Pacific Gas and Electric Company

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Emerging Technologies Program

Application Assessment Report # 0404

Indirect-Direct Evaporative Cooler (IDEC) Relocatable Classroom Demonstration Project

Issued: **December 29, 2006**

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Executive Summary

There are currently over 90,000 relocatable classrooms installed in K-12 schools throughout California, most with old and inefficient envelope, lighting, and HVAC systems. Advanced indirect-direct evaporative cooling (IDEC) is one promising technology for reducing the energy consumption of relocatable classrooms while delivering sufficient space cooling.

Pacific Gas and Electric Company (PG&E) hired Davis Energy Group (DEG) to evaluate the energy savings potential of the Outside Air System (OASys), an Indirect-Direct Evaporative Cooler developed by Davis Energy Group and manufactured by Speakman CRS of Wilmington, Delaware, under a licensing agreement with DEG.

OASys units were installed in relocatable classrooms at two different Northern California sites where their performance was monitored and compared with conventional wall-mounted 10 SEER vapor compression air conditioning systems in adjacent and otherwise identical relocatable classrooms.

The results of the study are summarized in Table 1.

Table 1: OASys Relocatable Classroom Study Results
(Results are per HVAC unit averages)

HVAC Unit	Est. Annual Energy Use	Annual Energy Cost	Demand	Upgrade Cost	Simple Payback
Standard 4-ton SEER=10 wall-mount unit	1360 kWh	$204	4.72 kW		
Retrofit DEG OASys	395 kWh	$55	0.75 kW	$1250	**8.4 yrs**
Savings	**965 kWh** **(71%)**	**$149**	**Non-coin peak** **3.97 kW (84%)** **Coin. Peak** **0.95 kW**		

Notes
1. The project monitored two standard and two OASys units.
2. Energy costs are based on an average electricity price of $0.15/kWh.
3. Upgrade costs are for new unit equipment only and do not include teardown or installation costs.
4. Installed costs of standard and retrofit units are considered comparable.

Over the monitoring period, the OASys units:

- demonstrated energy and peak demand savings of 71% and 84%, respectively, relative to the conventional HVAC units
- resulted in an average indoor wet bulb temperature that was 2 degrees higher than for the conventional HVAC units
- had 75% fewer hours when CO_2 concentrations exceeded 1000 ppm compared to the conventional HVAC units[1].

[1] For more characteristics of operating performance, see Table 5.

Introduction

Background

Even though prior IDEC development efforts targeted residential applications, the physical size and nearly 2.5-ton cooling capacity of the OASys unit make it well suited for relocatable classrooms in hot, dry, inland areas of California such as the Central Valley and the Sierra Foothills.

PG&E Emerging Technologies (ET) program sponsored the IDEC monitoring project as a component of the larger Relocatable Classroom (RC) Demonstration Project funded by the PG&E "School Resources Program" in 2005-06. The RC Project explored the potential benefits of eight technologies appropriate for RC retrofit applications. IDEC was one of the eight technologies. The project demonstrated, monitored, and evaluated the third-generation IDEC system in relocatable classrooms. The IDEC system was developed by Davis Energy Group under funding from the California Energy Commission's "Public Interest Energy Research" program (PIER).

The results of this IDEC system performance study will also be used to calibrate computer simulations of RCs developed by the Emerging Technologies program. The findings could also potentially influence future utility incentive programs and possibly construction codes and standards.

Speakman CRS is currently producing the OASys in limited quantities. Information about the product can be found at www.oasysairconditioner.com.

The demonstration project compared IDEC cooling against conventional vertical, wall-mounted HVAC units. Cost-effective heating was not part of the ET project, and is one of the challenges of introducing an IDEC system into a classroom application. A previous version of the OASys IDEC system was used successfully in four new relocatable classrooms as part of the Lawrence Berkeley National Laboratory's (LBNL) "High Performance Commercial Building Systems" project in 2001[2]. Those systems used a gas-fired water heater and a hydronic heating coil (located in the IDEC supply plenum) to supply heat to the classroom. DEG has conceptualized other options, and we recommend that future R&D funding consider an integrated heating-cooling system.

Objectives

The OASys system claims over 70% cooling energy and demand savings, superior indoor air quality, non-CFC (refrigerant) based cooling, and reduced indoor humidity relative to conventional evaporative cooling equipment. This project aimed to verify these claims.

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[2] Report on HVAC Option Selections for a Relocatable Classroom Energy and Indoor Environmental Quality Field Study, Apte, M.G., W.W. Delp, R.C. Diamond, A.T. Hodgson, S. Kumar, D.G. Shendell, D.P. Sullivan, and W.J. Fisk, LBNL, and L.I. Rainer, Davis Energy Group, Inc. Lawrence Berkeley National Laboratory, California. LBNL-49026. October 2001. Also see: http://buildings.lbl.gov/CEC/Element_6/02_E6.html

With results from field monitoring, the project was able to document the impacts on cooling energy use and peak demand, indoor environmental quality impacts, and overall system economics.

IDEC systems were installed in two RCs in hot, dry climate areas in PG&E's service territory. This project was carried out in coordination with the PG&E School Resources Program (SRP) and its consultants. SRP has a program component to install a variety of cost-effective energy efficiency improvements in existing RCs, monitor the equipment or systems, and compare the results against adjacent "control" RCs. Site selection, installation assistance, monitoring protocols, and occupant surveys were provided by SRP.

IDEC Technology

The IDEC system cools air in a two-stage process, as shown in Figure 1. First, the indirect cooling module (ICM) separates the outdoor air stream into a dry air stream and a secondary air stream where moisture is added. The evaporatively cooled secondary air stream cools the dry air stream through a non-permeable plastic heat exchanger. Then the supply air stream passes through the direct cooling module (DCM), where it is further cooled (and humidified) by the direct evaporation of water. The cooled outdoor air is then delivered to conditioned space. As a 100% outdoor air system, the supply air must be relieved to outdoors, typically through ceiling or wall barometric dampers that open when the indoor space is positively pressurized.

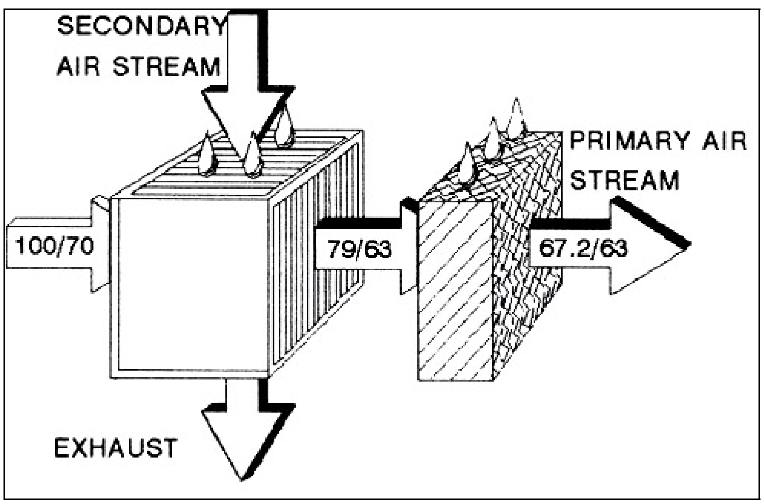


Figure 1: IDEC Schematic

(Numbers in arrows represent Dry /Wet Bulb Temperature in °F)

A variable-speed blower controlled by proportional fan speed control logic allows the OASys to vary fan speed based on cooling demand to optimize energy savings. At low speed, the system cools, cleans, and circulates air using less than 100 watts of electricity. A leak-proof plastic cabinet and other design enhancements eliminate the potential for corrosion. System controls also include a shutdown sequence that shuts off the water, drains the sump, and runs the fan until the evaporative media is dry. The water used in this process is renewed periodically by a self-purging reservoir. The OASys runs more quietly than compressor-driven air conditioning, and the unit is expected to require very little maintenance. Because it provides 100% outside air, the OASys should improve indoor air quality.

Figure 2 below depicts the OASys airflow paths and key components.

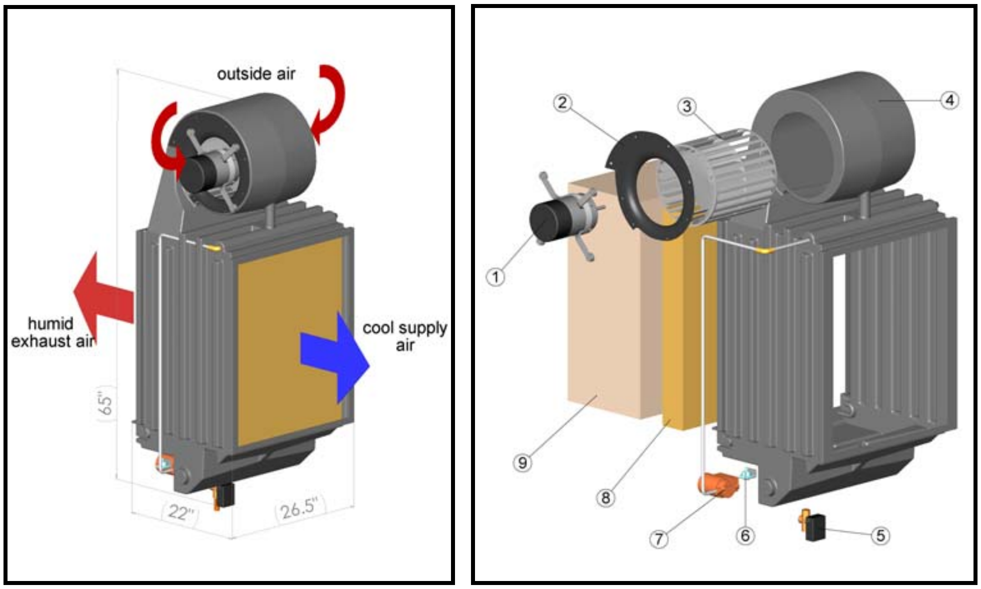


Figure 2: OASys Schematics. Air flow diagram (left) and Parts (right). 1: ¾ hp GE ECM2.3 Electronically Commutated Motor; 2: Venturi mounting plate; 3: Morrison 11-11 squirrel cage blower wheel; 4: Polyethylene rotationally molded cabinet; 5: Drain valve; 6: Fill valve; 7: Taco 003 water circulator; 8: Munter's CELdek® 5090 direct cooling stage; 9: Speakman indirect cooling stage.

Experimental Design and Procedure

Monitoring Plan

Table 1 lists the monitoring equipment used in the project for both the IDEC and conventional HVAC units. All continuously monitored points were recorded at fifteen minute intervals using stand-alone "stick-on" loggers with their own memory and battery backup. Due to a shortage of sufficient (and expensive) equipment, the CO_2 measurements were only recorded for one month at each site. One-time measurements of power components, airflow, and sound were taken before and after the monitoring (see Table 2 below).

All data were downloaded monthly from each site. A monthly report summarizing monitored variables and graphically rendering key variables (such as temperatures and demand) was sent to PG&E Project Managers during the monitoring period.

Table 1. Monitoring Points and Equipment Used

Monitoring Point	*Sensor*	*Logger*
RC Monitoring Points		
Indoor Temp and RH	Integral	Hobo U12
Outdoor Temp and RH	Integral	Hobo Pro RH/Temp
Occupancy	Integral	Wattstopper IT-200
Power (Lights, HVAC, Total)	20A and 50A CTs	Elite Pro
Carbon Dioxide (CO_2)	Telaire 7001	Hobo U12

Table 1. Monitoring Points and Equipment Used (continued)

Monitoring Point	*Sensor*	*Logger*
Additional IDEC Points		
Water Use	ISTA flow meter	ACR SmartReader9
Power	20 amp CT with CC WNA-1P-240-P power transducer	ACR SmartReader9
Supply Temperature	Hobo Temperature Probe	Hobo Pro

Table 2: One-Time Measurements

Measurement	*Location*	*Equipment*	*Notes*
Air flow	Supplies, return, outside air damper	Flow-hood for supply and return, duct blaster for OSA	With HVAC in cooling and fan mode
Sound	One reading facing forward at 4 locations, plus outside	Sound meter	With HVAC in off, fan, and cooling modes
HVAC, and Fan power	Breaker panel	Power logger	V, A, kW, kVA, and PF

Sensible Capacity

The cooling capacity of the unit was calculated with the following equation:

$$q_s = \dot{Q} \times \rho \times c_p \times (TAR_{db} - TAS_{db})$$

where,

q_s is the capacity (Btu/hour)

Q is the air flow rate (cfm)

ρ is the air density (lb/ft^3)

c_p is the specific heat of air (Btu/lb-°F)

TAR_{db} is the relief air temperature, and

TAS_{db} is the supply air temperature

This metric is termed "sensible" capacity because the direct evaporative process is isenthalpic, meaning there is no change in the sensible plus latent energy content of the air. Provided that the indoor air remains within comfortable humidity levels, it is reasonable to compare these metrics to the capacity and EER of conventional vapor compression air conditioning systems.

The primary purpose of this measure of capacity is to provide a method for comparing the performance of evaporative coolers with that of vapor compression air conditioning systems.

However, the measure is an imperfect indicator of performance because, although supply air temperature is independent of the characteristics of the building, relief air temperature depends on several building-specific factors such as envelope characteristics, orientation, and internal loads. In contrast, the supply air temperature for a vapor compression system depends directly on the return air temperature (equivalent to relief) in such a way that the building characteristics have less impact on the validity of the capacity measure.

To avoid "building" and "condition-specific" influences on the calculation of capacity, all calculations in this report assume the relief air temperature is 80°F, which is the standard value used in calculation of the Evaporative Cooler Efficiency Ratio defined in California's Title 20 Appliance Standard.

Sensible EER

The sensible EER of the system is defined as follows:

$$EER = q_s/P$$

where P is the *unit* demand.

Airflow and other data were measured as part of the RC Retrofit Project. The following calibrations and verifications were completed:

- **Air Temperature** sensors were calibrated using a combined temperature/humidity meter.
- **Power** was measured using a digital handheld wattmeter.
- **Air Flow.** Supply and exhaust air flows were measured using a fan-assisted flowhood.
- **Sound Level**. A-weighted sound levels were recorded at six locations with the IDEC system in three modes: off, fan on, and cooling.

Monitoring was originally planned to continue until the end of the 2005 cooling season. At the completion of monitoring, a second set of measurements identical to those performed at the beginning of the study, as shown in Table 2, were completed to check for any changes in building characteristics.

Host Sites

The sites of the relocatable classrooms were at two schools in the Sierra Nevada foothills of California. Site #1 was at a high school in Jackson and Site #2 was at an elementary school in Auburn, about 60 miles North of Site #1. The RCs were standard 24 x 40 foot units designed for up to 30 students. Base case and test classrooms were selected to guarantee similar student grade levels, usage and operating patterns, and occupancy profiles.

The control classrooms at each site were equipped with a 4-Ton wall-mount HVAC unit, with gas heat. Site #1 was unducted with direct supply air delivery to the classroom. Site #2 was ducted with two supply registers.

Installation Procedures

The OASys units were installed in the two RCs adjacent to the control RC in April of 2005. DEG then installed monitoring equipment. At both sites, the first step of the installation was to cut a

24” wide by 30” high hole in the back wall of the classroom. The hole in the wall exposed one framing member, which was left in place to minimize costs; the member was wrapped with sheet metal cover for protection. The OASys unit was then positioned on the outside wall, over the hole, and secured with lag bolts. A 24” x 30” sheet metal plenum was fastened to the OASys supply opening and extended through the wall to the supply register on the inside to prevent supply air from escaping into the wall of the building.

Two barometric dampers were installed on the front wall of each building. When the OASys operates, it pressurizes the space and the dampers open to allow air to exhaust from the building. When the OASys unit is off, the dampers close to prevent the loss of conditioned building air and infiltration of outside air. The dampers were mounted on the inside wall and registers were mounted on the exterior wall at the damper penetrations.

The other major operations required for the installation were to run water to the IDEC unit, to connect the unit to the building electrical system, and to mount the thermostat.

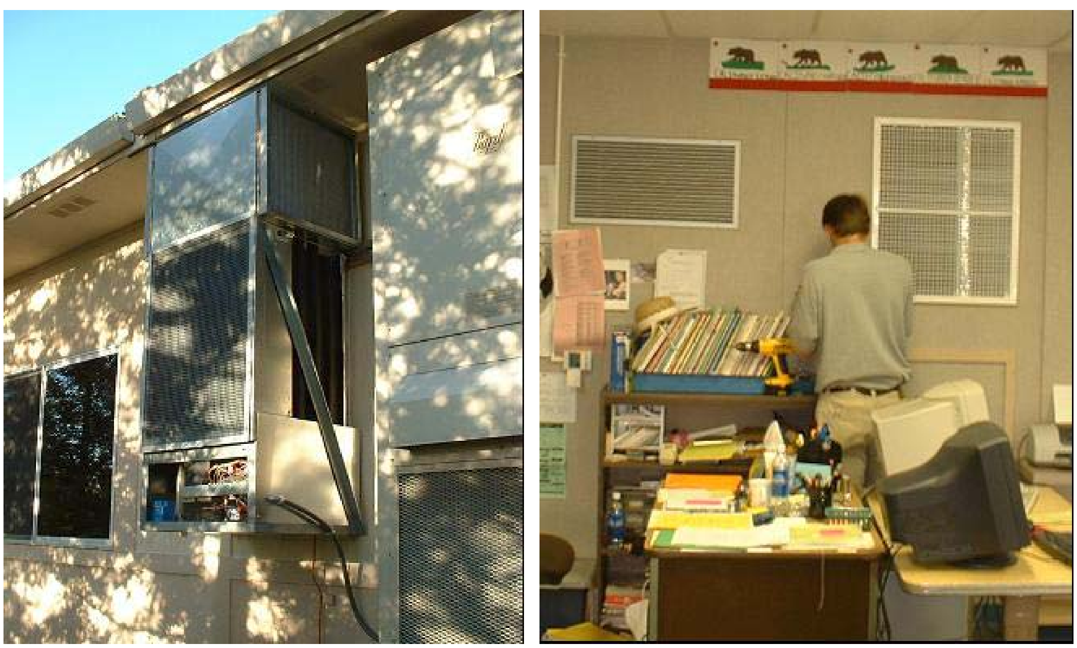
The existing wall mount heat pumps were kept in place to provide heating for the classrooms and to give the school districts the security of a fall-back system. A lockout control system was used to prevent the simultaneous operation of the OASys and wall-mount units. The lockout system consisted of a toggle switch mounted next to the thermostat with which one could select either the conventional air conditioner or the OASys unit. Because of control differences, the heat pump at Site #1 was disabled by disconnecting power to the thermostat, while at Site #2, a contact closure was provided to the energy management and control system.

Amaro Construction completed the major operations of each installation within 10 hours with two people (20 person-hours total), not including travel time. These operations included mounting the OASys, thermostat, and supply register, connecting building electrical supply to the unit, and running water to the unit. In both cases, the barometric dampers were installed on a later date because they were unavailable on the date of the original installation. In future installations, it is expected that dampers can be installed on the same day, saving 1 hour per installation. Because the construction team was unfamiliar with the IDEC and extra installation care was taken by the entire installation team, the 20 hours is considered high. A more practiced installer should be able to reduce this time significantly. Also, in a new construction situation (manufacturer production line), installation would take no longer than that for a conventional heat pump.

Site #1

Left photo: OASys mounted on outside wall, adjacent to conventional HVAC unit.
Right photo: supply register on inside wall (tears in tackboard are pre-existing).

Site #2



Left photo: OASys mounted on outside wall, adjacent to conventional HVAC unit.
Right photo: supply register on inside wall

Project Results

Monitoring Period

Table 3 below summarizes the monitoring periods of both IDEC sites and the periods that provided system operation data while the classrooms were occupied. Although a total of over 20 months of data was recorded, only three months of data were useable for comparing system operation during occupied periods.

For Site #1, the IDEC and HVAC thermostats were set incorrectly at first so that both operated during the day. The summer provided extensive data for analysis of equipment operation, but the classrooms were not occupied. Useful data were confined to the beginning of the 2006 school year.

For Site #2, the IDEC unit was not operational until May 23rd. Good equipment operation data was obtained during the summer, but the IDEC classroom was not used during the 2006 school year (due to unanticipated student relocation during construction on the campus) so comparison with the control classroom was not adequate.

Table 3. IDEC monitoring periods

	Site # 1	*Site # 2*
Full monitoring period	5/20/05 - 12/29/05	4/21/05 - 7/10/06
CO_2 monitoring period	8/11/05 – 9/13/05	9/13/05 – 10/21/05
Occupied operation period	8/10/05 – 10/19/05	5/23/05 – 6/13/05

Energy and Demand Savings

Energy and demand savings during the occupied operation period are summarized in Table 4. Site #2 had slightly lower savings due to some overlapping conventional HVAC system operation during the period. Peak power use of the OASys unit reflects its ¾ HP fan motor and will not change significantly with load or temperature. Peak load for the control units are typical of a 4-ton unit and will be highest at the highest load and hottest outdoor conditions.

About one-third of the total energy use in relocatable classrooms is used for cooling. The 14 control classrooms in the overall PG&E demonstration project averaged 1360 kWh/year for cooling, mostly during the months of May, June, August, September, and October. Assuming an average cooling energy savings of 71%, an OASys unit could be expected to save 965 kWh/year.

Table 4. Comparison of Energy Savings

	Site #1			*Site #2*		
	OASys	*Control*	*Savings*	*OASys*	*Control*	*Savings*
Cooling energy use (kWh/day)	2.5	11.2	77%	4.4	12.6	65%
Peak power (kW)	0.74	4.94	86%	0.75	4.50	83%

Other Performance Measures

Because the OASys unit is a two-stage (indirect-direct) unit, the saturation effectiveness can exceed 100 percent. Physical laws limit direct-only evaporative cooling effectiveness to less than 100%, with typical values less than 90 percent. This means the supply air temperature of direct evaporative coolers is always greater than the outdoor ambient wet bulb temperature. The OASys unit tested in this project achieved effectiveness results ranging from 105% to 118% in laboratory testing. This project confirmed that range with saturation effectiveness averaging 114%.

Operating results are summarized in Table 5. Classroom indoor dry bulb temperatures were similar but OASys temperatures were cooler at site #1 and warmer at site #2. Indoor average wet bulb temperatures during occupied hours were two to three degrees higher in the OASys classrooms. However, indoor wet bulb temperatures during occupied hours exceeded ASHRAE 55 comfort levels of 68°F only 2% of the time at Site #2 and never at site #1. Indoor CO_2 levels in the OASys classrooms were 90-140 ppm lower on average during occupied hours. The OASys classrooms also had a significantly lower number of occupied hours during which the CO_2 levels exceeded 1000 ppm. All classrooms experienced peak CO_2 levels of over 2400 ppm on days when cooling loads were relatively low and, consequently, the air conditioning systems operated very little (i.e., reduced mechanical ventilation).

Table 5. Comparison of Operating Performance

	Site #1		*Site #2*	
	OASys	*Control*	*OASys*	*Control*
Average occupied indoor dry bulb temperature (°F)	71.8	75.0	73.6	71.6
Average occupied indoor wet bulb temperature (°F)	62.2	59.2	62.7	60.1
% of occupied hours indoor wet bulb temperature exceeded 68°F	0%	0%	2%	0%
Average occupied CO_2 concentration (ppm)	446	534	590	736
% of occupied hours CO_2 exceeded 1000 ppm	1%	7%	5%	18%

Occupant Acceptance

Heschong-Mahone Group provided and analyzed occupant surveys for all classrooms in the RC retrofit study. Although two classrooms were retrofitted with an OASys system, only one teacher returned a completed survey. Hence, a report on only one case study is provided.

The teacher in the retrofitted classroom gave a high score for the OASys "**ventilation system**" compared to its pair control classrooms. There were high levels of satisfaction with the "**thermostat system**" as well, with the teacher giving it a much higher score than the control pair. The teacher gave OASys the best possible score to describe the "**ease of use of thermostat controls**". She rated the "**overall comfort compared to other classrooms**" also higher than the control pair. All these scores indicate a high level of acceptance of the IDEC system and show an improvement in overall comfort.

The OASys classroom got neutral scores for all three "**health and satisfaction,**" related questions. This indicates neither better, nor worse performance in "**student health,**" "**student behavior,**" and "**impact on teaching methods**" due to the IDEC.

The most surprising results were that the teacher in the OASys-retrofitted classroom gave low scores for "**air quality**" compared to the control classroom, indicating that it is often "**too stale / stuffy**" and "**often too drafty.**" The "too stale" reports are most likely due to non-operation times which could be eliminated by using a constant fan operation mode. The "too drafty" reports might be due to operation of the OASys at high speed with the single supply duct. These could addressed by using ducted delivery. The teacher also reported that she often keeps the "**windows and doors open for natural ventilation**." Again, a constant fan operation mode could eliminate these problem times, although in our experience many teachers prefer to open windows and doors regardless.

The OASys ventilation system as well as thermostat got the very highest possible scores for "**ease of maintenance**".

Incremental Costs

The current volume sale price of the OASys is $2,500, while per unit price is $2,850. These are expected to drop as market volume increases and production costs are reduced. Installation in the test sites showed that it takes 2 technicians 10 hours to install a unit, grill, dampers, control system, and water connection. Since this was the first time these technicians had installed an OASys unit, future installations should go more quickly.

The estimated cost of a conventional wall-hung HVAC unit is about $1,600. Installation costs for new installs should be close to the same price considering the conventional HVAC unit may need a gas line for heating and ducting, whereas the OASys needs a water line and a source of heating.

Many of the RCs in California today could benefit from an OASys retrofit. In the retrofit cases, finding new heating would not be necessary. However, not all RCs have a ready supply of water. While many RCs have sinks and drinking fountains, the two in this study had to have a water line brought out from over 25 feet away.

Service Life

Based on previous manufacturing knowledge of similar units, the useful service life of an OASys unit is expected to be 15 to 20 years. Although OASys cabinets have a lifetime guarantee, several components will need to be replaced on a shorter time interval. Expected media life is 3-5 years, depending upon water quality. Pumps should be expected to last up to 10 years. The indirect heat exchanger is warranted for up to 10 years.

The unit also requires annual maintenance, which includes cleaning of the sump and media and verification that water is uniformly distributed to the direct and indirect heat exchanger. Manufacturers of conventional HVAC systems recommend that air filters be checked and possibly changed monthly, and that the system be inspected annually by a qualified service technician.

Training Requirements

Schedules for routine IDEC maintenance should be supplied to the maintenance staff. A manufacturer's representative or trained HVAC technicians familiar with evaporative cooling technologies should provide the initial training. Manufacturer literature should clearly state inspection steps and expected replacement intervals for key components such as direct media, indirect heat exchanger, and pump.

A major component of customer satisfaction is careful training of the teachers to provide a clear understanding of the capabilities of the OASys unit. A simple brochure explaining the technology's benefits and limitations (potential for increased humidity) would be valuable to help teachers obtain the best performance from the system.

Indoor Humidity

Although the OASys classrooms maintained indoor humidity within ASHRAE 55 standard levels for all but a short amount of time, the added humidity provided by these units can be a concern for two reasons.

1. High relative humidity levels could potentially lead to the growth of mold, mildew, and dust mites.
2. High humidity levels can make pages stick together and paper difficult to handle.

Humidity levels can be controlled by operating the OASys unit only during occupied times and by providing controls that implement a dry-out schedule to purge moisture from the classroom. Although the potential exists for mold and mildew growth, our experience with evaporative coolers in dry climates has not found this to be a problem. Contrary to winter season conditions, when cold interior surfaces of walls and windows may contribute to condensation and the growth of mold and mildew growth, dry California summer conditions are less conducive to mold and mildew growth.

Discussion

As this project demonstrated, the OASys unit demonstrated significant energy and demand savings over the traditional air conditioning units used in RCs. In addition, the unit improved indoor air quality. Indoor relative humidity was found to be significantly higher in the OASys classrooms than in the control classrooms, due largely to the much lower setpoints selected in the OASys classroom. A lower setpoint causes the unit to operate longer and release more moisture into the indoor space. Better education of the teachers is needed to obtain optimal performance and comfort from an OASys unit.

With over 90,000 relocatable classrooms installed in K-12 schools throughout California, the potential for retrofitting OASys systems into existing RCs is significant. The IDEC unit is projected to have under a 5-year payback in retrofit applications with expected savings of over 900 kWh/year (depending on climate, occupancy patterns, and other usage factors).

Key barriers to commercialization include the following:

1. Emerging Technology: The OASys is currently available in limited production. This means higher costs than for a mature technology, a lack of skilled and trained installers, and an unproven record of performance and reliability. All of these issues need to be addressed before the technology achieves widespread acceptance.
2. Lack of Heating Capability: To avoid duplicate and costly HVAC systems, the OASys must provide a low cost heating component.
3. Indoor Comfort: The OASys unit will result in increased indoor relative humidity in virtually all applications. For some teachers this may prove unacceptable. This barrier may be overcome by educating teachers and maintenance staff.

Conclusions

The results of this report clearly demonstrate that in the applications monitored the OASys system can:

- reduce cooling energy use by an average of 71%
- reduce peak demand by 84%
- reduce average indoor CO_2 levels by 100 ppm.

Indoor relative humidity was higher in the IDEC conditioned classrooms, and the indoor wet bulb temperature did exceed the ASHRAE-55 limit of 68°F during some hours. However, indoor temperature set points were very low (approximately 70°F), causing longer system run times and therefore higher relative humidity than would have occurred if the indoor temperature set points had been 4 or 5°F higher.

All data indicate that the reliability of the OASys systems was excellent.

Recommendations for Future Work

There are currently over 90,000 relocatable classrooms installed in K-12 schools throughout California, most with old and inefficient envelopes, lighting, and HVAC systems. Further investigation of the condition of these existing units (perhaps by a state agency) will be needed to assess the market potential of IDEC or any other AC system accurately.

Because 2,500-4,000 RCs are added each year, it would be worthwhile to explore new construction as an additional market point-of-entry for OASys..

OASys systems have been shown to provide significant energy and demand savings. They are appropriate anywhere the design wet-bulb is below 70 degrees, which applies to all of California's central and inland valley areas.

The two most significant market barriers must be addressed:

1) Lack of a cost effective heating system

.Wall mount heat pumps are extremely cost effective because they provide both heating and cooling with the same unit. If an IDEC system is going to compete successfully against these systems it must have either an integrated heating system or be combined with a low-cost but efficient separate heating system. The integrated hydronic heating system used in the 2001 LBNL High Performance Commercial Building Systems project worked well, but required large capacity gas lines that were costly to install. Electric radiant panel heating has many potential benefits and should be investigated for use with the IDEC system.

2) Lack of an installation and maintenance infrastructure

Another strength of wall mount heat pumps is their robustness and ease of maintenance. Although their operating efficiency can suffer significantly, they will continue to operate even when severely neglected. Conversely, OASys units must be installed correctly and maintained consistently if they are to remain in top operating condition. Media pads quickly become ineffective and delivered air temperatures rise when the water delivery system is not maintained. The key to the operational success of OASys is the dedicated interest of maintenance personnel.

Considering some of the setbacks that occurred with the ET installations, the instructions for installation and maintenance training need improvement. Drawings could be improved to convey better the necessary equipment placements and supply electrical lines. The ability of contractors to efficiently install the equipment will improve as they gain more experience with the technology.