# THE BRAZOS VALLEY ENERGY CONSERVATION COALITION, PART OF THE REBUILD AMERICA PROGRAM IN TEXAS: PROGRAM UPDATE

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## ABSTRACT

The Rebuild America program is network of community-based partnerships that rebuilds communities by promoting the efficient use of energy. Rebuild America is coordinated at the national level by sponsorship through the Office of Energy Efficiency and Renewable Energy at the United States Department of Energy (USDOE). The Brazos Valley Energy Conservation Coalition (BVECC) has been a Rebuild America since 1996. Since 1996 BVECC has contacted 57 facilities in Texas about joining Rebuild America. Twenty-five of these facilities have authorized BVECC to conduct walk-through audits, and fourteen preliminary walk-through audits have been performed. As of June 1999, nine facilities have joined the Rebuild America program covering a total of 8 million square feet of conditioned area. The total estimated project costs for retrofits at these 9 facilities are over $11 million, with annual savings of $2.6 million and an estimated 4.3 year payback. This paper presents an overview of the BVECC Rebuild America program in Texas, including a description of the program, conservation measures installed at the participating facilities, a description of the savings measurement methodology and a discussion of indoor environmental measurements.

## INTRODUCTION

The Rebuild America program is network of community-based partnerships that rebuilds communities by promoting the efficient use of energy. Rebuild America is coordinated at the national level by sponsorship through the Office of Energy Efficiency and Renewable Energy at the United States Department of Energy (USDOE). Rebuild America has 250 partnerships in 47 states, Native American Tribes and in three U.S. Territories. Rebuild America's goal is to reduce the energy use in participating communities by 20-30%, which would amount to a nationwide savings of $650 million by 2003 and air pollution reductions of 1.6 million tons of carbon dioxide (USDOE 2000).

The Brazos Valley Energy Conservation Coalition (BVECC), administered by the Energy Systems Laboratory (ESL) of Texas A&M University, received a Rebuild America Partnership from the U.S. Department of Energy in June, 1996. BVECC is one of six Rebuild America Partners currently in Texas, which include: Rebuild Texas, the City of Texas City, Texas Christian University, EnerSource Capital, and the East Austin Economic Development Corporation. The original BVECC members and their associated responsibilities include program administration, monitoring and commissioning to be provided by the ESL, engineering services to be provided by the Texas Energy Engineering Services, Inc., (TEESI 2000), the City of Bryan (COB) and the Bryan Utilities (now Bryan Texas Utilities; BTU 2000) who provided many of the initial rebuild clients, and commercial financing provided by $mart Energy Systems (SES 2000). Figure 1 provides a organization chart for the original BVECC partners.

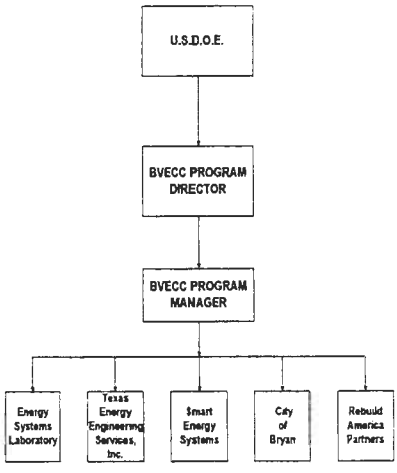



***Figure 1:*** *Organizational Chart of the BVECC Rebuild America program.*

*Table 1. Status of the Brazos Valley Energy Conservation Coalition (BVECC) Rebuild American Partnership*

| Item | Brazos County | Wichita Falls ISD | Bryan ISD |
|---|---|---|---|
| Area (sq.-ft) | 277,077 | 1.4 million | 1.6 million |
| Project Cost ($) | $601,541 | $2,511,382 | $741,427 |
| Annual Savings ($/yr.) | $95,139 | $293,090 | $178,657 |
| Payback Period (yr.) | 6.3 | 8.6 | 4.2 |
| Retrofits | Lighting retrofit, HVAC-replace DX units, replace cooling tower, Energy Management and Control System installations. | HVAC system upgrades and modifications including, Chiller replacements, Air Handling Unit replacements, Control system upgrades, VFD installations, Energy Management System installations and modifications, General lighting system upgrade, Lighting controls, Stadium lighting modification and upgrade, Gymnasium lighting retrofits, | Building Automation and Comfort Control, General lighting, Stadium lighting retrofit, Gymnasium lighting retrofits, Replace AHUs, IAQ projects (heat recovery systems), Boiler replacements, Chiller replacements (7), Install chiller plants, Air condition old gyms, Cooling tower replacements, Chill water and hot water pump replacements, Replace HVAC pipes, etc. |
| Energy Monitoring | Whole building electricity, chillers, lighting. | Whole building electricity, whole building gas at six schools. Utility bills analysis at the remaining schools. | Whole building electricity, chille and lighting at three BISD schoo (Will be expanded to other schools). |
| IAQ Measurements | Indoor/outdoor $CO_2$ levels, indoor/outdoor relative humidity, indoor/outdoor temperature. | None. | Pending. |

Since 1996 BVECC has contacted 57 facilities in Texas about joining Rebuild America. Twenty-five of these facilities expressed interest in a walk-through audits, and fourteen preliminary walk-through audits have been performed. As of June 1999 nine facilities have joined the Rebuild America program covering a total of 8 million square feet of conditioned area. The total estimated retrofit project costs for these 9 facilities are over $11 million, with annual savings of $2.6 million and an estimated 4.3 year payback.

Table 1 provides a summary of the nine facilities that have retrofits installed or pending as of June 1999. The information in this table includes the conditioned area of each site, the estimated project cost, estimated annual project savings, simple payback, a summary listing of the retrofits for each site, the type of metering installed to measure the savings and status of any IAQ measurement activities. In general, the energy conservation retrofits at these sites include lighting upgrades, HVAC systems modifications, chiller and boiler replacements, and EMCS upgrade/installations. These projects have been financed through a variety of funding mechanisms from internal facility funding to third party financing. The average payback period of all the retrofit projects is 4.3 years.

Retrofits for all sites except Texas A&M were identified using the procedures outlined in the following section. At Texas A&M the project primarily involves a combination of metering and Continuous Commissioning (Claridge et al. 1996). At the Scott and White Clinic administrators decided to implement and monitor the measures internally. Projects are pending at the Webb ISD and San Marcos ISD. Projects at all the remaining sites are either installed or under construction.

***Table 1 (cont).*** *Status of the Brazos Valley Energy Conservation Coalition (BVECC) Rebuild American Partnerships.*

| Item | College Station ISD | Texas A&M University | Education Service Center Region II |
|---|---|---|---|
| Area (sq.-ft) | 1.2 million | 3.0 million | 135,000 |
| Project Cost ($) | $1,501,539 | $2,150,000 | $285,631 |
| Annual Savings ($/yr.) | $183,811 | $1,550,000 | $30,878 |
| Payback Period (yr.) | 8.17 | 1.4 | 9.3 |
| Retrofits | Lighting retrofit, LED exit signs, Gymnasium lighting retrofit, HVAC upgrades, Boiler replacements, Pool heating boiler, Chiller replacement, Gym condensing unit replacement, Install dedicated MZU control, Irrigation Control, Continuous Commissioning, and Energy Management and Control System. installation and upgrade | Project involves Continuous Commissioning which involves evaluating and optimizing building HVAC controls in order to reduce energy costs without sacrificing customer comfort. A more subtle but equally important goal is to uncover and address maintenance deficiencies, and to conduct opportunity assessments of mechanical systems | Lighting system upgrade, Exit light modifications, Replace 110 ton air cooled chiller, replace four AHUs, Upgrade HVAC controls |
| Energy Monitoring | Under Construction | Whole building electricity, chilled water & hot water. | Utility Bills analysis |
| IAQ Measurements | Indoor/outdoor $CO_2$ levels, indoor/outdoor relative humidity, indoor/outdoor temperature. | Pending. | None |

| Item | Webb ISD | Scott & White Clinic College Station | San Marcos ISD |
|---|---|---|---|
| Area (sq.-ft) | 143,152 | 180,000 | 902,963 |
| Project Cost ($) | $240,500 | $106,000 | $3,034,640 |
| Annual Savings ($/yr.) | $32,000 | $16,500 | $239,600 |
| Payback Period (yr.) | 7.5 | 6.4 | 12.7 |
| Retrofits | General lighting retrofit, Exit light replacements, Air conditioning upgrades, Manual timers. | Office lighting retrofit, Lighting controls. | Lighting Retrofit, HVAC system modifications and installations, Control system modifications, Energy Management System installations, Electric rate study, meter consolidation study, |
| Energy Monitoring | Pending | None | Pending. |
| IAQ Measurements | Pending. | None | Pending |

## PROCEDURE

The following is a description of the procedures that are followed in the BVECC Rebuild America program (Figure 2). First, initial contact is made with a facility and the facility is asked to fill-in and return an initial contact form. After a facility signs the no-cost, no-obligation Rebuild America assessment form a initial walk-through audit is scheduled with one or more of the BVECC partners. The objective of this walk-through audit is to identify ECRMs and O&M measures. This preliminary audit is free of charge to the client and takes roughly 4 - 8 hours depending on the size of the facility. Each facility is also asked to provide copies of the last 12 months of all utility bills so that EUIs can be calculated. At this time the billing data are also evaluated to determine whether or not a monthly baseline model can be calculated and how accurate that model will be.

After the results of the preliminary audit have been analyzed a Facility Survey Report (FSR) is generated and representative members of the BVECC meet with the candidate and present the cost-effective ECRMs and discuss the potential to save energy and dollars at the facility. BVECC usually provides a plan to finance the energy conservation projects in case the facility is not able to arrange financing. Up to this point, the candidate is not obligated to pay for the walk-through audit or any preliminary analysis or presentations.

If the building owner or administrator chooses to participate in the program a more detailed energy audit of the facility is conducted by TEESI. The detailed audit is based on the ECRMs determined by the earlier walk-through energy audit. The detailed audit report will be generated by TEESI and reviewed by the ESL for adequacy and correctness of the engineering conceptual designs, implementation costs, metering costs, and payback periods. Short term energy monitoring equipment is often installed at this time and is included in the cost of the audit. Initially, a portion of the cost of the detailed audit (depending on the size of the facility) was paid by the USDOE-funded BVECC partnership, and the remainder is rolled into financing. More recent detailed audits have been completely financed by the facility. If the candidate chooses not to implement the ECRMs, then the candidate will be obligated to pay for the total cost of the detailed audit.

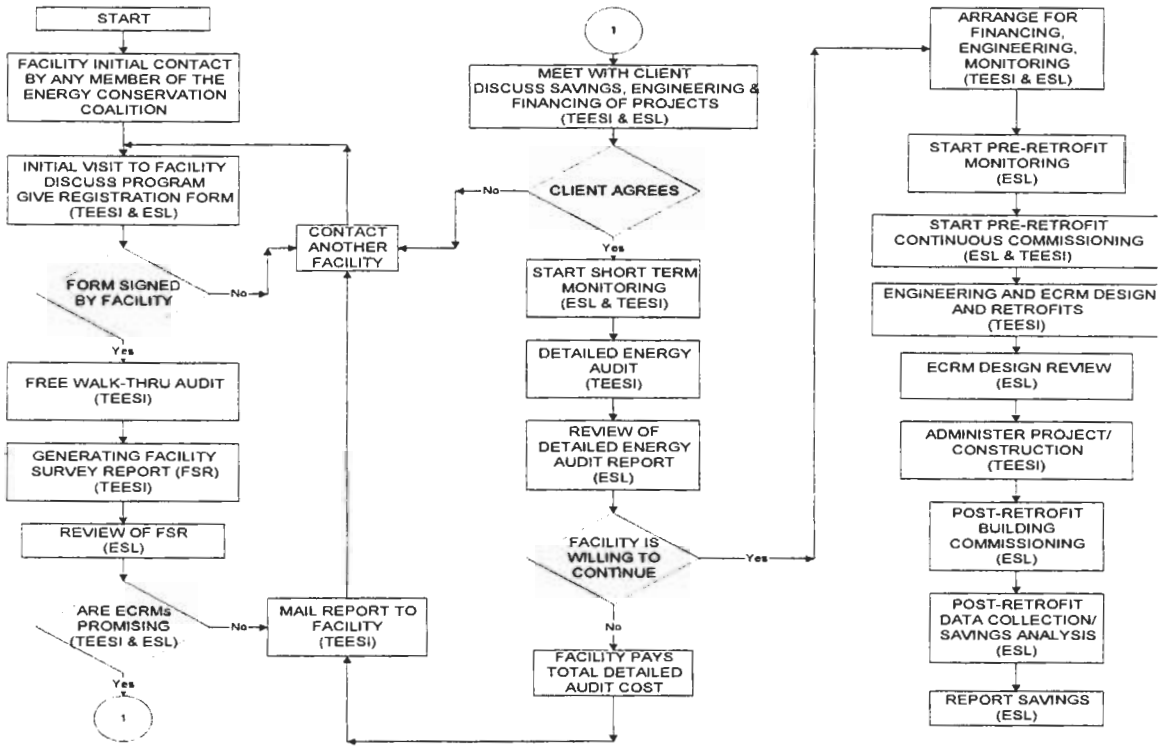



***Figure 2:*** *Flow Chart of the Procedure followed by the BVECC on Rebuild America Projects.*

Upon the completion of the detailed audit by TEESI and review of the audit by the ESL a second meeting is scheduled with the facility to discuss the recommendations from the detailed audit. If the facility decides to implement the ECRMs, the ESL installs permanent meters (as needed) at the facility for the collection of the baseline (pre-retrofit) and post-retrofit energy usage data. The cost of the permanent metering is paid by the building owner as part of the retrofit cost and is included in the implementation cost of the detailed audit. TEESI prepares the design/specification package and oversees construction of the energy conservation projects. At several of the facilities the ECRMs included Continuous Commissioning of the building's HVAC systems before the capitalized retrofits were installed.

The completed design/specification package is then delivered to the facility and the facility initiates the bidding process for the construction of the retrofits. This assures that the facility has control over the quality of the construction, choice of contractor, etc. TEESI and ESL provide advice as needed where it pertains the to installation and commissioning of ECRMs. In many cases training about energy conservation measures and O&M opportunities is provided to the facility personnel at their facility is also part of the program.

Savings generated from the implementation of the ECRMs are monitored and reported in quarterly reports using techniques developed at the ESL as part of the Texas LoanSTAR energy conservation program (Turner et al. 1998). In most cases the analysis follow Option C of IPMVP (USDOE 1997). If the savings do not match the anticipated audit-estimated savings, the BVECC works with the client to identify why and solve the problem.

## MEASURING ENERGY SAVINGS

The measurement of savings at the BVECC Rebuild sites is conducted primarily with before-after regression models (Kissock et al. 1994) that utilize the linear and change-point linear models recommended by the USDOE (IPMVP 1997) and by ASHRAE's Proposed Guideline 14P (ASHRAE 2000). The cost of the monitoring and verification falls within the IPMVP's guidelines which is about 4% of the retrofit cost and 1 to 2% per year for data collection and report generation. At those sites which represent a considerable investment hourly data loggers are installed that record whole-building electricity and, in other channels as needed for measuring the retrofits (e.g., whole-building natural gas or heating, whole-building cooling and the electricity used by the motor control centers). Continuous monitoring (when available) provides data that prompts changes in operation and maintenance practices to further reduce energy use in buildings. An accurate assessment of savings is necessary to ascertain if the ECRMs are performing as estimated. In some instances, the BVECC conducts short term monitoring during the detailed audit process, and pre/post retrofit monitoring period. The data from the pre-retrofit period can often be used to cross-check assumptions about operating hours, etc.

Figure 3 shows one of the savings calculations for a courthouse in central Texas. For this building, monthly utility billing data were used in the baseline model and hourly measurements were taken in the post-retrofit period to confirm the effectiveness of the retrofit. The baseline model for this building was a three-parameter change-point regression model that normalized the monthly energy use for variations in the billing period and ambient temperature (the solid line). The accuracy of the regression model is indicated by the dashed lines which border the baseline model. In the case of the court house, the electricity use is well described by the model and had a CV(RMSE) of 6.2%. This was significantly smaller than the anticipated savings from the retrofits, and therefore it was deemed accurate for reporting savings.

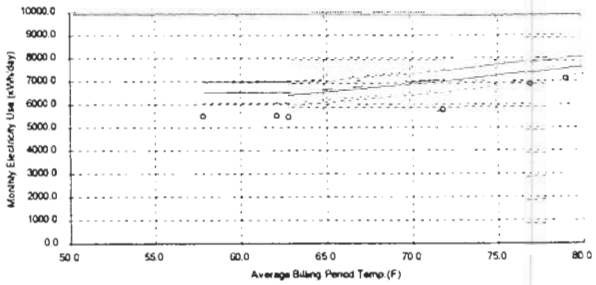



***Figure 3.*** *Example savings calculation. This figures shows an example savings calculation that uses a three parameter model. The solid line is the baselin e energy use in the post-retrofit period. The data point s are the post retrofit usage and the dashed lines are the confidence intervals (i.e., ± CV(RMSE)).*

Figures 4a and 4b are examples of the quarterly savings reports that are provided to a facility that participates in the BVECC Rebuild program. In the example shown (Figure 4a) the cumulative savings for the first eight months of 1999 are shown for the courthouse in tabular form along with the audit estimated savings, site contact information and any special comments about this site. Savings are calculated with constant dollars that use the costs in effect at the time of the Energy audit. Figure 4b graphically displays the same information contained in the table in Figure 4a, where savings are shown for electricity use, electric demand and cumulative savings for the year.

**Brazos Court House**
Brazos County

| Site Contact | ESL Metering Contact |
|---|---|
| **Name** | **Dr. Jeff Haberl** |
| Affil. | 053B WERC |
| City State Zip | Texas A&M University |
| | College Station, TX 77843-3581 |

January 1999 - August 1999
Summary of Measured Energy Consumption and Savings

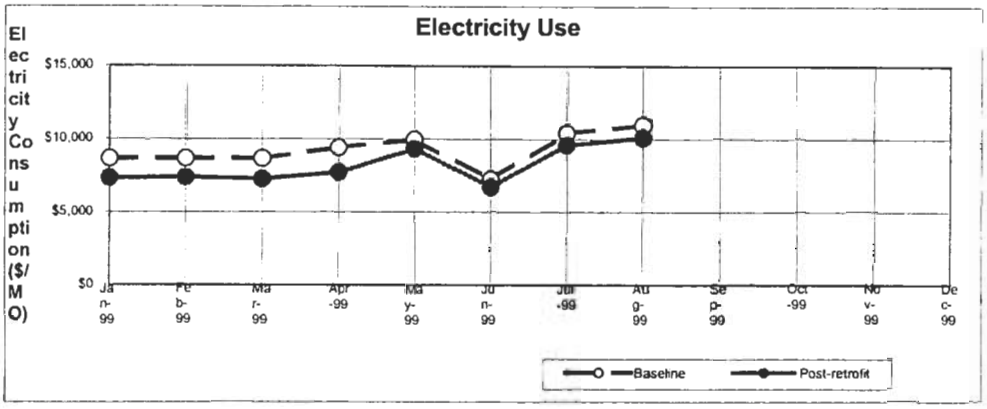
| | Electricity Use | | | Electric Demand | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Use | | Savings | Demand | | Savings | Monthly | Cumulative |
| Month | kWh | $ | $ | kW | $ | $ | Savings | Savings |
| Jan-99 | 170,475 | $7,330 | $1,342 | 340 | $2,159 | $548 | $1,890 | $1,890 |
| Feb-99 | 171,012 | $7,354 | $1,319 | 339 | $2,153 | $554 | $1,874 | $3,764 |
| Mar-99 | 169,016 | $7,268 | $1,405 | 339 | $2,153 | $554 | $1,960 | $5,724 |
| Apr-99 | 178,953 | $7,695 | $1,711 | 355 | $2,254 | $509 | $2,220 | $7,944 |
| May-99 | 216,850 | $9,325 | $659 | 417 | $2,648 | $191 | $851 | $8,794 |
| Jun-99 | 156,108 | $6,713 | $529 | 443 | $2,813 | $115 | $644 | $9,439 |
| Jul-99 | 223,155 | $9,596 | $644 | 450 | $2,858 | $103 | $947 | $10,386 |
| Aug-99 | 235,261 | $10,116 | $875 | 480 | $3,048 | $10 | $886 | $11,271 |
| Sep-99 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Oct-99 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Nov-99 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Dec-99 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| TOTAL | **1,520,829** | **$65,396** | **$8,686** | **3,163** | **$20,085** | **$2,588** | **$11,271** | |
| Audit Estimated Savings | | | **$7,608** | | | **$3,673** | **$11,281** | |

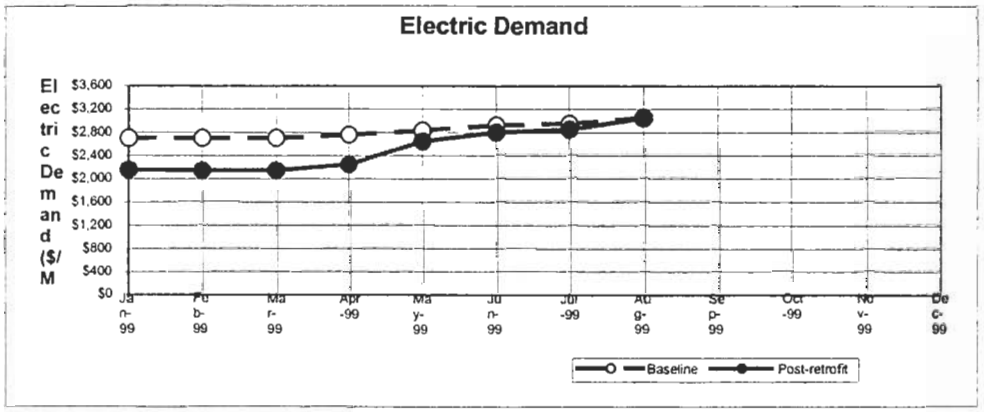
Comments:

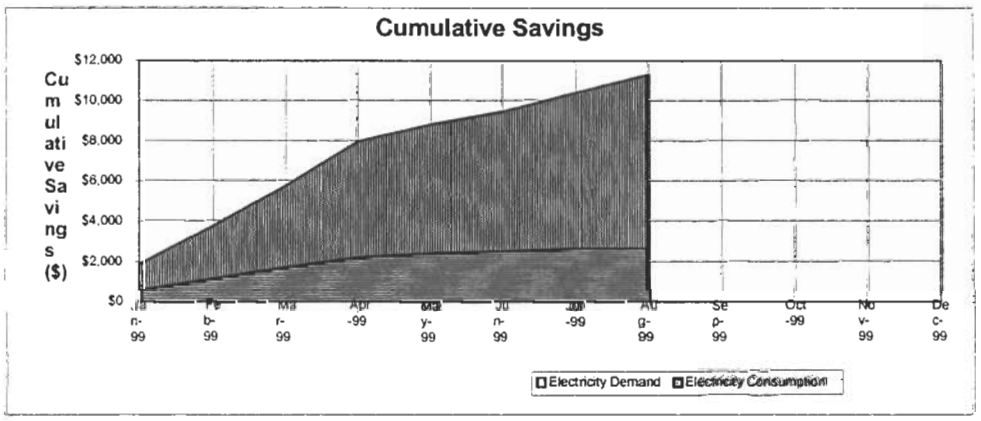
* Electricity monitoring began September 18, 1997.
* Retrofits started in April 98 and were finished in July 98.
* Unit costs: $0.043/kWh and $6.35/kW.
* Conditioned area 100,000 square feet.
* The installation of the EMS has not yet been completed.



***Figure 4a:*** *Example savings report for a BVECC Rebuild site. This figure shows the first page of a savings report for a courthouse in Central Texas.*




Brazos Court House

Energy Systems Laboratory | Rebuild America Cumulative Energy Consumption Report | Texas A&M University

***Figure 4b:*** *Example savings report for a BVECC Rebuild site. This figure shows the second page of a savings report for a courthouse in Central Texas.*

## MEASURING INDOOR IAQ

Short-term measurements are also taken using NIST-traceable instruments that consist of aspirated temperature, humidity and CO2 measurements. An example of the IAQ measurements taken during the school year at an intermediate school are provided in Figure 5. In Figure 5 the upper graph shows the indoor-outdoor temperature (F), the middle graph shows the indoor-outdoor relative humidity (%) and the lower graph shows indoor-outdoor CO2. Such measurements are taken to document conditions before any modifications are made to the HVAC equipment and can provide valuable information about a building's ventilation systems. In Figure 5 it is clear to see that indoor temperatures are well maintained, and relative humidity is kept below 60% during occupied periods. However, CO2 can be seen to rise above 1,000 ppm (i.e., the maximum recommended by ASHRAE 62-1999) for several hours each day which may be indicating inadequate ventilation during fully occupied periods.

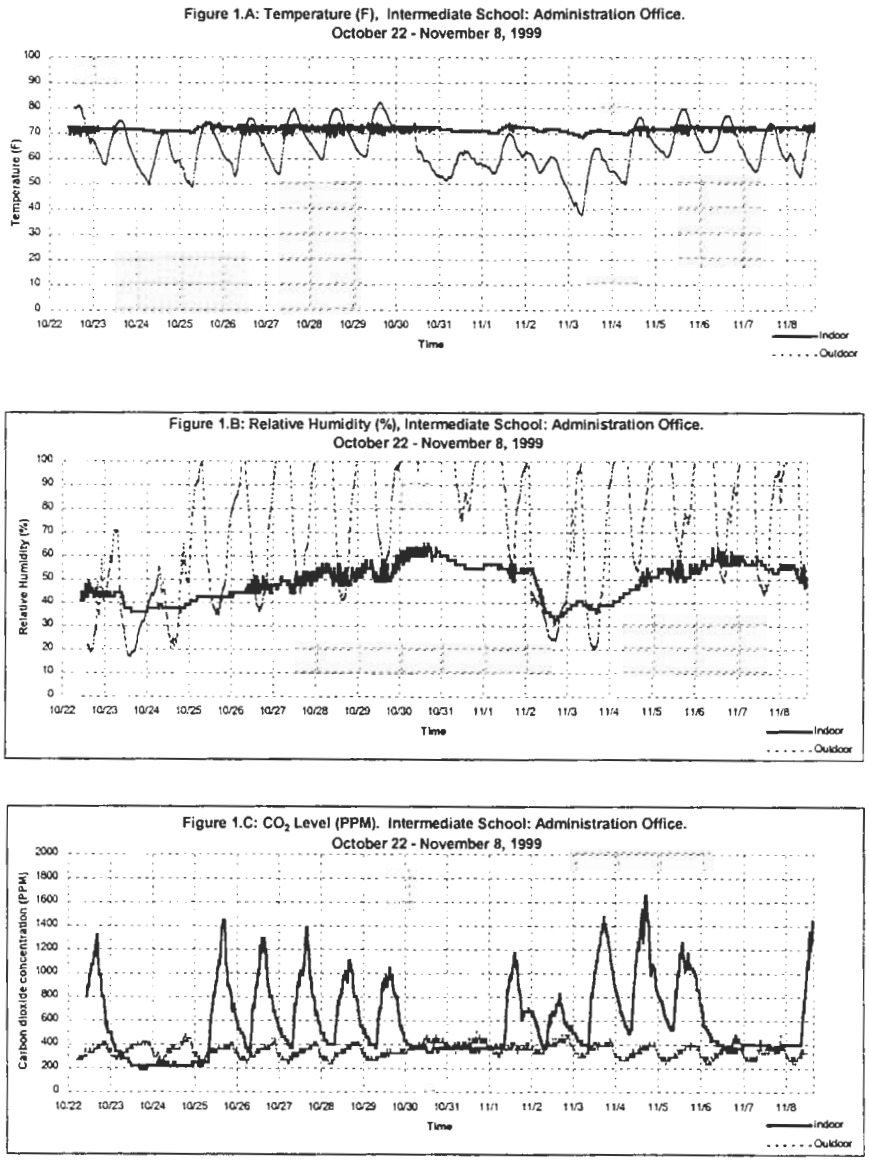



***Figure 5.*** *IAQ measurements at an intermediate school. This figure shows an example of IAQ measurements that are taken at a facility.*

## SUMMARY

The BVECC Rebuild America program has contacted 57 facilities in Texas in three years of operation. As of June 1999 nine facilities have joined the Rebuild America program covering a total of 8 million square feet of conditioned area. The total estimated retrofit project costs for these 9 facilities are over $11 million, with annual savings of $2.6 million and an estimated 4.3 year payback. Savings are primarily measured with before-after analysis techniques and are reported to participating facilities quarterly. Costs of M&V are held to the guidelines recommended by the USDOE's IPMVP. Indoor IAQ measurements are also provided to assure that HVAC modifications do not reduce the indoor environment and provide a useful diagnostic for evaluating ventilation rates. BVECC has already surpassed its goal of installing $6 million in retrofits in the first five years and, as a publicly funded energy conservation provider, is working to document how this was accomplished in order to assist the USDOE with technology transfer to other Rebuild American partners.

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BTU 2000, Bryan Texas Utilities, Utility Building, 205 E. 28th Street, Bryan, Texas, 77803,

TEESI 2000, Texas Energy Engineering Services, Inc., Capital View Center, 1301 Capital of Texas Highway, Suite B-127, Austin, Texas, 78746.

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