EVALUATION OF
DEMONSTRATION PROJECT FOR
ICE BEAR™ THERMAL ICE STORAGE SYSTEM
FOR DEMAND SHIFTING

Final Report
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Submitted to:

Sacramento Municipal Utility District
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Submitted by

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1. EXECUTIVE SUMMARY

ADM Associates, Inc., under a contract with the Sacramento Municipal Utility District, conducted an evaluation of the Ice Bear™ Thermal Storage System (manufactured by Ice Energy), and its effectiveness in reducing peak load, when applied to rooftop and split system air conditioners in the SMUD service territory. The evaluation was based on data collected on the performances of two systems installed and monitored by Ice Energy.

This evaluation focused mainly on the impact of peak power reduction available from shifting power use to off peak periods by using the Ice Bear™ System. The Ice Bear™ System makes and stores ice during off-peak hours, and harvests this ice to cool the buildings during the peak power periods. Ice Bear Systems were installed at two Los Rios Community College District (LRCCD) campuses; Cosumnes River College (CRC) and Sacramento City College (SCC), in Sacramento, California. At SCC, the Ice Bear™ System was set up in parallel with the existing conventional direct expansion (DX) system to enable operation of both systems, one at a time for comparison. At CRC, the Ice Bear™ System was a stand-alone unit with a second 5-ton DX unit. Performance data were collected using monitoring systems installed at both sites.

Analysis of the data collected from these sites suggests that the Ice Bear Systems may have been oversized for these two applications. Consequently, the savings potential for the Ice Bear technology may be higher when used for applications with higher cooling loads.

Based on SMUD's TOU1 rate schedule, applicable for the SCC facility, if an existing 5-ton DX unit is replaced with the Ice Bear system, an annual bill savings of $103 can be obtained. However, if other rate schedules offered by SMUD and other utilities are applied, the cost savings are much higher. The annual cost savings for the same systems for SMUD's TOU2, PG&E's E-20P, and SCE's TOU-8 schedules are provided in Table 1.

Table 1. Summary of cost savings based upon different rate schedules

Utility	Rate Schedule	Bill Savings
SMUD	TOU1	$103
SMUD	TOU2	$212
PG&E	E-20P	$325
SCE	TOU-8	$765

2. EVALUATION OF THE ICE BEAR^{TM} THERMAL STORAGE SYSTEM

2.1 Introduction

This report provides an evaluation of the Ice Bear System, as a means of summer peak load shifting in the SMUD service territory.

This evaluation focused mainly on the impact of peak power reduction available from shifting power use to off peak periods by using the Ice Bear™ System. Ice Bear Systems were installed at two Los Rios Community College District (LRCCD) campuses; Cosumnes River College (CRC) and Sacramento City College (SCC), in Sacramento, California. At SCC, the Ice Bear™ System was set up in parallel with the existing conventional direct expansion (DX) system to enable operation of both systems, one at a time for comparison. At CRC, the Ice Bear™ System was a stand-alone unit with a second 5-ton DX unit. Performance data were collected using monitoring systems installed at both sites.

The evaluation was performed using the following four objectives:

- ***Assessment of Peak power shift with the Ice Bear™ System:*** The project needed to demonstrate the total power shift for air-conditioning from peak hours to off-peak hours.
- ***Assessment of Changes in Performance at Two Sites****:* The project had to demonstrate comparisons of the results obtained from the two systems installed at CRC and SCC locations.
- ***Economics of utilizing Ice Bear system:*** It showed the economics of utilizing Ice Bear™ System based on current SMUD's rate schedule applicable to these facilities.
- ***Economics in other utilities service areas:*** It was desired to show the economics of utilizing Ice Bear™ System based on other rate schedules at SMUD and other utilities.

This report is organized to provide a detailed description of the technology and its application, the results of the demonstration of Ice Bear systems at two locations, and the economics of the use of Ice Bear Systems in conjunction with different utility rate structures.

2.2 Technology Overview

Until 2005, ice-based Thermal Energy Storage (TES) systems were limited to large buildings with chillers. In January 2005, Ice Energy began production of its Ice Bear 50, the first ice-based TES system designed to replace unitary, refrigerant-based air conditioners, thus making off-peak ice storage an option for commercial buildings in the 2,000 to 50,000 ft^2 range and for larger homes. The Ice Bear 50 has 45 ton-hours of cooling storage and is typically charged using a 5-ton compressor. Figures 1 and 2 show typical electrical load profiles for the conventional air-conditioning system and Ice Bear system.

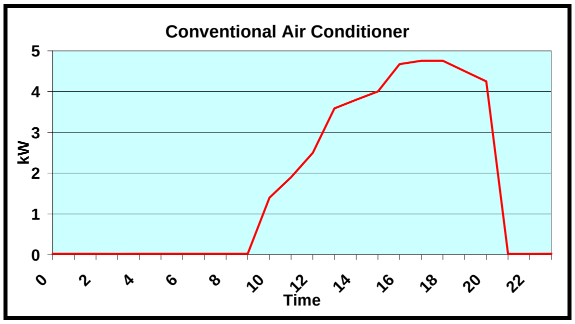

Figure 1. Typical electrical load profile for a Conventional Air Conditioning System

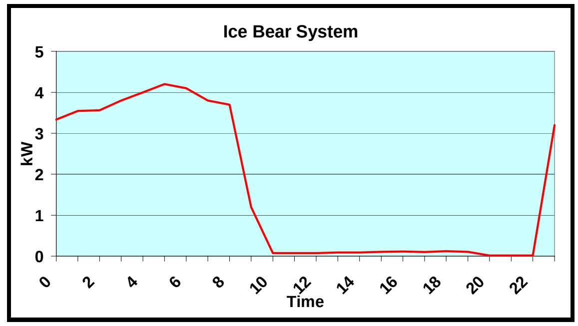

Figure 2. Typical electrical load profile for Ice Bear System

The Ice Bear™ System employs technology for efficient energy storage for refrigerant-based air conditioning systems. The heart of the Ice Bear™ System is the Refrigerant Management System (RMS). There are three main subcomponents to the Ice Bear™ System, the Tank, the Heat Exchanger, and the RMS.

- ❑ **Tank:** Doubly insulated with an inner and outer skin of High Density Cross-linked Polyethylene. Between the two layers is a nearly 4” thick foam insulation made of BASF Type AF-0306, injected to fill the entire space between the two layers. The shell material is designed for high UV resistance, is expected to last for more than 70 years. The foam provides enough insulation to keep a tank of ice at 120 °F outside temperature for more than 100 days.

- ❑ **Heat Exchanger:** One of the unique features of the Ice Bear™ is the design of the heat exchanger. The heat exchanger is composed of helical coils of copper tubing from the premier tubing supplier in the country, Wolverine Tube. It is designed to minimize the amount of copper (and hence cost and refrigerant) while covering the entire volume with equal ice thickness for maximum efficiency.
- ❑ **The Refrigerant Management System (RMS)**: Designed with a unique liquid overfeed system that is widely recognized within the refrigeration industry as a very efficient technology. The functions accomplished by the RMS include:

  - Provide refrigerant metering (flow regulation) matched to the cooling load (ice formation) required. This is accomplished by a proprietary metering device (patented by Ice Energy).
  - Provide oil return through an unique, patented oil distillation heat exchanger.
  - Feed refrigerant liquid to both the ice tank heat exchanger during ice making and to the pump during cooling.

- Circulate refrigerant with a refrigerant pump (another unique component not found in standard refrigeration systems) to the evaporator coils

The unique combination of these various components provides the high efficiency of the Ice Bear™ System that cannot be replicated with other technologies, such as glycol-water systems. This presents a high barrier to entry for competitors in the TES space or for other large manufacturers. The Ice Bear™ System integrated controller is implemented with a programmable logic controller, thus increasing functionality at reduced cost. The refrigerant pump being used for the production models consumes less than 300 W. The Ice Bear™ System has three main modes of operation:

1. **Ice Melt:** This is the cooling mode when the refrigerant pump is operated to provide building cooling. The condensing unit is turned off in this mode. This mode is normally operated during the peak hours of the day.
2. **Ice Make:** The condensing unit is operated to freeze the water in the Ice Bear™ System to store cooling capacity. This mode is normally operated at night.
3. **Direct Cooling:** This mode allows usage of the Ice Make condensing unit to provide cooling instead of using stored ice. In the majority of cases, direct cooling is applied when the Ice Bear™ System is the only cooling system for a space, but at a time when it is not desirable or possible to use the ice (see sub modes below). During direct cooling, the energy consumption for the Ice Bear™ System includes the power consumption of the Ice Bear™ System plus the power consumption of the condensing unit. In this configuration, the user avoids the first cost of purchasing and installing an additional condensing unit. There are three sub-modes for direct cooling:
    - i. **Ice Make Cooling:** This occurs in cases where there is a requirement for cooling during the preferred time for Ice Make, and there is no other system to serve the load. In this mode, the condensing unit stays on continuously for the duration of Ice Make, but whenever there is a call for cooling, the refrigerant pump is turned on to provide refrigerant to the cooling coil. When the call for cooling stops so does the refrigerant pump and the cold refrigerant provided by the condensing unit reverts to cooling the water and making ice.
    - ii. **Ice Save Cooling:** This mode is used usually for the mid-morning hours. This is the time between the end of Ice Make and the beginning of Ice Melt. Ice Melt is not used in order to save the ice for the peak hours of the day. In this mode, when there is no call for cooling, all systems are turned off. When the thermostat calls for cooling, both the refrigerant pump and the condensing unit are turned on at the same time. The pump re-routes the cold refrigerant generated by the condensing unit to the evaporator coil for room cooling. Both systems turn off when the call for cooling stops.
    - iii. **Ice Exhausted Cooling:** This mode serves to cool the building at the end of the day when all the ice has been melted but the room still requires cooling. Proper design ensures that this mode is not needed during the peak hours of the day. This mode operates similar to the Ice Save Cooling mode with regards to the condensing unit and the Ice Bear™ System, except that there is no ice or cooling capacity left in the

tank. This mode also serves to provide backup-cooling in case of an equipment malfunction that results in insufficient ice being produced during the previous night.

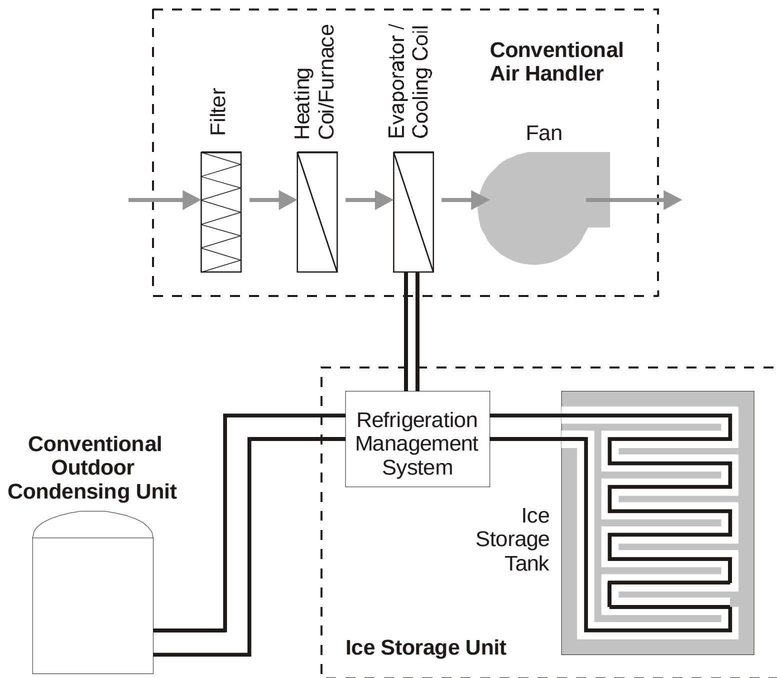

Figure 3. Ice Bear System Components

2.3 Manufacturer's Claims

The Ice Bear™ System is designed to alleviate the electrical grid loading during the peaking hours by attacking the primary source of the peaking, namely, air-conditioning equipment. With the prevalence of air-conditioning, there are two distinct markets – large buildings and facilities cooled by water (or a water-glycol mixture), and smaller buildings and residences cooled directly by refrigerant. In all cases, the ultimate heat sink is refrigerant, but in the first case, a secondary heat exchange is used to provide cold water to cool buildings. Of the entire floor space in the country, 48% is cooled by refrigerant-based systems and 32% by water based systems. There is already a well-established market for thermal energy storage in water and glycol based systems with proven economics. However, the market barrier to the refrigerant-based systems is the complexity of technology required to manage refrigerant, which is not a competency that any of the other existing energy storage unit manufacturers possess.

According to Ice Energy, the Ice Bear™ System is designed to replace units up to 8-tons during on-peak hours, which may extend for up to 6 hours. The design is flexible with regards to loading and there are almost no part-load losses as with standard air-conditioning systems. The Ice Bear™ System consumes about 300 W of power when it provides cooling, which is 20 times less power consumption that standard air-conditioners. It also has the option of stepping down the power consumption during low load time by turning off some components.

The Ice Bear System can be operated in various configurations based on the building load requirements. For instance, in buildings requiring larger amounts of cooling (10 or 12.5 Tons), the Ice Bear™ System can be operated in combination with a 5 Ton condensing unit to deliver up to 12.5 Tons while saving both peak and total energy. Of these configurations, the most popular, peak shifting moves more than 90% of air-conditioner power consumption to off-peak. The Ice Bear™ System can be applied to a multitude of different commercial building types, including office buildings, shops, restaurants, and sports centers, as well as for larger residential buildings.

The Ice Bear^{TM} provides up to a 95% reduction in cooling-related peak demand. While most ice-based TES systems achieve the peak-load reduction at the expense of efficiency—because the water has to be chilled to a lower temperature—Ice Energy claims that its system can actually achieve higher efficiency. Part of this gain in efficiency is achieved because the air-conditioner condenser operates more efficiently at cooler nighttime temperatures, and part of the efficiency gain is achieved because the compressor operates continuously while making ice, rather than cycling on and off. Ice Energy claims that savings can be as great as 35% in climates with large diurnal temperature swings, such as America's western high desert. However, the analysis in this report does not address the overall efficiency claims of the manufacturer.

2.4 Project Description

This project was designed to illustrate the impact of peak power reduction using the Ice Bear™ System's. Two Ice Bear systems were installed as part of the project, one at the Cosumnes River College (CRC) and the other one at Sacramento City College (SCC) in Sacramento, California.

2.4.1 SCC System

At SCC, the Ice Bear™ System was set up in parallel with the existing systems to enable operation of both systems. Only one system was operated at a time. Data monitoring systems were installed at both systems to measure the performance of the Ice Bear™ and the existing DX systems. Figure 4 shows Ice Bear System installation at Sacramento City College. The unit is serving a classroom area, shown in Figure 5.

Figure 4. Ice Bear System installation at Sacramento City College

Figure 5. A classroom at Sacramento City College is being served by an Ice Bear System

Figure 6 shows the monitoring layout for the systems installed at SCC and Figure 7 presents the legend for the layout in Figure 6.

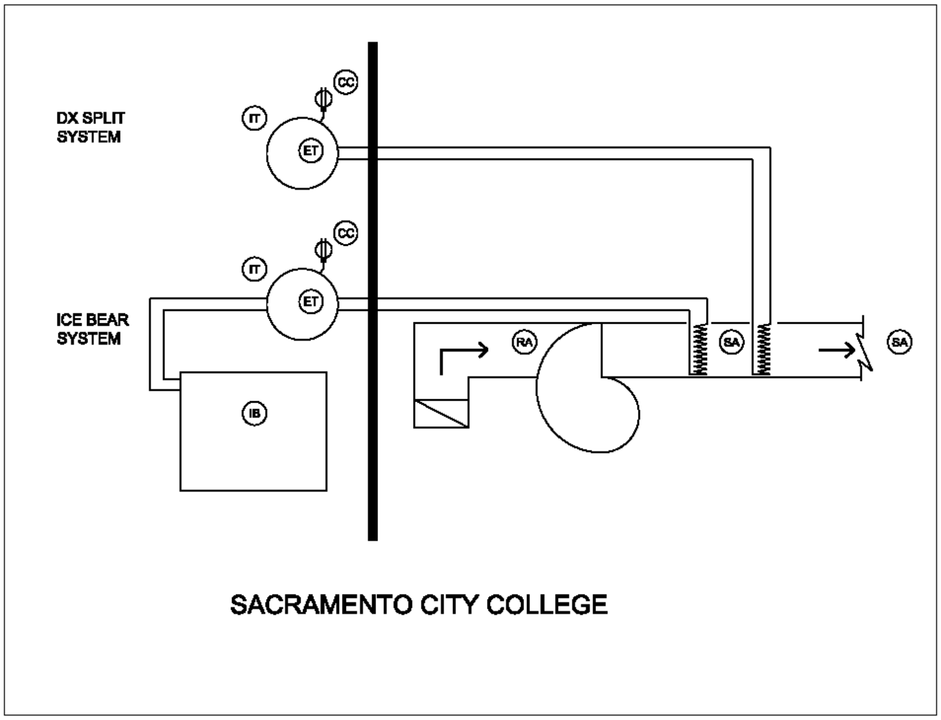

Figure 6. Monitoring layout for systems at SCC

SACRAMENTO CITY COLLEGE

ICE BEAR SYSTEM

DWG MARK	DESCRIPTION
IB	SYSTEM CURRENT SYSTEM PRESSURE WATER HEAT EXCHANGER INTAKE WATER HEAT EXCHANGER EXHAUST
CC	ICE-MAKING COMPRESSOR CURRENT
IT	ICE-MAKING COMPRESSOR INTAKE TEMPERATURE
ET	ICE-MAKING COMPRESSOR EXHAUST TEMPERATURE
RA	EVAPORATOR RETURN TEMPERATURE EVAPORATOR RETURN R.H.
SA	EVAPORATOR SUPPLY TEMPERATURE EVAPORATOR SUPPLY R.H.

DX SPLIT SYSTEM

DWG MARK	DESCRIPTION
CC	COMPRESSOR CURRENT
IT	CONDENSOR INTAKE TEMPERATURE
ET	CONDENSOR EXHAUST TEMPERATURE
RA	EVAPORATOR RETURN TEMPERATURE EVAPORATOR RETURN R.H.
SA	EVAPORATOR SUPPLY TEMPERATURE EVAPORATOR SUPPLY R.H.

Figure 7. Legend for Figure 6 monitoring layout for systems at SCC

2.4.2 CRC System

The Ice Bear™ System at Cosumnes River College was cut into an existing 10 ton rated dual circuit rooftop packaged unit. The Ice Bear served the initial stage evaporator coil while the existing second stage DX coil was unaltered. Initial plan was to monitor a conventional HVAC system along with the Ice Bear system serving similar areas. The Ice Bear was planned to be monitored via onboard monitoring capabilities. However, monitoring of the conventional system did not take place. The Ice Bear system was monitored for a period of approximately three days between July 26, 2005 and July 29, 2005.

Figure 8 shows the monitoring layout for the systems installed at CRC and Figure 9 presents the legend for the layout in Figure 8.

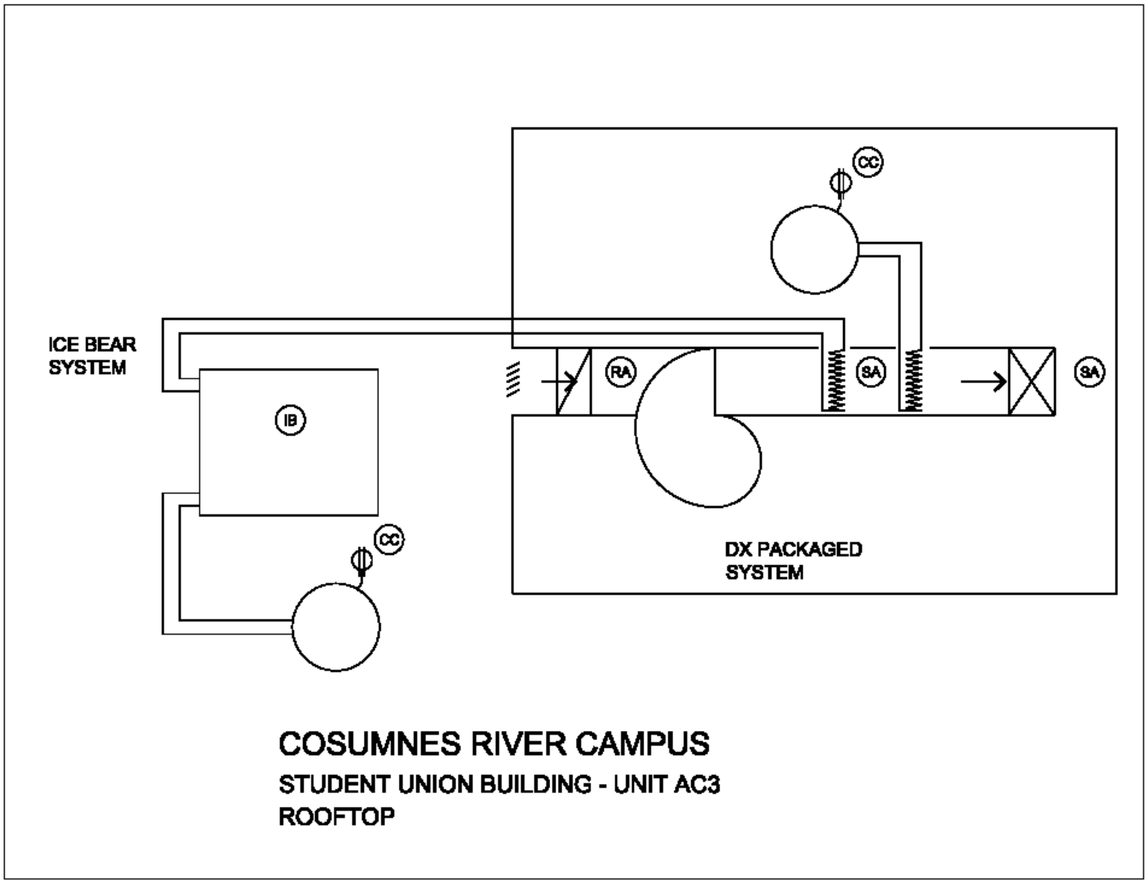

Figure 8. Monitoring layout for systems at CRC

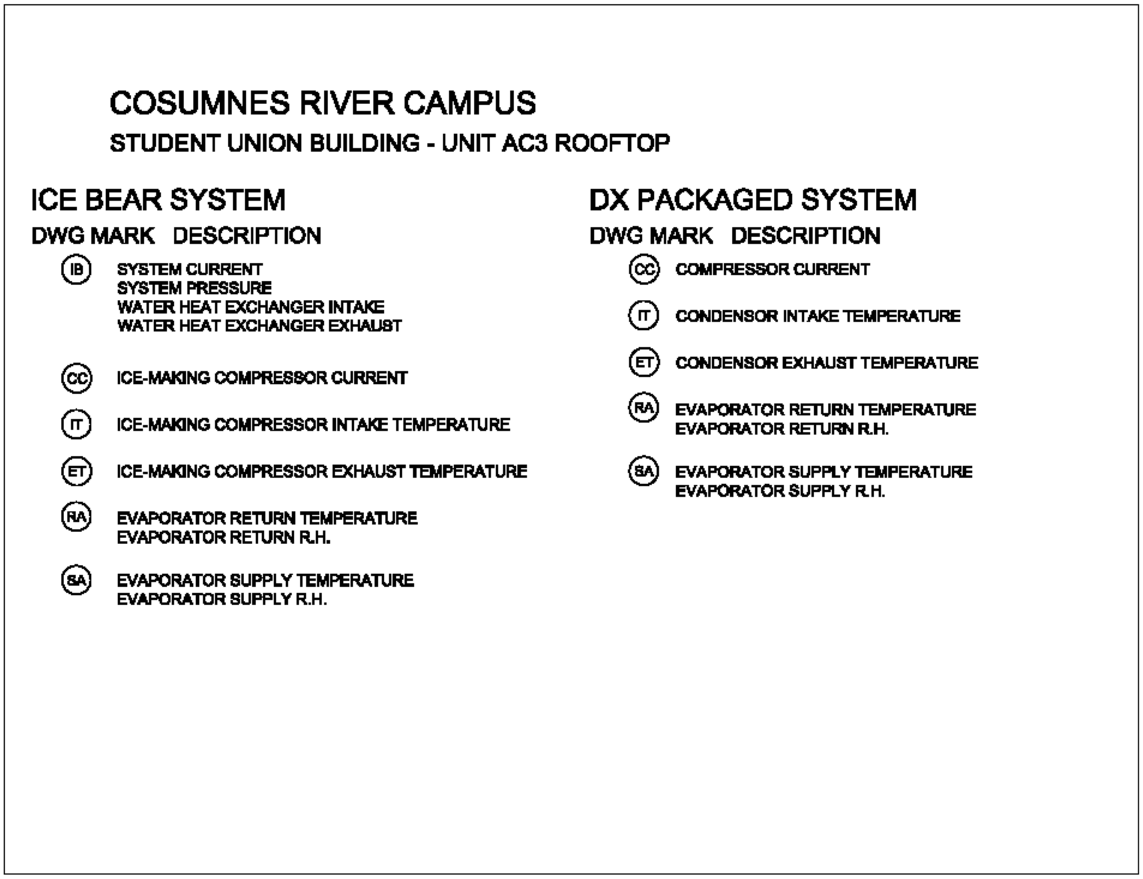

Figure 9. Legend for Figure 8 monitoring layout for systems at CRC

2.4.3 Data Analysis

The data selection was based on two to three days of continuous data for both the Ice Bear™ System and conventional DX System at Sacramento City College with similar conditions. The demand shifting for the Ice Bear versus the conventional DX system is the focus of the data analysis. Since the air handler load is the same for both systems, it was not included in the demand comparisons. Data from the Ice Bear system at Cosumnes River College is provided to qualitatively present the demand shifting capability of the Ice Bear systems. The days of operation considered for data analysis for the systems are shown in Table 2.

Table 2. Dates of Data Analysis

Site	Dates of Data Analysis	
	Ice Bear System	DX System
SCC	7/27/2005-7/29/2005	8/8/2005-8/12/2005
CRC	7/26/2005-7/29/2005	N/A

Fifteen-minute demand load (kW) profile for the conventional DX system serving a classroom at Sacramento City College and outdoor temperature are shown in Figure 10. The peak load occurs each day during SMUD's Super-Peak period. The SMUD Super-Peak period is identified in the graphs by the pink vertical bands. Fifteen-minute demand load (kW) profile for the Ice Bear™ system serving the same classroom at Sacramento City College and outdoor temperature are shown in Figure 11. The peak load occurs each day during SMUD's Off-Peak period.

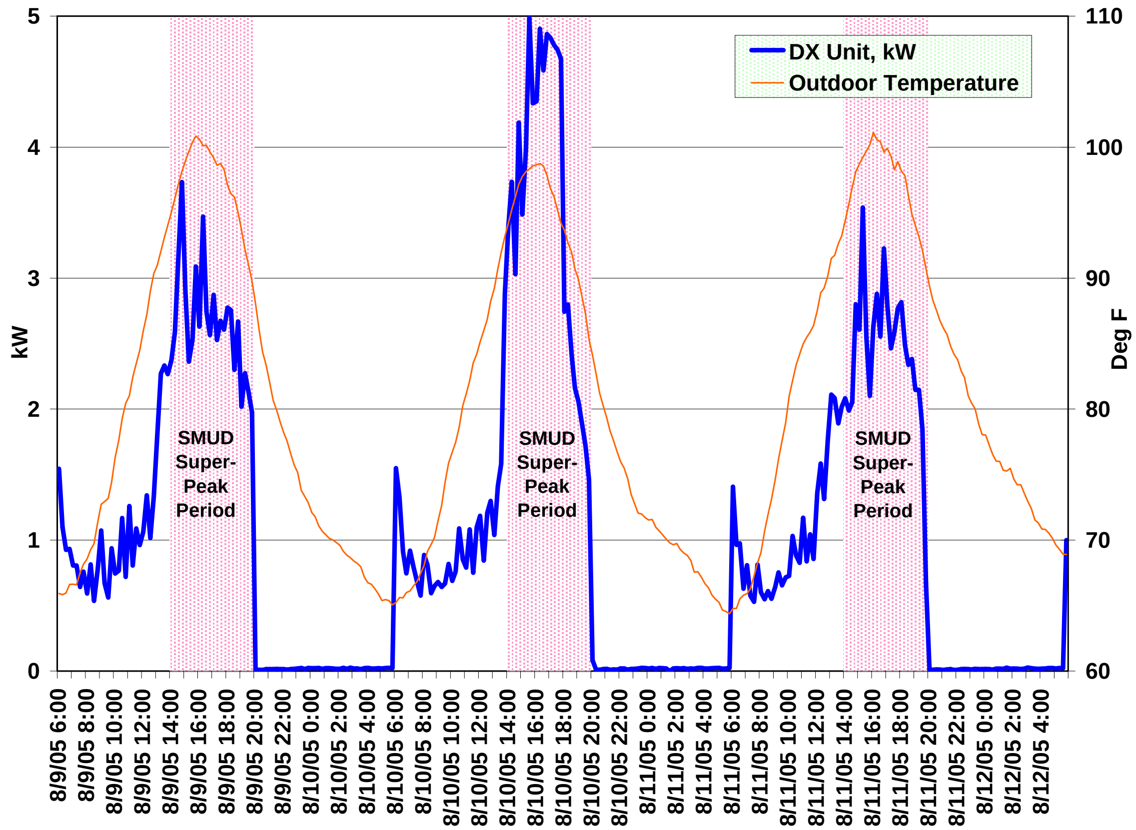

Figure 10. Demand load profile for DX system at SCC

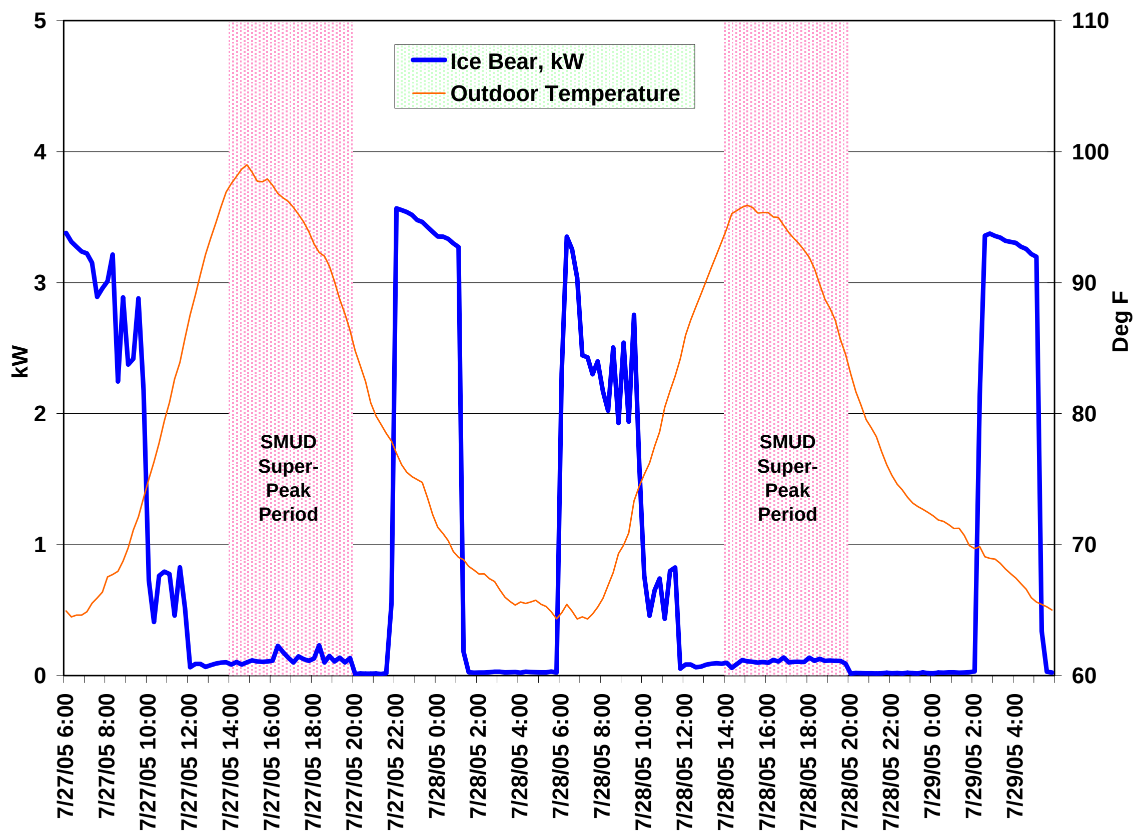

Figure 11. Demand load profile for Ice Bear system at SCC

Fifteen-minute demand (kW) load profile for the Ice Bear™ system serving a classroom at Cosumnes River College and outdoor temperature are shown in Figure 12. The peak load occurs each day during SMUD's Off-Peak period.

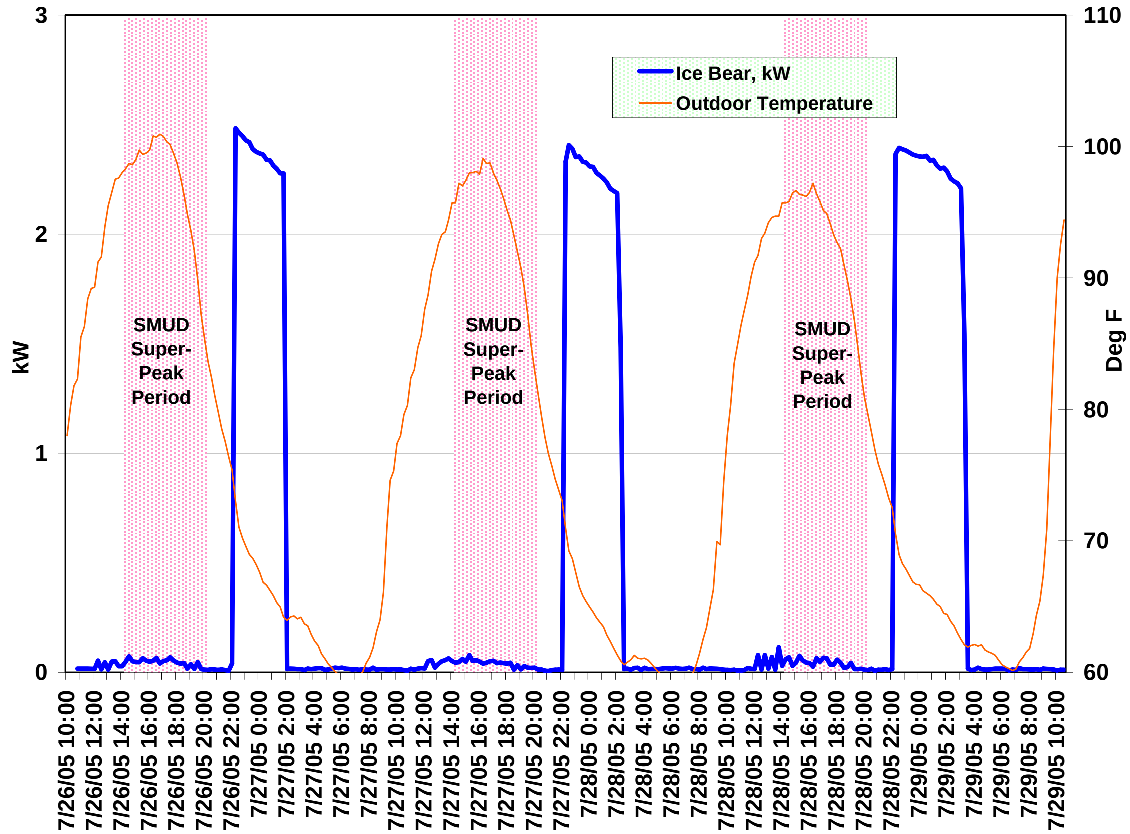

Figure 12. Demand load profile for Ice Bear system at CRC

3. DEMAND SHIFTING ECONOMICS

As illustrated in the load profiles presented in the preceding section, the Ice Bear™ System shifted >96% of super- peak energy consumption to off-peak hours.. On average, the power consumed by the Ice Bear system during the Super-Peak hours, excluding the indoor fan power, was less than 200 W that was associated with the pumps. Table 3 presents the maximum demand (kW) during different Time-Of-Use periods, under Ice Bear and conventional DX system scenarios for the existing 5 ton cooling maximum capacity at the SCC site. The economics are based only on summer rate schedules. The maximum demand at SCC was reduced from 4.76 kW to only 0.17 kW during Super-Peak hours, an average reduction of 4.6 kW

Table 3. Maximum demand during different Time-Of-Use periods, under Ice Bear and DX system scenarios

TOU Period	DX Max. Demand (kW)	IB Max. Demand (kW)
Off-Peak	1.50	3.44
On-Peak	3.59	3.54
Super-Peak	4.76	0.17

A Time-of-use (TOU1) rate schedule, presently applicable to the SCC primary voltage facility, was used to estimate the bill savings with the installation of the Ice Bear system. Table 4 presents the SMUD's TOU1 rate schedule, applicable to the SCC facility. It is to be noted that there are no demand charges associated with this rate schedule; however, there is a $3/kW facility charge on maximum kW or installed capacity.

Table 4. SMUD's Time-of-use rate schedule (TOU1), applicable to the SCC facility during summer period (June 1 to September 30)

Period	Time of Day	$/kWh	$/kW
Summer Off-Peak	10:00 p.m. to 12:00 Noon (Mon-Fri) & All Day (Sat, Sun, & Holiday)	$0.0725	-
Summer On-Peak	12:00 Noon 2:00 p.m. & 8:00 p.m. to 10:00 p.m. (Mon-Fri except holidays)	$0.0946	-
Summer Super-Peak	2:00 p.m. to 8:00 p.m. (Mon-Fri except holidays)	$0.1044	-
Facilities Charge	Max demand anytime during the month	-	$3.00

Table 5 presents the peak demand (kW), and associated energy and demand charges for summer months. All the energy consumption and demand estimates are based on the monitored data for the two scenarios. The energy consumption figures are calculated by establishing an average value for each of the three time-of-use (i.e. off-peak, on-peak, and super peak) periods and then multiplying by the number of hours in the period.

Further adjustments to the energy consumption estimates were applied based upon cooling degree-days in each month for the Sacramento region. In view of the fact that the load shifting strategy is only applicable to peak periods, the energy consumption estimates include weekday hours only. The energy and demand charges have been calculated based upon the applicable rate schedule (Table 4).

The results show that if the existing 5-ton DX system is replaced with the Ice Bear system, a reduction of at least 4.6 kW in super-peak demand can be achieved. This will translate into $103 in bill savings. However, if the Ice Bear is used to replace higher tonnage systems (e.g. up to 8-tons), much greater savings may be expected.

Table 5. Estimated savings based upon SMUD's TOU1 rate schedule

Month	Energy Charges	Demand Charges	Total
DX System Scenario			
June	$28	$14	$42
July	$54	$14	$68
August	$56	$14	$70
September	$34	$14	$48
Total			$229
Ice Bear System Scenario			
June	$20	$0.50	$21
July	$39	$0.50	$39
August	$41	$0.50	$41
September	$24	$0.50	$25
Total			$126
SAVINGS			**$103**

Since SMUD's TOU1 rate schedule does not include demand charges, the bill savings for this site are very limited and are a result of energy consumption being shifted from super-peak to off-peak periods. Therefore, it is important to evaluate the potential bill savings using more favorable rate schedules that include both energy and demand charges. To that end, savings for the following rates have been calculated:

- SMUD's TOU2 rate schedule: Table 6
- PGE's E-20P: Table 9
- SCE's TOU-8: Table 12.

Table 6. SMUD's Time-of-use rate schedule (TOU2) for summer period (June 1 to September 30)

Period	Time of Day	$/kWh	$/kW
Summer Off-Peak	10:00 p.m. to 12:00 Noon (Mon-Fri) & All Day (Sat, Sun, & Holiday)	$0.0721	-
Summer On-Peak	12:00 Noon 2:00 p.m. & 8:00 p.m. to 10:00 p.m. (Mon-Fri except holidays)	$0.0966	-
Summer Super-Peak	2:00 p.m. to 8:00 p.m. (Mon-Fri except holidays)	$0.1406	$5.00
Facilities Charge	Max demand anytime during the month	-	$2.00

Table 7 shows the results based upon SMUD's TOU2 rate schedule. The bill savings ($212) are more than twice compared to the savings based upon TOU1 rate schedule.

Table 7. Estimated savings based upon SMUD's TOU2 rate schedule

Month	Energy Charges	Demand Charges	Total
DX System Scenario			
June	$34	$33	$67
July	$65	$33	$99
August	$68	$33	$102
September	$41	$33	$74
Total			$342
Ice Bear System Scenario			
June	$20	$1.16	$22
July	$39	$1.16	$40
August	$41	$1.16	$42
September	$25	$1.16	$26
Total			$130
SAVINGS			**$212**

4. ECONOMICS IN OTHER UTILITY SERVICE AREAS

This section presents the economics of utilizing Ice Bear^{TM} System to replace an existing 5-ton rated DX system in two other utilities service areas; PG&E and SCE. While it is true that the operation strategy used under SMUD's territory may not work properly for other utilities due to the difference in the time-of-use definitions used under each utility's rate schedule, the following results still provide fairly reasonable comparisons.

4.1 Pacific Gas & Electric (PG&E)

Table 8 presents the maximum demand (kW) during PG&E's defined Time-Of-Use periods, under Ice Bear and DX system scenarios as represented by performance measurements at the 5iton system displacement at the SCC field installation. The maximum demand was reduced from 4.76 kW to only 0.17 kW during Peak hours, an average reduction of 4.6 kW.

Table 8. Maximum demand during PG&E's defined Time-Of-Use periods, under Ice Bear and DX system scenarios

TOU	Max Demand DX (kW)	Max Demand IB (kW)
Off-Peak	1.13	3.54
Partial-Peak	2.09	2.46
Peak	4.76	0.17

Table 9 presents PG&E's E-20P rate schedule, applicable to similar large size commercial facilities with primary voltage service.

Table 9. PG&E's Time-of-use rate schedule (E-20) during summer period (May 1 to October 31)

Period	Time of Day	$/kWh	$/kW
Summer Off-Peak	9:30 p.m. to 8:30 a.m. (Mon-Fri) All Day (Sat, Sun, & Holiday)	$0.0687	-
Summer Partial-Peak	8:30 a.m. 12:00 noon & 6:00 p.m. to 9:30 p.m. (Mon-Fri except holidays	$0.0945	$2.60
Summer Peak	12:00 Noon to 6:00 p.m. (Mon-Fri except holidays)	$0.1255	$11.38
Max Demand Summer	Max demand anytime during the month)	-	$5.06

Table 10 presents the estimated energy consumption (kWh), peak demand (kW), and associated energy and demand charges for the four summer months. The energy consumption figures are calculated in a similar manner as before. The energy and demand charges have been calculated based upon the PG&E's E-20P rate schedule (Table 9).

The results show that applying the PG&E's E-20P rate schedule would result in $325 in bill savings, which is considerably higher than savings based on SMUD's TOU1 rate, but similar to TOU2 rate.

Table 10. Estimated savings based upon PG&E's E-20P rate schedule

Month	Energy Charges	Demand Charges	Total
DX System Scenario			
May	$15	$65	$80
June	$33	$65	$99
July	$64	$65	$129
August	$67	$65	$132
September	$40	$65	$106
October	$6	$65	$71
Total			$617
Ice Bear System Scenario			
May	$9	$26	$35
June	$20	$26	$46
July	$38	$26	$65
August	$40	$26	$66
September	$24	$26	$50
October	$3	$26	$30
Total			$292
SAVINGS			**$325**

4.2 Southern California Edison (SCE)

Table 11 presents the maximum demand (kW) during SCE's defined Time-Of-Use periods, under Ice Bear and DX system scenario as represented by performance measurements at the 5 Ton system displacement at the SCC field installation. The maximum demand was reduced from 4.76 kW to only 0.17 kW during Peak hours, an average reduction of 4.6 kW.

Table 11. Maximum demand during SCE's defined Time-Of-Use periods, under Ice Bear and DX system scenarios

TOU	Max Demand DX (kW)	Max Demand IB (kW)
Off-Peak	1.13	3.33
Mid-Peak	2.09	3.54
On-Peak	4.76	0.17

Table 12 presents the SCE's TOU-8 rate schedule, applicable to similar large size commercial facilities.

Table 12. SCE's Time-of-use rate schedule (TOU-8) during summer period (First Sunday in June to first Sunday in October)

Period	Time of Day	$/kWh	$/kW
Summer Off-Peak	11:00 p.m. to 8:00 a.m. (Mon-Fri) All Day (Sat, Sun, & Holiday)	$0.1151	$0.00
Summer Mid-Peak	8:00 a.m. 12:00 noon & 6:00 p.m. to 11:00 p.m. (Mon-Fri except holidays)	$0.1580	$4.06
Summer On-Peak	12:00 Noon to 6:00 p.m. (Mon-Fri except holidays)	$0.2313	$26.19
Facility-related Demand Charges	Maximum Demand	-	$8.47

Table 13 presents the estimated energy consumption (kWh), peak demand (kW), and associated energy and demand charges for the four summer months. The energy consumption figures are calculated in a similar manner as before. The energy and demand charges have been calculated based upon the SCE's TOU-8 rate schedule (Table 12).

The results show that applying the SCE's TOU-8 rate schedule would result in $764 in bill savings, which is considerably higher than savings based on SMUD and PG&E's rates.

Table 13. Estimated Savings Based Upon SCE's TOU-8 Rate Schedule

Month	Energy Charges	Demand Charges	Total
DX System Scenario			
June	$60	$173	$233
July	$115	$173	$289
August	$121	$173	$294
September	$73	$173	$246
Total			$1,063
Ice Bear System Scenario			
June	$35	$20	$55
July	$68	$20	$88
August	$71	$20	$91
September	$43	$20	$63
Total			$298
SAVINGS			**$765**

5. CONCLUSIONS

This project was designed to illustrate the impact of peak power reduction using the Ice Bear™ System. Ice Bear Systems were installed as part of the project at two college locations within the Los Rios Community College District (LRCCD); one at the Cosumnes River College (CRC) and the other at Sacramento City College (SCC) in Sacramento, California. The Ice Bear™ System was a stand-alone unit at CRC, with a second 5-ton DX compressor that could cool the space, but never needed to run. At SCC, the Ice Bear™ System was set up in parallel with the existing systems to enable operation of either system. Data monitoring systems were installed at both sites to measure the performance of the Ice Bear™ and the existing systems.

The systems were installed in May 2005 and operated under normal summer conditions. To accomplish a fair comparison, the Ice Bear system was operated for a three-day period followed by the operation of DX unit for another three-day period. The results of the tests illustrate that the Ice Bear™ System was effective in shifting the air conditioner load from SMUD's super-peak hours between 2 pm and 8 pm to off-peak hours. The results demonstrate that an average of at least 4.6 kW of power displacement can be achieved per Ice Bear™ System if applied appropriately to commercial facilities.

The analysis of the results, based upon SMUD's TOU1 rate schedule, applicable for the SCC facility, show that if the existing 5 ton DX system is replaced with the Ice Bear system, a bill savings of $103 per unit can be obtained. However, these savings could be substantial where demand charges are also applicable along with the energy charges. The rate structure for SMUD's service area is not as conducive to load shifting opportunities as in other locations in California. For comparison purpose, SMUD's TOU2 rate and rates from two other utilities were also used. Table 14 presents a summary of bill savings based upon these different rate schedules.

Table 14. Summary Of Bill Savings Based Upon Different Rate Schedules

Utility	Rate Schedule	Bill Savings
SMUD	TOU1	$103
SMUD	TOU2	$212
PG&E	E-20P	$325
SCE	TOU-8	$765

The manufacturer believes substantially more savings is possible--especially in applications where the capabilities of the Ice Bear System could be more fully utilized (i.e. to replace up to 8-ton systems). We concur with the manufacturer but believe additional testing is needed to quantify the savings potential for these situations.