Rebuild America Program in Texas: Update on the Brazos Valley Energy Conservation Coalition

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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 partner 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 simple payback. This paper presents an overview of the BVECC Rebuild America program in Texas, including a description of the program and the projects, and details of conservation measures installed at one facility, 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 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), the City of Bryan, and the Bryan Utilities (now Bryan Texas Utilities - BTU) who provided many of the initial rebuild clients. Commercial financing for BVEWCC is provided by $mart Energy Systems ($ES).

Since 1996 BVECC has contacted 57 facilities in Texas about joining Rebuild America. Twenty-five of these facilities expressed interest in 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 simple 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 Indoor Air Quality (IAQ) measurement activities. In general, the energy conservation retrofits at these sites include lighting upgrades, heating ventilating and air-conditioning (HVAC) systems modifications, chiller and boiler replacements, and Energy Management and Control System (EMCS) upgrade/installations.

These projects have been financed through a variety of funding mechanisms from internal facility funding to third party financing. 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^{SM} (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 Independent School District (ISD) and San Marcos ISD. Projects at all the remaining sites are either installed or under construction.

Procedure

The following is a description of the procedures that are followed in the BVECC Rebuild America program (Figure 1). 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, an initial walk-through audit is scheduled with one or more of the BVECC partners. The objective of this initial walk-through audit is to identify Energy Conservation Retrofit Measures (ECRMs) and Operation and Maintenance (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 utility bills for 12 months so that Energy Use Indices (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. The accuracy of the monthly baseline model is a key factor in deciding if hourly metering is to be installed.

After the results of the preliminary audit have been analyzed a Facility Survey Report (FSR) is generated, representative members of the BVECC meet with the candidate to 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 is usually generated by TEESI and reviewed by the ESL for adequacy and correctness of the

engineering conceptual designs, implementation costs, metering costs, and simple 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. The remainder of the audit cost is rolled into financing. More recent detailed audits have been completely financed by the participating facilities. 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.

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 total 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^{SM} 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, as 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 the International Performance Measurement and Verification Protocols - IPMVP (USDOE 1997), which are the before-after analysis methods. 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 Savings

General Procedures. The measurement of savings at the BVECC Rebuild sites is conducted primarily with before-after regression models (Kissock et al. 1994; Haberl et al. 1998; Reddy et al. 1997a, 1997b; Claridge et al. 1994; Ruch et al. 1993; Claridge et al. 1991) that utilize the linear and change-point linear models recommended in the USDOE's 1997 IPMVP (USDOE 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 total retrofit cost and 1 to 2% per year for data collection and report generation. At those sites that represent a considerable retrofit investment hourly data loggers are installed that record whole-building electricity (WBE or Wbele) and other channels as needed for measuring the retrofits (e.g., whole-building natural gas - WBNG or heating - WBH, whole-building cooling - WBC and the electricity used by the motor control centers - MCC). 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 to assist with the analysis process. The short-term data from the pre-retrofit period can often be used to cross-check assumptions about operating hours, etc.

Figure 2 shows one of the savings calculation models 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 middle line). The accuracy of the regression model is indicated by the outermost lines, which border the baseline model (middle line). In the case of the courthouse, the electricity use is well described by the model and had a coefficient of variation of the root mean square error - CV(RMSE) of 6.2%. This was significantly smaller than the anticipated savings from the retrofits (i.e., 13% savings/usage ratio in Table 5), and therefore it was deemed accurate for reporting savings.

Figure 3 is an example of the quarterly savings reports that are provided to a facility that participates in the BVECC Rebuild program. In Figure 3 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. Retrofits for the courthouse include a lighting retrofit (completed), a cooling tower replacement (completed) and the installation of an EMCS (out for bid). Savings are calculated with constant dollars that use the costs in effect at the time of the energy audit. The second page of the report (i.e., the right side of Figure 3) graphically displays the same information contained in the table in the first page (i.e., the left side of Figure 3), where savings are shown for electricity use, electric demand and cumulative savings for the year.

Measuring Project-level Savings. Tables 2 to 4 provide a detailed look at the savings for one of the BVECC Rebuild projects where savings are now being reported. Table 2 shows a detailed list of the ECRMs identified for (10) buildings and includes the building where the ECRMs were recommended, the ECRM type, the audit estimated cost of the ECRM, the estimated annual natural gas savings (or penalty), the estimated annual electricity savings, the total savings (Electricity + N.G.), maintenance savings, and the status of the retrofit as of September 1999. Table 3 presents a summary of the retrofits by type of ECRM and Table 4 presents a summary of the measured savings for each of the facility as calculated with a whole-building before-after analysis.

In Table 3 over one half of the project cost can be seen going to HVAC upgrades which represent 53.4% of the retrofits costs, followed by lighting (27.2%), an EMCS upgrade (in one building - 18.4%), and motion sensors (1%). As expected, these ECRMs contributed differently to the annual savings, with the HVAC upgrades contributing 35%, the lighting retrofits contributing 33.2%, followed by an 11.6% contribution from the EMCS upgrade, and finally the motion sensors (1.1%). The average simple paybacks for the retrofits (before the maintenance savings allowance) varied from a low of 4.9 years for the lighting retrofits to a high of 9.5 years for the EMCS upgrade. The average simple payback for all the retrofits was 7.5 years (before the maintenance allowance). As indicated in Table 4, an $18,500 maintenance allowance was also estimated which is based on previous experience with

similar installations. This allowance accounts for the reduced maintenance of the (8) new HVAC systems, and reduced maintenance for a cooling tower, which further reduces the overall simple payback to 6.1 years.

In Table 4 the measured savings for the first 8 months of 1999 are presented for the retrofits that were completed in 9 of the 10 buildings. These savings were calculated with linear and change-point linear regression models using monthly baseline data and monthly or hourly post-retrofit data for the post-retrofit period, and exclude both the cost and savings of retrofits not completed as of August 1999. On average, for all the sites in Table 4, the measured savings amounted to 75.7% of audit-estimated savings. Although this value falls short of the expected savings it is within range of the previously reported values from the nationwide survey performed by Kats et al. (1996).

In the Brazos County buildings a number of factors had to be accounted for in order to begin to report quarterly savings after 8 months. First, several retrofits had not been completed, including DX units at the Courthouse Annex and the Brazos Center, and an EMCS in the Courthouse that had not been installed. Second, at the jail savings cannot be calculated with a before-after, whole-building analysis because of an increase in energy use during the post-retrofit period due to increased usage of the building and a nearby construction project that used the building's electricity panel to feed the construction activity. Third, several of the retrofits were completed during the 8-month period, which means that there are one or more months in the "post-retrofit" data that include baseline conditions. In such cases larger savings are anticipated during the following quarterly reports. Fourth, at a number of the sites where the DX units were upgraded, the maintenance personnel decided to replace only the condensing/compressor units and not the complete condenser/compressor/evaporator that may be contributing the lackluster performance (Table 4).

Finally, there is one additional point that needs discussion when one evaluates energy savings with regression models, and that is the relationship between the model statistics and the relative size of the retrofit savings when compared to the utility costs. This is presented in Table 5 where the model type, CV(RMSE), and the ratio of the savings to the 8-month usage are listed for each site. In Table 5 model types include three-parameter change-point models (3p), four parameter change-point models (4p) and one site where direct utility bill comparisons were used (which were normalized for the length of the billing period). The CV(RMSE) represents the RMSE divided by the average annual energy use and indicates what percentage of the annual energy use is not explained by the regression model. Good fitting models should have CV(RMSE) values that are less than the anticipated savings.

In Table 5 the use of monthly models (which use post-retrofit data from loggers at the Courthouse, Annex and Brazos Center) appears to be adequate for those sites where the CV(RMSE) is less than the calculated savings/usage ratio. At several sites the Savings/Usage ratio is less than the CV(RMSE) of the model, which indicates that there are other factors affecting the energy use that are not captured by the change-point model. If the CV(RMSE) is much larger than the savings/usage ratio then the use of the regression models to predict savings is questionable. Careful comparisons of these ratios are important in the design of the M&V program because they should be used to allocate scarce metering resources only to those sites where a monthly utility billing analysis will not measure savings. The total 8-month savings/usage ratio in Table 5 also shows that the retrofits chosen by the BVECC Rebuild program for the Brazos County buildings have reduced electric usage costs by 9.7%

for kWh and 11.6% for demand (kW). When one includes maintenance savings, the savings are 18.4% of the total 8 month costs, which is on-track for the Rebuild America's 2003 goal of a 20 to 30% reduction.

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 baseline IAQ measurements taken during the school year at an intermediate school is provided in Figure 4. In Figure 4 the upper graph shows the baseline (or pre-retrofit) 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 4 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., which is 700 ppm above outside air as recommended by ASHRAE 62-1999) for several hours each day which may be indicating inadequate ventilation during fully occupied periods. In some cases, modifications may be needed to the ventilation systems to increase the outdoor air fraction that can reduce the savings of any ECRMs associated with that building.

Summary

The BVECC Rebuild America program is generating $2.6 million in savings from $11 million in installed retrofits in Texas in three years of operation, with annual savings of $2.6 million and an estimated 4.3-year simple payback. The program has been designed to build on the successes of the Texas LoanSTAR program, including the measurement of before-after savings using linear and change-point linear models and the use of Continuous Commissioning^{SM} . Preliminary savings reported in one of the BVECC sites are less than audit estimates but are in general agreement with previously reported savings from LoanSTAR and other programs (Kats et al. 1996). BVECC has made several improvements to the procedures implemented in the LoanSTAR program and has introduced a few new procedures, including the use of portable metering at the time of the energy audit and the use of IAQ monitoring to document the conditions in the building prior to performing any modifications to the HVAC systems.

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 America partners with the goal of meeting the 20 to 30% reduction in energy use.

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

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
Simple Payback (yr.)	6.3	8.6	4.2
Retrofits	Lighting retrofit, HVAC- DX units, cooling tower, Energy Management and Control System installations.	HVAC system upgrades and modifications including: Chiller & Air Handling Unit replacements, Control system upgrades, VFD, Energy Management System, General lighting system upgrade, Lighting controls, Stadium lighting modification and upgrade, Gymnasium lighting retrofits,	Building Automation and Comfort Control, General, Stadium & Gymnasium lighting, Replace AHUs, IAQ projects (heat recovery systems), Boiler & Chiller replacements, Air condition old gyms, Cooling tower, chilled water and hot water pump replacements.
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, chillers, and lighting at three BISD schools. (Will be expanded to other schools).
IAQ Measurements	Indoor/outdoor CO_2 levels, indoor/outdoor relative humidity, indoor/outdoor temperature.	None.	Pending.

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
Simple Payback (yr.)	8.17	1.4	9.3
Retrofits	Lighting retrofit, LED exit signs, HVAC upgrades, Boiler & chiller replacements, Pool heating boiler, Gym condensing unit, MZU control, Irrigation Control, Continuous Commissioning, and EMCS	Project involves Continuous Commissioning of building HVAC controls. Fix maintenance deficiencies. 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
Simple Payback (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, Control system modifications, Energy Management System installations, Electric rate study, meter consolidation study,
Energy Monitoring	Pending	None	Pending.
IAQ Measurements	Pending.	None	Pending

Table 2. Project-level Savings for Local County Buildings.

	Description of Retrofit	Audit Estimated Cost of Retrofit $	Audit Est. Ann. N.G. Penalty $	Audit Est. Ann. Elec. Savings $	Audit Est. Total Ann. Savings (Ele-Gas) $	Status of the Retrofit as of September 1999
Tax Office	Install F32TB Lamps and Electronic ballast lighting retrofit	$9,549	-$76	$2,326	$2,250.00	Completed 3/26/98-8/21/98
Tax Office	Replace DX Units with high efficiency units	$14,070	$0	$1,816	$1,816.00	Completed 3/26/98-8/21/98
Tax Office	Install motion sensors	$1,258	-$10	$183	$173.00	Completed 3/26/98-8/21/98
Brazos Crthouse. Anx.	Install F32TB Lamps and Electronic ballast lighting retrofit	$13,697	-$115	$3,465	$3,348.00	Completed 3/26/98-8/21/98
Brazos Crthouse. Anx.	Replace DX Units with high efficiency units	$65,725	$0	$7,410	$7,410.00	Not completed
Brazos Health Dept	Install F32TB Lamps and Electronic ballast lighting retrofit	$9,195	-$75	$2,326	$2,251.00	Completed 3/26/98-8/21/98
Brazos Health Dept	Replace DX Units with high efficiency units	$58,324	$0	$7,162	$7,162.00	Completed 3/26/98-8/21/98
Minimum Security Jail	Install F32TB Lamps and Electronic ballast lighting retrofit	$13,424	-$143	$4,333	$4,190.00	Completed 3/26/98-8/21/98
Arena	Install F32TB Lamps and Electronic ballast lighting retrofit	$838	$0	$293	$293.00	Completed 3/26/98-8/21/98
Arena	Replace DX Units with high efficiency units	$14,635	$0	$1,766	$1,766.00	Completed 3/26/98-8/21/98
Ag. Extension building	Install F32TB Lamps and Electronic ballast lighting retrofit	$3,978	-$33	$1,038	$1,005.00	Completed 3/26/98-8/21/98
Ag. Extension building	Replace DX Units with high efficiency units	$7,079	$0	$883	$883.00	Completed 3/26/98-8/21/98
Ag. Extension building	Install motion sensors	$1,032	-$9	$202	$193.00	Completed 3/26/98-8/21/98
Road & Bridge Shop	Install F32TB Lamps and Electronic ballast lighting retrofit	$6,855	-$51	$1,639	$1,588.00	Completed 3/26/98-8/21/98
Road & Bridge Shop	Replace DX Units with high efficiency units	$7,079	$0	$883	$883.00	Completed 3/26/98-8/21/98
Road & Bridge Shop	Install motion sensors	$646	-$5	$144	$139.00	Completed 3/26/98-8/21/98
Constable's Office	Install F32TB Lamps and Electronic ballast lighting retrofit	$2,851	-$20	$666	$645.00	Completed 3/26/98-8/21/98
Constable's Office	Replace DX Units with high efficiency units	$5,944	$0	$706	$706.00	Completed 3/26/98-8/21/98
Constable's Office	Install motion sensors	$806	-$5	$87	$87.00	Completed 3/26/98-8/21/98
Brazos Center	Install F32TB Lamps and Electronic ballast lighting retrofit	$22,603	-$182	$4,834	$4,653.00	Completed 3/26/98-8/21/98
Brazos Center	Replace DX Units with high efficiency units	$96,336	$0	$8,875	$8,875.00	Not completed
Brazos Center	Install motion sensors	$2,129	-$32	$537	$505.00	Completed 3/26/98-8/21/98
County Courthouse	Install F32TB Lamps and Electronic ballast lighting retrofit	$76,565	-$512	$12,476	$11,964.00	Completed 3/26/98-8/21/98
County Courthouse	Replace cooling tower	$44,128	$0	$4,446	$4,446.00	Completed1/20/98-4/15/99
County Courthouse	Install EMS	$107,795	$0	$11,249	$11,249.00	Not bid yet
Total Energy Savings		**$586,541**	**-$1,268**	**$79,475**	**$ 78,480.00**	
Maintenance Savings	**(7.5%lighting, 45 HVAC, 4 hrs/mo- tower):**				**$18,500**	
Total (Energy+Main)					**$96,980.00**	

Table 3. Summary of Costs and Savings by ECRM Type at Brazos County Buildings.

ECRM Type	Estimated Retrofit Cost		Estimated Annual Savings		Simple Payback (yrs)
	Cost	Percent of Total	Annual Savings	Percent of Total	
Lighting	$159,555	27.2%	$32,187	33.2%	4.9
Motion Sensors	$5,871	1.0%	$1,097	1.1%	5.4
HVAC upgrades	$313,320	53.4%	$33,947	35.0%	9.2
EMCS	$107,795	18.4%	$11,249	11.6%	9.5
Sub-total	$586,541	100.0%	$78,840	80.9%	7.5
Maintenance Savings	--	--	$18,500	19.1%	--
Total	$586,541	100.0%	$96,900	100.0%	6.1

Table 4 Summary of Estimated and Measured Retrofit Savings (8 month).

Building	Measured Savings $			Audit Estimated	Ratio: Meas/Est
	Wbele	Demand	Total	Savings $	%
Agriculture Extension	$702	$178	$880	$1,415	62.2%
Arena Hall	$781	$17	$798	$1,373	58.1%
Brazos Center	$1,434	$2,253	$3,687	$3,581	103.0%
Brzs. Cnty. Annex	$667	$1,055	$1,721	$2,310	74.5%
Brzs. Cnty. Courthouse	$8,686	$2,587	$11,273	$11,281	99.9%
Constable's Office	$630	$231	$861	$972	88.6%
Health Department	$2,629	$196	$2,825	$6,326	44.7%
Minimum Security Jail	N.A.	N.A.	N.A.	N.A.	N.A.
Road & Bridges Shop	$440	$360	$801	$1,777	45.0%
Tax Office	$792	$519	$1,311	$2,884	45.5%
Total Elec.Savings (8mo)	$16,762	$7,395	$24,157	$31,918	75.7%
Main.-N.G.Savings (8mo)				$11,488	
Total Savings (8mo)				$43,406	

Table 5. Summary of Regression Model Statistics and Savings to Usage Ratio.

Building	Model Statistics [model type, CV(RMSE)%]		8 mo. Savings/Usage	
	Wbele	Demand	Wbele	Demand
Agriculture extension	3p, 5.6%	3p, 8.3%	28.0%	14.2%
Arena Hall	Direct	Direct	76.8%	1.3%
Brazos Center	3p, 11.3%	3p, 9.3%	6.5%	20.1%
Brzs. Cnty. Annex	3p, 11.7%	4p, 6.2%	4.0%	16.4%
Brzs. Cnty. Courthouse	3p, 6.2%	3p, 3.6%	13.0%	12.9%
Constable's Office	3p, 5.5%	3p, 6.4%	23.0%	22.3%
Health Department	3p, 7.4%	3p, 10.4%	28.8%	4.4%
Minimum Security Jail	N/A	N/A	N/A	N/A
Road & Bridges Shop	3p, 4.1%	3p, 9.0%	9.0%	18.0%
Tax Office	3p, 5.1%	3p, 3.9%	16.0%	21.0%
Total (8mo)	--	--	9.7%	11.6%

NOTE: Total 8 mo. Savings/Usage values do not include the Minimum Security Jail.

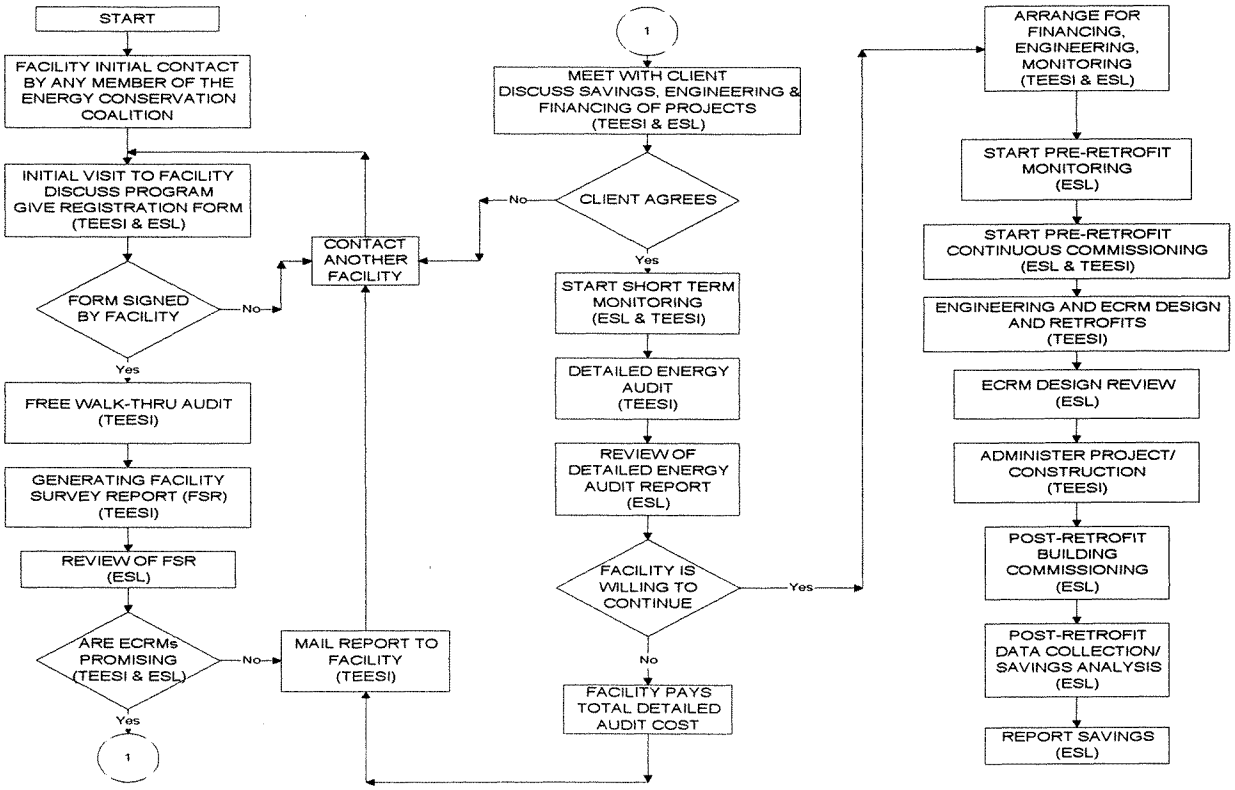


Figure 1: Flow Chart of the Procedure followed by the BVECC on Rebuild America Projects.

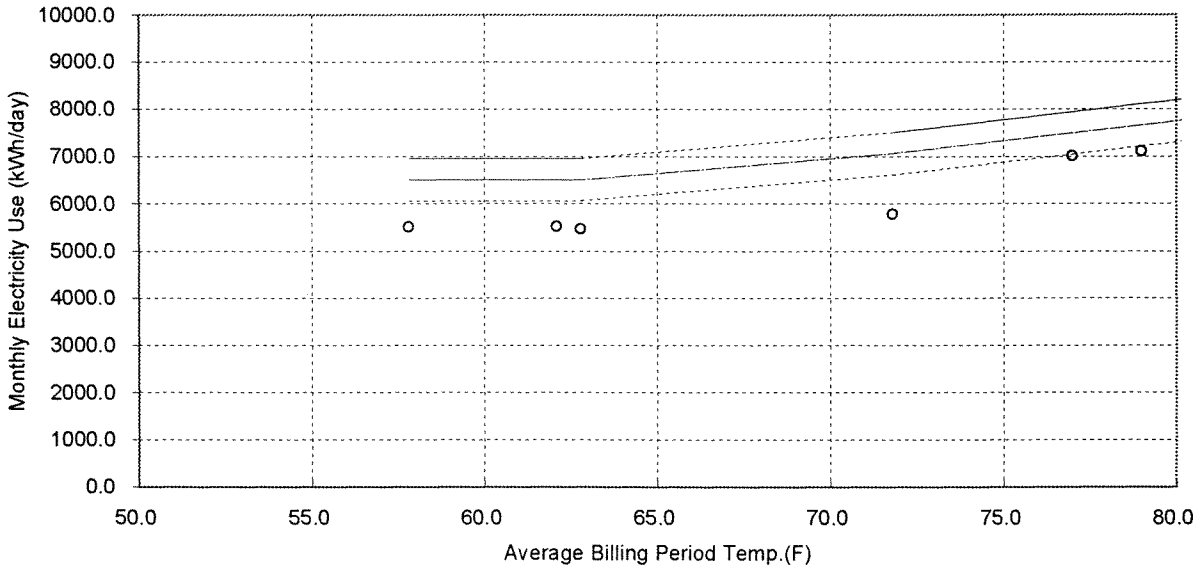
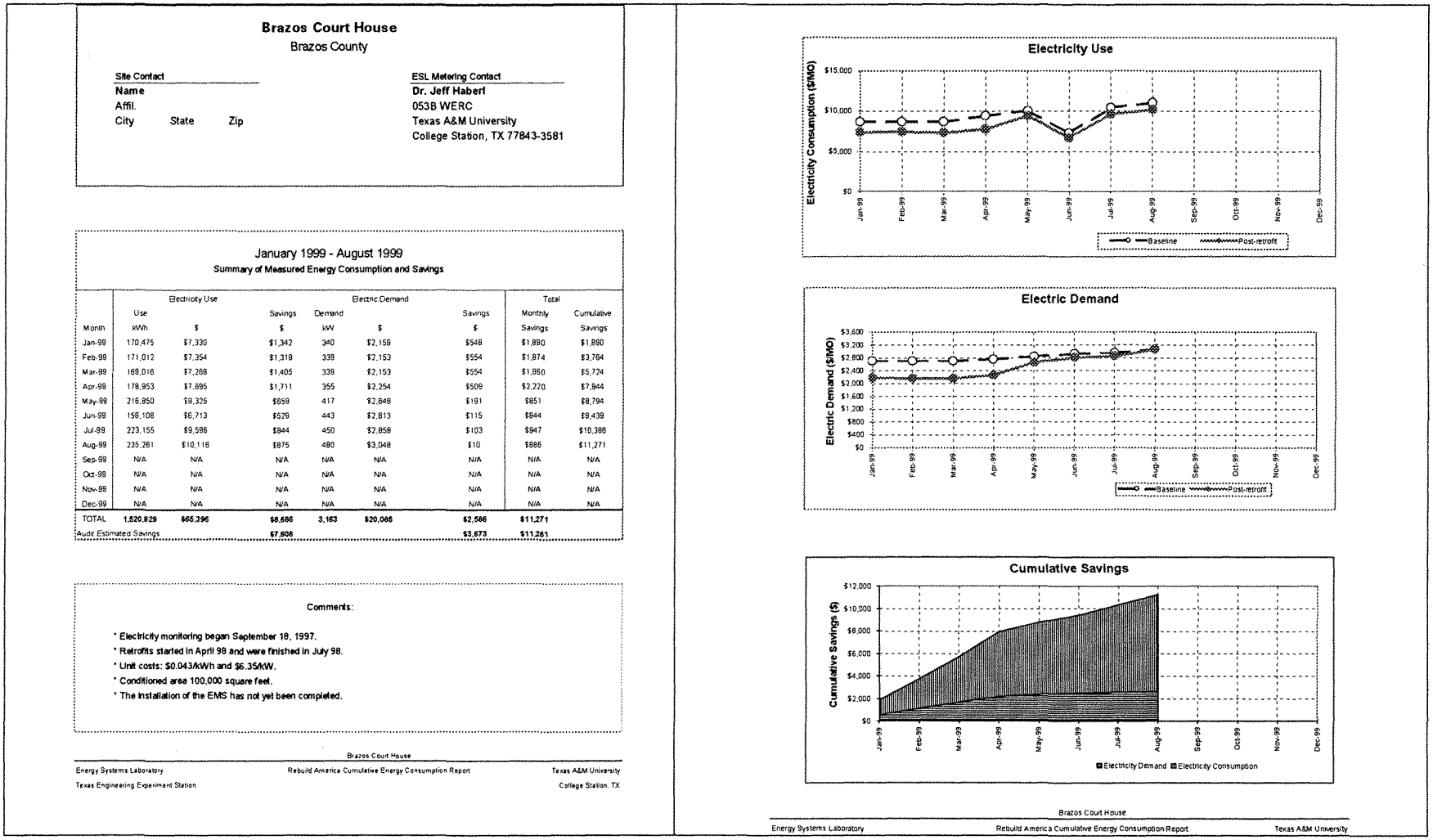


Figure 2. Example savings calculation. This figures shows an example savings calculation that uses a three parameter model. The solid line is the baseline energy use in the post-retrofit period. The data points are the post retrofit usage and the dashed lines are the confidence intervals (i.e., ± CV(RMSE)).



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

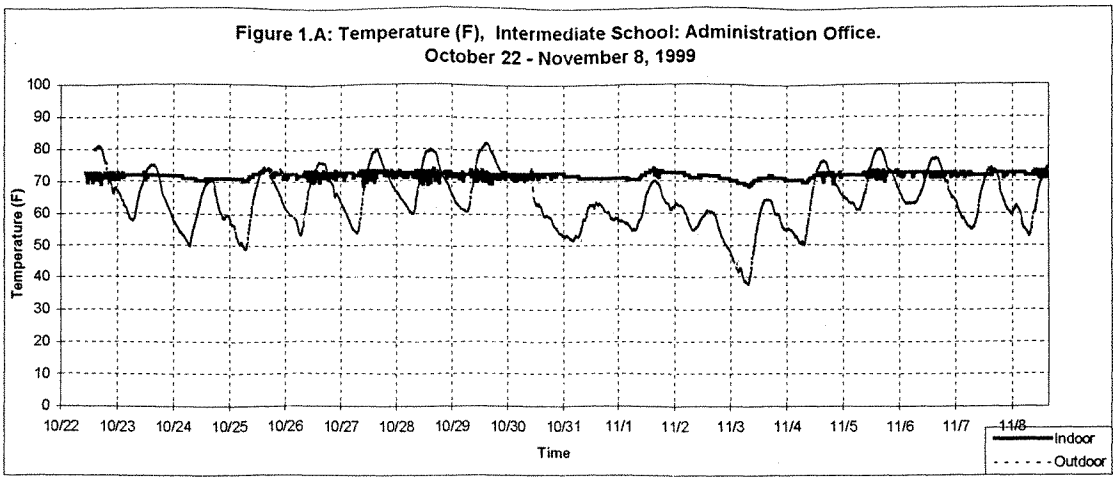
	Electricity Use			Electric Demand			Total	
	Use		Savings	Demand		Savings	Monthly	Cumulative
Month	kWh	$	$	kW	$	$	Savings	Savings
Jan-99	170,475	$7,330	$1,342	340	$2,159	$548	$1,890	$1,890
Feb-99	171,012	$7,354	$1,319	339	$2,153	$554	$1,874	$3,764
Mar-99	169,016	$7,268	$1,405	339	$2,153	$554	$1,960	$5,724
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	$844	450	$2,858	$103	$947	$10,386
Aug-99	235,261	$10,118	$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**	**$2,586**	**$11,271**	
Audit Estimated Savings			**$7,608**			**$3,673**	**$11,281**	

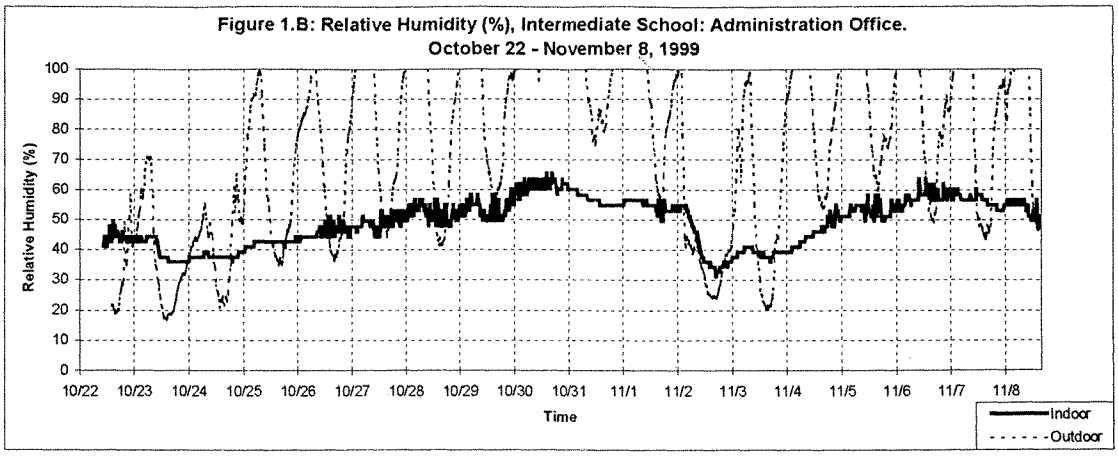
Comments:

* 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.

Brazos Court House
Energy Systems Laboratory — Rebuild America Cumulative Energy Consumption Report — Texas A&M University
Texas Engineering Experiment Station — College Station, TX

Figure 3: Example savings report for a BVECC Rebuild site. This figure shows the two page savings report for a courthouse in Central Texas.





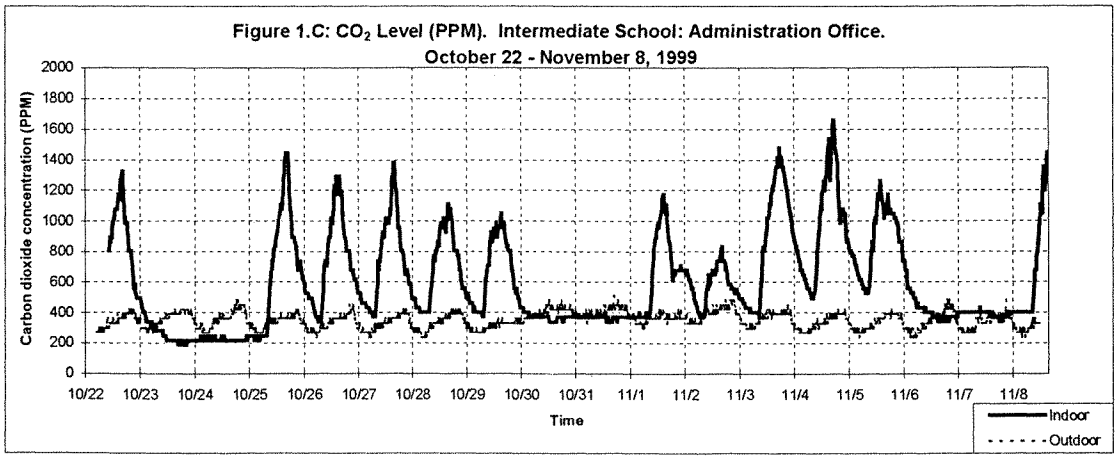


Figure 4. IAQ measurements at an intermediate school. This figure shows an example of IAQ measurements that are taken at a facility.