Program Overview
The Texas LoanSTAR Program; 1989-1999, A 10-Year Experience

W. Dan Turner, Texas A&M University
David E. Claridge, Texas A&M University
Dennis L. O'Neal, Texas A&M University
Jeff S. Haberl, Texas A&M University
Warren M. Heffington, Texas A&M University
Dub Taylor, State Energy Conservation Office
Theresa Sifuentes, State Energy Conservation Office

ABSTRACT

The Texas LoanSTAR (Loans to Save Taxes and Resources) program was conceived by the Texas State Energy Office as a $98.6 million capital retrofit program for building energy efficiency. The funding source is petroleum violation escrow funds (PVE) from the Federal government. The primary recipients of these revolving loan funds are state agencies, universities, public schools, and local government subdivisions. Through 1999, more than $133,000,000 of loans have been made for energy efficiency retrofits. This paper summarizes the 10-year accomplishments of LoanSTAR and describes the role of the Energy Systems Laboratory in providing technical support to the Texas State Energy Office for the program. Important contributions from LoanSTAR, in addition to the energy and dollar savings, include emissions reductions and protocols contributions to the NEMVP, IPMVP, and ASHRAE's GPC-14P. LoanSTAR was conceived in 1988 and approved by the U. S. Department of Energy as a statewide demonstration program. The first loans were made in 1989.

INTRODUCTION

The Texas LoanSTAR (Loans to Save Taxes and Resources) program was initiated by the Texas Energy Office in 1988 and approved by the U. S. DOE as a statewide energy efficiency demonstration program. LoanSTAR was unique in a number of ways (including the acronym for its name, especially since its origins are in the Lone Star State). The size, $98.6 million, made it the largest state-run building conservation program in the United States. The loans are targeted for public buildings, including state agencies, school districts, and local governments. LoanSTAR is a revolving loan project, which will allow it to continue indefinitely and benefit many generations of future Texans. Since LoanSTAR was initiated as a statewide demonstration project, the State Energy Office was mandated to track the program savings and provide good documentation on the results of the program. The quality control on all phases of LoanSTAR, particularly in the early years, helped make it a huge success. Early in the program, the Texas Energy Office, headed by Ms. Carol Tombari as Director, and Mr. Malcolm Verdict as LoanSTAR Manager, contracted with the Texas A&M University Energy Systems Laboratory (ESL) to provide technical support for

LoanSTAR, including metering and monitoring of all major retrofit installations. The ESL personnel:

1) assisted in the writing of the energy auditing guidelines
2) trained Texas consulting engineers on audit techniques and the LoanSTAR guidelines
3) reviewed and approved audit reports by consulting engineers
4) developed protocols for metering and monitoring buildings
5) extended existing methods and developed new methods of analyzing energy savings from retrofits
6) established a calibration laboratory for calibrating and troubleshooting equipment used in building monitoring
7) wrote software to handle the enormous data to be collected from the buildings
8) developed improved operations and maintenance techniques for buildings (called Continuous Commissioning[SM]) using the metered data.

An early paper (Verdict et al. 1990) describes the LoanSTAR program in detail. Subsequently, dozens of papers have been published from various aspects of the LoanSTAR program and these may be found on the ESL web page, which includes a bibliography of published papers.

As a consequence of the quality control, i.e., good audit guidelines, training, report review, conservative savings estimates by the energy auditors, the metering and monitoring, and follow-up with the agencies after the retrofit, the measured LoanSTAR savings exceeded audit estimates of energy savings. The initial loans (1989-94) were made for a period of four years, and the program paybacks averaged about 3.4 years. Part of the responsibilities for the ESL engineers was to work with the agencies to ensure the retrofits were working properly and to provide building commissioning assistance to the agencies for improved operation and even greater efficiency. After six years of program success, the State Energy Office submitted a program change to DOE to remove the "demonstration" label for LoanSTAR. This was approved by DOE.

There have been several philosophical changes in LoanSTAR since program inception. Initially loans had to pay back within four years, and all major projects had to be metered and monitored for savings verification. The metering and monitoring were initially paid by the Energy Office and not included in the loan. About 1995 the loan period was lengthened to eight years, and the loan recipients were asked to pay for the metering installation, which was rolled into the loan. In 1996-97 the Energy Office eliminated building recommissioning and required metering, monitoring, and reporting on loans. Administrative funds were running low in the Energy Office and the building recommissioning and metering were eliminated. The agencies could, however, contract directly with the ESL for commissioning. The loan payback period was still kept at eight years, which allowed the agencies to replace longer payback items such as new chillers and boilers.

In 1998-99, the metering requirement was added back in for state agencies and universities, but was left optional for school districts, local governments, and community colleges. The metering costs of 3.5% of the loan were added to the loan, and monitoring and verification costs were set at 1.6% of the loan value per year of monitoring. A five-year metering and monitoring program, for example, would cost the loan recipient 11.5% of the

loan value, which was added to the loan. The agency has the option of M&V from three years to eight years, and the monitoring costs can be rolled into the loan. Agencies can also request that metering equipment remain in place at the end of the required LoanSTAR M&V period should they decide to do their own M&V or continue to contract with the ESL.

The remainder of this paper summarizes the LoanSTAR accomplishments through December 1999. The number of loans, program size, retrofit savings, demand savings, environmental impact, and commissioning savings will be documented. In addition, the overall program impacts will be briefly assessed, including the contributions to national documents such as the DOE building monitoring protocols (NEMVP and IPMVP), the ASHRAE GPC-14P standards work, and other related programs.

Loans and Loan Amounts

Figure 1 provides a history of LoanSTAR loans from program inception through November 1999. The total number of loans made is 118, and the dollar amount is $133,170,025. The LoanSTAR program has truly "revolved," since the total dollar value of the loans exceeds the original $98.6 million. Note on Figure 1 that there are long periods when no/few loans were made, i.e., January 1993 to March 1994 and January 1995 to July 1996. Not all the PVE money was made available to the LoanSTAR program initially, and the release of the dollars required the concurrence of the Governor, the Lieutenant Governor, and the Speaker of the House. The maximum loan amount to any entity at any time is five million dollars, and several state agencies have applied for and received the maximum loan amount. Some agencies have also borrowed the full five million dollars, completed the retrofits, and then have paid off the loan early in order to apply for a second loan. Loans to school districts and local governmental entities have, in general, been smaller than those to state agencies, but the average LoanSTAR loan is around $1.1 million.

In the 1997 legislative session, a bill was passed which established a floor of $95 million on LoanSTAR, thus ensuring its availability for public buildings in Texas for future generations. The bill sets aside a minimum of 85% of the available money for loans to state agencies, school districts, and local governments, i.e., institutional loans. Up to 15% can be loaned to the industrial and commercial sectors.

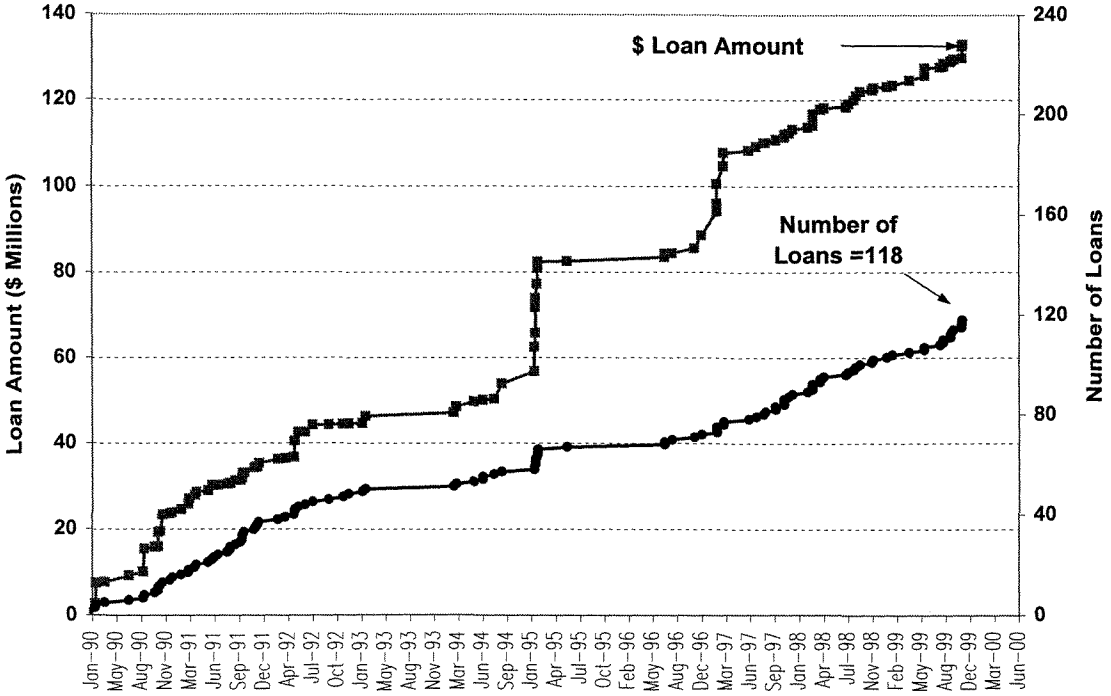


Figure 1. Cumulative Loan Amount as of November 1999
Total Loan Amount: $133,170,025

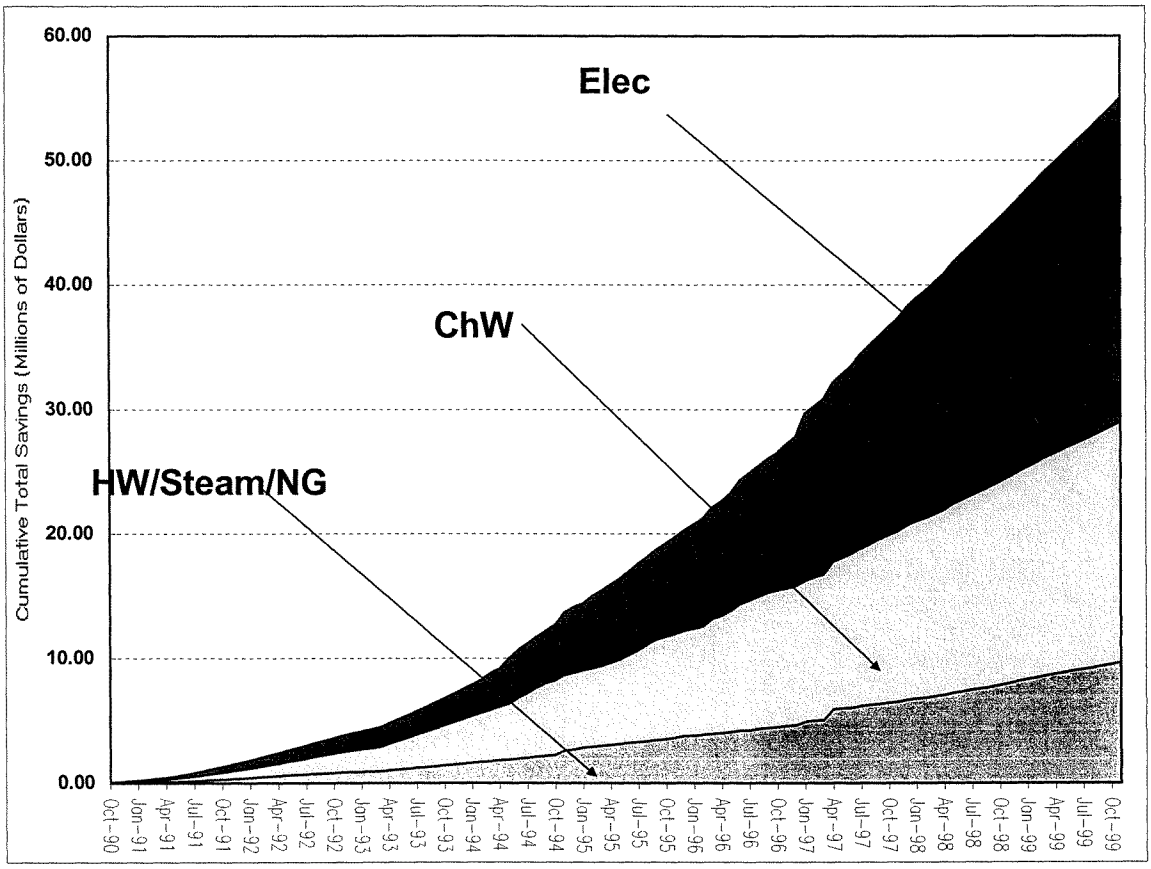
Retrofit Savings

Figure 2 is a summary of cumulative measured retrofit savings from LoanSTAR since 1989. These savings were determined largely by regression models from pre-retrofit data and post-retrofit measured energy use. The models are weather adjusted, but the energy rates are the pre-retrofit baseline rates. In most cases the actual savings are even greater because of utility rate increases. The Zachry Engineering Center, on the Texas A&M University campus, was the first building to receive retrofits under LoanSTAR. Since Zachry has been metered and monitored since 1989, there is an enormous amount of data on this building. ASHRAE initiated two international modeling contests where hourly data were given on a building over a limited period, and contestants were then asked to model future building energy consumption. These were called ASHRAE's Great Predictor Shootout I and II (Haberl & Thamilseran 1996; Kreider & Haberl 1995; Katipamula 1996). The Zachry Engineering Center was the building used for the competition. Note in Figure 2 that cooling energy savings and electrical savings are roughly equal in the LoanSTAR program. As one would expect for buildings in Texas, the savings in steam/hot water/natural gas are significantly lower.

Texas LoanSTAR Monitoring and Analysis Program
Energy Consumption Report

October 1990 - November 1999 Summary of Measured Energy Consumption and Savings

Baseline Use	$167,819,000	$51,225,000	$26,439,000	$245,483,000
Post-Retrofit Use	$141,807,000	$31,913,000	$16,736,000	$190,456,000
Measured Savings	$26,012,000	$19,312,000	$9,703,000	$55,027,000
% of Baseline Use	15.5	37.7	36.7	22.42
% of Total Measured Savings	47.3	35.1	17.6	100
Audit Estimated Savings	$26,685,200	$16,000,100	$11,284,300	$53,969,600



Comments

Cumulative measured savings in 31 loan sites (296 buildings) for which the retrofits have been completed as of November 1999. In addition street lighting retrofits in nine cities have saved $4,292,600 through November 1999, lighting retrofits at 43 Fort Worth ISD buildings have saved $2,208,400 through November 1999, 11 utility bill analysis sites have saved $546,500 and 21schools at Austin ISD have saved $333,600 bringing the LoanSTAR retrofit savings total to $62,408,100 through November 1999.

Figure 2. Texas LoanSTAR Monitoring and Analysis Program Energy Consumption Report

Figure 3 is a graph of LoanSTAR retrofit savings, including non-metered sites (but excluding most commissioning savings). Since hourly metering and monitoring cannot be justified for smaller sites, either utility bill analyses or stipulated savings (i.e., for street lighting retrofits), are used for a small number of loans.

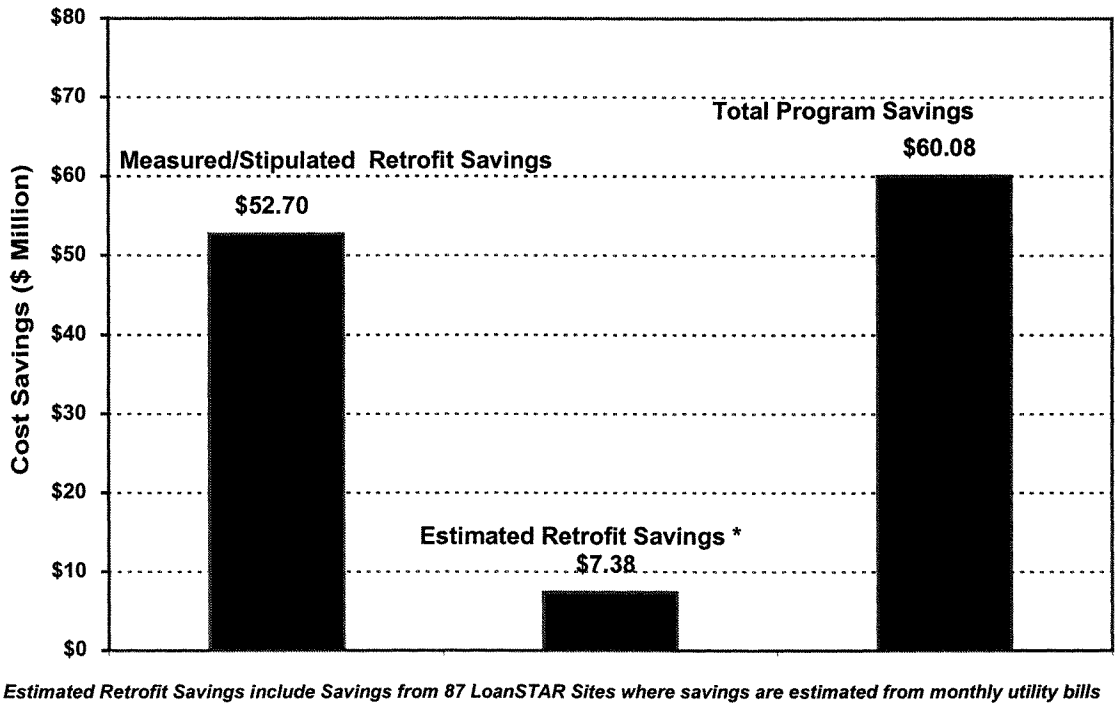


Figure 3. Cumulative LoanSTAR Retrofit Savings as of November 1999
Total Retrofit Savings: $60,078,000

Demand Savings

The LoanSTAR program was established as an energy conservation program; hence the U. S. Department of Energy in the program approval did not allow dollar savings for electricity demand. The LoanSTAR program thus had to pay for itself based on energy savings alone. Nevertheless, demand savings have occurred, and Figure 4 is a graph showing the estimated demand savings resulting from the LoanSTAR retrofits. These savings have been achieved primarily from lighting retrofits, installation of variable frequency drives, and thermal storage systems (TES). Even though energy savings were the primary focus, as a demonstration program, TES retrofits were funded. If demand savings dollars were credited to LoanSTAR, the program dollar savings would increase by several million dollars, depending on the dollars/kW value of demand. Abbas, Haberl, and Turner 1995 discusses some of the cool storage applications in LoanSTAR.

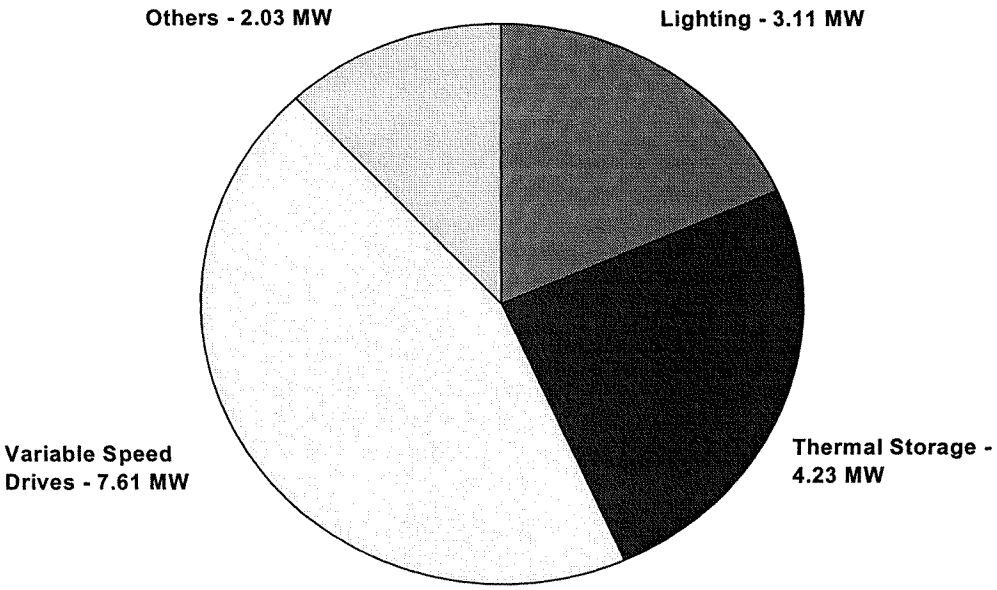


Figure 4. Distribution of 16.9 MW of LoanSTAR Demand Savings by Retrofit Type as of November 1999

Building Commissioning Savings

In the 1993-94 period, engineers at the ESL noted that many of the LoanSTAR buildings were still consuming large amounts of energy, even after the retrofits were completed and "commissioned." Using the metered data, our engineers visited a number of buildings and determined that the building systems were still not being operated efficiently. Cold deck temperatures were set too low, duct static pressures were higher than needed, VFD's were not operating properly, controls system schedules were not optimal, just to name some of the findings. These discoveries ultimately led to the creation of a whole new field of fine-tuning buildings, which the ESL has labeled as "Continuous Commissioning[SM]" (CC). The CC process uses metered and monitored data to optimize the comfort of the building's occupants and reduce building energy consumption. The CC successes have been documented in several papers (Claridge, et al, 1994; Claridge, et al 1996; Liu, et al 1994). The significance of CC to the LoanSTAR program is shown in Figure 5. The CC savings are accumulating at roughly $3.5 million a year. The larger savings in 1996 and 1997 are a function of when the savings were reported, i.e., for several sites, savings achieved in 1995 were modeled and reported in 1996. Similarly, some 1995 and 1996 savings were actually reported in 1997. Total CC program savings through October 1999 were $18.49 million, a number which represents approximately 25% of the total cumulative retrofit savings in LoanSTAR. As noted in the CC paper references, the savings from Continuous Commissioning[SM] have, in some buildings, exceeded the retrofit savings, at a fraction of the cost of the capital retrofits! Figure 6 shows the CC savings as a fraction of total program savings.

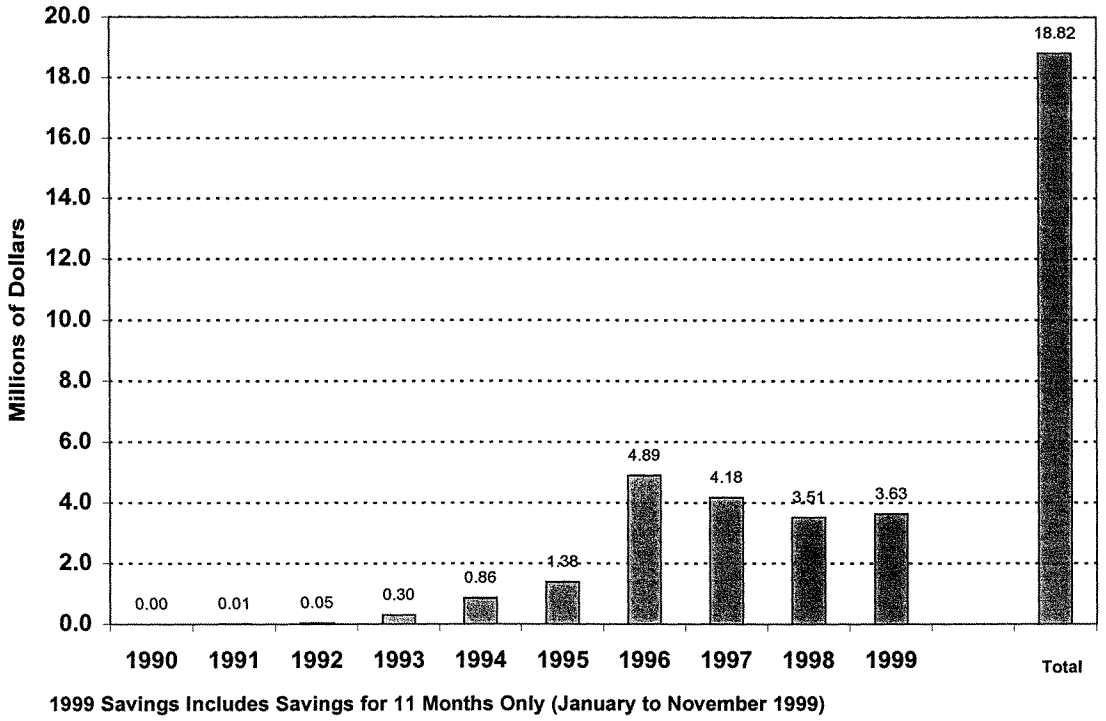


Figure 5. Continuous Commissioning Savings from the LoanSTAR Program
Total CC Savings $18.82 Million

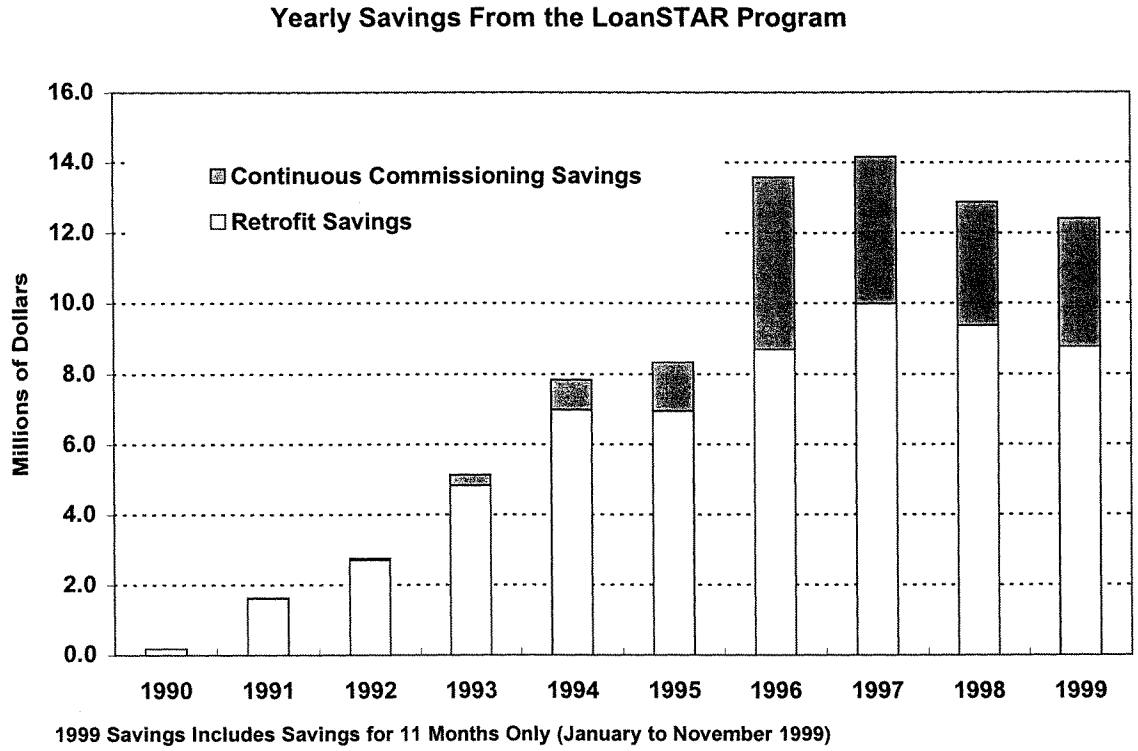
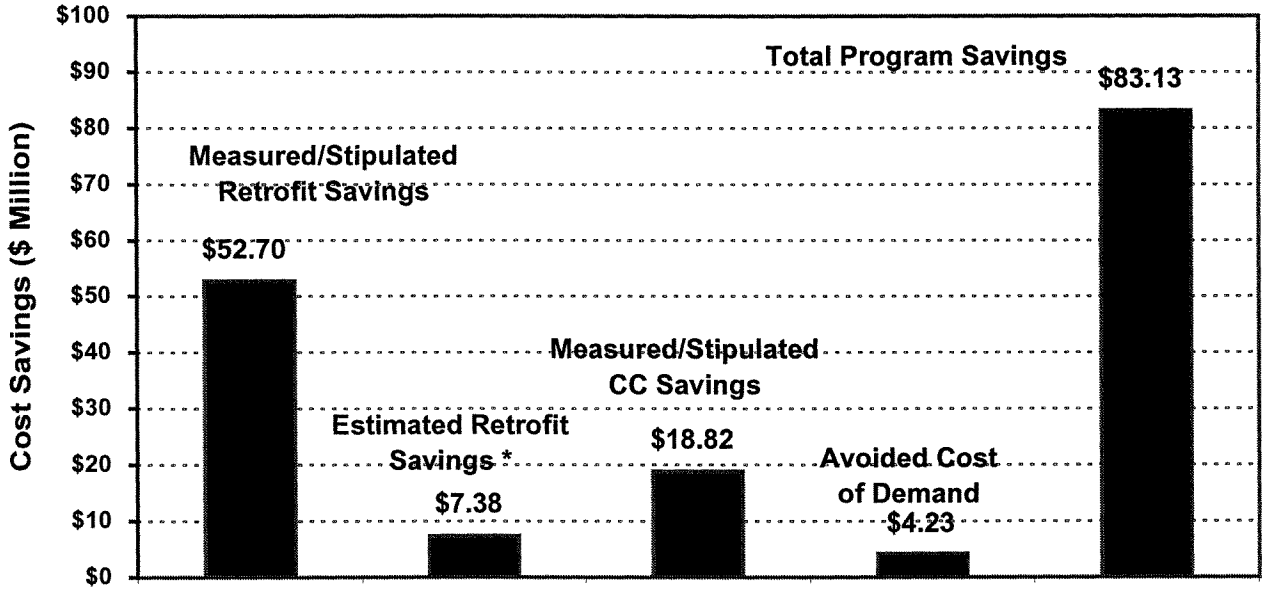


Figure 6. Yearly Savings from the LoanSTAR Program

Total Program Dollar Savings

If we "credit" the dollar savings from demand retrofits[1] to the dollar savings from the energy retrofits, the total dollar savings from LoanSTAR would be approximately $82 million dollars. Figure 7 is a graph showing the total program dollar savings, with a breakdown of each of the four major areas: (1) metered and monitored retrofit savings; (2) estimated or utility bill savings; (3) Continuous Commissioning savings; and (4) demand savings.



** Estimated Retrofit Savings include Savings from 87 LoanSTAR Sites where savings are estimated from monthly utility bills*
** Avoided Cost of Demand by Utilities is Calculated by using $250/kW Rebate given to the Customers by Utilities*

Figure 7. Cumulative LoanSTAR Savings as of November 1999
Total Program Savings: $83,126,000

Environmental Savings

Like demand savings, the reduction of environmental pollutants such as NO_x. CO_2, and particulates, are not part of the "credits" obtained from LoanSTAR, but there have been very significant environmental impacts. An ESL study completed in 1995 documented the environmental impacts, based on the mix of electric utility generation in Texas. The study

[1] Demand savings are calculated at 250/kW, which credits an additional $4.23 million to LoanSTAR for demand savings. The $250/kW is a conservative number and is a statewide average. Some utilities had rebates as high as $400/kW and others offered no rebates at all.

was updated to October 1999 reductions, and Table 1 summarizes the reduction in NO_x, CO_2, and SO_2 through October 1999. The basis for the calculations of emissions is as follows. For electricity generation in Texas, we have primarily coal, lignite, natural gas, nuclear, and a small amount of hydro. We based the "avoided emissions" on a regional basis and not a retrofit-by-retrofit basis. Chilled water savings were determined on an assumed kW/ton for electric generation, and absorption cooling emission savings were assumed from burning natural gas. Steam and hot water savings were assumed to be from avoided natural gas consumption.

Emissions Savings Summary
(As of November 1999)

	NOx Tons	CO2 Tons	SO2 Tons
HEATING (2,168,746 MMBtu)	772	168,446	0.84
CHILLED WATER (2,039,393 MMBtu)	467	144,457	412
ELECTRICITY (589,017 MWh)	1,620	500,664	1,428
TOTAL SAVINGS	2,859	813,568	1,841

Table 1. The combined reduction in pollutants in tons resulting from heating, cooling, and electricity savings. The numbers in parentheses are the total heating, cooling, and electricity savings from the LoanSTAR sites.

State, National and International Impacts from LoanSTAR

The metering and monitoring techniques and methodologies developed in the LoanSTAR program have had major impacts on state, national and international programs. Both Jeff Haberl and David Claridge have served on the national DOE committee charged with developing protocols for metering and monitoring savings in building retrofits. Initially called the NEMVP (North American Energy Measurement and Verification Protocols) and now called the IPMVP (International Performance Monitoring and Verification Protocols), this document contains many of the methodologies developed in LoanSTAR. ASHRAE is also developing consensus standards and measurement techniques for measuring the effectiveness of various retrofits. This proposed new standard, GPC-14P, is also being developed using many of the findings and procedures proven and developed in LoanSTAR.

The State of Minnesota is using software developed by the ESL, and the State of Florida established a pilot conservation program based on the LoanSTAR approach, the FlaSTAR program. The ESL worked with both states in this technology transfer effort. The

Continuous Commissioning[SM] process, unique software, new and/or improved analysis techniques, a greater understanding of sensors and their accuracy found from the calibration laboratory, and over 160 technical papers, reports, and presentations have resulted from the Texas LoanSTAR program (these can be found on the worldwide web at www-esl.tamu.edu). In addition, the experience from the metering and monitoring program has been translated to the Texas guidelines for performance contracting developed by SECO and the Texas Energy Coordination Council (TECC). LoanSTAR's contributions form the cornerstone for the monitoring and verification portions of the document.

Summary

While energy conservation was the original focus of LoanSTAR, it is obvious that the demand reductions, Continuous Commissioning[SM] efforts, and environmental reductions have all been extremely important contributions from the original program. Program savings exceed $80,000,000, and LoanSTAR has been legislatively established as a $95 million program for conservation and energy efficiency retrofits. It has had an enormous positive impact on the State of Texas, and this success has carried over to other states and the Federal government.

Acknowledgments

The Texas LoanSTAR program is administered by the State Energy Conservation Office of the Comptroller's Office, Dub Taylor, Director. SECO provides the funding to the Energy Systems Laboratory to provide technical support for LoanSTAR. The success of the Energy Systems Laboratory effort on LoanSTAR is due to a very talented and dedicated group of engineers, computer scientists, and graduate students who have worked with the program. Mr. Sam Farouz, an ESL staff engineer, provided the graphs presented in this paper.

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