Belleayre Mountain Ski Center UMP-DEIS

Appendix G
Energy Audit Report

October, 2008

Prepared for:

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1 Introduction

Ecology & Environment has conducted an energy audit of the existing Belleayre Ski Mountain and a review of key elements of the proposed expansion described in the UMP.

Conducting an energy audit is the first step in understanding how the existing facilities use energy and how energy can be saved. The purpose of the energy audit is to identify, quantify, and describe existing energy use and recommend, quantify and prioritize cost saving measures.

E & E typically performs baseline data normalization to evaluate the impact of both cooling degree-days and heating degree-days on energy consumption. However, Belleayre Mountain operated under a unique scenario that did not fit into typical normalization scenarios. Since less than 20% of the energy use is attributed to building use and submetering data are not sufficient to adequately distinguish areas, normalization for the purpose of benchmarking energy use is not an effective tool for this application. Also, the use USEPA's ENERGY STAR Portfolio Manager is not an effective benchmark for energy use at Belleayre Mountain. In lieu of these generic benchmarking procedures, this assessment contains a detailed evaluation of Belleayre Mountain's systems and buildings, comparing the energy use between systems and buildings to document and recommend where energy savings recommendations should be implemented to achieve the greatest benefit.

The most critical observation of this audit is that Belleayre Mountain's snowmaking system, particularly, the central compression system, represents a significant cost right now, and threatens to represent a significant increase in costs in the future. It also represents Belleayre Mountain's most lucrative opportunity to reduce energy costs.

2 Facility Description

The Belleayre Ski Resort is located on 2,193 acres in the Catskill Mountains. The facility has 47 trails and 8 chairlifts, and conducts snowmaking on all trails to extend and enhance the ski season. There are 3 lodges; Discovery, Overlook and Sunset. In addition to a busy ski season, the facility also hosts music festivals and provides camp for young people at the Pine Hill facility. To support these activities, Belleayre Mountain has a maintenance staff that operates essential equipment and maintains the facility property. The Maintenance building, Carpenter Shop, and various pump houses provide space for this equipment and maintenance activities. A large inventory of mobile equipment, from trail groomers to landscaping tools, is used to maintain the site. Belleayre Mountain's main offices are staffed year round to support management and maintenance of the facility.

3 Existing Energy Use Analysis

3.1 Methodology

To measure and evaluate energy use at Belleayre Mountain, it is important to review energy use from two perspectives: utility invoices and operations data. A review of billing data provides total cost and rate structure information. Cost data also provide an important tool for the comparison of systems that consume multiple energy sources at variable rates and energy intensities, for different uses. Operations data provides a more specific review of actual energy use, allowing a more accurate assessment of how the energy is used. This review will provide opportunities for specific improvements to reduce energy consumption based on the current use of certain systems.

To provide a complete year of information and allow for the assessment of an entire season, the time period assessed in this audit includes April 2007 thru March 2008. This time period is represented in text, table and graphs as "2007-2008."

3.1.1 Billing data

Belleayre receives electric supply from NYSEG and fuel from various vendors. There is no natural gas supplied to the site. The billing data collected for this assessment are summarized in Table 1 (Morier, 2008).

Table 1 Belleayre Energy Billing Information, April 2007-March 2008

Energy Supply	Data	2007-2008 Costs
Electricity	Monthly billing totals from Main Area and Pine Hill Phase 3 Meters, 2000-2008 Monthly invoices from Main and Pine Hill Accounts, 2007-2008 Billing totals for all meters, 2007-2008	$604,542
Diesel/Fuel Oil/Other	Invoice totals for fuel purchases, 2007-2008	Diesel $815,131 Fuel Oil $85,445 Kerosene $0 Propane $6,416 Total $906,993
Total Energy Costs, April 2007- March2008		**$1,511,535**

3.1.2 Estimated operational use data

While billing data provide an overall picture of how much energy is used at Belleayre Mountain, they cannot show how efficiently that energy is used, or for what purpose. A more comprehensive and informative analysis comes with collecting use data and reviewing equipment throughout the facility to determine where energy is consumed and how effectively it is used.

The data on energy equipment were collected by Andrew Niles, NYSDEC in the form of a preliminary audit data request (Niles, 2008) and at the site during a visit on August 11-14, 2008. Ecology and Environment, Inc. staff conducted a walk-thorough of most facilities on Belleayre Mountain (Ficker, 2008), collecting an inventory of the equipment within the facilities, including the size and potential energy use of this equipment. For large equipment, such as compressors and pumps, hours of operation data and fuel use was also obtained. Data were collected for mobile equipment, such as trail groomers and construction equipment. Based on this information, energy use and costs were estimated for the major energy demands. Energy use was estimated based on information on the size and use of the inventoried equipment and assumptions related to schedule and power use. Small plug-in equipment, and equipment in buildings that were not accessible have not been included. Because not all equipment was included in the inventory, there is a gap between the billing electricity use total and the electricity use estimated based on equipment. This gap is noted as "Unidentified" or grouped with "Other" use.

The inventory of energy use and costs provides a big-picture view of how energy is consumed at Belleayre Mountain and how much each activity costs. This overview provides insights into potential energy efficiency improvement efforts as well as a means of prioritizing these efforts. Using the data collected to establish a baseline of energy use and expense, various improvement options have been identified and evaluated. Projections of future energy costs based on increased prices have also been estimated.

3.2 Energy Use

From April 2007-March 2008, Belleayre Mountain spent $1,511,535 on energy, using electricity, diesel fuel, and other fuels to power snowmaking, ski lifts, buildings, and mobile equipment. Table 2 provides a summary of energy used and Figure 1 provides a breakdown of energy uses and types of energy by cost.

Table 2 Summary of Belleayre Mountain Energy Uses

Uses	Electricity	Diesel	Fuel Oil	Other (Propane, Kerosene)
Snowmaking	Compressors Water pumps Snow guns	Compressors Water pumps (generator)		

Table 2 Summary of Belleayre Mountain Energy Uses

Uses	Electricity	Diesel	Fuel Oil	Other (Propane, Kerosene)
Trail use/ site maintenance	Ski Lifts Trail lighting	Groomers Construction equipment Landscaping Equipment		Construction equipment Landscaping Equipment Snowmobiles/ATVs Other vehicles
Building Use	Lighting Appliances (Kitchens) Electronics Vending Machines Computers Air Conditioning Heating		Heating	Heating Cooking

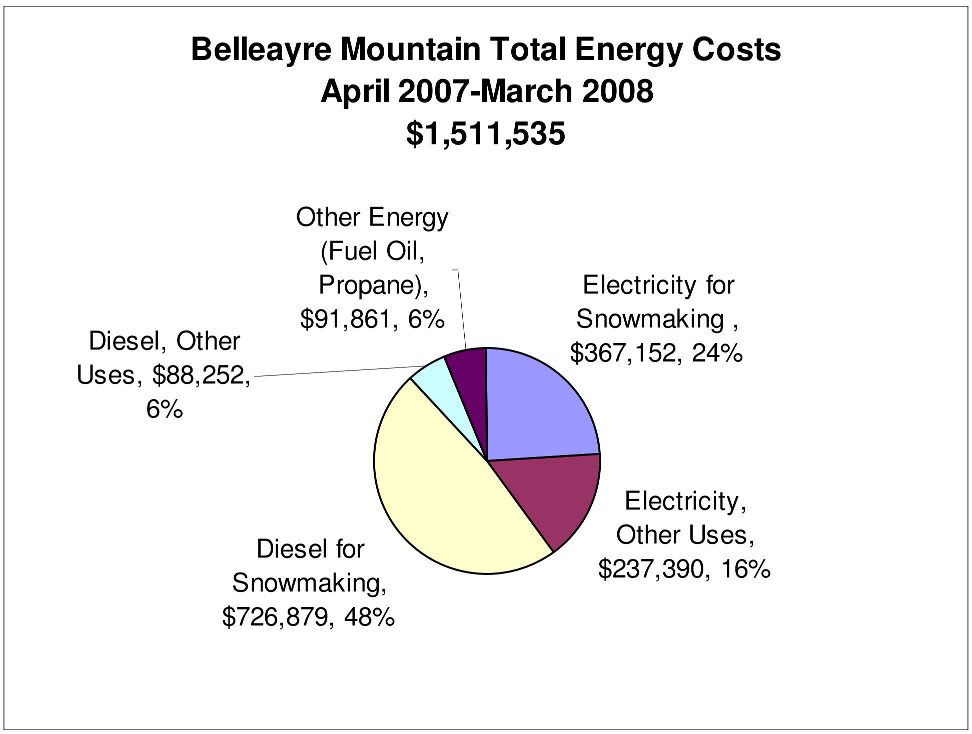

Figure 1 Belleayre Mountain Total Energy Costs April 2007-March 2008

3.2.1 Snowmaking

Snowmaking represents at least 72% of the energy costs at Belleayre Mountain. Figure 2 provides a summary of the cost breakdown of snowmaking energy use. 43% of the cost of snowmaking between April 2007 and March 2008 went toward electricity use, while 57% went toward diesel fuel use.

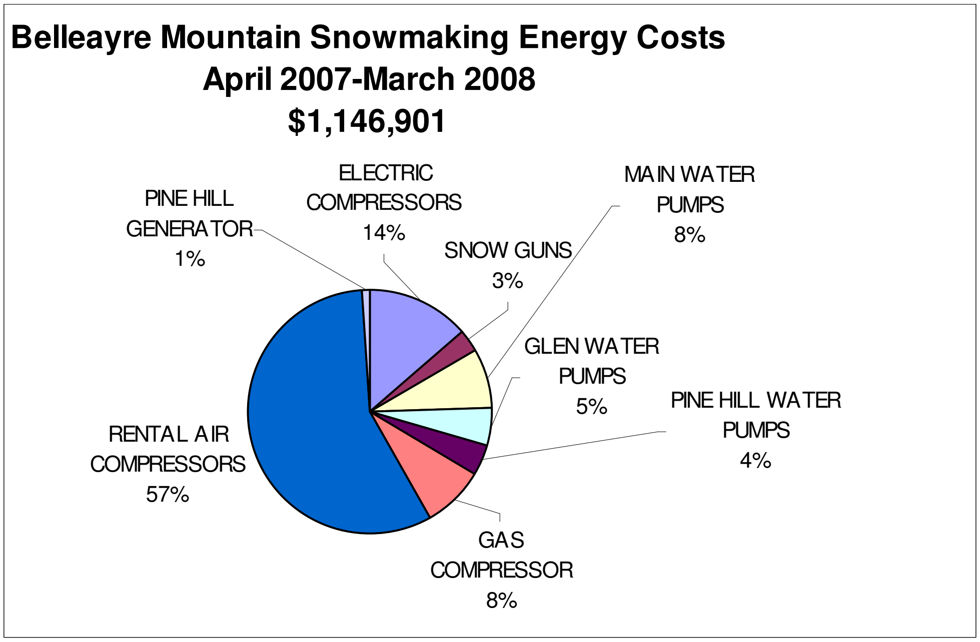

Figure 2 Belleayre Mountain Snowmaking Energy Costs April 2007-March 2008

Snowmaking is accomplished at Belleayre Mountain through the use of an air compression system (90 psi operating pressure) and a water supply system (500 psi at the pump house, 125 psi at hydrants located at the top of the upper slopes) that utilize snow "guns" to create snow and place it on the ski trails. Table 3 summarizes the snowmaking equipment on Belleayre Mountain. The compression system itself, with a combination of diesel and electric components and over 15 miles of compression lines, represents Belleayre Mountain's largest energy consumer, representing 79% of snowmaking energy (See Figure 3) and 57% of total energy. Additional energy is used by snow-grooming equipment to move the snow around the mountain but this is quantified here as grooming, not snowmaking.

Table 3 Belleayre Mountain Snowmaking Equipment

Energy	Compressors	Water Pumps	Snow Guns
Electricity	(3) 1500 CFM	(3) Upper pump house pumps: 750, 750, and variable 1480 GPM (2) Glen pump house pumps, 750 GPM each (4) Pine Hill Lake pumps, 900 GPM each (4) Pine Hill Lake submersible pumps, 40 HP each	96 Snow Machines Incorporated (SMI) electric snow guns, (only 42 can operate at a time) Note: high and low energy snow guns operate using supplied compression and water only—Electric units operate using electricity and water supply.

Table 3 Belleayre Mountain Snowmaking Equipment

Energy	Compressors	Water Pumps	Snow Guns
Diesel	(1) 4000 CFM (Altas Copco) (10) Rentals, for total of 16,000 CFM	800 KW generator used to pump from Pine Hill Lake during on-peak hours	

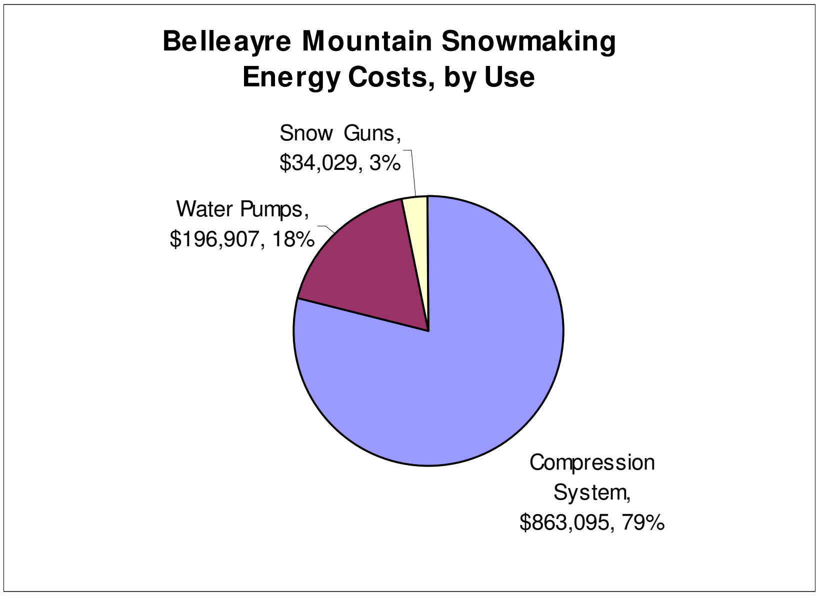

Figure 3 Belleayre Mountain Snowmaking Energy Costs, by Use

The water supply system is operated using a series of electric pumps that deliver water from various reservoirs. The Pine Hill Pump House moves water from Pine Hill Lake (elev. 1424') to the Upper Reservoir (elev. 2541'), located near Overlook Lodge. The Cathedral Glen Pump house draws from Cathedral Glen Reservoir (elev. 1745') and provides water to the snowmaking system on the bottom mountain slopes. The Upper Pump House feeds water from the Upper Reservoir to the top of mountain portion of the15 miles of water lines. While all pumps are electric, if water is required from Pine Hill Lake during the day, a diesel driven generator is used to provide electricity to the pumps to prevent high on-peak demand. The snow guns use air and water or water and electricity to create and disperse snow on Belleayre Mountain's trails.

3.2.1.1 Electric Snowmaking Equipment

Belleayre Mountain operates three electric compressors, which provide 1,500 cfm each for a total of 4,500 cfm. These compressors are located in the Main Pump house. The electric compressors are equipped with a cooling system that cools the air for use in the snow making system, and two 15 kw pumps are used to move a glycol coolant through the system, circulating it to an outside cooling unit.

Electric snowmaking water pumps are located in three pump houses at Belleayre Mountain. At the Pine Hill Pump House, which is serviced by a dedicated three phase power supply, there are four 400 horsepower pumps. There are also four submersible 40 horsepower pumps in Pine Hill Lake that supply water to the main pumps. The Cathedral Glen Pump House has two 250 horsepower pumps, and the Upper Pump House has two 350 horsepower pumps and one 500 horsepower variable speed pump.

3.2.1.2 Diesel Snowmaking Equipment

As mentioned above, Belleayre Mountain rents temporary compressors to provide most of the compressed air supply for the snowmaking system. During the 2007-2008 season, ten compressors were rented to provide 16, 000 cfm, at a cost of $205,920. The rental compressors are placed in the Upper Pump House and are fueled from a 30,000 gallon tank near Overlook Lodge. Belleayre Mountain also owns one stationary diesel compressor, which is located in the Barneyville area and has provided 4000 cfm. This compressor did operate during the 2007-2008 season; however, it is currently out of service and is not likely to be operable by the 2008-2009 season.

A 800 KW diesel generator is located at the Pine Hill Lake Pump House. This generator is only used when it is necessary to move water from Pine Hill Lake to the Upper Reservoir during the day, and can power two of the large pumps and their accompanying submersible pumps.

3.2.1.3 Snow guns

Belleayre Mountain is equipped with three different types of snow guns: high, low and Snow Machines Incorporated (SMI) blower guns. High and low energy guns are essentially nozzles that are attached to the hill supplied compression and water supply systems. These units do not use electricity on the mountain. There are 517 air/water towers, with 352 high energy and 219 low energy compressed air guns. There are 96 SMI units, some are over 30 years old. These units are supplied water and are powered by electricity—they do not use the central compression system. Belleayre Mountain also operates one New SMI Polecat unit that was supplied by SMI last year as a demonstration unit.

3.2.2 Ski Lifts (Electric)

Belleayre Mountain operates eight electric ski lifts, which include three rope-tows, two double chairs, one triple chair, and two quad chairs. Table 4 provides a summary of the Belleayre Ski lifts. It is estimated that the operation of the ski lifts represents about 5% of the energy use, at a cost of about $70,000 annually. This cost is estimated based on hours of operation provided by Belleayre Mountain staff. Average 2007-2008 kWh costs were based on the Main Belleayre meter, and assume that the lifts run at 50% capacity when operating.

Table 4 Belleayre Mountain Ski Lifts

Lift #	Name and description	Location	Motor size (horsepower)
1	Double chair	Discovery to Overlook	125
2	Double chair	Discovery to Overlook	125
3	Rope tow	Little Creek	15
4	Rope tow	Running Bear	15
5	Rope tow	Kids Camp	15
6	Superchief Quad chair	to Sunset Lodge	600
7	Triple Chair	from Overlook	200
8	Tomahawk Quad chair	from Ticket booth	400

3.2.3 Grooming (Diesel)

Trail grooming is accomplished with five diesel Bombardier groomers. During the 2007-2008 season, these groomers required the use of 30,925 gallons of diesel fuel at a cost of $88,252, which represents about 6% of total energy costs. Diesel fuel has increased considerably since last season. Assuming the same required fuel use and a cost of $3.39 per gallon for diesel fuel, the estimated cost for groomer operations in the 2008-2009 season will be $104,870.

3.2.4 Buildings

While most of Belleayre Mountain amenities, and therefore energy uses, are outdoors, there are about 80,000 square feet of building space utilized for various seasonal and year round uses. Table 5 provides a summary of the buildings and their uses on Belleayre Mountain.

Table 5 Belleayre Mountain Buildings

Buildings	Size (sq. ft.)	Description	Heating Supply	Cooling?
Sunset Lodge	2,331	Snack service, restrooms, lunch area. The kitchen uses propane for cooking.	Electric baseboard	No
Overlook Lodge	26,986	Ticket sales, cafeteria, lunch area, lounge area, retail ski shop, rental shop, Snowsports school, lockers, restrooms, phones, first aid, skier info, guest services, lost and found. The kitchen uses propane for cooking.	Hot water boiler, Fuel Oil	Yes, in some areas
Longhouse Lodge	6,400	Conference rooms, locker room for ski school and ski patrol employees	Hot water boiler, Fuel Oil	Yes, in some areas

Table 5 Belleayre Mountain Buildings

Buildings	Size (sq. ft.)	Description	Heating Supply	Cooling?
Discovery Lodge	29,000	Ticket sales, cafeteria, snack and lunch area, lockers, retail ski shop, Snowsports school, Kid-scamp, rentals, restrooms, phones, first aid. The kitchen uses propane for cooking.	Hot water boiler, Fuel Oil	Yes, in some areas
Maintenance Garage	4,281	Tool room, office, vehicle bay, welding shop, electric shop	Hot water boiler, Fuel Oil	No
Upper Pump House	1,440	Snowmaking Equipment housing	Electric Space Heaters	No
Nursery	3,345.50	Daycare facility	Hot water boiler, Fuel Oil	No
Group Sales Ticket Booth		Office for ticket sales	Kerosene	No
Pine Hill Pump House		Snowmaking Equipment housing	Kerosene	No

Electric use in the majority of Belleayre Mountain buildings is supplied by a line passing through the Main Belleayre Electricity meter, which provides 88% of the electricity use. Figure 4 provides a summary of the uses under the Main Belleayre Meter, and Figure 5 provides a summary of estimated building electricity uses. Specific electricity use has been estimated based on operating hours, equipment rated capacities, and estimated loads.

Some buildings on Belleayre Mountain have been monitored for kilowatt hour totals and peak kilowatt loads. Table 6 provides a summary of this data. Data from Overlook Lodge is not available because the meters were not operating correctly. Estimates using capacity and operating hours information have predicted totals slightly higher than those observed by the submeters, but the totals are similar.

Table 6 Summary of Submeter Data, July 2007-June 2008

Meter Location	Total KWH	Peak KW
Discovery Lodge	70,880	30
Overlook Lodge	not available	not available
Sunset Lodge	53,664	44
Pine Hill Lake Pumphouse	13,312	24

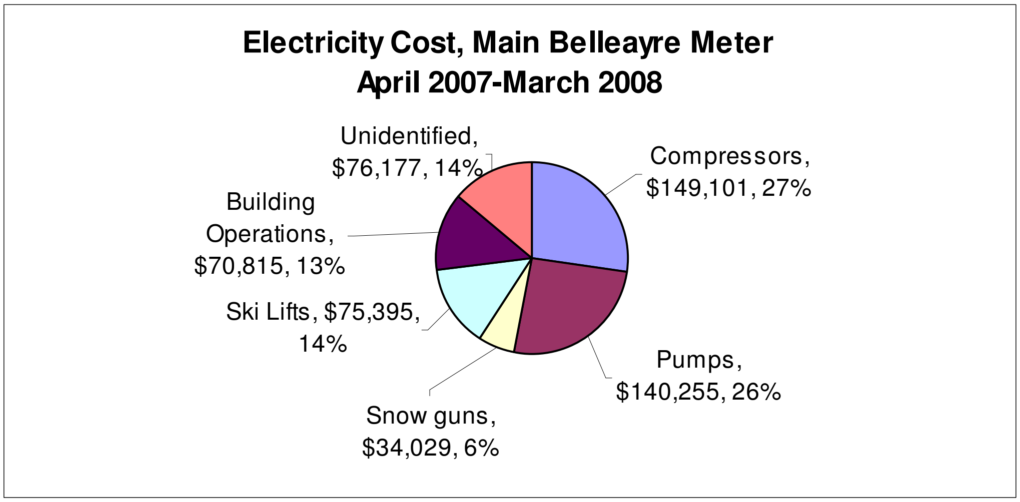

Figure 4 Electricity Cost, Main Belleayre Meter April 2007-March 2008

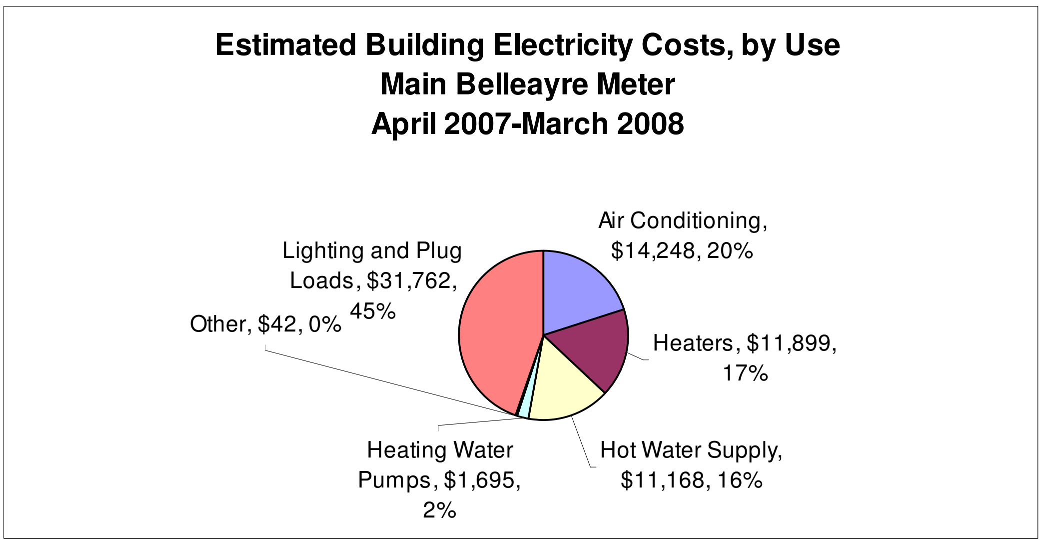

Figure 5 Estimated Building Electricity Costs, by Use Main Belleayre Meter April 2007-March 2008

Most buildings at Belleayre Mountain are heated using fuel oil fired hot water boilers. Figure 6 provides a summary of the breakdown of fuel oil costs for heating of the different buildings. These costs will rise considerably in future years since fuel oil costs have increased since the 2007-2008 season.

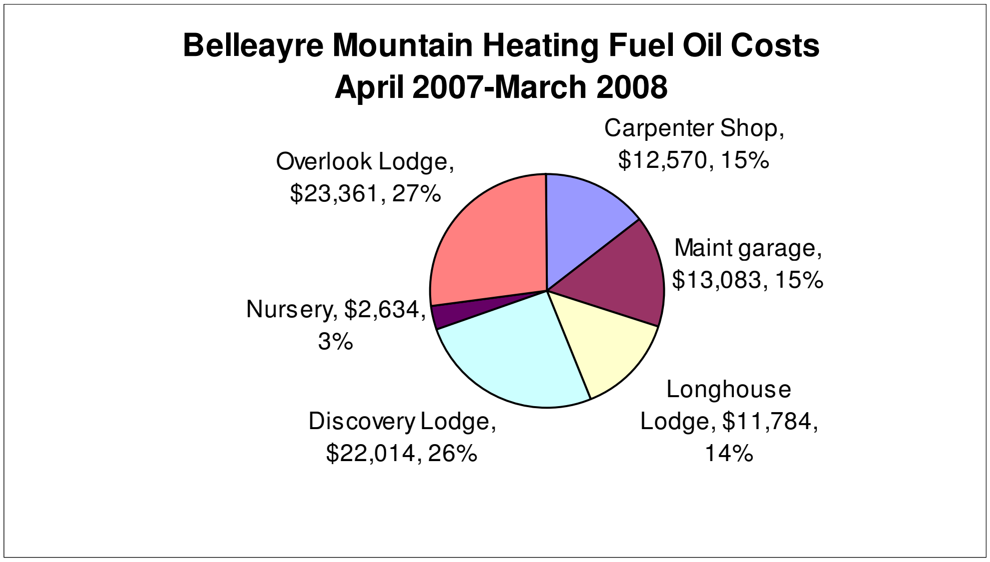

Figure 6 Belleayre Mountain Heating Fuel Oil Costs April 2007-March 2008

Figure 7 provides a bar chart of estimated annual heating costs per square foot for the different buildings at Belleayre Mountain. Note that electric heat values assume all equipment is used 2240 hours of the year, and fuel oil values do not account for the hours of operation of these buildings.

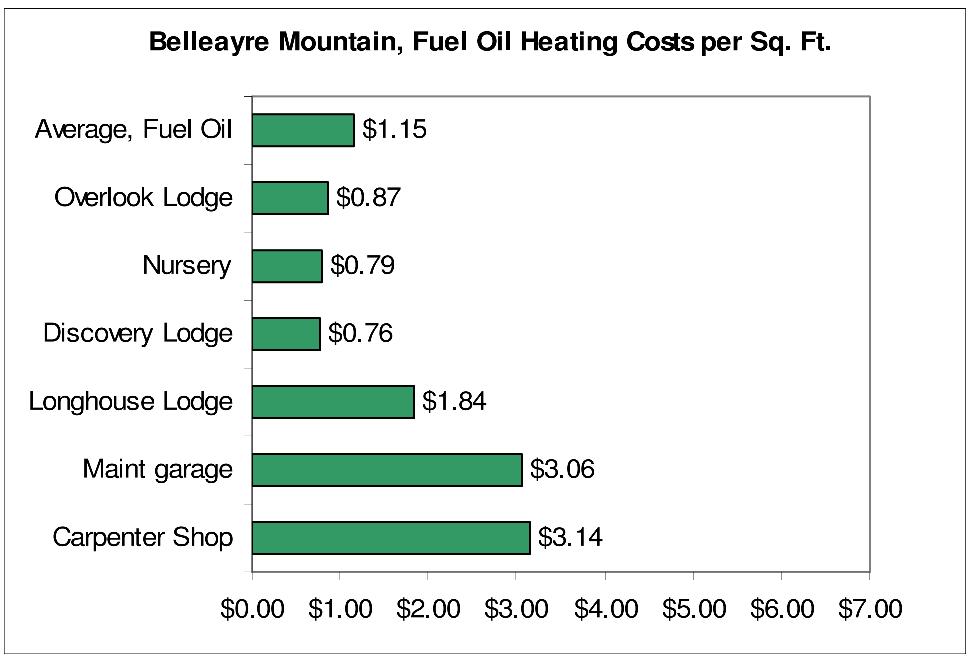

Figure 7 Belleayre Mountain Fuel Oil Heating Costs per Square Foot

Electricity and kerosene are also used for heat in some buildings. The energy needed for these heating applications is difficult to quantify. There were not records collected on the purchase of Kerosene from April 2007-March 2008 for the heating of the Pine Hill Pump House or the Group Sales Ticket Booth, so this use could not be quantified. Electricity used for heat at the Sunset Lodge and Upper Pump House has been calculated based on the load capacity of the existing heaters and an estimate of hours of operation and is incorporated in the Electricity use summaries. Other small buildings such as lift operator huts have not been quantified.

3.2.5 Mobile Equipment

Mobile equipment, landscaping equipment, and vehicles are also used on Belleayre Mountain for trail and building maintenance and transportation. Table 7 provides a summary of this equipment and the type of fuel it uses. This equipment is fueled from the Diesel and Gasoline tanks at the fuel island, and Table 8 provides a summary of estimated annual fuel use at that source. This island is also used to fuel other DEC vehicles that are not assigned to the Belleayre Mountain Ski Center—in addition, it is likely that vehicles listed may also obtain fuel from off-site sources. For that reason, the costs have not been estimated for these uses, but the equipment and fuel use totals have been listed here for information.

Table 7 Belleayre Mountain Mobile and Portable Equipment

Type	Gas	Diesel	Electric
Snowmobiles	12		
All Terrain Vehicles	10		1
Generator/Welders	4	2	
Mowers/Blowers	2	1	
Saws	11		
Miscellaneous Equipment	3	3	
Construction Equipment	7	3	
Vehicles	27	10	

Table 8 Belleayre Mountain Annual Fuel Use Totals

Type	Gallons
Diesel	7,500
Gasoline*	6,300
Non-Belleayre Mountain use *	4,700

* Fuel distributed to other DEC vehicles from Belleayre pumps is assumed to come from gasoline total.

3.3 Rate Structure and Energy Cost Considerations

3.3.1 Electricity billing structure

Electricity on Belleayre Mountain is provided by NYSEG under six separate accounts. Table 9 summarizes each of these accounts with energy and cost total for each.

Table 9 Belleayre Mountain NYSEG Electric Billing Data, April 2007-March 2008

Account	KWH	Cost	Average Cost per KWH
Belleayre - Main Lodge	4,880,138	$545,771	$0.11
Belleayre - Bonnieview Pump Station	1,691	$403	$0.24
Cross Country Pump and Chlorine	28,536	$5,270	$0.18
Pine Hill 3-Phase	581,344	$52,255	$0.09
Pine Hill Lake	139	$203	$1.46
Belleayre Sign	3,715	$639	$0.17
Total	**5,495,563**	**$604,542**	**$0.11**

Over 99% of electricity at Belleayre Mountain is accounted to the Main Lodge and Pine Hill 3-Phase accounts. The Main Lodge account includes all lodges, maintenance buildings, and upper and cathedral glen pump houses, including associated pumps, compressors and other equipment, as well as all ski lifts and site lighting. The Pine Hill 3-Phase account includes the Pine Hill Lake pump house and associated facilities and equipment. These two accounts are subject to non-residential time-of-use variable pricing which includes a break down of supply and demand charges.

Figure 9 is a page from a typical bill from NYSEG, showing the billing details applicable to service at the Pine Hill Lake Pump House. On this account, on-peak and off peak supplied power (KWH) and demand (kKW) for the month are listed and as well as the information for using to calculate costs. Demand charges are set using the highest on-peak KW demand (7 AM to 10 PM) during the billing period. On-peak and off-peak rates apply to delivery, transition and supply charges, so total KWH values for on-peak and off-peak electricity use are recorded and used to calculate delivery and supply charges. The Main Lodge account has a similar rate structure, except that on-peak and off-peak supply charges both set at the off-peak rate.

This billing structure is beneficial to Belleayre Mountain, because the most energy intensive activity, snowmaking, occurs primarily during off-peak hours. Most importantly, energy demand (KW) is highest during snowmaking operations, and since the demand cost is set during the day, these operations do not set the demand charges. For example, from the values in Figure 9, if the demand cost had been set by the on-peak high demand of 1,345.16 KW, the resulting charge would be $10,088.70 instead of $162.30. At the Pine Hill Lake pump house, this savings is maintained by using the diesel generator to operate two pumps if supply is needed during on-peak hours, avoiding the use of electricity at on-peak times and thereby providing a significant savings in electricity costs during each of the heavy snowmaking months of December, January, and February. If the two pumps were operated at anytime during on peak hours, it would result in an additional $5000 in demand charge on that month's bill, as well as a increased cost for on-peak electricity supply.

The differences in on-peak and off-peak demand at the Main Lodge vary significantly from month to month, with the difference in the past year ranging between no difference to 1800 KW, which without the on-peak condition could have resulted in a $14,000 increase in demand charges.

Service Address: PINE HILL LAKE, PINE HILL NY 12465 Page 3 of 4

NYSEG DETAILED ACCOUNT ACTIVITY

Nov

Electricity Service - Nonresidential Time-of-Use *Service from:* *11/01/07 - 12/03/07*

Electricity Rate - 120072 Variable Price *PoD ID:* *N01000000190496*

On Peak	3522 kwh	33 days
On Peak	21.64 kw	33 days
Off Peak	92650 kwh	33 days
Off Peak	1345.16 kw	33 days
Reactive	63000 rkvah	33 days

10,088

Electricity Delivery Charges

Basic service charge					185.88
Bill issuance charge					0.89
Meter charge					5.80
Meter service charge					8.83
Meter data service charge					8.60
Demand charge	21.6400	kw	@	7.50	162.30
On-peak delivery charge	3522	kwh	@	0.00262	9.23
Off-peak delivery charge	92650	kwh	@	0.00262	242.74
Transition charge	96172	kwh	@	0.00350727	337.30
Reactive charge	30943	rkvah	@	0.00095	29.40
SBC/RPS charge	96172	kwh	@	0.002	192.34
Subtotal Electricity Delivery					$1,183.31

Electricity Supply Charges

On-peak variable supply charge	3522	kwh	@	0.07873205	277.29
Offpeak variable supply charge	92650	kwh	@	0.06018556	5,576.19
Merchant function charge	96172	kwh	@	0.0012	115.41
Subtotal Electricity Supply					$5,968.89

Total Electricity Cost	$7,152.20
Total Energy Charges	$7,152.20

Detailed Adjustments

11/17/07	Electricity Customer Refund	-344.21
Total Adjustments		$-344.21

Figure 9 Typical Monthly Electric Bill for Belleayre

3.3.2 Curtailment payments

Belleayre Mountain receives compensation for curtailment. Curtailment involves the voluntary reduction of energy use from peak regular energy use to reduce overall energy use in a region at times when high use is expected. Since most curtailment is necessary during the day and during the high energy use for cooling during the summer, Belleayre again benefits from its winter time and nighttime energy use. Table 10 summarizes the curtailment payments Belleayre Mountain received between April 2007 and March 2008.

Table 10 Belleayre Mountain Energy Curtailment Rebates, April 2007-March 2008

Accounts	Electric Refund (3/10/07)	Electric Refund (11/17/07)
Belleayre - Main Lodge	$16,319.00	$2,537.88
Belleayre - Bonnieview Pump Station	$112.72	$14.85
Cross Country Pump and Chlorine	$2,361.90	$344.21
Pine Hill 3-Phase	$0.87	$0.43
Pine Hill Lake	$0.85	$0.40
Belleayre Sign	$22.62	$10.52
Total	**$18,817.97**	**$2,908.27**

3.3.3 Potential Impacts from Variable Costs

Belleayre Mountain faces many energy challenges now and in the near and distant future.

Belleayre Mountain is some exposure to risk of increasing energy costs. Electricity and fuel is purchased at market prices. Revenues depend on the Ski Center's ability to provide a quality skiing experience for as long a season as possible, which will continue to rely on the effectiveness of snowmaking capabilities. The ability to fund the snowmaking capabilities will require more efficient use of energy sources.

Currently, many of these energy challenges are mechanical. The existing diesel driven Atlas-Copco compressor is no longer operable. The existing snowmaking system does not provide adequate quantities of water and air to service the entire ski facility, limiting effectiveness during important snow making opportunities.

Diesel compressors are rented each year to provide most of the snowmaking effort, at a significant price for rental and fuel. The use of the Pine Hill Pumps is managed to limit energy use during daytime houses to control demand electricity costs, which has been successful. However, this effort requires the use of an older, inefficient diesel generator which requires a great deal of maintenance.

Increases in the cost of energy will have a significant impact on the operational budget of Belleayre Mountain. Diesel fuel use represents over half the energy bill; diesel prices have increased significantly and are likely to continue to do so. The limitations of electrical service at Belleayre Mountain represent another challenge, as does the current billing structure. The current kilowatt (kW) demand charge assessment method establishes the charge based on the highest 15 minute peak for the month during on-peak (daytime) hours. While this is beneficial to the facility due to high demands occurring during off- peak night-time snowmaking efforts, it restricts daytime operations and allows the risk of incurring large bills if equipment is accidentally operated during on-peak hours.

3.4 Recommendations

3.4.1 Pine Hill generator use for day time pumping

While the Pine Hill generator has been instrumental in reducing demand charges on the Pine Hill 3-Phase electricity account, it is an expensive way to pump water from Pine Hill Lake. Between April 2007 and March 2008, the generator operated for 86 hours, using about 4300 gallons of diesel fuel, costing $12,885. This results in an average fuel cost of $3.00 a gallon and an average cost of operation of $150 per hour. At current diesel fuel prices (Dennis, 2008) of $3.39 per gallon, the same hours of operation will cost a total of $14,566 and an average of $170 per hour.

The generator is used to keep the on-peak demand at under 40 kW, which equates to a demand cost of $300 each month. Establishing a policy that prevents any pumping during on-peak hours would maintain this reduction of the electric bill while saving the cost of diesel fuel for the generator. If it is necessary to pump during the day using two pumps, even for only one hour a month, it would still be more cost efficient to use the generator for that purpose, since setting the demand cost with the 650 kW needed to power two pumps and two submersible pumps would increase the demand cost from about $300 to about $5000 for the month.

If it is necessary to pump from Pine Hill Lake during on-peak times, another option would be the use of one pump and one submersible. This would result in an increased peak demand of about 325 kilowatts and a demand charge of $2,400 for the month. In the 2008-2009 season, 25 hours of generator use would cost $4,250, while operation of the one pump, even if it had to operate for 50 on-peak hours, would result in an increase of about $3700 for the increased demand and use charges in one month. Table 11 summarizes these alternative operating scenarios and the resulting cost savings.

Table 11 Options for Operation of Pine Hill Lake Pumps During On-Peak Hours

Description of costs	2007-2008 Costs	Option 1	Option 2	Option 3	Option 4
Diesel charges	$12,885.36	0	0	0	$14,566.152
Electricity					
Demand charges*	$533.10	$533.10	$15,000	7200	$533.10
Increased on-peak use charges**	0		$5,500	$5,500	0
Total annual cost	$13,418.46	$533.10	$20,500.00	$12,700.00	$15,099.25
Projected difference from 2007-2008 costs	0	-$12,885.36	$7,081.54	-$718.46	$1,680.79

Table 11 Options for Operation of Pine Hill Lake Pumps During On-Peak Hours

Description of costs	2007-2008 Costs	Option 1	Option 2	Option 3	Option 4
Projected difference from projected 2008-2009 costs	-$1,680.79	-$14,566.15	$5,400.75	-$2,399.25	$0.00

Option 1: No pumping during on-peak hours.
Option 2: Use Electricity for two pumps during on-peak hours.
Option 3: Use Electricity for one pump for on-peak hours.
Option 4: No change from existing operations.

* Total demand charge for the months of December, January, and February.
* Use charges based on 86 hours of 2 pump operations, or 172 hours of 1 pump operations.

3.4.2 Replacement of incandescent lighting with fluorescents

During the audit and walk through, E & E energy experts assembled an inventory of lighting. While tube fluorescent lighting is used in many of the facilities, 151 incandescent light bulbs were found. The replacement of these bulbs with comparable compact fluorescent lighting (CFL) bulbs is estimated to provide an annual savings of about $1,200 per year.

Table 12 Projected Savings from the Replacement of Incandescent Light Bulbs

Existing Bulb Wattage	# Bulbs In Operation	Estimated Annual Hours Of Operation	Kwh/Year	Replacement CFL Wattage	Kwh/Year
60	45	675	1,823	13	395
75	46	1350	4,658	18	1,118
90	26	1350	3,159	20	702
100	34	1350	4,590	23	1,056
Total	**151**		**14,229**		**3,270**
				Difference	**10,959**
				Savings at $0.11 per kwh	**$1,205.45**

An estimated $14,000 was spent on lighting at the facility from April 2008 to March 2009, which is approximately 20% of the estimated building electricity use at Belleayre Mountain. Additional savings could be gained from the following actions:

- Reassess timing on bathroom fans to ensure they are only operated when necessary.
- Assess vending machine electrical loads and reduce these loads by requiring energy efficient equipment and removing display lighting bulbs.

Further investigations into improving lighting systems with a NYSERDA certified lighting contractor could provide additional energy savings.

3.4.3 Compression System Improvements

As described earlier in this report, the snowmaking compression system represents 57% of the energy costs at Belleayre Mountain. Even at this expense, the current size and configuration of the system does not adequately serve the snowmaking needs of the center, because air and water supply rates can only fulfill a fraction of the snowmaking system requirements. The need for additional compression from rental diesel compressor units represents a large expense that will continue to climb. Assuming the same operations as last year, and based on current fuel prices and next year's compressor rental agreement, Belleayre Mountain is facing over $200,000 in additional expenses from the compression system alone (See Table 12).

Table 12 Past and Projected Costs of Belleayre Mountain Diesel Compressors

Costs for Diesel Compressors	Rental Cost	Gallons of Fuel	Fuel Cost	Total
April 2007- March 2008	$205,920.00	241,505	$711,381.35	$917,301.35
2008-2009 Season	$306,628.00	241,505	$818,702.63	$1,125,330.63
Estimated increase in the 2008-2009 season				**$208,029.28**

Replacement of the compressors is a priority of the UMP, however, immediate actions are recommended to address current operations.

Compressed Air Losses

The Department of Energy estimates that compression systems lose 30% of efficiency to leakage, which for this system equates to 7,350 CFM and over $250,000 in energy cost. With 15 miles of air lines and 813 hydrants, there is likely to be opportunities to fix leaks in the system. Finding and repairing major leaks could offset the projected energy cost increases, and may result in the need for two or three less rental compressors next season.

A pressure drop test could provide a rough assessment of the potential savings that can be gained from leak repairs. This would be done by pressurizing the entire system with all hydrants closed and observe pressure levels over time. If the system maintains pressure, then leakage is not a problem. If it does not, the rate of pressure drop is an indication of the extent of the problem. In addition, observation of pressure at the outer branches of the system will provide insight into the effort it takes to pressurize such a large and expansive system.

A contractor that specializes in the identification, quantification, and repair of compressor leaks will be able to assess the true efficiency of the system. It is recommended that Belleayre Mountain arrange for this service as soon as possible.

With over 15 miles of compression lines, it is likely that loss of efficiency is also an expense in the running of this system. A compression system contractor may also provide guidance on the partitioning of the system to improve efficiency. Since the system is currently operated in sections because only a fraction of the snow guns can be operated at the same time, efficiency could be gained if only lines to working snow guns were pressurized. Maintenance of compression lines and leak detection could significantly reduce energy costs, allow for a more snowmaking on the mountain, and reduce the proposed size of new equipment.

Compression System Replacement: Projected Energy Costs

Based on 2007-2008 energy use and cost data and information on the capabilities and efficiencies of new electric snow guns from manufacturer data(Parker, 2008) potential options for compressor service replacement were considered. Using estimated kW/CFM based on the operation of existing electric compressors, a 18,000 CFM compression system (which would replace the 20,000 CFM of diesel compression used in 2007-2008) would require 3719 kW. Distributed compression systems, using electric snow guns that incorporate compression and do not require a centralized system, will require significantly less CFM to operate. The Arapahoe Basin in Summit County, Colorado is a example of a ski resort that has successfully replaced its compression system with an all airless system to dramatically reduce energy consumption. (Jedlicka, 2008)

In order to estimate the energy use of a snow gun based system that is equivalent to the existing system, the equivalent system water volume was used as a common denominator. Total gallons used in 2007-2008 and potential GPM currently available on the hill, with average water throughput rates that consider temperature variation, provide the estimated number of snow guns required to replace the existing system. Costs were calculated using 2007-2008 hours of operation and average kWh electricity rates. The energy cost information for four different compression replacement options, costs to operate the system is summarized in Table 13. Further investigations into specific energy and capacity needs are appropriate to confirm this estimate, but this analysis shows a significant potential for energy savings if a distributed supply system replaced the existing central supply system. In addition to savings in energy costs, newer snow guns provide opportunities for automation that will cut down on manpower and safety risk associated with the current snow guns and nozzles operational requirements. This option would require electrical distribution upgrades on the mountain.

Table 13 Energy Cost Information for Different Compression Replacement Options

Description of costs	2007-2008 Costs	Option 1	Option 2	Option 3	Option 4
Diesel charges (fuel only)	$711,381.35	0	0	0	$818,702.63
Electricity*	$152,153.36	$786,560.48	$183,634	$143,845.15	$152,153.36
Total annual cost	$863,534.71	$786,560.48	$183,633.66	$143,845.15	$970,855.99
Difference from 2007-2008 costs	0	-$76,974.23	-$679,901.05	-$719,689.56	$107,321.28
Difference from projected 2008-2009 costs	-$107,321.28	-$184,295.51	-$787,222.33	-$827,010.84	$0.00

Table 13 Energy Cost Information for Different Compression Replacement Options

Description of costs	2007-2008 Costs	Option 1	Option 2	Option 3	Option 4
Estimated electricity (KW) demand from snowmaking (on Main account only)	2616	6335	2176	1939	2616
Equipment (Listed based on use, not inventory)	5 Pumps	5 Pumps	5 Pumps	5 Pumps	5 Pumps
	42 Snow guns	42 Snow guns	42 Super Polecat Snow Guns	57 Standard Polecat Snow Guns	42 Snow guns
		3 Electric Compressors			3 Electric Compressors
		18,000 CFM of New Compressors			11 Diesel Compressors

Option 1: Replace all diesel compression with new central compressor.
Option 2: Replace all compression with de-centralized SMI Super Polecat snow guns.
Option 3: Replace all compression with de-centralized standard polecat SMI snow guns.
Option 4: No change from existing operations.

* Electricity charges calculated using 2007-2008 average KWH costs under Belleayre's Main account. Changes to demand charges will effect this average.

3.4.4 Water Supply for snowmaking

Water supply to the snowmaking system is a large expense at Belleayre Mountain, second only to compressor operation costs. The amount of water that can be pumped to the mountain is the defining limit of the capabilities of the snowmaking system. The more water that is available on the mountain, the more snow can be created. Temperature is an important factor in the ability to make snow. Very cold temperatures offer the best opportunity to make snow, and therefore such conditions require large amounts of water. For this reason, the UMP calls for an expansion of the snowmaking water supply system. The energy efficiency of the existing pumping system as well as expansions will depend on the effort it takes to move the water from its storage location to the snow guns—the closer the storage system is to the guns, and the easier it is to move the water to the guns, the less energy will be required by the system. Existing systems are not efficient, and require a great deal of energy to move water to the snow guns, in addition to providing only a fraction of the pumping capabilities needed on the mountain.

Table 14 shows the limitations and capabilities of the existing system. On both the upper and lower areas, the water is moved twice—once from Pine Hill Lake and then again from the Upper or Cathedral Glen Reservoirs to distribution by the snow guns.

Table 14 Water Pump Requirements, Belleayre Mountain's Snowmaking System

	Vertical Feet, from Pumps to Top of Line	Static Pressure (PSI Required, Based on Vertical Feet)	PSI Needed For Snowmaking	Total PSI Needed*	Existing Rated Capacity (GPM)
Upper reservoir to top(snowmaking)	894.0	387.0	125.0	512.0	2900
Cathedral Glen to Mid-way (snowmaking)	766.0	331.6	125.0	456.6	1500
Pine Hill to Upper Res-ervoir	1,117.0	483.5		483.5	4200
Pine Hill to Proposed New Reservoir	509.0	220.3		220.3	
Proposed New Reservoir to Upper Reservoir	641.0	277.5		277.5	
Proposed New Reservoir to Midway (snowmak-ing)	600.0	259.7	125.0	384.7	

* Friction is not considered in this equation.

When the Upper snowmaking system is operating at maximum output, it quickly drains the Upper reservoir and the Pine Hill Lake pumps cannot maintain the water level. As a result of these conditions, the Pine Hill Lake pumps must operate during the day to re-fill the Upper reservoir so it is ready for snowmaking the next day and night. Given on-peak electricity and diesel prices, this is a very expensive time to pump water. The design capacities of the Pine Hill Lake and Upper pump houses indicate that there should be enough capacity to meet these needs. This discrepancy should be investigated further, because it indicates a loss in efficiency in the Pine Lake pumps. This could be caused by malfunctioning equipment, unbalanced power factors, or leaking systems. As mentioned above, eliminating daytime pumping from Pine Hill Lake could result in significant savings in energy use and maintenance.

The replacement of existing pumps with new pumps will result in a significant reduction in energy cost. According to figures provided by Keith Fazekas of Gartner Equipment (email to A Niles, 8/20/2008), new equipment would require less power to provide more pumping capacity (See Table 15). However, it will be important to investigate the issues that are causing loss of efficiency in the existing systems, because these problems, such as unidentified leaking pipes and unbalanced power factor, could also cause inefficiency in the new systems.

Table 15 Water Pump Capabilities, Belleayre Mountain's Snowmaking System

Pump Locations	Existing Systems	Proposed Systems
GPM		
Upper Pump House	2900	5100
Glen Pump House	1500	2000

Table 15 Water Pump Capabilities, Belleayre Mountain's Snowmaking System

Pump Locations	Existing Systems	Proposed Systems
New Lower Pump House		10050
Pine Hill	4200	2400
Total GPM to snow equipment	4400	8100
Total GPM of Pumping	8600	19550
Increase from Existing GPM	0	10950
Increase Water supply to Hill (GPM)	0	3700
Electricity		
Main Account		
Peak Demand (KW)	1212	839
Use(KWH)	1,254,122	561,761
Pine Hill 3 Phase Account		
Peak Demand(KW)	1312	671
Use(KWH per year) 2007-2008 season data, or assuming 1500 hours of snowmaking and 400 hours of pumping from Pine Hill and Cathedral Glen for proposed system)	486,912	281,795
Average GPM/KW	3.41	12.95
Diesel(Gallons)	4297	0
(2007-2008 season)		
Equipment		
Upper Pump House	3 Pumps	3 Pumps
Glen Pump House	2 Pumps	2 Pumps
New Lower Pump House		5 Pumps
Pine Hill	4 Pumps, 4 Submersible pumps Diesel generator	4 Pumps

Strategic placement of the new water reservoir will take advantage of gravity to reduce pump use and potentially generate electricity. New, more efficient pumps at the new reservoir will require less energy, both demand and use, and will therefore be less costly to run. Table 16 summarizes estimated pumping costs under the existing and proposed systems.

Table 16 Water Pump Costs, Belleayre Mountain's Snowmaking System

Description of Charges	2007-2008 Costs	Projected Proposed System Costs*	2008-2009 Projected Costs, With No Changes to Equipment Use*
Diesel charges	$12,885.36	$0.00	$14,566.15
Electricity*	$184,022.08	$88,154.35	$184,022.08
Total annual cost	$196,907.44	$88,154.35	$198,588.23

Table 16 Water Pump Costs, Belleayre Mountain's Snowmaking System

Description of Charges	2007-2008 Costs	Projected Proposed System Costs*	2008-2009 Projected Costs, With No Changes to Equipment Use*
Projected difference from 2007-2008 costs	0	-$108,753.09	$1,680.79
Projected difference from projected 2008-2009 costs	-$1,680.79	-$110,433.88	$0.00

* Electricity charges calculated using 2007-2008 average KWH costs. Changes to demand and use charges will effect these averages

In addition to reducing energy by investigating or upgrading equipment to gain efficiency, groundwater reclamation could provide an opportunity to protect the watershed while reducing the need for pumping. While most of the winter may not provide opportunities to recharge uphill ponds, the past few years have provided at least one or two periods of melt-off during the ski season. Directing more surface run-off to the upper and new reservoirs instead of allowing it to flow all the way to Pine Hill Lake would require less pumping after mid-season thaws.

Another consideration related to run off is the potential of a micro turbine between the new reservoir and Pine Hill Lake to generate electricity. While the inefficiencies of such a system would not provide a benefit if water needed to be pumped up to the reservoir to allow it to flow back down, the natural flow of water down the mountain during the spring melt off and other seasons could be enough to generate power during the off-season. A 8000 ft long, 16" diameter steel pipe from the proposed new reservoir to Pine Hill Lake (assuming a 476 ft drop), could produce a flow of almost 5000 GPM. According to Energy Alternatives Ltd's micro-hydro calculator (www.energyalternative.ca), this could produce up to 176 kW of power (See Table 17) depending upon the application selected.

Table 17 Estimated Power Generated by Micro-hydro Application between the Proposed New Reservoir and Pine Hill Lake

	Micro-hydro Applications			
	Permanent Magnet	70 Amp Ford Alternator	AC Brushless	Other, 50% Efficient
KW	158	113	176	149
KWH/Day	3797	2722	4227	3582
Potential energy cost recuperated per day*	$424.64	$304.42	$472.73	$400.59

* Based on average cost of electricity of $0.112 per KWH.

3.4.5 Additional Recommendations

The scope and purpose of this audit was to identify and define existing conditions, assessing the energy use of existing and proposed systems. As a part of this overview, several issues have been identified that would benefit from the specific analysis of equipment specialists, in addition to the specific analysis of compression and water pumping It is also recommended that continued review of energy use would benefit from documentation of current experience and procedures.

3.4.5.1 Evaluation of Single and 3-Phase Motors to Assess and Correct Power Factor Disruption

Power factor can have a significant impact on the efficiency of an electric supply. The lower the power factor, the less energy is being converted to effective work. 3-Phase and single phase electric motors can cause the reduction in power factor. Appendix B provides an article that specifically addresses the challenge of power factor balancing for a snowmaking pumps at a ski center. It is recommended that Belleayre Mountain arrange for the services of a contractor that specializes in capacitors for power factor balancing for all three pumping facilities and ski lift motors. Correction of power factor deficiencies could improve power use by 10%. When new motors are installed as planned in the UMP, contracts should include verification and correction of power factor issues to ensure that new motors can be operated at peak capacities and efficiency.

A detailed evaluation of the ski lifts was not completed as a part of this audit, because the variability of these motors, in addition to power factor considerations, is required to provide a useful assessment of the existing systems and proposed new systems. These new systems should also be evaluated to ensure power factor balancing.

3.4.5.2 Consider Alternative Heating Options in Maintenance Buildings

Heating boilers at the Garage and Carpenter Shop are not as efficient as other buildings, based on square footage (see Figure 7). Despite the fact that new boilers have been installed at the Carpenter Shop, it appears to require as much energy to heat as the Maintenance building does. Of all the facility buildings, improvements to these buildings provide the best return on investment. The following recommendations could reduce the use of the existing boilers in these facilities:

- Improve building envelope. Through sealing of existing doors and insulating doors and walls, these buildings would retain more heat and therefore would require less fuel oil.

- Radiant heating devices. Radiant heaters provide excellent heat sources in large areas, because they do not heat the air, they heat objects or people. Using radiant heat directly over work stations or doorways in the garage will require less need for centrally supplied heat. Radiant heat systems can be powered by propane, fuel oil, or electricity.

- Reuse of heat from compression systems. If Belleayre installs a new electric compression system, this system will require cooling of the compressor. One consideration may be the use of this waste heat to heat interior space, saving both the cost of operating an air cooler and heating the nearby facilities. This decision will require a careful assessment of the placement of the new compressors and a new heating system for the buildings, but could be valuable when considering life cycle costs of the system.

- Consider heat pump options at new maintenance garage. The construction of the new snowmaking reservoir near the new maintenance garage may provide an opportunity for a heat pump using the reservoir.

3.4.5.3 Establish Procedures and Automation for Energy Use

The current maintenance staff provides a well run system for managing electricity demand and recording energy use. The success of this system relies heavily on the talents and memories of the maintenance staff and management. The following ideas are suggestions to ensure the continued success of their efforts.

- Establish a manual of Standard Operating Procedures that would:
  - Establish short, easy to follow procedures using a check list or bullets, to define the energy management strategy and document the experience of the current maintenance staff. The instructions should include which equipment needs to remain off at which times, and/or which meters should be checked to verify energy limits are maintained. Electricity costs are now calculated on an hourly variable price, NYSEG's Energy Profiler Online can be used to check and estimate hourly rates using the "day ahead hourly pricing" page to estimate the best times to operate equipment.
  - Establish short, easy to follow procedures using a check list or bullets, to define the snowmaking strategy and document the experience of the current maintenance staff. The instructions should include which equipment works best at different temperatures, what are the limitations of the equipment (demand, CFM, GPM) and what combinations work best to provide the most snow on the mountain.

- Install timers and/or breakers to prevent accidental use of equipment during peak hours.

- Evaluate automation systems for the operation of pumps, compressors and snow guns. Automation would maximize energy efficiency and reduce the manual control of the systems.

- Establish a spreadsheet for the regular recording of submetering data, with information confirming the location of the meter and what areas the meter covers. These meters could be used to provide clearer understanding of equipment that is operated under variable loads, such as ski lifts and cooling fans. Accurate assessment of the energy use of such equipment may provide useful information as new equipment is selected.

- Install timers and switches on electric equipment such as lighting, bathroom fans, and appliances to allow systems to be automatically and manually shut off based on the needs of the occupants.

- Review power save status of all computer systems, and establish a purchasing requirement to replace all office equipment with energy efficient equipment that is equipped with automatic shut down or sleep mode.

3.4.5.4 Re-evaluate Billing Structure and Electricity Supply

While Belleayre Mountain benefits from its existing billing structure, there may be other opportunities based on use and service. Belleayre Mountain's position as a large electricity user during off peak season and hours may provide better prices from electricity suppliers. As mentioned above, hourly variable prices could be monitored to accurately assess the cost of snowmaking and track opportune times for filling the reservoirs.

Demand costs are set under the Pine Hill 3 Phase bill and the Main Belleayre meter during off peak hours. This is beneficial because electricity is not used at Pine Hill 3-Phase meter for pumping during the day, and daytime use is restricted at the Main Belleayre meter as well. Unfortunately, these restrictions do require close management, with additional costs for generator use and reduced capacity during prime snowmaking opportunities. These demand costs are set for the entire month, despite the fact that Belleayre Mountain rarely uses energy at its peak amount (See Figures 10 and 11). Belleayre Mountain should approach NYSEG to negotiate a more reasonable demand charge calculation method, which could reduce electricity costs, or at least eliminate some of the operational restrictions used to avoid expensive demand charges. Further exploration of opportunities for purchase of electricity from third party providers should be reviewed to evaluate Belleayre Mountain's load profile value in the deregulated market.

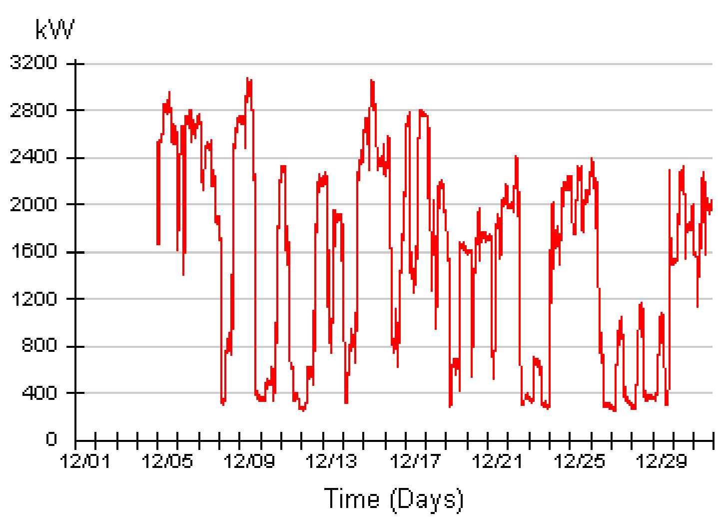

Figure 10 KW Demand, 12/05/2007 to 1/01/2008, Belleayre Mountain, Main Belleayre Meter

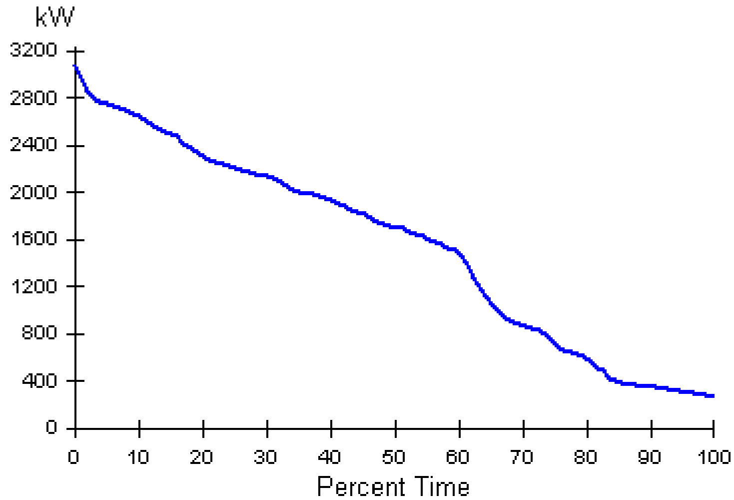

Figure 11 Percent of time at given KW Demand, 12/05/2007 to 1/01/2008, Belleayre Mountain, Main Belleayre Meter

4 Conclusion

Operations at Belleayre Mountain require a complex system of energy use, managed successfully by a competent and experience maintenance team. The maintenance staff at Belleayre Mountain have made huge efforts to control energy costs, restricted by electricity billing conditions and mechanical challenges. The rate structure with its need for controlled demand costs drives most of the restrictions, while existing equipment is out of date, and inefficient.

Snowmaking accounts for at least 72% of the energy costs at Belleayre Mountain. The compression system itself, with a combination of diesel and electric components and over 15 miles of compression lines, represents 57% of total energy use. Compressor rental and diesel fuel expenses will continue to rise, increasing Belleayre Mountain's energy costs next year and into the future, as long as the compression system continues to operate as currently configured. Maintenance of this system, and future replacement, should be a priority at Belleayre Mountain. Additionally, replacement of the water pumps will provide another significant cost reduction, as new pumps will be more efficient. Table 18 summarizes the recommendations offered, ranked in order of their potential to decrease costs.

Table 18 Summary of Energy Saving Recommendations for Belleayre Mountain

Recommendation	Level of Difficulty	Potential Savings
Check existing compression system and repair leaks, and contract a compression system specialist to assess and improve efficiency of the system	Medium	High
Replace central compression system with distributed electric snow guns, eliminating hill compression system	High	High
Replace existing water pumps, using higher elevation water storage to minimize pumping	High	High
Re-evaluate use of Pine Hill Generator	Medium	Medium
Contract a power factor balancing specialist to evaluate power factor balancing of pumps and motors	Medium	High
Add effective sub-metering, SOP's, and more comprehensive energy management system	Medium	Medium

Table 18 Summary of Energy Saving Recommendations for Belleayre Mountain

Recommendation	Level of Difficulty	Potential Savings
Replace incandescent bulbs with compact fluorescent bulbs	Low	Low
Replace or supplement maintenance building heating with radiant heating	Medium	Low
Replace aging building mechanical systems and equipment with more efficient models	Low	Low

5 References and Resources

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Additional Resources

Sha Miklas Guest Services/Environmental Manager Arapahoe Basin Ski Area.
970-513-5736 (ph) sha@a-basin.net

Association of Energy Engineers (AEE), www.aeecenter.org.

National Ski Association, The Green Room,
http://www.nsaa.org/nsaa/environment/the_greenroom/

US Department of Energy, Energy Efficiency and Renewable Energy (EERE) Information Center,   www.eere.energy.gov