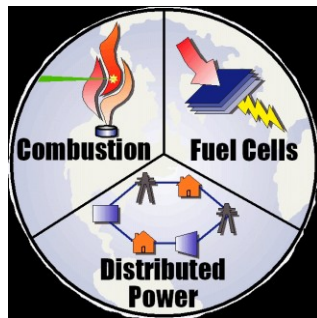


**YEARLY ENERGY REQUIREMENTS
FOR
WHITE MOUNTAIN RESEARCH STATIONS
(CROOKED CREEK AND BARCROFT)**

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EXECUTIVE SUMMARY

Significant energy savings are possible for the White Mountain Research Stations (WMRS) located at Crooked Creek (10,200 ft elevation) and Barcroft (12,500 ft elevation). Barcroft is in dire need of energy infrastructure upgrades in order to provide reduced operating costs, safety and reliability especially throughout the winter months. This study compiles data from Southern California Edison (SCE) electricity bills, AmeriGas propane bills and Haycock Petroleum diesel bills spanning roughly June 2003 to June 2004, with some greater historic records incorporated where possible. The intent of the study is to characterize the baseline yearly energy use for the stations (separately where possible) as they apply to stationary energy applications.

SCE feeds electricity to both stations and monitors them as a single unit from the White Mountain Radio Substation. The average yearly electrical energy use was found to be 242,567 kWh spanning June 2001 to May 2004. Peak electrical energy use has historically been predominant in the winter months but has remained at a more constant high throughout the first half of 2004. Peak power demand ranged from 48-77 kW spanning June 2003 to May 2004 with an average of 65.4 kW. SCE electricity costs totaled \$33,440 for the same time period.

WMRS is classified under the SCE "General Service-2" rate schedule (GS-2) which is bounded by users within the 20-500 kW peak power range. An estimated 96% of the total electrical energy use at Barcroft is associated with space heating. If significant electricity reducing measures are implemented, cost will be reduced by (1) lowering the facility related peak power demand charge (10% of monthly electricity costs), (2) lowering charges associated with the higher block of the two-tiered block energy charge, and (3) and potentially allowing WMRS to move into a lower cost non-demand GS-1 SCE rate schedule. Time-of-Use GS-2 rate scheduling may also be advantageous to the station since most of the WMRS peak demand is not associated with the higher SCE costs during summer.

Diesel back-up generators are used for electricity during grid failures. From July 2003 to May 2004, 85 gallons of diesel (kerosene) was delivered to the stations. This is thought to be low relative to average diesel use, which has been claimed to be more in the range of 500 gallons per year. This corresponds to 4741 kWh of electric energy at 25% electrical efficiency for the generator. This translates to 2% of the total electrical energy usage per year, or 7 days per year.

Propane is used only for cooking needs at both stations. Each station generally receives one delivery per year at roughly 800 gallons. This translates to 66,500,000 BTU/year for each station. Using an average cost of \$1.40/gallon this comes to \$1120/year per station.

1.0 ELECTRICAL ENERGY

The analysis in this section (electricity use only) comes from data found in electrical bills spanning June 2003 to May 2004. The electricity provider is Southern California Edison (SCE). The meter is read from a 2400V SCE substation at the White Mountain Radio Substation that provides 12000V to an adjacent WMRS owned overhead transmission line. The power line is bifurcated at Crooked Creek to both stations. All analyses correspond to the combined electrical usage of the two stations.

The billing period is monthly usually spanning 29-31 days between meter reads. Each monthly bill also gives electrical energy use for the corresponding month dating back two years into the past, allowing historical comparison of energy use trends. Figure 1 shows monthly electrical energy use from June 2001 to May 2004.

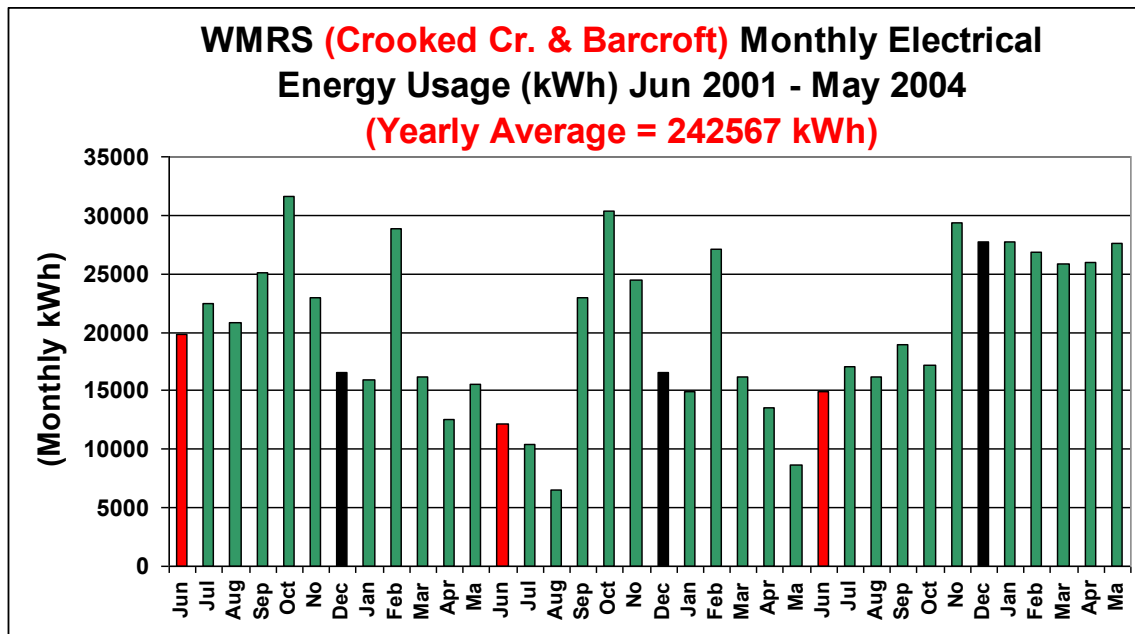


Figure 1. WMRS (Crooked Creek & Barcroft) Monthly Electrical Energy Usage (kWh) from June 2001 to May 2004.

Red columns correspond to June and black columns December for better visual separation of years. There is a discernible trend from 2001-2003, where Sept-Nov are the heaviest use months with Feb existing as an isolated heavy use month. This trend appears to break down in 2003-2004 with continual heavy electrical use spanning Nov 2003 to May 2004. Possible reasons for this new trend may be an increase in station use, ongoing construction, new equipment additions, or system losses.

Figure 2 shows daily average electrical use for each month of the year. The trends mimic what was seen in Figure 1.

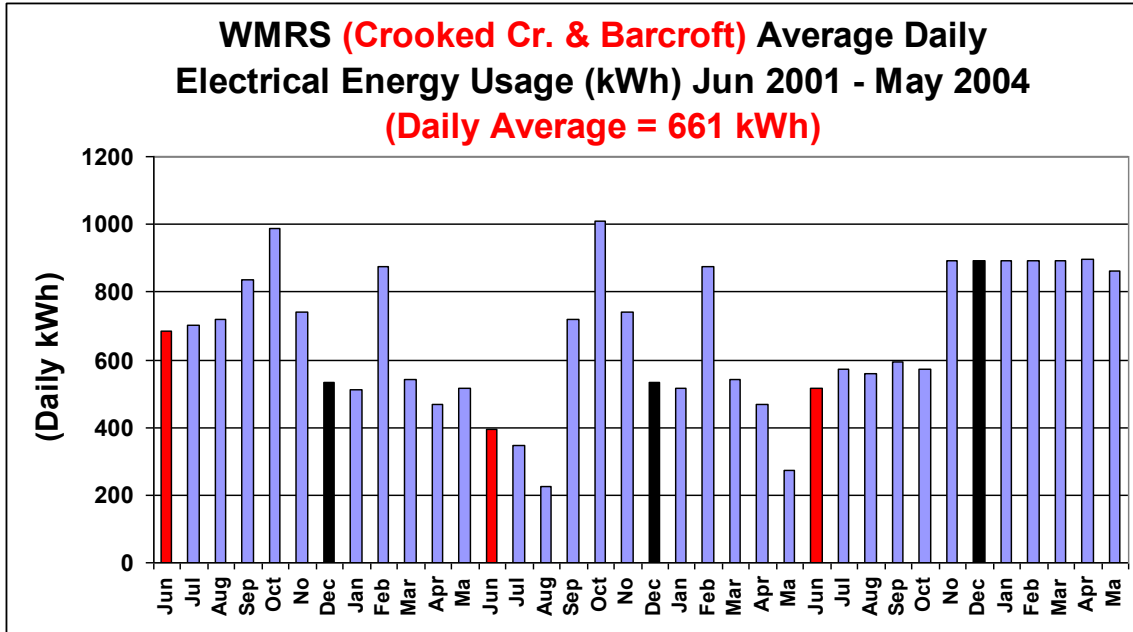


Figure 2. WMRS (Crooked Creek & Barcroft) Average Daily Electrical Energy Usage (kWh) from June 2001 to May 2004.

Peak power demand spanning June 2003 to May 2004 can be found in Figure 3. Monthly peak demand ranges from 48-77 kW, with the winter months showing continuously high peak demand from Nov to March. The average monthly peak power demand for the two stations was 65.4 kW. Renewable energy such as wind and PV will help lower this peak demand, which will also reduce the associated SCE peak charges. At this point in time, we have no knowledge of how much of this peak is associated with each of the two stations with the exception of the winter when Crooked Creek is closed. The bifurcation of use will be elucidated by power monitoring at Barcroft which should be coordinated with an SCE monthly billing period such that the two stations peak demand can be characterized.

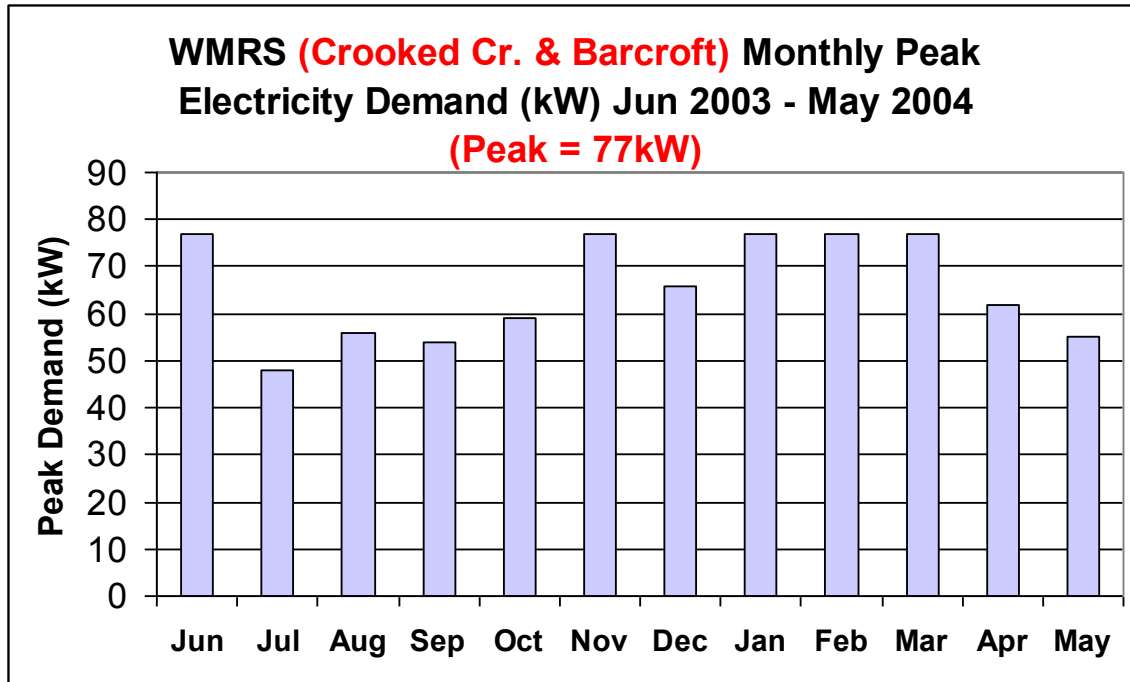


Figure 3. WMRS (Crooked Creek & Barcroft) Monthly Peak Electrical Power Demand (kW) from June 2003 to May 2004.

Monthly SCE electricity costs can be found in Figure 4. Winter months show the highest costs reflecting the increased electrical heating demand. Electricity costs totaled \$33,440 for the year.

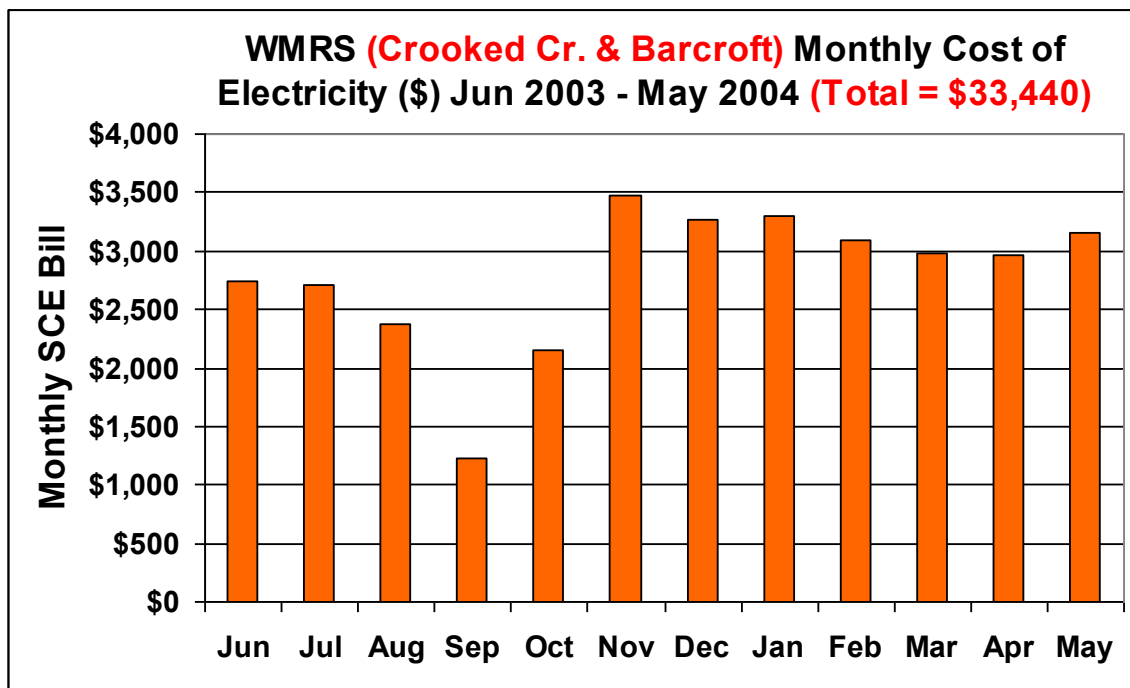


Figure 4. WMRS (Crooked Creek & Barcroft) Monthly Cost of Electricity (\$) from June 2003 to May 2004.

1.1 GS-2 Rate Schedule

The power being metered to Crooked Creek and Barcroft falls under SCE's GS-2 rate schedule. The GS-2 rate schedule applies to medium sized commercial and industrial customers who have peak power demands greater than 20kW but less than 500kW.

The average monthly peak power demand for the two stations combined was 65.4 kW. Tables 1-7 compile data from the April 2004 SCE bill.

Table 1 gives general demand and costs

Table 1
Rate Schedule: GS-2

| <u>Date</u> | <u>Total Cost</u> | <u>Total Energy</u> | <u>Peak Power</u> |
|-------------|-------------------|---------------------|-------------------|
| Apr-04 | \$2,970 | 26000 kWh | 62kW |

Table 2 gives the macroscopic view of charges.

Table 2
By Usage

| | |
|--------------------------------|-------------|
| Delivery Related Charges (A) | \$ 710.55 |
| Generation Related Charges (B) | \$ 2,275.11 |
| Electric Deferred Refund | \$ (23.48) |
| State Tax | \$ 7.80 |
| Total | \$ 2,969.98 |

Table 3 details delivery related charges.

Table 3
(A) Delivery Related Charges

| <u>(A) Delivery Related Charges</u> | <u>Value</u> | <u>Multiply By</u> | <u>Equals</u> |
|-------------------------------------|--------------|--------------------|------------------|
| Facilities Related Demand | 62 kW | \$4.47 | \$ 277.14 |
| Block 1 Energy Charge | 18600 kWh | \$ 0.01286 | \$ 239.20 |
| Block 2 Energy Charge | 7400 kWh | \$ 0.01286 | \$ 95.16 |
| DWR Bond Charge | 26000 kWh | \$ 0.00493 | \$ 128.18 |
| Customer Charge | | | \$ 52.72 |
| Demand Voltage Discount | \$ 334.80 | 23.30% | \$ (78.01) |
| Energy Voltage Discount | \$ 19.19 | 20% | \$ (3.84) |
| Delivery Subtotal | | | \$ 710.55 |

Table 4 details generation related charges.

Table 4
(B) Generation Related Charges

| <u>(B) Generation Related Charges</u> | <u>Value</u> | <u>Multiply By</u> | <u>Equals</u> |
|---------------------------------------|--------------|--------------------|--------------------|
| <u>DWR Generation:</u> | | | |
| Block 1 Energy Charge | 5509 kWh | \$ 0.08918 | \$ 491.29 |
| Block 2 Energy Charge | 2192 kWh | \$ 0.08918 | \$ 195.48 |
| <u>SCE Generation:</u> | | | |
| Facilities Related Demand | 62 kW | \$ 0.93 | \$ 57.66 |
| Block 1 Energy Charge | 13901 kWh | \$ 0.07934 | \$ 1,038.64 |
| Block 2 Energy Charge | 5208 kWh | \$ 0.09597 | \$ 499.81 |
| Customer Charge | | | \$ 7.58 |
| Energy Voltage Discount | \$ 19.19 | 80% | \$ (15.35) |
| Generation Subtotal | | | \$ 2,275.11 |

Table 5 gives miscellaneous details.

Table 5

| | |
|-----------------------------|------------|
| Daily Average Cost | \$ 102.41 |
| Service Voltage | 2400 Volts |
| % Energy from DWR | 29.618% |
| Franchise Fees (From Total) | \$ 23.96 |

Table 6 details charges by component.

Table 6

By Rate Component

| | |
|---------------------------------|--------------------|
| DWR Generation | \$ 686.77 |
| SCE Generation | \$ 1,588.34 |
| DWR Bond Charge | \$ 128.18 |
| Transmission Charges | \$ 71.74 |
| Distribution Charges | \$ 409.49 |
| Nuclear Decommissioning Charges | \$ 14.56 |
| Public Purpose Program charges | \$ 83.46 |
| Electric Deferred Refund | \$ (23.48) |
| Taxes and Other | \$ 10.92 |
| Total | \$ 2,969.98 |

The information that follows comes from SCE’s website: www.sce.com and explains the GS-2 rate schedule. For more details go to the links below.

http://www.sce.com/NR/rdonlyres/eryoaeiokqh745bfn3s7quffjo5sqsvczjv2tahfebxv2uicrfz5ftryr3fcboki3v4nafhppt6hfp2wzncryx3fech/534-CI-0602_GS-2.pdf

<http://www.sce.com/NR/sc3/tm2/pdf/ce30-12.pdf>

THE BASIC CHARGES

The GS-2 rate schedule basic charges are separated into three categories:

- A monthly **customer charge** that covers a portion of basic services such as meter reading and customer billing.
- **Energy charge** per kilowatt-hour (kWh) consumed that varies by season and time of day.
- **Demand charges**, consisting of “Time-Related Demand” and “Facilities-Related Demand” charges.

GS-2 “BLOCKED-RATE” ENERGY CHARGE

Rate schedule GS-2 is designed to encourage conservation by having an increasing two-tiered “energy charge,” known as a **blocked rate**. The first block of kWhs consumed is charged at a lower rate, and the remaining kWhs, called the second block, is charged another rate. Customers on this rate schedule are charged the lower first block rate for the first 300 kWh per kW of demand registered. kWhs in excess of 300 per 1 kW of demand will be charged at the second block rate.

TIME-RELATED DEMAND CHARGE

On the GS-2 rate schedule you are charged for two kinds of demand: Time-Related and Facilities-Related. **The Time-Related Demand Charge** is applied only during SCE's summer season. It is meant to help recover part of SCE's higher costs of providing transmission and distribution services during the summer months. It is a per-kW charge applied to the greatest amount of demand created in each summer season month.

FACILITIES-RELATED DEMAND CHARGE

The **Facilities-Related Demand Charge** is also billed on a per-kW basis, yet it is in effect each month of the year. It is applied to the greatest amount of demand created in the current month, *or* 50 percent of the highest demand created in the previous 11 months, whichever is greater. This method of billing for demand is called a **ratchet**. By using this method, you pay for the installed transmission and distribution facilities required to serve your highest demand during the year.

HOW A DEMAND CHARGE DIFFERS FROM AN ENERGY CHARGE

To understand the difference between energy and demand charges, imagine using ten 100-watt light bulbs. The moment the ten bulbs are turned on, they place a **demand** on the power system for 1,000 watts of electricity (10 bulbs x 100 watts each), or 1 kilowatt (kW). In this example, your electric meter would register 1 kW of demand. Whereas, if these light bulbs are left on for ten hours, they will consume 10,000 watt-hours of **energy**, or 10 kWhs. In this case, your electric meter would register 10 kWhs of energy.

SEASONS

The summer season begins the first Sunday in June and continues to the first Sunday in October of each year. The remainder of the year is the winter season.

OTHER RATE OPTIONS

If you are eligible for the GS-2 rate schedule, you may also be eligible for other rate options that could help lower your electric bills. These include:

- **Other Time-of-Use Rate Options**, which have differing demand and energy charges based on the time of day and season electricity is used. Charges during the on-peak period are significantly higher than other periods. (See Schedule TOU-GS-2 charts below). Customers who benefit from these pricing options tend to operate close to, or completely, around-the clock, or have sufficient energy usage during the lower priced mid- and off peak hours to offset the cost of the higher priced on-peak usage.

DEMAND RESPONSE PROGRAMS

SCE offers a variety of Demand Response programs offering incentives to qualified customers who reduce their energy usage during peak times, while helping to lower their electricity costs. Qualified customers who can reduce power when statewide energy supplies are low may earn financial incentives and/or other benefits by participating in these programs. And while saving money, your participation can make a difference in the state's energy and economic well-being. Some of these Demand Response programs are available to GS-2 customers.

BECOMING ELIGIBLE FOR A NONDEMAND RATE SCHEDULE

If you register a demand of 20 kW or less for 12 consecutive months, you will be eligible to transfer to the non-demand GS-1 rate schedule. Or, if you make a change in operating conditions that SCE determines will permanently reduce your demand to 20 kW or less, you may transfer to GS-1 before completing 12 consecutive months at a demand of 20 kW or less.

PROCURING POWER FROM ANOTHER PROVIDER

The right of retail customers to procure power from another provider was suspended by the California Public Utilities Commission. Customers currently receiving services from another provider will continue to be billed the GS-2 tariff charges noted above, and will continue to receive a credit on their bills equal to SCE's power procurement and generation costs (the Generation component) associated with their applicable rate.

FOR MORE INFORMATION

SCE has several programs available to help customers better manage their electricity costs, such as rebates, incentives, energy surveys and payment options. If you have questions about other SCE programs or the GS-2 rate schedule, call **(800) 990-7788**, contact your SCE representative, or visit www.sce.com.

1.2 Summary of SCE Electricity Analysis

There are a number of opportunities for reducing electrical demand and therefore SCE costs at WMRS. Facilities related peak power demand charges account for roughly 10% of monthly billing costs. Remember that the facilities related demand cost “is applied to the greatest amount of demand created in the current month, *or* 50 percent of the highest demand created in the previous 11 months, whichever is greater.” If peak demand can be reduced to below 20 kW then it will be possible to transfer service to the non-demand GS-1 rate schedule. Reducing peak demand via improvements in building efficiency, the installation of renewables or MTG's are various solutions.

Consuming less electrical energy will result in charges that predominately fall into the lower bracket of the “two-tiered block charge”. Since the majority of energy demand for WMRS occurs in the winter, the higher rates effective in summer do not severely impact the stations. Because of this, it may be advantageous for the stations to be switched to a “Time-of-Use GS-2” rate schedule.

Rough calculations based on the “annotated Barcroft appliance list - energy ratings and use” show electrical space and water heating requirements at Barcroft comprising 96% of the total electricity use. Currently, neither diesel nor propane is used for space or water heating.

2.0 DIESEL ENERGY

Diesel use at Crooked Creek and Barcroft was difficult to quantify. From the diesel bills spanning 7/03 to 5/04 only 85 gallons were used (Table 7), but this may be due to a large stored capacity after significant power failure in 2002.

Table 7
Diesel 7/15/03 - 5/19/04

| Date | Amount (Gallons) | Fuel Charge | Other Charges | Total Charges |
|--------------------|-------------------------|--------------------|----------------------|----------------------|
| 12/11/2003 | 10 | \$ 26.94 | \$ - | \$ 26.94 |
| 12/31/2003 | 20 | \$ 62.58 | \$ 112.40 | \$ 174.98 |
| 12/31/2003 | 55 | \$ 103.35 | \$ 20.00 | \$ 123.35 |
| Grand Total | 85 | \$ 192.87 | \$ 132.40 | \$ 325.27 |

The only diesel use related to this study is that used to power electrical generators. However, diesel is also used to power a bulldozer, backhoe and snowcat. There is no way to clearly differentiate these uses within the bulk diesel purchases. Furthermore, diesel is only used in the generator in the case of an electricity grid failure, which is intermittent. According to the WMRS staff, 500 gallons per year for generator use may be average. 500 gallons of light diesel is equivalent to 18,962 kWh (LHV) and if the generator is 25% efficient, 4741 kWh of electric energy could be obtained. This value translates to 2% of the total electrical energy usage per year, or 7 days per year. Significant diesel storage capacity is available at the stations.

3.0 PROPANE ENERGY

Propane deliveries to both Crooked Creek and Barcroft have historically occurred only once per year Table 8 and Table 9. Currently, propane is used solely for cooking needs at both stations. 1500 gallons of tank capacity was located at each station during our visit, with 2000 gallon capacities being claimed. Less than half of the 2000 gallon capacity is currently being filled each year (however AmeriGas claims that maximum tank fills are to 85% of capacity). Also, additional propane tank capacity is being planned for summer of 2004. This will pave the way for greater propane utilization in space and water heating applications to offset electrical heating. One limitation is that fuel can only be re-supplied between June 1 and Nov 1, so at least seven months of propane storage are required.

Table 8
Propane
Crooked Creek

| <u>Year</u> | <u>Date</u> | <u>Gallons</u> | <u>Cost</u> | <u>\$/Gallon</u> | <u>BTUs</u> |
|-------------|-------------|----------------|-------------|------------------|-------------|
| 2004 | NA | 0 | 0 | NA | 0 |
| 2003 | NA | 0 | 0 | NA | 0 |
| 2002 | October | 724.0 | \$ 882.56 | \$ 1.22 | 60,186,482 |
| 2001 | June | 900.0 | \$ 1,401.91 | \$ 1.56 | 74,817,450 |
| 2000 | NA | 0 | 0 | NA | 0 |

Table 9
Propane
Barcroft (All fills for Barcroft #2)

| <u>Year</u> | <u>Date</u> | <u>Gallons</u> | <u>Cost</u> | <u>\$/Gallon</u> | <u>BTUs</u> |
|-------------|-------------|----------------|-------------|------------------|-------------|
| 2004 | NA | 822 | 0 | NA | 68,333,271 |
| 2003 | NA | 0 | 0 | NA | 0 |
| 2002 | October | 781.8 | \$ 1,026.87 | \$ 1.31 | 64,991,425 |
| 2001 | June | 450.0 | \$ 700.95 | \$ 1.56 | 37,408,725 |
| 2000 | NA | 0 | 0 | NA | 0 |