OVERVIEW OF THE REBUILD AMERICA PROGRAM IN TEXAS

Namir Saman, Ph.D., P.E., CEM
Project Development Engineer
PG&E Energy Services*
6900 E. Camelback Rd., Ste. 800
Scottsdale, AZ 85251

Jeff Haberl, Ph.D., P.E.
Associate Professor
Energy Systems Laboratory
Texas A&M University System
College Station, TX 77843

W. Dan Turner, Ph.D., P.E.
Director
Energy Systems Laboratory
Texas A&M University System
College Station, TX 77843

ABSTRACT

The Rebuild America program is a multi-year program, through the U.S. Department of Energy (USDOE), that will increase investment in energy efficiency. As the program progresses, it will save energy, create jobs, and improve the environment. The Brazos Valley Energy Conservation Coalition (BVECC), administered by the Energy Systems Laboratory (ESL) of Texas A&M University, in College Station, Texas received notification of the U.S. Department of Energy (USDOE)-Rebuild America award in June, 1996. In the first year of this partnership, the BVECC has developed three Rebuild America related projects in Texas totaling more than $3 million in construction costs.

The energy conservation retrofits in the three projects include a lighting upgrade, HVAC systems modifications, and an EMCS upgrade/installation. These projects have been financed through internal facility funding or through third party financing institutes. The average payback period of the retrofit projects is eight years. This paper presents an overview of the BVECC Rebuild America program in Texas. It also describes the energy conservation projects in three facilities in Texas where energy conservation retrofits are being implemented.

INTRODUCTION

The Brazos Valley Energy Conservation Coalition (BVECC), administered by the Energy Systems Laboratory (ESL) of Texas A&M University, in College Station, Texas received notification of the U.S. Department of Energy (USDOE)-Rebuild America award in June, 1996. The contract was finalized between the Texas Engineering Experiment Station (TEES) and USDOE in November 1996. The BVECC members include the Energy Systems Laboratory (Texas A&M University), Texas Energy Engineering Services Inc. (TEESI), City of Bryan (COB), $mart Energy (SE) financing company, along with other Rebuild America partners in Texas (see Figure 1 for a flow chart of the BVECC). The BVECC stated goal is to implement energy conservation/environmental improvement projects in Texas with a total cost of approximately $6 million, in facilities with 2 million square feet of area within a five-year period.

Rebuild America partners are encouraged to participate in selecting Energy Cost Reduction Measurers (ECRMs) suitable for their facility, capital improvement priorities and the financial plan that uniquely fits their needs. The BVECC Rebuild America program has extensive experience in designing, financing and installing such energy conservation retrofits. The range of projects planned for the Rebuild America Program is summarized in Table 1.

Table 1 shows Energy Cost Reduction Measures (ECRMs) that will be recommended for Rebuild America energy conservation projects. The ECRMs are divided into eight broad categories based on projects most commonly recommended by audit firms, namely, chillers (C), energy management systems or EMS (E), heating, ventilating and air conditioning or HVAC (H), lights (L), motors (M), pumps (P), steam systems (S), and miscellaneous (O). A subcategorization is used to further distinguish between different types of retrofits which could be envisioned on the same equipment. Subcategorizations are identified by using a number next to the letter representing the major category. The

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first three subcategories are consistent from category to category. Subcategory 1 involves control modifications, 2 relates to equipment change/replacement, and 3 is upgrade. The types of ECRMs in the miscellaneous category included O1, electric rate schedule revisions, power factor corrections, combination of electric meters, peak shaving with generators and cogeneration; O2, timeclock control and pipe insulation; and O3, solar shading, window films, wall and ceiling insulation, reduction of infiltration and storm windows. Table 1 also shows types of projects in the various subcategories.

PROCEDURE

The following is a description of the procedures that are followed after a facility signs the initial no-cost, no-obligation Rebuild America assessment form (Figure 2 shows a flow chart of the complete Rebuild America Project approach adapted by the BVECC):

1- Upon owner's permission, a preliminary walk-through energy audit is conducted at the customer's facility by TEESI. 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.

2- Representative members of the BVECC meet with the candidate and present the ECRMs and discuss the potential to save energy and dollars at the facility. The BVECC also proposes a plan to finance the energy conservation projects. Up to this point, the candidate is not obligated to pay for the walk-through audit or the presentations.

3- 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. An audit report will be generated by TEESI and reviewed by the ESL for adequacy and correctness of the engineering conceptual designs, implementation costs and payback periods. Short term energy monitoring equipment is also installed at this time and is included in the cost of the audit. Part of the cost of the detailed audit (depending on the size of the facility) is paid by the BVECC. The remainder is rolled into financing. 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.

4- If the candidate decides to implement the ECRMs, the ESL develops a metering plan and installs permanent meters at the facility for before/after retrofit energy data collection. The cost of the permanent metering is paid by the building owner as part of the retrofit cost. TEESI prepares the design/specification package and oversees construction of the energy conservation projects.

5- Training of facility personnel on energy conservation measures and O&M opportunities at their facility is also part of the program to be conducted by the BVECC Rebuild America program.

6- 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. In addition, savings analysis follow primarily Option C of IPVMP (Reference 7). If the savings do not match the audit report anticipation, the BVECC works with the client to identify why and solve the problem.

ENERGY USE MONITORING

Continuous monitoring provides data that prompts changes in operation and maintenance practices to further reduce energy use in buildings. Monitoring is a highly important task that is often ignored or overlooked by administrators following the application of ECRMs. In addition, the BVECC is planning to conduct short term monitoring during the detailed audit process, and pre/post retrofit monitoring when the retrofit projects are approved by the owner(s) of the facility.

During the detailed audit of a facility, portable meters are installed for short-term monitoring (one month) to provide improved information for the audit and valuable pre-retrofit data which has also helped determine the kind and placement of permanent meters. The short-term monitoring is not provided by any other energy conservation program in the country. The short term monitoring data will aid in improving the detailed audit report. The BVECC team has extensive experience with metering installation and data acquisition projects. In addition, members of our team have become national leaders in the development of protocols and procedures for measuring savings and reporting these savings.

CURRENT PROJECTS

Table 2 summarizes current BVECC Rebuild America projects in Texas. The three Rebuild

America projects in Texas cover more than three million square feet of facilities totaling more than $3.5 million in construction costs. Energy and IAQ monitoring and savings calculations have been performed at two of the three Rebuild America projects. The type of energy retrofit projects range from lighting retrofits to implementing EMCs.

RESULTS

Case Study: Bryan ISD-Energy Savings

The energy conservation measures initiated at three schools of Bryan ISD in Texas, namely, Sam Houston Elementary School, Sam Rayburn Middle School, and Bryan High School have resulted in large energy savings in FY96, FY97, and the first quarter of FY98 as compared to FY95 (chosen as the base year.) The electricity and gas savings calculations (see Table 3 for model details) showed that the three schools have saved $128,023 in electricity and $41,142 in gas in FY96, $141,673 in electricity and $46,476 in gas in FY97, and $22,458 in electricity and $9,226 in gas in the first quarter of FY98.

Figures 3 through 8 show comparisons between the time series plots of measured enrollment-normalized gas use and electricity use and baseline predicted energy use at the three schools. The areas between the curves show the savings in energy consumption. Compared to FY95, Bryan High School saved 69.3% in gas consumption and 29.3% in electricity consumption. Sam Houston Elementary School saved 11.2% in electricity consumption and 22.6% in gas consumption. For Sam Rayburn Middle School decreases in electrical consumption were 8.9%. The decrease in gas consumption was very significant, dropping 57.9%.

Case Study: Brazos County-IAQ Measurements

The ESL has started short-term/pre-retrofit monitoring of energy consumption at two Rebuild America projects. The ESL is currently collecting data at three Brazos County Buildings and three Bryan ISD schools. The monitoring includes whole building electricity, chillers, motor control center, and Indoor Air Quality (IAQ) measurements. Samples of the IAQ data (indoor/outdoor temperature, relative humidity and CO_2) collected by the ESL at the Brazos Center building in Bryan, Texas are shown in Figures 9, 10, and 11. The IAQ measurements at the Brazos Center were conducted for a period of two weeks. For the first week the data were collected at an office space. For the second week, the data were collected at the Brazos County Museum of Natural History. The IAQ measurements show how well the HVAC systems/controls are working. For example, it is clear from figure 10 that the HVAC system is closely controlled to keep the humidity level within a narrow range at the Brazos County Museum.

CONCLUSIONS

1- The Rebuild America program sponsored by the USDOE is an excellent opportunity for facilities to conduct energy conservation projects. The case studies at BISD and the Brazos County show that energy conservation not only results in facility upgrades, but also it pays for itself at the same time.

2- BVECC is well on-track toward accomplishing the $6 million in retrofits within five years.

3- Meters have been installed at Bryan ISD and the Brazos County, and data are being collected for analysis.

4- BVECC has developed portable metering for use in the audit calculations and pre-retrofit analysis.

5- BVECC has developed IAQ portable meters to accretion if indoor environment conditions are being maintained.

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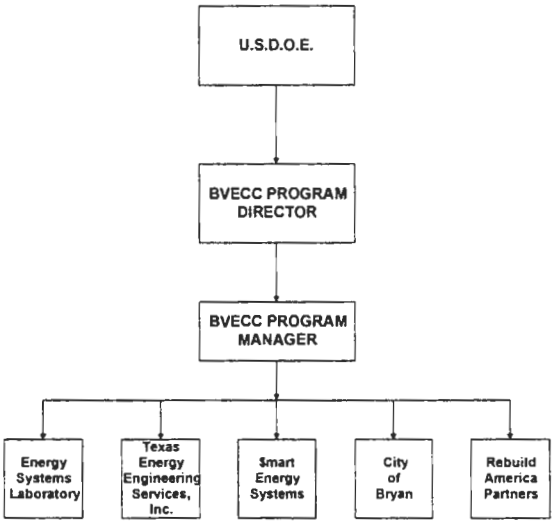

Figure 1- Organizational Chart of the BVECC Rebuild America program

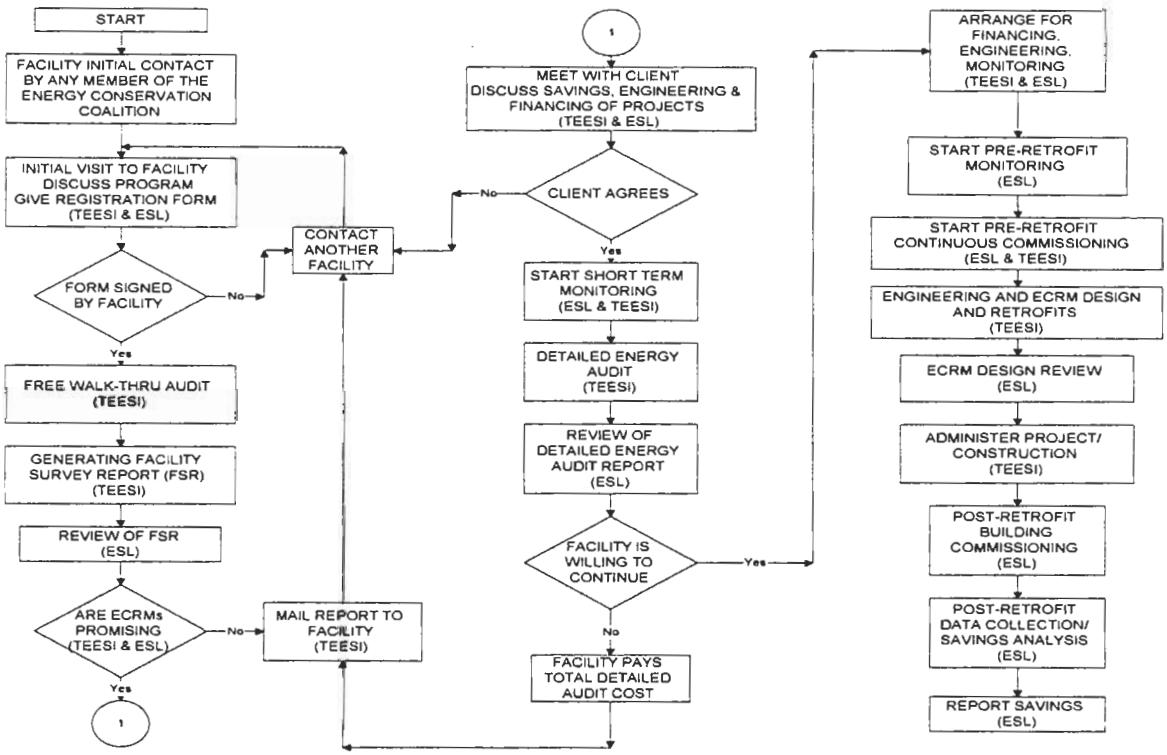

Figure 2- Flow Chart of the Procedure followed by the BVECC on Rebuild America Projects.

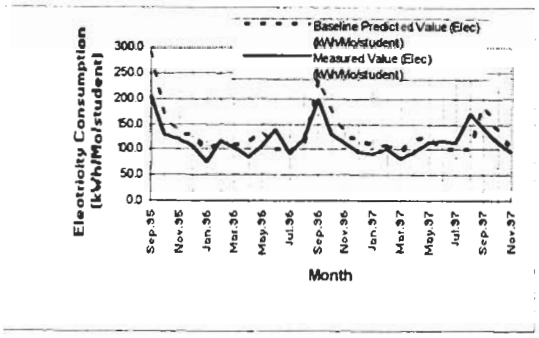

Figure 3. Monthly Predicted and Measured Electricity Energy Consumption for Sam Houston Elementary School.

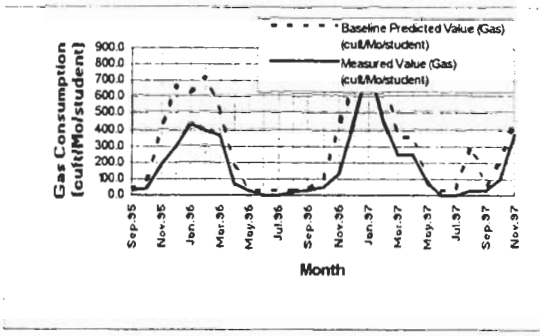

Figure 6. Monthly Predicted and Measured Gas Consumption for Sam Houston Elementary School.

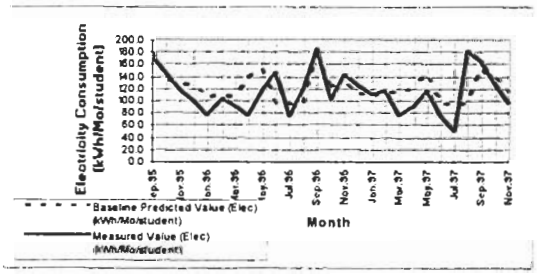

Figure 4. Monthly Predicted and Measured Electricity Energy Consumption for Sam Rayburn Middle. .

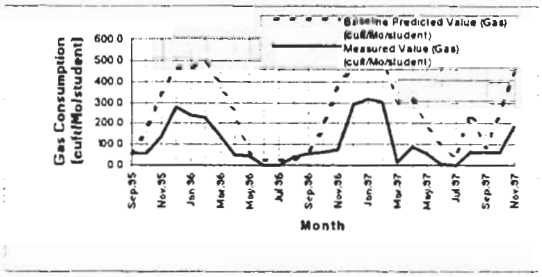

Figure 7. Monthly Predicted and Measured Gas Consumption for Sam Rayburn Middle School.

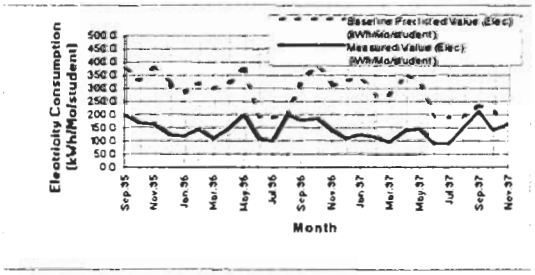

Figure 5. Monthly Predicted and Measured Electricity Energy Consumption for Bryan High School.

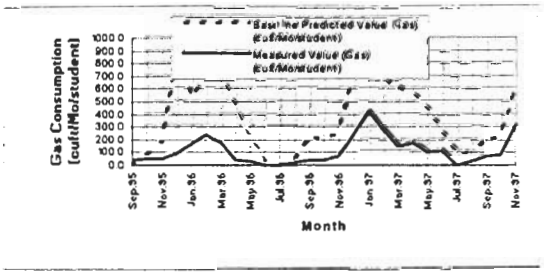

Figure 8. Monthly Predicted and Measured Gas Consumption for Bryan High School.

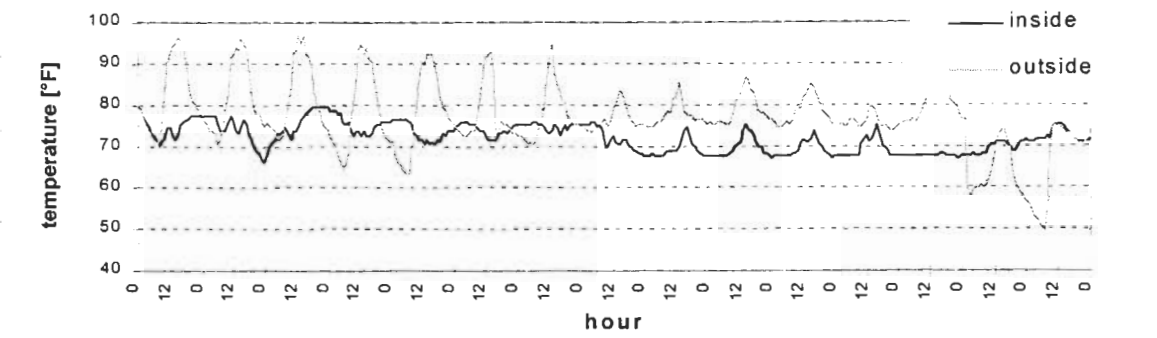

Figure 9- Time series plot of inside and outside temperatures at the Brazos Center.

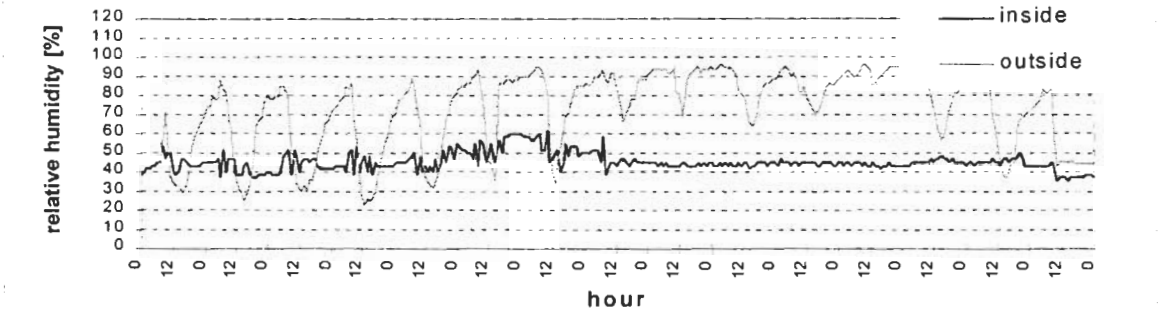

Figure 10- Time series plot of inside and outside relative humidity at the Brazos Center.

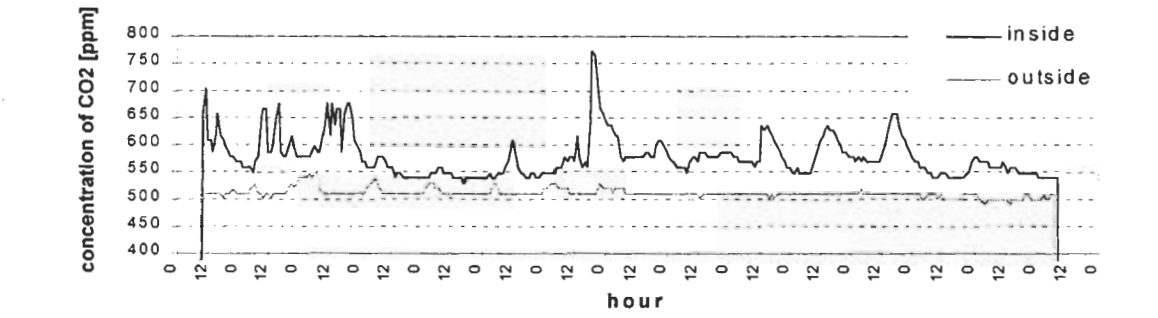

Figure 11- Time series plot of inside and outside CO_2 concentrations at the Brazos Center.

TABLE 1- Types of Energy Conservation Projects to be Proposed for the Rebuild America Program.

Major Categories	Subcategories	Types of Projects Considered
CHILLER	C1: Controls	Automatic chilled water reset, chiller lead/lag modification, DDC of chillers, condenser water reset, modify chiller control.
	C2: Equipment change	Air to water cooled chillers, replace absorption chillers, high efficiency chillers, remove through wall units, new base load chillers, use gas driven chillers, replace cooling towers.
	C3: Upgrade, optimize	Re-tube steam driven centrifugal chiller, increase CHW system efficiency, utilize plate frame heat exchanger, chiller evaluation, optimize CHW performance, repair cooling tower.
	C4: Piping changes	Condenser water system adjustment, improve chilled water distribution system, primary/secondary decoupling, expanding chilled water systems.
	C5: Thermal storage	Thermal storage.
EMS	E1: Programming changes	Medical air scheduling, modify EMS controls.
	E2: Replace EMS/Install	Install EMS systems, DDC EMS conversion, replace EMS.
	E3: Upgrade or add points	Control room temperature via EMS, repair and reactivate EMS, connect system to EMS, EMS upgrade, EMS interface.
HVAC	H1: Controls	Schedule start/stop, night temperature setback, auto reset on outside air temperature, sequence control of heating and cooling, duty cycling, time-clock control, programmable thermostats, hot/cold deck reset, enthalpy controls, modulate outside air based on CO2 levels, install demand reset on multi -zone system, time control for exhaust fans, humidity control.
	H2: Equipment change	Replace existing roof top units, replace DX units, replace multi- zone with individual roof top units, convert HVAC units to central heating/cooling, use high efficiency heat pumps, replace low efficiency HVAC units, replace electric units with gas units.
	H3: Upgrade/optimization	Install AHU economizer, evaluate HVAC fans; pumps; heat recovery coils, convert to gas heating, repair coils, return air system implementation, evaluating heat reclaim systems, reactivate economizers.
	H4: Ductwork change	Repair AC duct work, install low leakage backdraft dampers, convert constant volume to VAV boxes, modify HVAC system air distribution, re-route return air, eliminate louvers.
LIGHTS	L1: Controls	Lighting controls, install motion sensors, time clock controls, install photocells.
	L2: Fixture change/reflectors	Replace/remove lamps/fixtures, convert incandescent to high efficiency fluorescent lamps, lighting reflectors.
	L3: Upgrade	Fluorescent lighting upgrade, convert 40-W lamps, install electronic ballasts, use high efficiency ballasts and lamps.
	L4: Exit signs	Replace exit light fixtures, energy efficient exit lights, change exit lights to fluorescent.
MOTORS	M1: Controls	Use VFD, VSD on pumps and AHUs, convert to VAV.
	M2: Equipment change	Two speed AHU motors, two speed motors, two speed drive on cooling towers, two speed fan motors.
	M3: Upgrade	High efficiency motors.
	M4: Speed reduction	Reduced speed motors (not VFD).
PUMPS	P1: Controls	Time control of DHW pumps, outside air control on HW pumps, off peak pumping.
	P2: Equipment change	Replace condensate pump, replace inefficient pumps, replace oversized pumps.
	P3: Upgrade/optimization	Modify pumping, pumping upgrade HW/CHW, trim impeller.
STEAM	S1: Controls	Demand control on DHW, reduce steam pressure on boilers, time clock control DHW, replace obsolete O2 analyzer on boilers, HW temperature reset, automatic control valves in boiler heating water, outside temperature control on HW, more efficient burner control on boilers.
	S2: Equipment change	Install downsize boiler, replace electric water heaters with gas water heaters, install on-demand water heater, replace faulty steam traps.
	S3: Upgrade/optimization	Tune boilers, repair leaks, insulate, add superheaters, relocate flashtanks, water heater efficiency improvement, upgrade DHW heaters, boiler evaluation.
	S4: Heat recovery	Preheat make-up water, waste heat recovery.
OTHER	Water/wastewater	Energy efficient fine bubble diffusion, EMS, VSD on motors.
	O1: Electrical	Power factor correction, lighting demand control, cogeneration, electric meters consolidation.
	O2: Mechanical	Piping insulation, boiler pressure reduction, add packaged gas-fired chiller/boiler.
	O3: Building	Window retrofit, swinging doors, ceiling and roof insulation, reduce infiltration, solar shading, window glazing upgrade.

Table 2 - Summary of Three BVECC Rebuild America Projects.

Item	Brazos County	Wichita Falls ISD	Bryan ISD
Area (sq-ft)	300,000	1.2 million	1.6 million
Project Cost ($)	601,541	2,511,382	741,427
Annual Savings ($/yr)	95,139	293,043	178,657
Payback Period (yr)	6.3	8.6	4.2
Retrofits	Lighting, HVAC-replace DX units, replace cooling tower	Lighting, HVAC-replace MZ and SZ , EMCS.	Lighting, HVAC-replace chillers, EMCS
Energy Monitoring	Whole building electricity, chillers, lighting.	Whole building electricity, whole building gas at six schools.	Whole building electricity, chillers, and lighting at thre BISD schools.(will be expanded to other schools).
IAQ Measurements	Indoor/outdoor CO_2 levels, indoor/outdoor relative humidity, indoor/outdoor temperature.	Indoor/outdoor CO_2 levels, indoor/outdoor relative humidity, indoor/outdoor temperature.	Indoor/outdoor CO_2 levels, indoor/outdoor relative humidity, indoor/outdoor temperature.

Table 3. Baseline Models Developed Based on the Billing Data in FY 95.

School	Energy Type	Baseline Model	R^2	CV-RMSE (%)
Sam Houston Elementary School	Electricity (kWh/student/day)	For spring and fall: Ele=4.5573+0.0509*(T-74.8) if T<74.8 F Ele=4.5573+0.3079*(T-74.8) if T>=74.8 F For non school summer: Ele=3.72	0.77	4.9
	Gas (cuft/student/day)	Gas=0.2494-0.5812*(T-81.59) if T<81.59F Gas=0.2494 if T>=81.59 F	0.95	24.0
Sam Rayburn Middle School	Electricity (kWh/student/day)	For spring and fall: Ele=0.5218+.0575*T For non-school summer: Ele=3.2	0.38	14.5
	Gas (cuft/student/day)	Gas=0.7918-0.5008*(T-83.62) if T<83.62 F Gas=0.7918 if T>=83.62 F	0.88	26.7
Bryan High School	Electricity (kWh/student/day)	For spring and fall: Ele=6.0409 if T<55.3 F Ele=6.0409+.0727*(T-55.3) if T>=55.3 F For non-school summer: Ele=6.39	0.86	10.3
	Gas (cuft/student/day)	For Fall: Gas=7.0776-1.9509*(T-63.2) if T<63.2 F Gas=7.0776-0.32*(T-63.2) if T>=63.2 F For other semesters: Gas=13.7047-0.5129*(T-74.2) if T<74.2 F Gas=13.7047-1.0997*(T-74.2) if T>=74.2F	0.98 0.97	24.5 16.7

Table 4. Retrofit Savings Summary

School	Energy Type	Year	Savings %	$ Savings
HOU	Electricity	FY 96	14	$9,485
	(kWh/yr/student)	FY 97	7	$4,335
		1st qrt/98	17.32	$3,068
		Total	11.2	**$16,888**
	Gas	FY 96	27.6	$2,078
	(cuft/yr/student)	FY 97	15.2	$1,229
		1st qrt/98	35.35	$684
		Total	22.6	**$3,991**
RAY	Electricity	FY 96	14	$16,849
	(kWh/yr/student)	FY 97	5	$5,472
		1st qrt/98	4.4	$1,335
		Total	8.9	**$23,656**
	Gas	FY 96	53.3	$7,680
	(cuft/yr/student)	FY 97	61.3	$11,415
		1st qrt/98	58.2	$2,404
		Total	57.9	**$21,499**
BHS	Electricity	FY 96	27.1	$101,689
	(kWh/yr/student)	FY 97	34.7	$131,866
		1st qrt/98	17.8	$18,055
		Total	29.3	**$251,610**
	Gas	FY 96	76.9	$31,384
	(cuft/yr/student)	FY 97	66.0	$33,832
		1st qrt/98	55.8	$6,138
		Total	69.25	**$71,354**
All three schools	**Electricity ($)**	**Total**		**$292,154**
	Gas ($)	**Total**		**$96,844**