

**PROGRAM OVERVIEW**  
**THE TEXAS LoanSTAR PROGRAM; 1989-AUGUST 1997**

William D. Turner Professor	David E. Claridge Professor	Dennis L. O'Neal Professor	J. S. Haberl Associate Professor	Warren M. Heffington Associate Professor
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Texas A&M University System  
Energy Systems Laboratory  
College Station, Texas

and

Tobin Harvey and Theresa Sifuentes  
General Services Commission  
State Energy Conservation Office  
Austin, Texas

**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 General Services Commission, under the guidance of Tobin Harvey, 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 August 1997.

**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.

A change in philosophy of the State Energy Conservation Office in 1996-97 has changed LoanSTAR from a well-documented, demonstration program in building energy efficiency to a low-interest, revolving loan program, by eliminating the required metering, monitoring, reporting and commissioning activities. This paper is an attempt to summarize the LoanSTAR program accomplishments through August 1997, the last month when metering and monitoring was required for all loans. This paper will document the number of loans, program size, retrofit savings, demand savings, environmental impact, and commissioning savings. In addition, the overall program impacts will be briefly assessed, including the contributions to national documents such as the DOE building monitoring protocols, the NEMVP, 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 August 1997. The total number of loans made is 77, and the dollar amount is \$105,735,532. The LoanSTAR program has begun to "revolve," 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. A program as large as LoanSTAR required close scrutiny also by DOE, and the large number of approvals, i.e., DOE, the legislature, and the three concurring heads all slowed the rate that loan money was available.

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.

As of the date of the writing of this paper, SECO has loaned virtually all of the available money and has a number of loans in the queue when loan repayments are made. The energy office decision in 1994-95 to allow loans of up to eight years in length has extended payback periods and has reduced the dollar amount of loan repayments to SECO, which slowed the rate at which the program revolves.

Figure 2 represents the number of sites and number of buildings that were monitored through August 1997. A large number of loans have been made to agencies in Austin, but loans have been made to agencies, local governments, and school districts all over Texas.

### Retrofit Savings

Figure 3 is a graph of cumulative measured savings from LoanSTAR since 1989. These savings were determined largely by 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 some cases the actual savings would be 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 modeling "contests," ASHRAE's Great Predictor Shootout I and II (20,21,22). Note in Figure 3 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 4 is a graph of LoanSTAR retrofit savings, including non-metered sites (but excluding most commissioning savings). 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 5 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. 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 6. Total program savings through August 1997 were \$10.5 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 7 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

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

would be well over \$53 million dollars. Figure 8 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.

### 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 impacts, based on the mix of electric utility generation in Texas. The study was updated to 1997 reductions, and Table 1 summarizes the reduction in NO<sub>x</sub>, CO<sub>2</sub>, and SO<sub>2</sub> through October 1997.

### National and International Impacts from LoanSTAR

The metering and monitoring techniques and methodologies developed in the LoanSTAR program have had major impacts on 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 proposed Texas

guidelines for performance contracting under development 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 General Services Commission, Tobin Harvey, 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 work with the program. Mr. Aamer Athar, an ESL senior staff engineer, provided all the graphs presented in this paper.

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Figure 1  
**Cumulative Loan Amount as of August 1997**  
**Total Loan Amount: \$105,735,532**

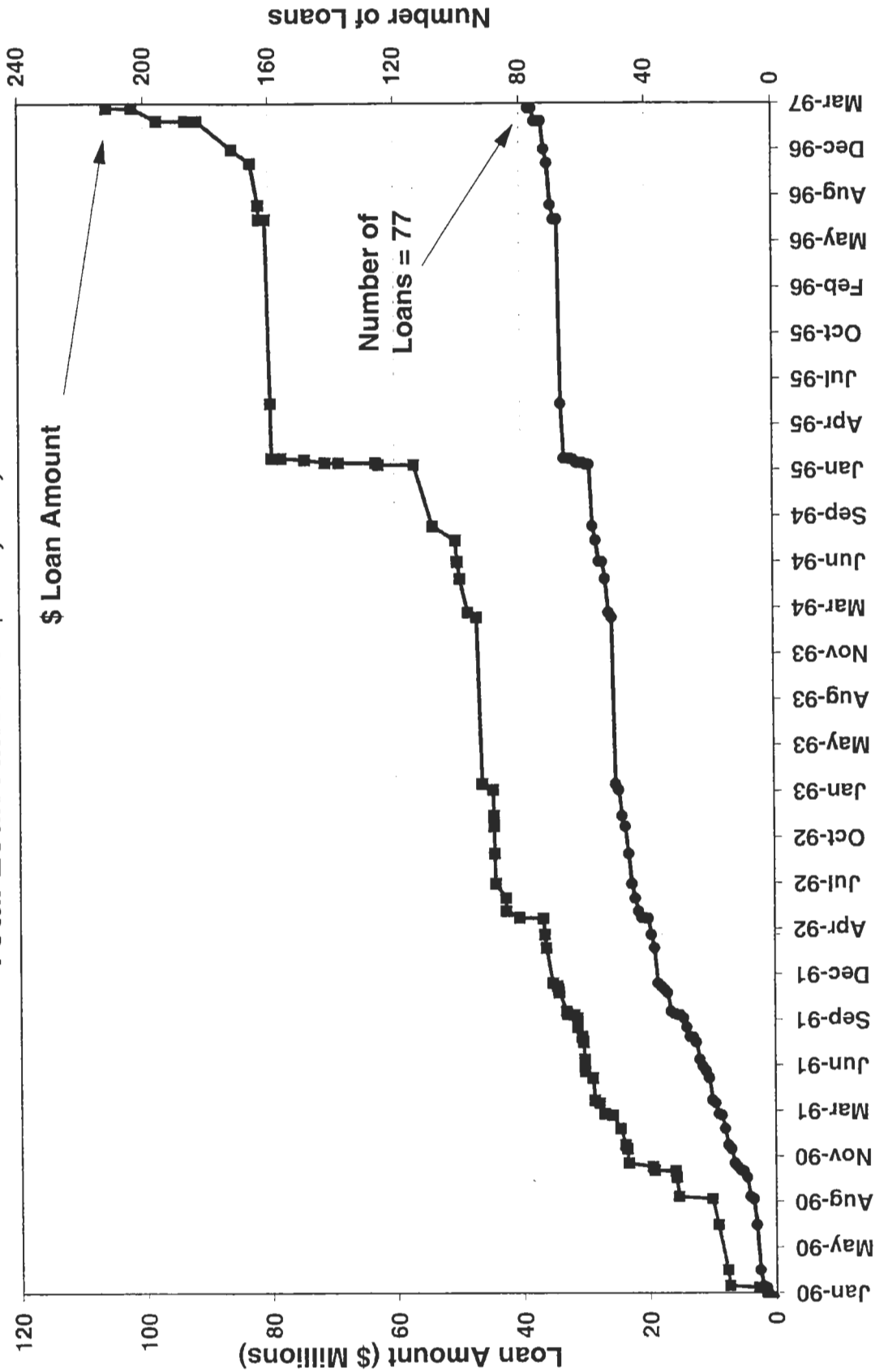


Figure 2  
**Sites Monitored Under LoanSTAR  
 Program as of August 1997**

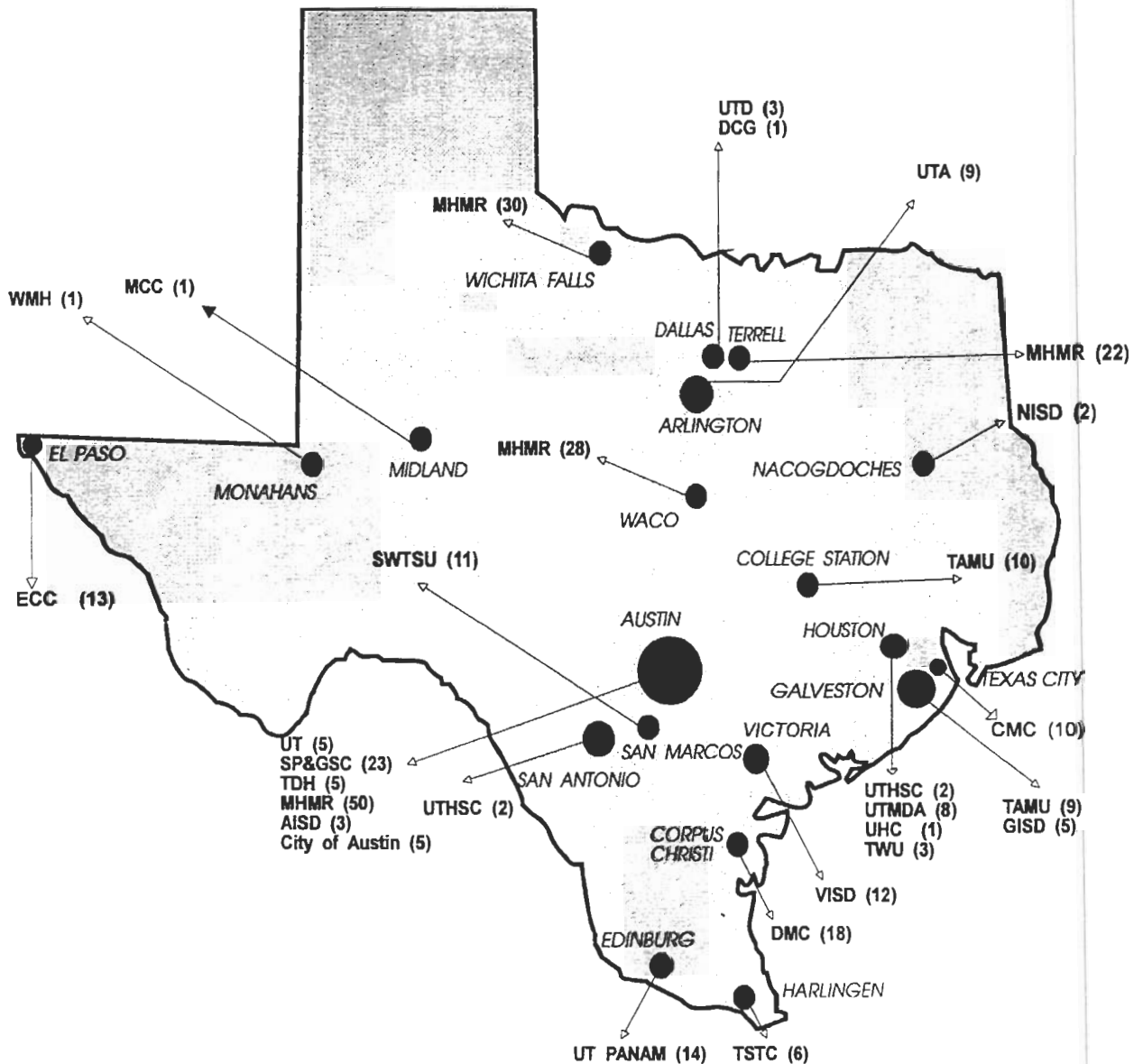
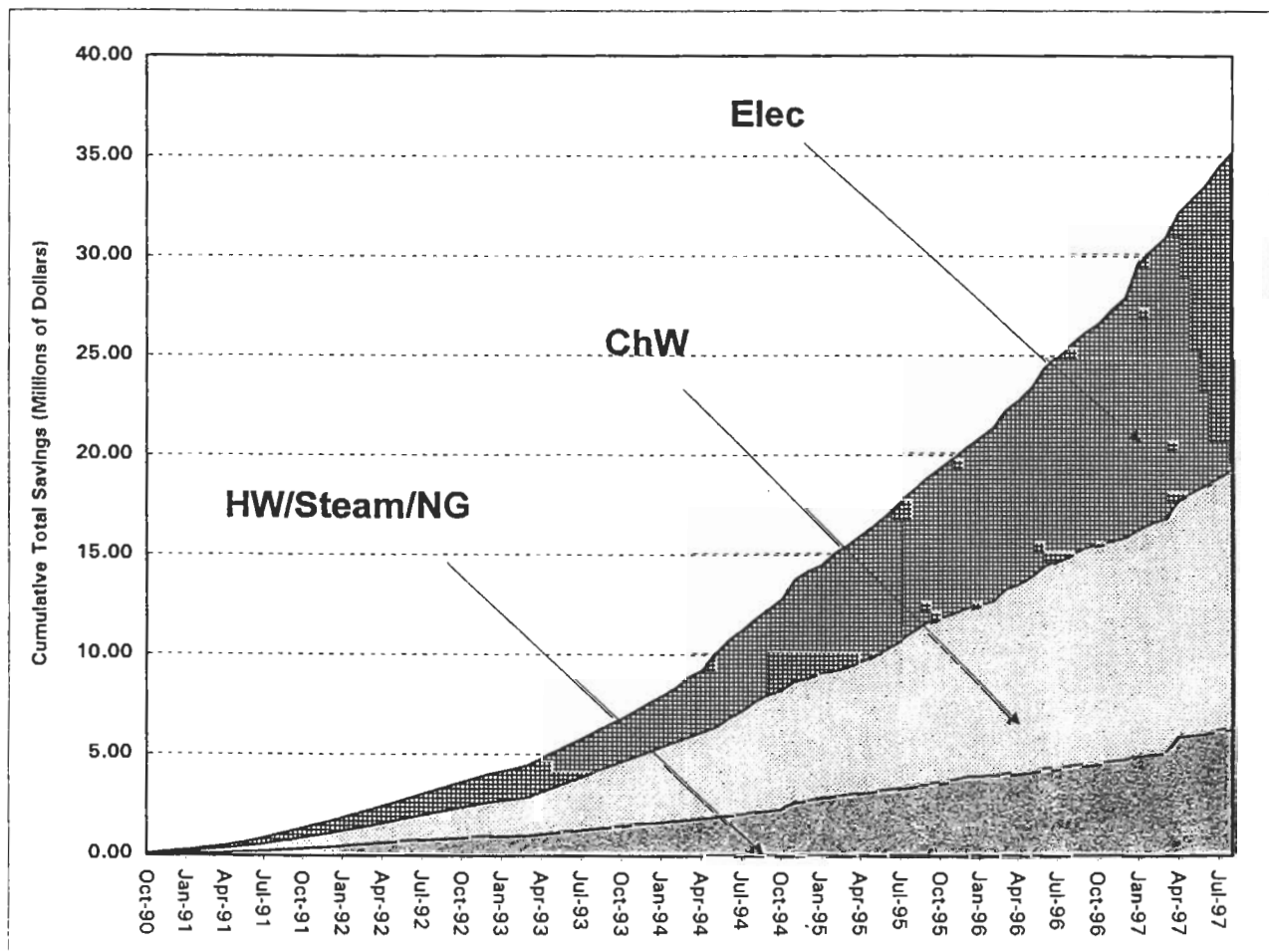


Figure 3

**Texas LoanSTAR Monitoring and Analysis Program**  
**Energy Consumption Report**  
 October 1990 - August 1997 Summary of Measured Energy Consumption and Savings

	Electricity	Chilled Water	Hot Water/ Steam/Nat. Gas	Total
Baseline Use	\$103,155,000	\$34,255,000	\$17,136,000	\$147,251,000
Post-Retrofit Use	\$87,166,000	\$21,341,000	\$10,847,000	\$112,058,000
Measured Savings	\$15,989,000	\$12,914,000	\$6,289,000	\$35,193,000
% of Baseline Use	15.5	37.7	36.7	23.9
% of Total Measured Savings	45.4	36.7	17.9	100.0
Audit Estimated Savings	\$16,414,500	\$10,100,000	\$6,726,700	\$33,241,200

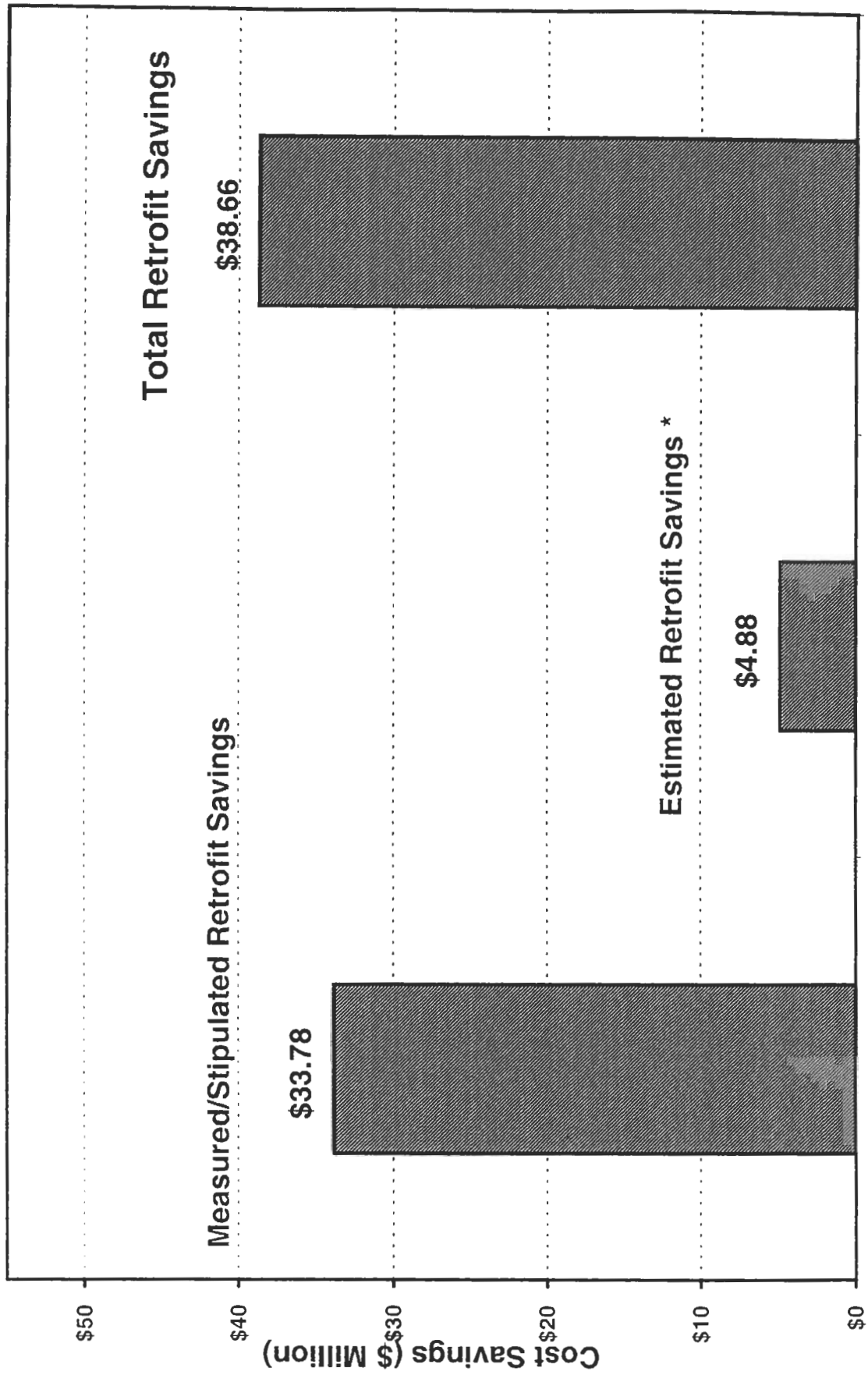


**Comments**

Cumulative measured savings in 30 loan sites (290 buildings) for which the retrofits have been completed as of August 1997. In addition street lighting retrofits in nine cities have saved \$2,915,600 through August 1997, lighting retrofits at 43 Fort Worth ISD buildings have saved \$1,606,300 through August 1997 and 11 Zero level sites have saved \$362,900 bringing the LoanSTAR savings total to \$40,076,800 through August 1997.



Figure 4  
Cumulative LoanSTAR Retrofit Savings as of August 1997  
Total Savings: \$38,663,000



\* Estimated Retrofit Savings include Savings from 66 LoanSTAR Sites where savings are estimated from monthly utility bills

**Figure 5**  
**Distribution of 16.9 MW of LoanSTAR Demand Savings by Retrofit Type**  
**as of August 1997**

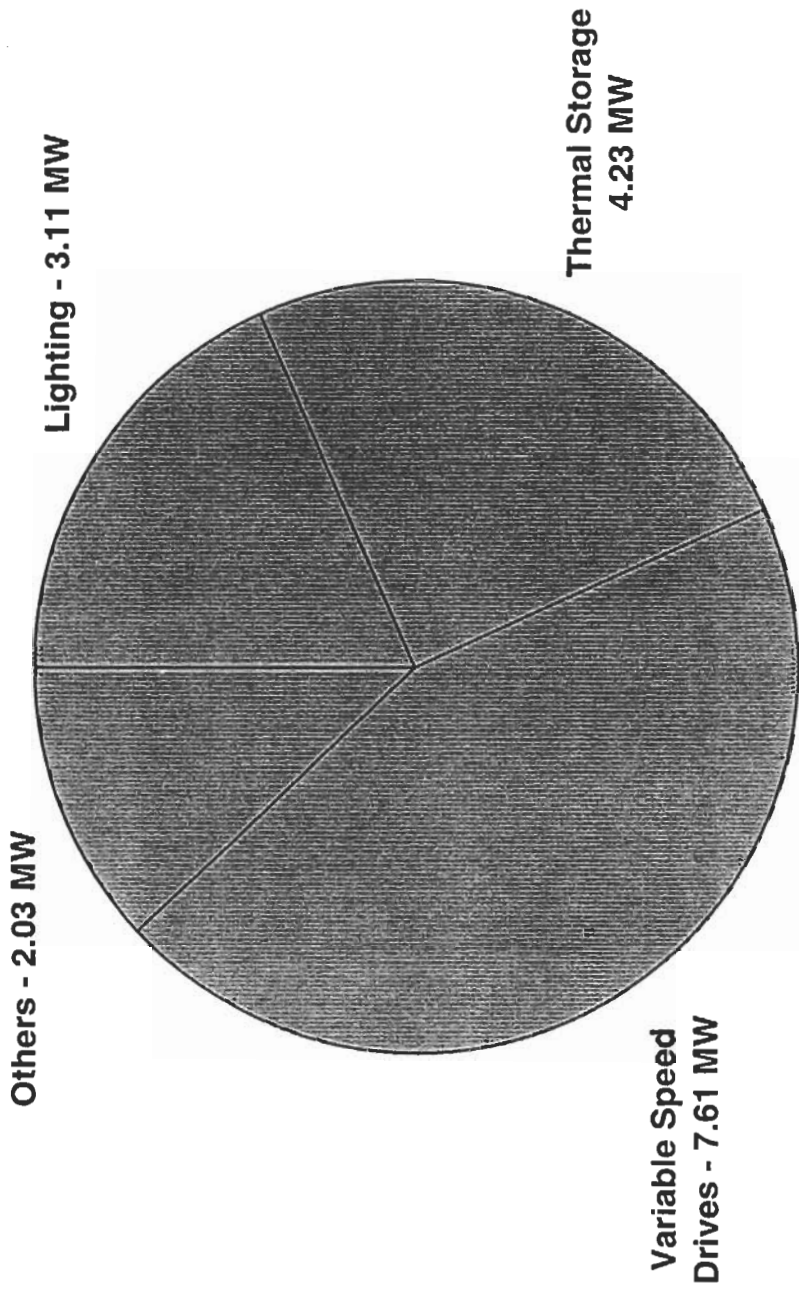
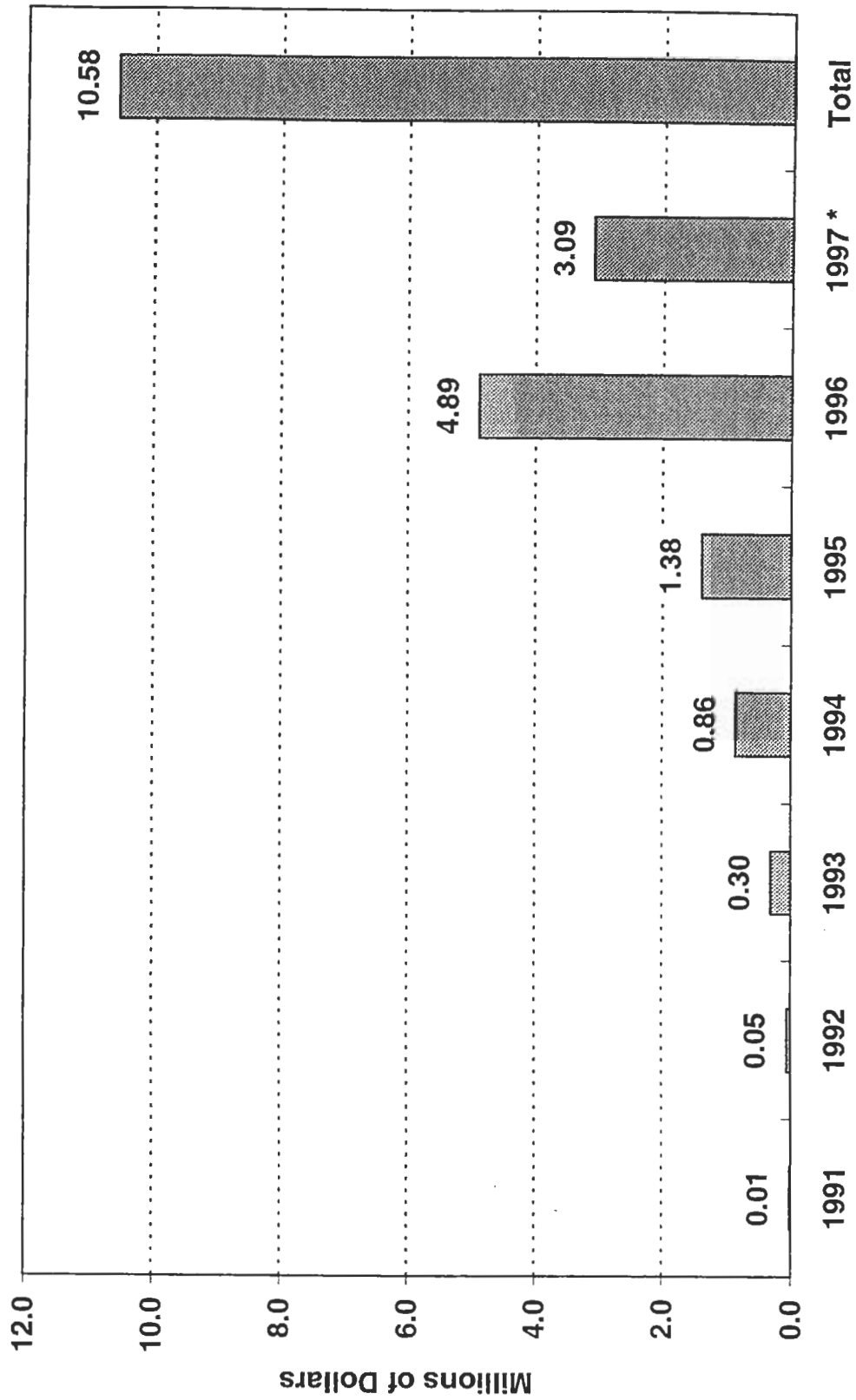


Figure 6  
**Continuous Commissioning Savings From the LoanSTAR Program**  
**Total CC savings \$10.58 Million**



\* 1997 Savings Includes Savings for 8 Months Only (January to August 1997)

Figure 7  
**Yearly Savings From the LoanSTAR Program**

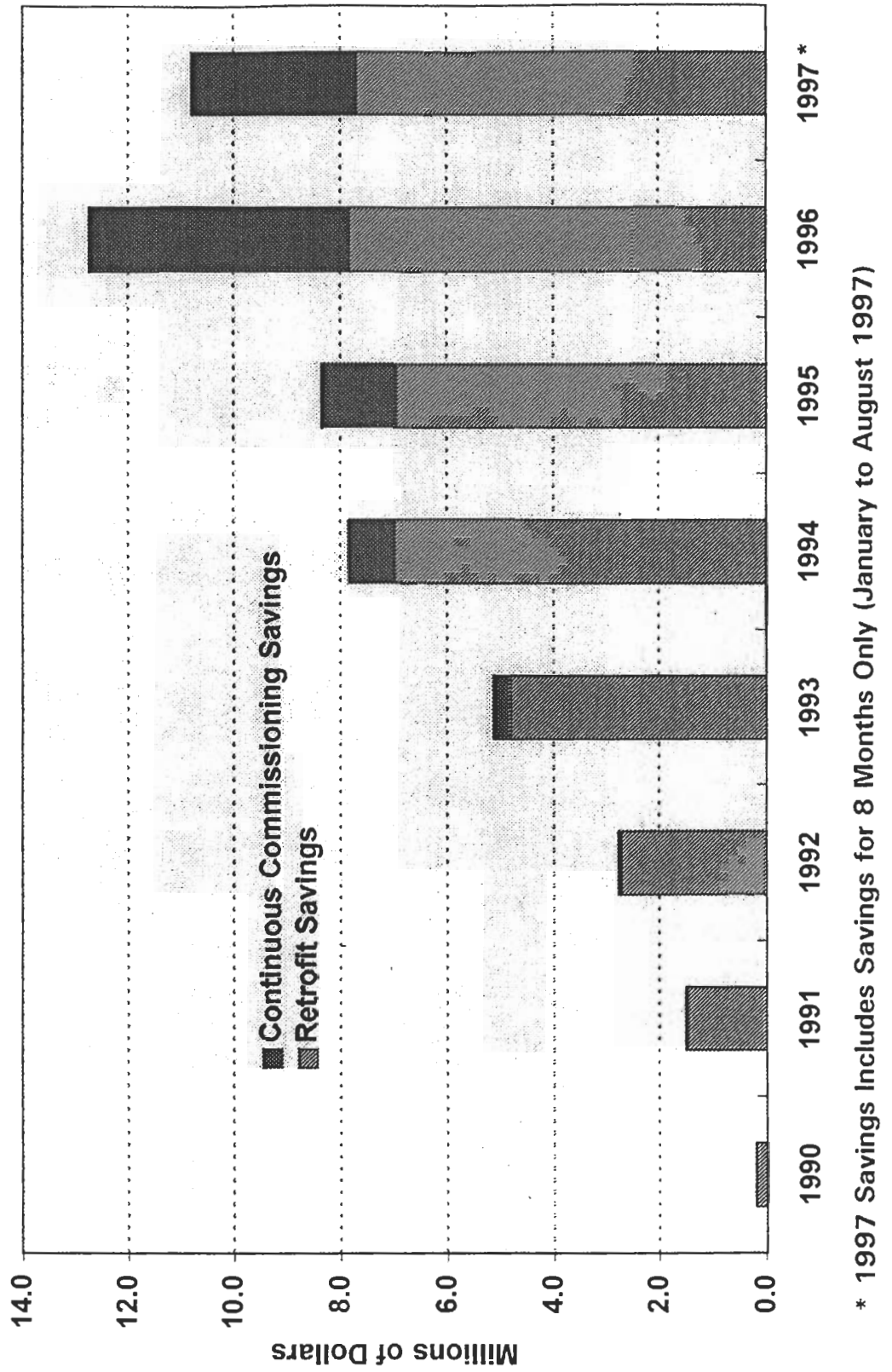
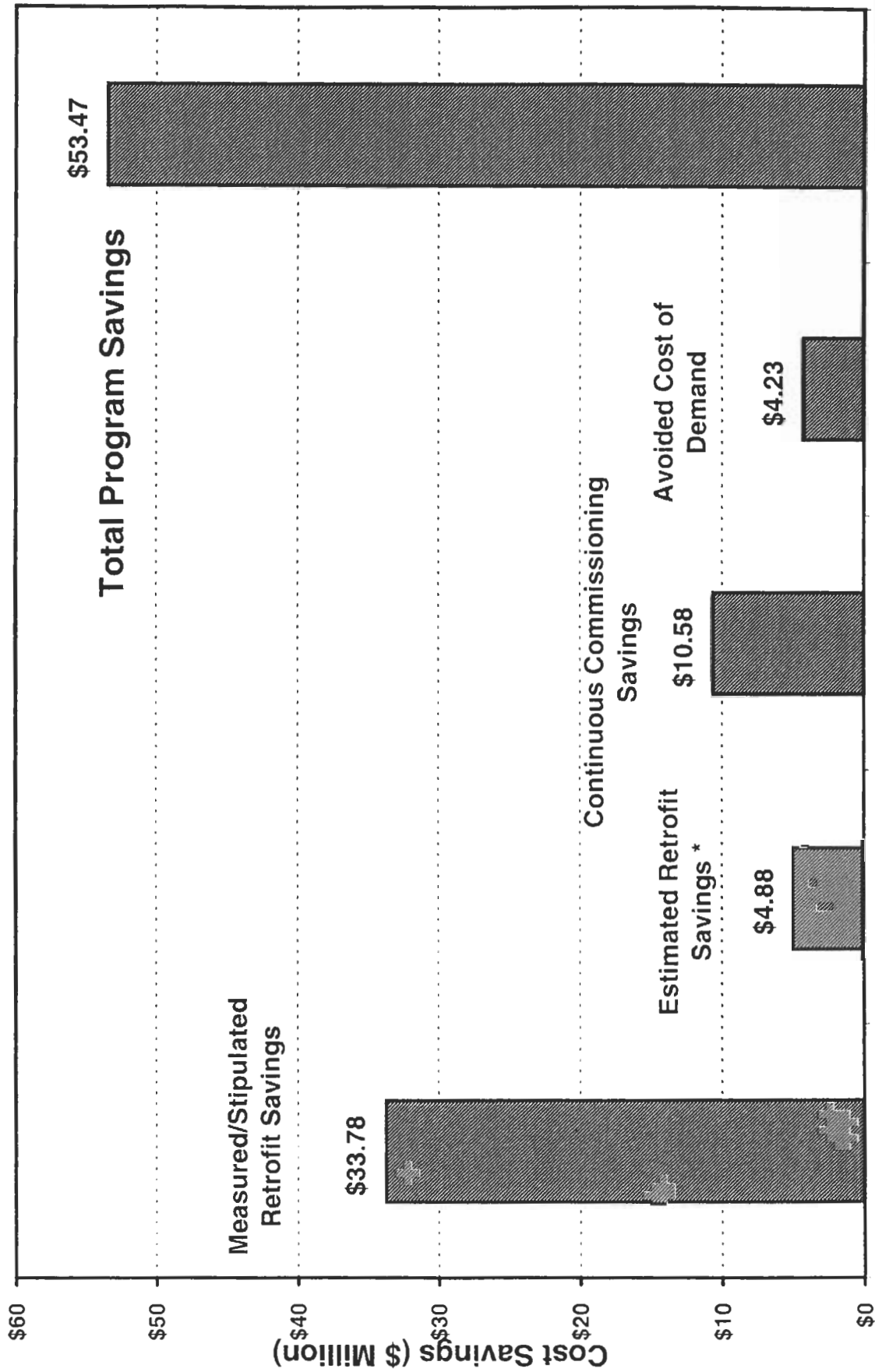


Figure 8  
**Cumulative LoanSTAR Program Savings as of August 1997**  
**Total Savings: \$53,471,000**



\* Estimated Retrofit Savings include Savings from 66 LoanSTAR Sites where savings are estimated from monthly utility bills  
 \* Avoided Cost of Demand by Utilities is Calculated by Utilities using \$250/kW Rebate given to the Customers by Utilities

## Emission Savings Summary (As of October 1997)

	NO <sub>x</sub> Tons	CO <sub>2</sub> Tons	SO <sub>2</sub> Tons
<b>HEATING</b> (1,426,778 MMBtu)	508	110,818	0.55
<b>CHILLED WATER</b> (1,362,417 MMBtu)	312	96,505	275
<b>ELECTRICITY</b> (379, 252 MWh)	1,043	322,364	920
<b>TOTAL SAVINGS</b>	1,863	529,687	1,196

**Table 1: The combined reduction in pollutant emission 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.**