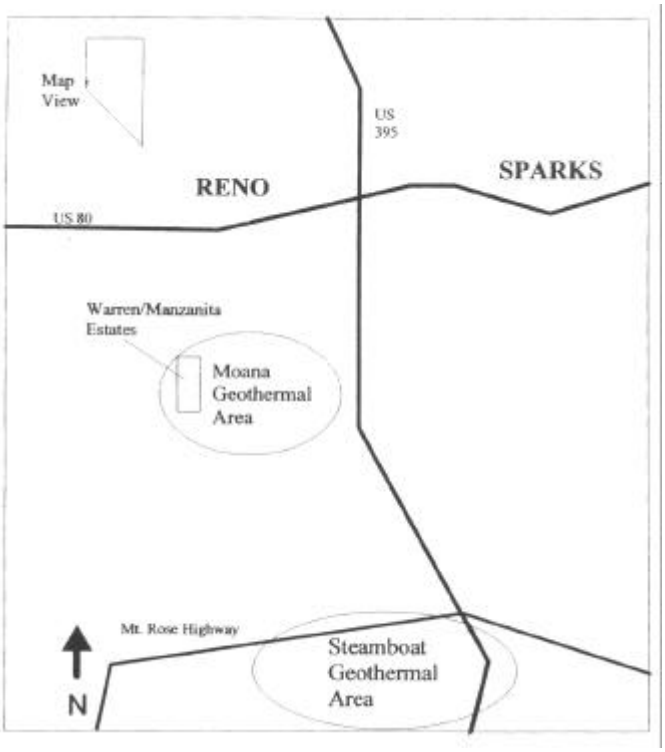

Figure 1. ***Sketch map of Reno, Nevada, showing approximate location of Warren and Manzanita Estates, and Moana Geothermal Area (not to scale).***

The source of heat is the well-documented Moana geothermal reservoir. Production well depths range from 700 to 800 ft with temperatures in excess of 200°F; high permeability is associated with northeast-trending fault-zone intersections. Geothermal water is pumped at a rate of 250-350 gpm from one of two production wells to flat-plate heat exchangers at the surface. Hot water (180°F) is circulated from the heat exchangers to the subdivisions via underground pipes. All geothermal water is injected back into the reservoir through a well located on the premises. In addition to Public Utility Commission (PUC) regulations, NGUC is in compliance with permits and regulations of the Nevada Division of Water Resources and Division of Environmental Protection.

The district has operated relatively smoothly, but with a negative cash flow, for years largely due to uncertain billing practices. The average size of a single-family home in these modern, relatively affluent subdivisions is 3,500 sq ft, but many are in excess of 5,000 sq ft. After more than ten years of unreliable results from Btu meters, a flat-rate billing procedure was proposed to the customers and Public Utilities Commission. This paper describes the factors that lead to the decision to implement flat-rate billing, the reception by consumers, PUC stipulated tests, the results of those tests, and final recommendations for flat-rate billing.

BACKGROUND

On March 11, 1983, the Public Service Commission of Nevada issued Geothermal Operating Permit (GOP-001) to the Nevada Geothermal Utility Company (NGUC) for space heating 10 homes in the Moana Geothermal Area, in southwest Reno. NGUC presently provides hot water to about 100 private homes in the Warren and Manzanita Estates. The Moana area has been the site of small-scale, but widespread, geothermal direct-use applications. Bateman and Scheibach (1975) reported 35 individual geothermal wells were used to heat homes in the Moana area. Well depths range from 100 to 500 ft and the highest temperatures (210°F) are associated with a series of north-trending fault zones. Additional information on the geology and geothermal resources of this and other areas is described in Garside and Schilling (1979), and Flynn and Ghusn (1984).

At the Warren Estates, hot water is pumped (250 to 400 gpm) from a single production well to surface, flat-plate heat exchangers. Heat is transferred to a second fluid circulating loop and delivered to the subdivisions. All pumped fluids are injected back into the geothermal reservoir through

an injection well. The original application contained a description of the geothermal production well drilled to a depth of 800 ft with a downhole temperature of 210°F. Since the wells have been completed, there has been no significant hydrologic drawdown nor temperature decrease in produced fluids.

Initially, each home was equipped with a Btu meter that measures flow rate and temperature drop, and computes heat energy consumption in therms (100,000 British thermal units-Btus). The system operator, Nevada Geothermal Utility Company (NGUC), reported significant problems, malfunctions and failures with the Btu meters due to their placement in subsurface utility boxes. For more than 10 years, NGUC tried several Btu meters with similar, disappointing results. Problems include water saturation of the meter box from lawn sprinkler runoff, failure of flow meters, and general failure of electronic components from steam condensation. With only 8 to 10 months of service life, replacement rates and maintenance costs were very high. As a remedy, NGUC proposed removing all Btu meters and provide unlimited hot water to all residences on a monthly, flat rate.

BILLING HISTORY

Billing data from 97 residences were reviewed in spreadsheet format covering the period March 1992 through February 1997; summary results are given below.

Table 1. Billing Categories

Category	Heating Requirements	Range of Monthly Bill
1	Space and domestic water	$0 to $74
2	Category 1 plus pool/spa	$27 to $105
3	Category 2 plus ice-melt	$181 to $232

These data were compared with expected heating costs using natural gas to underscore the fact that Btu meters were not performing, resulting in a depressed cash flow. The original PUC operating permit included the following provision:

> *In the event that meters are not available at reasonable cost or do not reliably reflect energy consumption, an equivalent rate will be developed on a flat-rate basis determined by home heat loss average for this area, and other average consumptive data for other uses such as, but not limited to, domestic water heating, swimming pools and spas.*

CALCULATION OF AVERAGE ENERGY CONSUMPTION

Three estimates were used to determine the flat-rate billing scheduled for geothermal heat: natural gas utilization, an estimate of natural gas use by the local utility company, and an estimate by the USDOE based on degree days. The following table lists the results of the preliminary energy calculations.

Table 2. Preliminary Energy Calculations

Item	Sq Ft	Therms	Annual Cost	$/ft^2	Therms/ ft^2
Homeowner	2,250	969	$547	$0.24	0.43
SPPC 1993	1,800	596	$337	$0.19	0.33
USDOE	1,800	600	$339	$0.19	0.33
Average				$0.21	0.363

The Washoe County Assessor's Office has a computer database of all commercial and residential buildings in the county. The listing provided a reliable source for the amount of living space, in sq ft, for each home in the Warren and Manzanita Estates. On the basis of the PSNC regulations, the existing service contract, comparative evaluations with natural gas heating, and the historical record for the Warren and Manzanita Estates, the following new rate schedule was proposed.

Table 3. 1998 Proposed Billing Provisions

Item	Rate
Monthly service charge	$3.25 per household
Space and domestic water heating	$0.016 per sq ft (75% of natural gas)
Swimming pool	$30.00 per month
Spa/jacuzzi	$10.00 per month
Driveway deicing	$50.00 per month

PSCN staff suggested that NGUC provide customers with the opportunity to evaluate and comment on the proposed new rate schedule before it is implemented. Staff also suggested a letter be drafted to the commission that clearly states the intention of the utility and provides evidence (photos of the Btu meters, receipts for replacement, labor costs, etc.) for the proposed change. A public hearing was held in May of 1998, and comments were incorporated into the docket.

On June 26, 1998, the Public Utility Commission of Nevada (PUC) issued a Compliance Order (Docket No. 98-1022) allowing Nevada Geothermal Utility Company (NGUC) to implement a program of flat-rate billing for geothermal customers at Warren/Manzanita Estates. The Compliance Order contained a set of stipulations, including one requiring installation and monitoring of five new Btu/flow meters.

> *...Nevada Geothermal will install within thirty (30) days of the issuance of a Commission Order, at its expense, up to five (5) new Btu/flow meters at locations aboveground and within the perimeters of the residences. That selection of the meters be made by a committee composed of one representative each from the Applicant, the Commission staff, and the homeowners, and that the meters be monitored monthly for a period of one (1) year. That within thirty (30) days of the expiration of the one (1) year period, the Committee shall file a report with the Commission and copies*

mailed to all customers of the Applicant. Such report shall describe the accuracy and dependability of the meters, based on the five-meter trial. That sixty (60) days after the filing of the report with the Commission, Nevada Geothermal will submit a report and proposal to the Commission as to what, if any, changes in billing method and rates should be implemented.

The ad hoc committee sought five volunteers based on the following criteria:

1. An accessible mechanical room;
2. The hot water supply and return enter and leave the mechanical room; and
3. An agreeable, year-round tenant.

EQUIPMENT SPECIFICATIONS

Btu meters were obtained from the following manufacturers:

Hersey Measurement Co. 150 Venture Avenue PO Box 4585 Spartanburg, SC 29305	Model No. 7431 B Btu Meter, battery operated, includes two RTD sensors: two wire, Pt-500 (3 5/16 in. length), and turbine flow meter Model No. 413, hot (1 ½ in. diameter)
ONICON Inc. Sales & Manufacturing 2161 Logan Street Clearwater, FL 33765	System-1 Btu meter, includes temperature sensors, 115 vac. F110 single turbine flow meter with frequency output

INSTALLATION

As of February 10, 1999, all Btu meters were installed in five residences serviced by NGUC. The table below lists information related to the volunteers; all homes were plumbed for space heat and hot water.

The five meters were read on a monthly basis. The ONICON meters recorded only total Btu; while, the Hersey meters recorded Btu, water flow, temperature in and out, and battery life. Readings were taken by phone, fax and by site visits.

Table 4. Btu Meter Installation Specifications

Name	Sq Ft Meter	Installed		Circ. Pump	Other
SP	4,252	Hersey	11/9/98	Yes	No
MC	2,600	Onicon	12/8/98	Yes	No
NB	4,647	Hersey	1/11/99	Yes	No
PG	2,176	Onicon	1/18/99	No	No
SM	3,600	Hersey	2/10/99	Yes	Pool

SPECIFIC METER NOTES

All meters operated as specified for the duration of the test. There were no problems or adjustments required for the NB, MC or SP meters. The monthly data for the PG meter were not used in this calculation. The readings were consistently low all year. The meter was reinspected and found to be working properly. The reason for the low meter readings has been attributed to the fact that there is no water circulation pump in this heating system. The heating system worked, but the heat consumption did not register on the meter, due to low flow.

The data for the SM meter included swimming pool energy consumption during the summer months (May - September). These data were adjusted by using a multiplier of 0.786 of the NB meter readings, an empirically derived number. In addition, the ratio between the sq ft of these homes is 0.777. The resulting adjustment shows the pool and house as separate energy items, and provides a method to evaluate the pool heating requirements.

RESULTS

Figure 2 shows the results of the monthly monitoring program in therms for the five participants. The shape is indicative of the seasonal heating curve, shown in Figure 3 as the Degree Day Curve for the Reno area. Data for this curve were obtained from the Desert Research Institute, NOAA Climate Website (http://nimbo.wrh.noaa.gov/Reno/).

Natural gas utilization by residents in Warren and Manzanita Estates are shown in Figure 4. These data were requested from the 39 homeowners who used natural gas in the Warren/Manzanita Estates. Of the 39 contacted, 12 responded, only 6 provided useful data.

ENERGY CONSUMPTION CALCULATIONS

Space and Water Heating

Figure 5 shows the relationship between energy use and sq ft of living space. The flat-rate billing model currently used by Nevada Geothermal Utility Company (based on sq ft of living space) is depicted as the thin, solid black line. The present pricing model for space and water heating is $\$0.15/ft^2$ for the first 3,500 ft^2 and $0.04 for additional space. These data are converted to therms (1 natural gas therm costs $0.565, slope is .2654).

The annual therms for the four geothermal Btu meters, plotted as solid circles, provide an average measured geothermal energy consumption equal to 0.40 therms/ft^2, or about $\$0.22/ft^2$ annually at present natural gas prices. The annual therms for the six natural gas meters, plotted as solid diamonds, provide an average measured natural gas use equal to 0.46 therms/ft^2, or about $\$0.26/ft^2$ annually. The pricing model includes a discount for sq ft of living space in excess of 3,500 sq ft. Both the Btu meter and natural gas data show a constant linear relationship for energy consumption in excess of 3,500 ft^2. There appears to be no indication that a price break at 3,500 ft^2 supported by these data. Table 5 lists the comparative costs for space and water heating for a typical 3,500 sq ft house. The cost is derived by multiplying therms by $0.565.

Swimming Pool

As described above, the heat budget for the SM swimming pool was extracted from the overall SM monthly

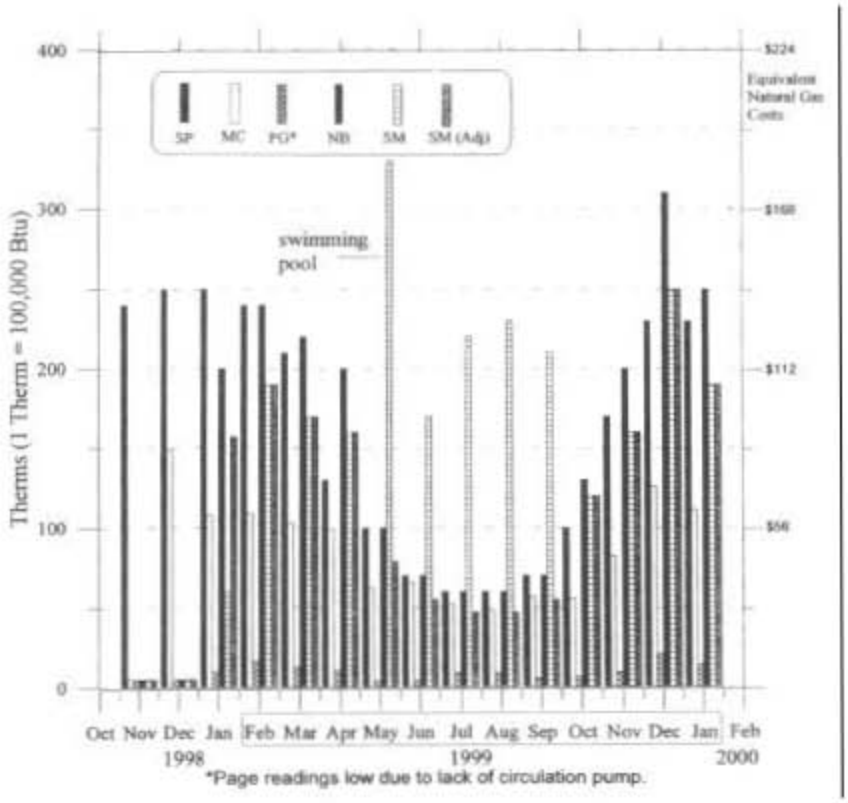

Figure 2. Results of the Btu meter test program as mandated by the Nevada PUC, 1998-2000.

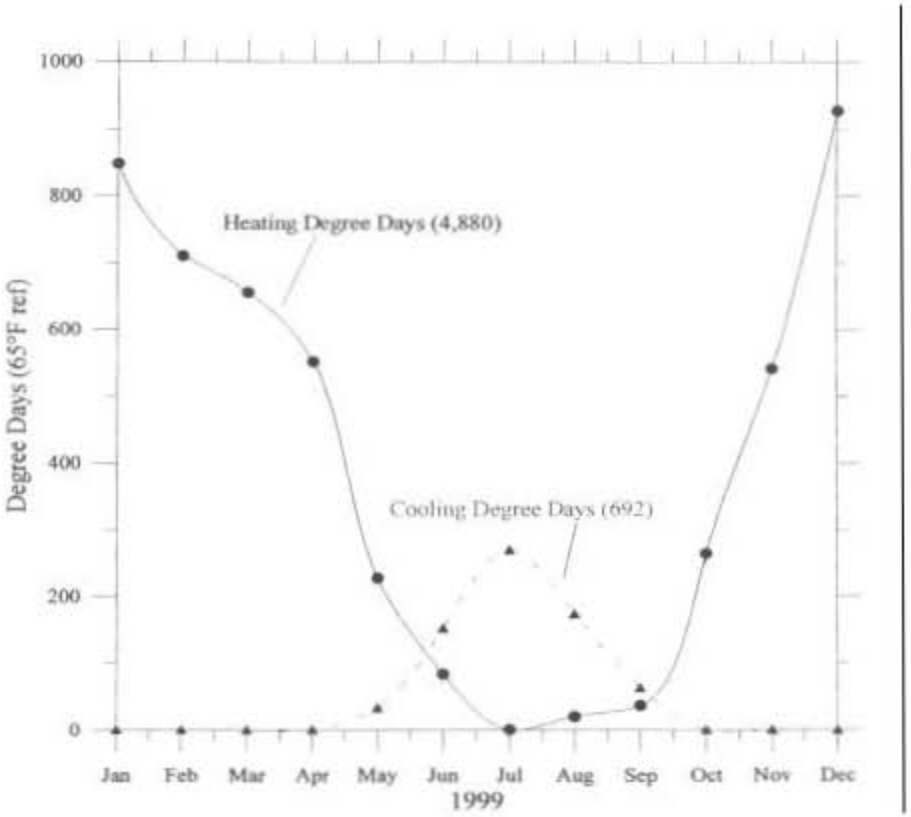

Figure 3. Degree day data, heating and cooling for Reno. Reference temperature is 65°F (data from DRI).

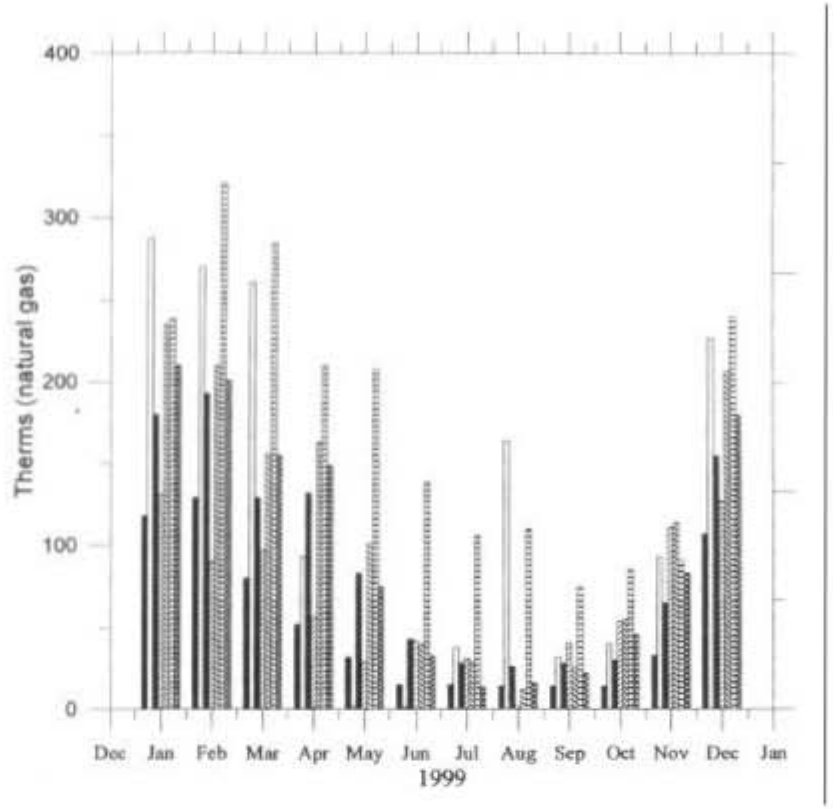

Figure 4. Energy consumption in natural gas-heated homes in Warren and Manzanita Estates, 1999 data.

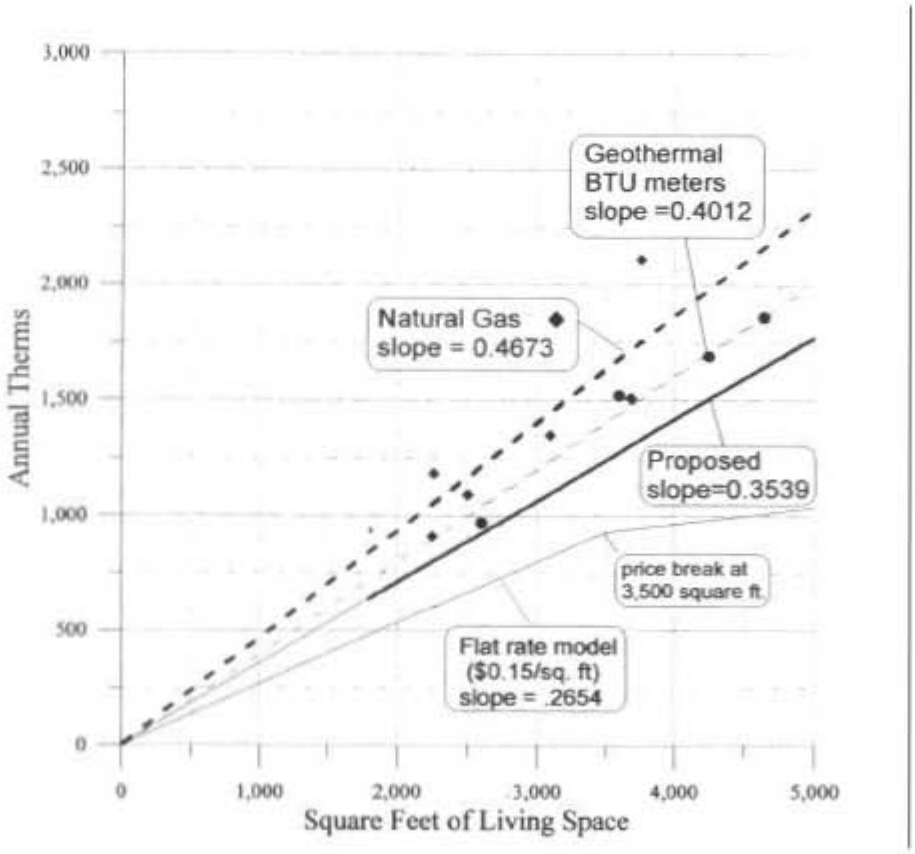

Figure 5. Relationship between sq ft of living space and annual therms used for space and water heating. The proposed rate of 0.3539 is equivalent to approximately 20 cents per sq ft at present natural gas prices.

Table 5. Comparison of Heating Costs

Item	Slope*	Times Ft^2	Equal Therms	Cost
Natural gas meter	.4614	X 3,500	1615	$912
Geothermal Btu meter	.4012	X 3,500	1404	$793
Flat-Rate billing	.2654	X 3,500	929	$525

* From Figure 5

energy budget by subtracting the equivalent of 0.786 of the NB monthly consumption. The results of this calculation is an estimate of the stand-alone energy budget for the SM swimming pool. The swimming pool operated for five months and consumed a total of 877 therms, or about 175 therms per month. At the present cost of natural gas, that is equivalent to about $98/month for five months, $495 per year, or about $41/month for 12 months. Presently, the flat-rate charge is $13/month.

RECOMMENDATIONS

Geothermal energy is an effective, clean, and efficient method to supply heat energy to residences in Warren and Manzanita Estates. It is renewable, non-polluting, but it is not free; appropriate fees must be established that satisfy both the developer and consumer. The developer is responsible for initial exploration, drilling, design and construction of the district heating system, as well as its long-term operation, regulatory permitting, accounting and maintenance. The consumer must install specialized heat exchange equipment in order to take advantage of the above listed benefits. There are no longer any federal or state programs that reward the risk of either development or use of geothermal energy. The financial burden is borne by both the developer and the consumer. The benefit of using non-polluting, renewable energy is, however, shared with society as a whole.

The present price model for geothermal heating offered by Nevada Geothermal Utility Company is fixed by the PUC until July 2001. On the basis of the data collected during this study, justifiable changes in the flat-rate billing model will be presented to the PUC (Table 6).

Table 6. 2001 Proposed Billing Provisions

Item	Rate	Example Monthly Costs
Monthly service charge	$3.25 per household	$03.25
Space/domestic water heating	0.3539 therms/ft^2/year	$58.32
Space heating only	0.3067 therms/ft^2/year	$50.54
Swimming pool	140 therms/mo (June-Sept)	$79.10
Spa/jacuzzi	20 therms/mo	$11.30
Driveway deicing	100 therms/mo (Nov-Apr)	$56.50

Those changes are also based on the following observations:

1. Geothermal Btu meters installed in a weatherproof and waterproof environment, provide the best method of energy accounting for individual homes.

2. Installation of Btu meters within homes in the Warren and Manzanita Estates should be considered on a site-by-site basis. For example, many of the newer homes can be retrofit with Btu meters relatively quickly. The costs would be about $1,200 for the meter and $500 to $1000 for installation. The existing plumbing in some of the older homes may be cost prohibitive if the retrofit includes digging up existing landscaping, sidewalks and driveways. Both the Hersey and Onicon meters work effectively, but the Hersey meter provides much more information.

3. The flat-rate billing that is presently based on cost per sq ft should be based on therms per sq ft of living space to maintain a consistent accounting system as the price of natural gas varies over time.

4. Billing should be monthly, based on the price of natural gas for that month.

5. The flat rate should be linear for homes of all sizes. This eliminates the price break at 3,500 ft, which is not supported by the data collected in this study.

6. Swimming pools will be billed at an estimated 140 therms per month for the five months from May through September (data based on a single pool).

7. The billing for spas and sidewalks deicing systems were slightly increased when they were converted to estimated therms.

ACKNOWLEDGMENTS

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