

**PROGRAM OVERVIEW**  
**THE TEXAS LoanSTAR PROGRAM; 1989-OCTOBER 1999, A 10-Year Experience**

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**ABSTRACT**

The Texas LoanSTAR (Loans to Save Taxes and Resources) program was conceived 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. LoanSTAR is administered by the Texas State Energy Conservation Office of the Comptroller's Office, under the guidance of Dub Taylor, Director, and is the largest revolving loan fund administered by a state for conservation purposes. LoanSTAR was conceived in 1988 and began in 1989. This paper summarizes the program dollar savings and environmental impact from its inception through October 1999.

**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. LoanSTAR was initiated as a statewide demonstration project, which allowed/mandated the State Energy Office to provide more oversight and documentation on the program. The quality control on all phases of LoanSTAR,

particularly in the early years, has made it the most successful, best documented, building energy efficiency program, state or federal, in the United States. 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 Energy Systems Laboratory to provide technical support for LoanSTAR, including metering and monitoring of all major retrofit installations. The Energy Systems Laboratory 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) using the metered data. Earlier papers on LoanSTAR include references 1-19, where details of the program planning may be found.

As a consequence of the quality control, i.e., good audit guidelines, training, and report review, the metering and monitoring, and follow-up with the

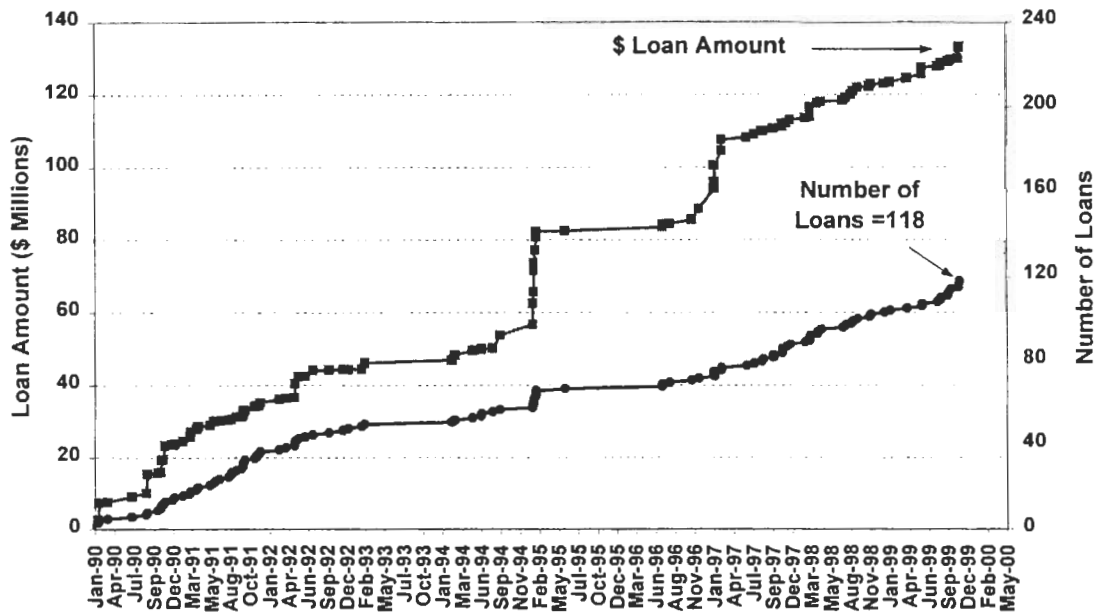
agencies after the retrofit, the measured LoanSTAR savings exceeded audit estimates of energy savings--one of the few energy efficiency programs that can make this claim. The initial loans (1989-94) were made for a period of four years, and the program paybacks were averaging about 3.4 years. Part of 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. In 1995 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 was 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. The loan payback period was still kept at eight years.

In 1998-99, the metering requirement was added back in for state agencies and universities, but was 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 metering costs can be rolled into the loan. Agencies can also request that metering equipment remain in place at the end of the LoanSTAR M&V.

This paper summarizes the LoanSTAR accomplishments through October 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.

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



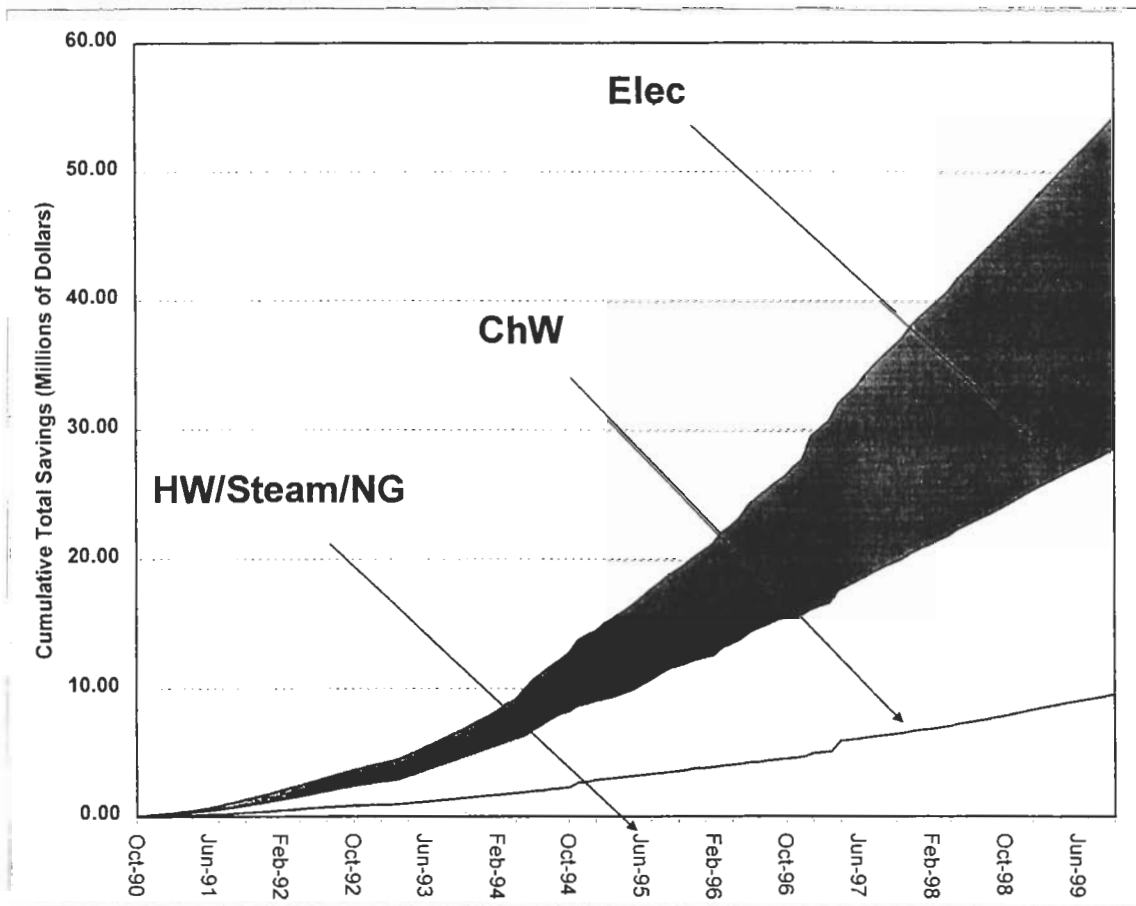
**Loans and Loan Amounts**

Figure 1 provides a history of LoanSTAR loans from program inception through October 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.

Figure 2

Texas LoanSTAR Monitoring and Analysis Program Energy Consumption Report				
October 1990 - October 1999 Summary of Measured Energy Consumption and Savings				
Baseline Use	\$165,406,000	\$50,592,000	\$26,027,000	\$242,025,000
Post-Retrofit Use	\$139,768,000	\$31,519,000	\$16,475,000	\$187,762,000
Measured Savings	\$25,638,000	\$19,073,000	\$9,552,000	\$54,263,000
% of Baseline Use	15.5	37.7	36.7	22.42041111
% of Total Measured Savings	47.2	35.1	17.6	100
Audit Estimated Savings	\$26,301,700	\$15,774,000	\$11,110,400	\$53,186,100



**Comments**

Cumulative measured savings in 31 loan sites (296 buildings) for which the retrofits have been completed as of October 1999. In addition street lighting retrofits in nine cities have saved \$4,241,600 through October 1999, lighting retrofits at 43 Fort Worth ISD buildings have saved \$2,186,100 through October 1999, 11 Zero level sites have saved \$539,700 and 21 schools at Austin ISD have saved \$323,175 bringing the LoanSTAR savings total to \$61,553,575 through October 1999.

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.

**Retrofit Savings**

Figure 2 is a graph of cumulative measured 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 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. It has been the source of two international energy modeling "contests," ASHRAE's Great Predictor Shootout I and II (20,21,22). Note in Figure 2 that cooling energy savings and electrical savings are

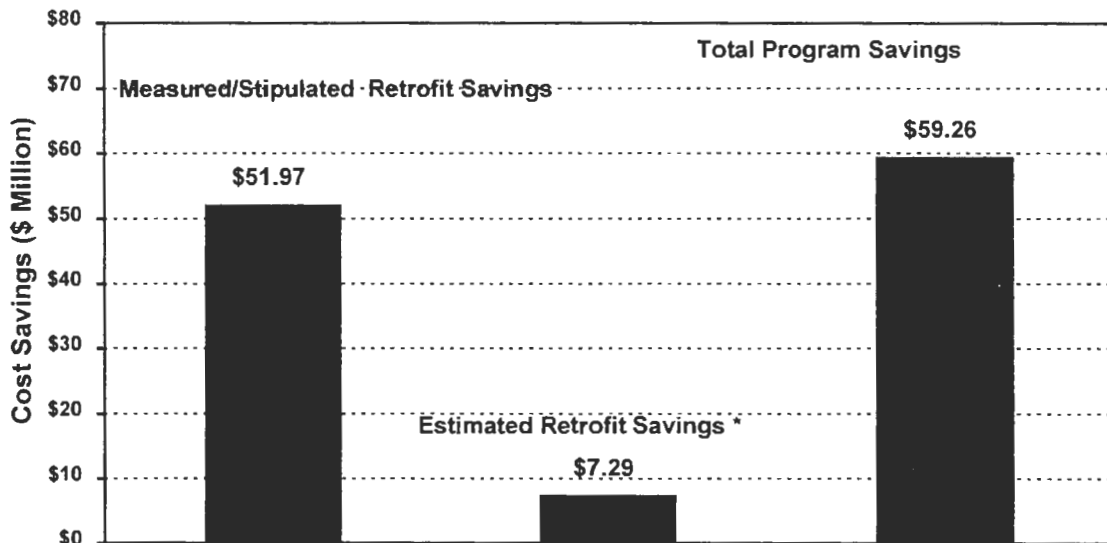
roughly equal in the LoanSTAR program. As one would expect for buildings in Texas, the savings in steam/hot water/natural gas are significantly lower.

Figure 3 is a graph of LoanSTAR retrofit savings, including non-metered sites (but excluding most commissioning savings). Hourly metering and monitoring cannot be justified for smaller sites, and either utility bill analyses or stipulated savings (i.e., for street lighting retrofits), are used for a small number of loans. As previously discussed, in the early phases of the program (i.e., the first four years), actual savings exceeded audit estimated savings by roughly 20%.

**Demand Savings**

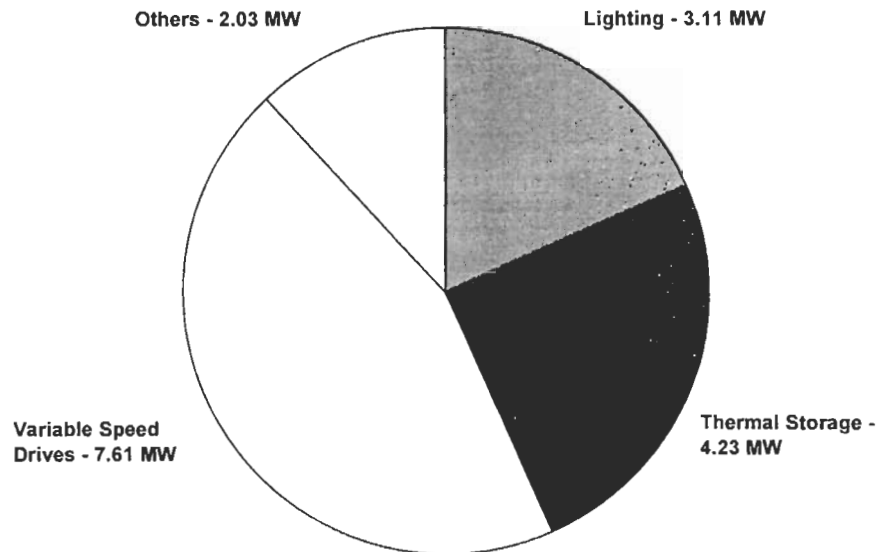
The LoanSTAR program was established as an energy conservation program, and hence no dollar savings were allowed for demand savings. Nevertheless, demand savings have occurred, and Figure 4 is a graph showing the estimated demand savings resulting from the LoanSTAR retrofits. These savings have been 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

Figure 3  
**Cumulative LoanSTAR Retrofit Savings as of October 1999**  
**Total Savings: \$59,257,000**



\* Estimated Retrofit Savings include Savings from 87 LoanSTAR Sites where savings are estimated from monthly utility bills

Figure 4  
**Distribution of 16.9 MW of LoanSTAR Demand Savings by Retrofit Type as of October 1999**



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. Reference 23 discusses some of the cool storage applications in LoanSTAR.

### **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" (CC). The 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 (24,25,26). The significance of CC to the LoanSTAR program is shown in Figure 5. Total 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 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.

### **Total Program Dollar Savings**

If we "credit" the dollar savings from demand retrofits<sup>1</sup> 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

<sup>1</sup> Demand savings are calculated at 250/kW, which credits an additional \$4.23 million to LoanSTAR for demand savings.

retrofit savings; (2) estimated or utility bill savings; demand savings.  
 (3) Continuous Commissioning savings; and (4)

Figure 5  
**Continuous Commissioning Savings From the LoanSTAR Program**  
**Total CC savings \$18.49 million**

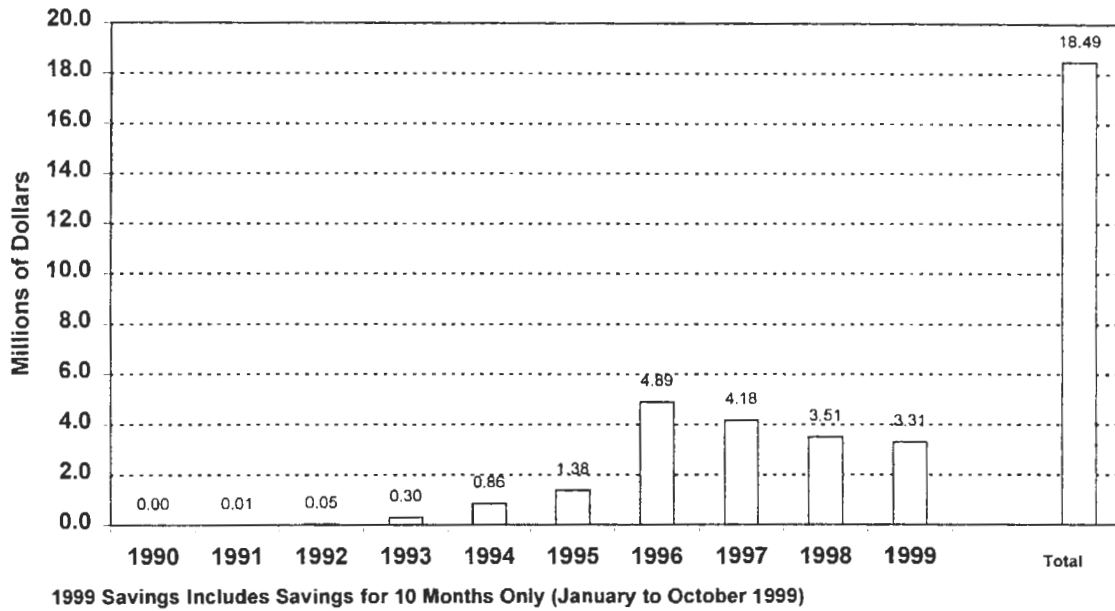
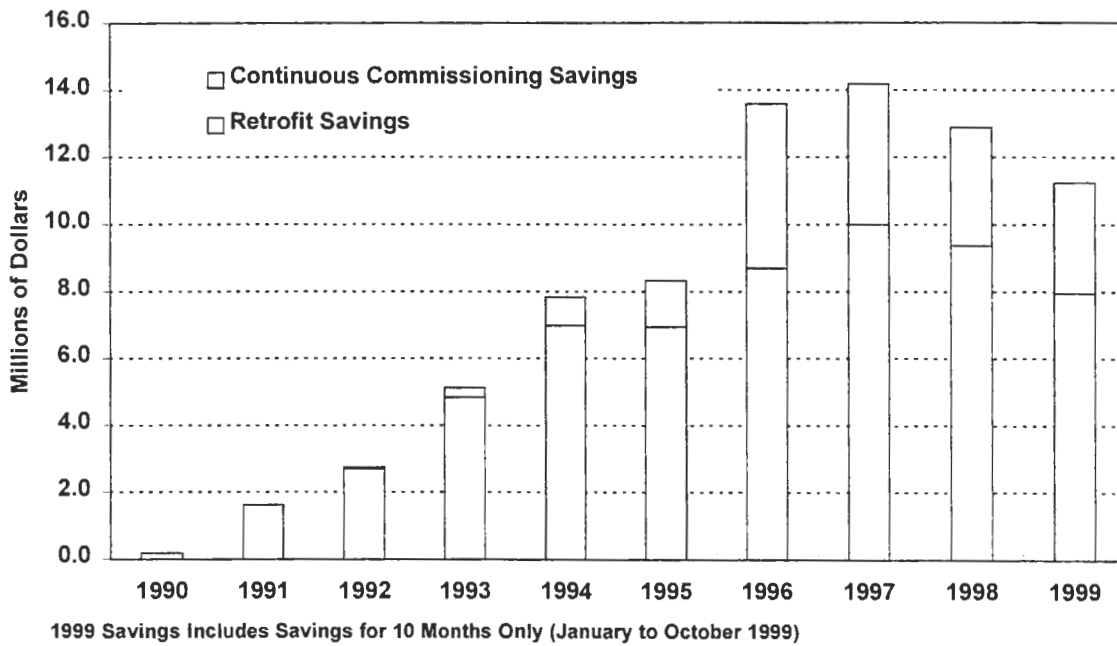


Figure 6  
Yearly Savings From the LoanSTAR Program

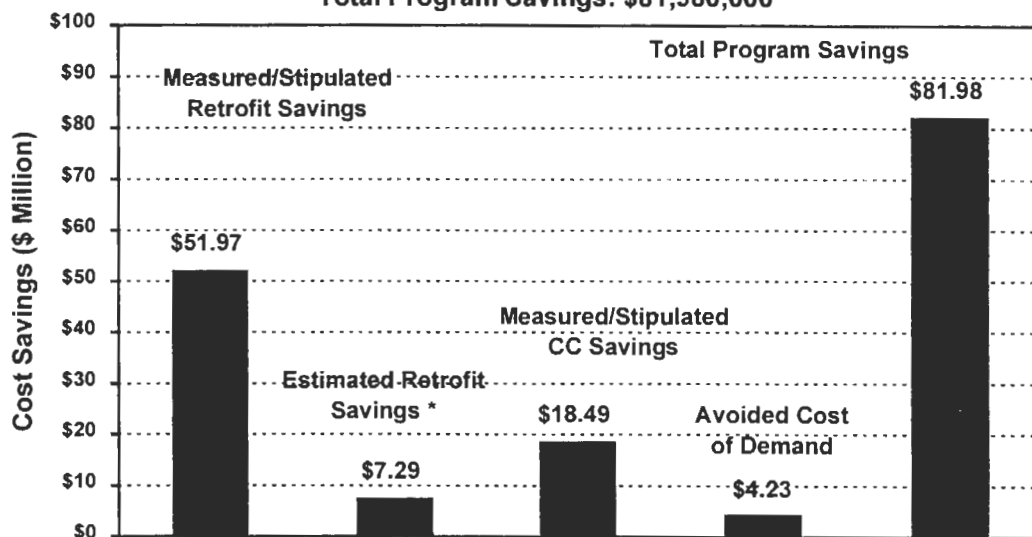


**Environmental Savings**

Like demand savings, the reduction of environmental pollutants such as NO<sub>x</sub>, CO<sub>2</sub>, 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

Figure 7  
Cumulative LoanSTAR Savings as of October 1999  
Total Program Savings: \$81,980,000



\* 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

**Emissions Savings Summary**  
(As of October 1999)

	NOx Tons	CO2 Tons	SO2 Tons
HEATING (2,133,452 MMBtu)	759	165,705	0.83
CHILLED WATER (2,012,305 MMBtu)	461	142,538	407
ELECTRICITY (580,512 MWh)	1,596	493,435	1,408
<b>TOTAL SAVINGS</b>	<b>2,817</b>	<b>801,679</b>	<b>1,815</b>

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.

impacts, based on the mix of electric utility generation in Texas. The study was updated to October 1999 reductions, and Table 1 summarizes the reduction in NO<sub>x</sub>, CO<sub>2</sub>, and SO<sub>2</sub> through October 1999.

#### 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 process, unique software, new and/or improved analysis techniques, a greater understanding of sensors and their accuracy found from the calibration laboratory, and over 150 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](http://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 efforts, and environmental reductions have all been extremely important contributions from the original program. It is doubtful that any other program, state or federal,



has provided as much technical information and documented results and will have as much an impact on building energy efficiency as has LoanSTAR.

#### 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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