The State Of Texas LoanSTAR Revolving Fund

Profile #101

Executive Summary

The State of Texas' LoanSTAR program is a model design for retrofitting public buildings. By loaning money to existing institutional facilities at low-interest rates the Loan to Save Taxes and Resources program is a revolving loan fund that has enabled a tremendous amount of retrofit activity in medical institutions, schools, libraries, university buildings, state offices, and other public facilities that would otherwise simply not have occurred.

LoanSTAR has leveraged significant dollar savings through the use of oil overcharge funds, money that the Federal government sought to have redistributed for maximum societal benefit. By identifying exceptional retrofit candidates, auditing facilities, enabling retrofits, and then working closely with facility managers to maximize operational improvements over time, through the use of approximately $100 million dollars worth of loan fund activity LoanSTAR has the potential to leverage as much as $850 million in savings over the next 20 years.

One of most important aspects of LoanSTAR has been its emphasis on monitoring and verification of energy savings. Rather than resting on auditors' projections and engineering estimates of potential savings, the State of Texas instead chose to carefully analyze the program's impact. To fulfill this function, the State Energy Conservation Office contracted with the Energy Systems Laboratory (ESL) at Texas A&M University. Through this collaboration and ESL's extensive knowledge of building systems, LoanSTAR has a tremendous amount of technical depth as well as resilience to political shifts that might have otherwise threatened a less well-documented program. Through careful attention to the detail uncovered through rigorous monitoring procedures, the program has achieved even greater savings through operations and maintenance improvements.

By the end of 1994 and only four years, LoanSTAR had provided capital for the retrofit of over 22 million square feet of space in 225 buildings at 34 sites. The average payback of the projects was 3.5 years while the program has stimulated retrofits ranging from lighting conversions to HVAC upgrades, shell improvements, high efficiency motors and variable speed drives, energy management control systems, and boiler upgrades. Already the program has generated over $20 million in cost savings derived from reductions in the use of electricity, natural gas, steam, and chilled water.

Given the challenges to conventional energy efficiency incentive programs promoted by utilities, revolving loan funds will likely become that much more important as a means of providing capital for cost effective retrofits in institutional facilities. While oil overcharge funds are drying up, the model that LoanSTAR represents can be funded through utility seed capital programs and from Federal, state, and municipal sources. LoanSTAR represents an attractive program design for the capture of efficiency in institutional facilities that can and likely will be replicated in other states and jurisdictions keen on the success enjoyed by the program in Texas.

THE STATE OF TEXAS
LoanSTAR Revolving Fund

Sector:	*Government buildings and schools*
Measures:	*Retrofits to lighting, HVAC systems, building shell, distribution systems, electric motors and drives, control systems, boilers, and thermal energy recovery systems*
Mechanism:	*Revolving loan mechanism provides financial catalyst whereby low-interest loans are granted for energy efficiency retrofits*
History:	*In 1988, SECO received approval from U.S. DOE to establish and administer $98.5 million program; by November 1994 over 225 buildings at 34 sites were retrofitted*

CUMULATIVE ENERGY SAVINGS DATA

Electricity:	*116,000 MWh*
Capacity:	*4.9 MW*
Chilled water:	*631,200 MMBtu*
Hot water/steam/natural gas:	*550,500 MMBtu*

CUMULATIVE COST SAVINGS DATA

Electricity:	*$5,059,000*
Chilled water:	*$6,044,000*
Hot water/steam/natural gas:	*$2,621,000*
Total cost savings:	*$13,724,000*

CONVENTIONS

For the entire 1994 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the U.S. Federal Reserve's foreign exchange rates.

The Results Center uses three conventions for presenting program savings. ANNUAL SAVINGS refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. CUMULATIVE SAVINGS represent the savings in a given year for all measures installed to date. LIFECYCLE SAVINGS are calculated by multiplying the annual savings by the assumed average measure lifetime. CAUTION: cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

THE STATE ENERGY CONSERVATION OFFICE

The Texas State Energy Conservation Office (SECO), formerly known as the Governor's Energy Office, is part of the General Services Commission's Division of Inter-Governmental Programs. SECO administers Texas' oil overcharge-funded energy programs. The oil overcharge funds represent money that Texans were overcharged at the oil and gas pumps by various oil companies between 1973 and 1981 when Federal price controls were in effect. President Jimmy Carter's administration sued the oil companies and the subsequent court settlements resulted in an enormous repayment to the American public doled out on a state-by-state basis prorationed by population. Texas alone received more than $300 million.[R#2]

One of SECO's main goals has been to return those oil overcharge dollars to the people of Texas. It has done this by supporting effective energy efficiency and renewable energy programs that comply with all state and Federal guidelines. Each biennium the Texas legislature determines how much oil overcharge money should be allocated to each of the energy programs administered by SECO. In addition, the Governor, Lieutenant Governor, and Speaker of the House, who constitute the state's Oil Overcharge Review Committee, make energy program decisions which are then approved by the U.S. Department of Energy (DOE).[R#2]

The core group of Texas' energy conservation programs are managed at SECO, however some programs have been transferred in the past year to satellite offices with other related missions. For example, the school energy programs have moved to the Texas Education Agency; residential energy programs have moved to the Department of Housing and Community Affairs; and transportation energy programs have moved to the Department of Transportation.

In addition, there are three energy councils that are funded by the oil overcharge funds and focus on particular aspects of Texas energy. The Sustainable Energy Development Council concentrates on the development of renewable energy and energy efficiency strategies for the state. The Alternative Fuels Council focuses on statewide strategies and initiatives for alternative vehicle fuels. The Texas Energy Coordination Council coordinates the development and marketing of energy research at Texas universities and non-profit organizations. [R#2]

OVERVIEW OF TEXAS A&M ENERGY SYSTEMS LABORATORY

Located at Texas A&M University, the Energy Systems Laboratory (ESL) is one of the nation's leading research and teaching facilities in the field of energy conservation and management. ESL is involved in myriad projects including the LoanSTAR program, the subject of this profile. Another notable project is the lighting retrofit of the U.S. Department of Energy building headquarters, the James E. Forrestal Building. (See Profile #100: EUA Cogenex/U.S. DOE Forrestal Building Retrofit) Here, ESL is under contract with the U.S. DOE to monitor and analyze the energy savings resulting from the lighting retrofit performed on the building. Other projects include developing systems for measuring the efficiency of air handling systems, developing diagnostics for trouble-shooting flow meters, conducting air conditioning and heat pump research, and producing numerous publications on the state-of-the-art in energy efficiency monitoring techniques and technologies.[R#15]

SECO DSM OVERVIEW	SAVINGS (%)	SAVINGS (trillion BTUs)	SAVINGS (MWh)
Thermal Efficiency Standards	38	64.9	19,021.93
Commercial Energy	3	5.1	1,501.73
Residential Energy	1	1.7	500.58
Transportation Energy	3	5.1	1,501.73
Local Government Energy	10	17.1	5,005.77
State Agencies	2	3.4	1,001.15
Industrial Efficiency	15	25.6	7,508.65
LoanSTAR	2	3.4	1,001.15
Lighting Efficiency Standards	21	35.9	10,512.12
School Energy Assistance Grant	5	8.5	2,502.88
Total	100	170.8	50,057.70

SECO supports a wide spectrum of programs to garner energy and dollar savings for the State of Texas. These include programs designed to make Texas' public buildings more energy efficient, to weatherize the homes of low-income citizens, to bolster recycling efforts, and to demonstrate new technologies in solar energy and alternative motor fuels.

RESIDENTIAL INITIATIVES

The Texas Department of Housing and Community Affairs (TDHCA), under contract with SECO, currently manages five energy assistance programs funded by oil overcharge dollars. The Weatherization Assistance Program (WAP), for example, provides measures to promote energy conservation to decrease energy consumption and utility costs for low-income residents of the state. TDHCA also administers the Native American Restitution Program which provides funds to Texas' three Federally recognized Indian tribes for energy conservation and assistance projects.[R#2]

RENEWABLE ENERGY INITIATIVES

To ensure the best use of Texas' renewable energy and energy efficiency resources, Governor Ann Richards created the Sustainable Energy Development Council in March of 1993. The 17-member council, the first of its kind in the nation, is comprised of members from electric utilities, renewable energy industries, environmental and consumer groups, and heads of government agencies.

Council members are currently crafting a strategic plan for sustainable energy development in Texas. As part of this plan the Council has commissioned several assessment studies. These include a site verification of Texas' solar, wind, and biomass resources; the potential for increased efficiency in the State's industrial and transportation sectors; the limitations of Texas' electrical transmission grid; and methodologies for incorporating the environmental and economic attributes of energy efficiency and renewable energy into the electrical resource evaluation process.[R#2]

ALTERNATIVE FUELS INITIATIVES

The Alternative Fuels Council encourages the increased use of alternative vehicle fuels to help public and private organizations finance the conversion of vehicle fleets from gasoline to alternative fuels. The Council recently approved nearly $4 million in oil overcharge grants for 60 projects statewide. Texas school districts and local governments received the bulk of the awards. These projects will help put 1,871 alternatively fueled vehicles on Texas roads and further develop the fueling infrastructure for alternative fuels.[R#2]

TRANSPORTATION INITIATIVES

The central energy project under the Texas Department of Transportation is the Traffic Light Synchronization program. Two hundred and twenty completed projects in towns and cities across the State have shown estimated annual fuel savings of more than 55 million gallons of motor fuel by synchronizing traffic lights and thus reducing stops and starts for motorists on major roadways. At $1/gallon, this represents savings of more than $55 million. With nearly $9 million funded from oil overcharges to help 65 local governments achieve these results, a benefit to cost ratio of more than 6 to 1 will result from this program.[R#2]

SUMMARY OF TEXAS OIL OVERCHARGE FUND ALLOCATIONS	TOTAL EXPENDITURES (x 1,000)
Agricultural Energy Efficiency	$4,273
Alternative Energy	$3,759
Alternative Fuels	$10,342
Consumer Representation	$1,279
Energy Crisis	$1,329
Energy Efficient Air Conditioning	$250
Energy Efficient County Jails	$5,174
Energy Emergency Planning	$50
Energy Management for Schools	$3,000
Emergency Nutrition/Relief	$11,638
Geophysical Parallel	$1,690
Housing Partnership	$4,000
Industrial Efficiency	$500
Institutuional Conservation	$5,276
LoanSTAR	$98,462
Low Income Housing Energy Assistance	$1,000
Mass Transit Energy	$8,086
Native American Restitution	$814
Public-Private Partnership	$4,271
Recycling	$1,998
Regional Transportation Center	$3,354
Ridesharing	$50
Rural Public Transportation	$9,000
School Energy Management Grant	$17,000
State Energy Conservation	$6,448
Superconductivity	$18,225
Sustainable Energy Development Council	$2,000
Technology Commercialization Fund	$200
Traffic Light Synchronization	$4,070
Water System Efficiency	$758
Weatherization Assistance	$5,132
Administrative Expenses	$320
Total	$233,748

SCHOOLS INITIATIVES

The Texas Education Agency (TEA) is making more than $23 million of oil overcharge money available to Texas public schools. The money is being distributed through TEA's School Energy Management Grant program to make school facilities more energy efficient. TEA has identified 254 eligible school districts (classified with "below-average property wealth per student") and solicited grant applications from them. To date, nearly one half of the program's $23 million has been awarded to 122 school districts.

Districts that receive grants may use the funds to purchase and install energy-efficient lighting systems, air conditioning systems, or energy control systems; to pay the incremental costs of installing energy-efficient equipment in new facilities; to make improvements to existing buildings that result in lower energy costs; or to pay the salary of a full-time energy manager for a particular school district.[R#2]

OTHER INITIATIVES

The grandparent of Texas' energy efficiency efforts for public buildings is the Federal Institutional Conservation Program (ICP) administered by SECO, now in its 16th annual cycle. This program assists public and private non-profit K-12 schools, colleges, universities, and hospitals in identifying and implementing energy efficiency retrofits. Since its inception in 1979, ICP has helped finance energy-efficient retrofits for 2,579 buildings, awarding grants of nearly $90 million in the process and leveraging an equal amount from local jurisdictions.[R#2]

Another program, the State Agencies Program, publishes Texas' Energy Conservation Design Standards for New State Buildings. The program also provides a state agency energy manager incentive program, arranges training and workshops for energy managers and building personnel, and collects and analyzes energy consumption data for state facilities. The program is currently expanding and enhancing its services in several areas including telecommuting, model energy code training, a residential energy design standard, and compliance review with the Solar In-State Structures Act.

SECO'S DOCUMENTED ENERGY SAVINGS

As required by the U.S. DOE, SECO has completed the Energy Savings Report for Texas' 1993 State Energy Conservation Plan. The Plan consists of 14 separate programs of which the 10 that produced savings are shown in the SECO DSM Overview table on the previous page. The total 1993 estimated energy savings for those programs is 170.804 trillion BTUs, equivalent to 50.1 GWh. That amount equals the energy contained in 28.7 million barrels of oil. At $19/barrel, this represents a savings of more than $545 million.[R#2]

The largest piece of that savings, 38%, or 19.0 GWh, has come from the adoption and implementation of thermal efficiency standards. Lighting efficiency standards have saved another

21%, or 10.5 GWh. The rest of the savings have resulted from other commercial, residential, industrial, transportation, and local government programs.

SECO'S LOANSTAR

The subject of this profile is the LoanSTAR (Loan to Save Taxes and Resources) program. This program has become a national model for energy-efficient retrofitting of public buildings. LoanSTAR's full title is the Statewide Retrofit Demonstration and Revolving Loan Program. As shown in the Summary of Oil Overcharge Funds table, the program uses a portion of Texas' oil overcharge money to make low-interest loans to public entities interested in making their existing buildings more energy efficient. The loans are repaid to the State through the savings that are realized.

Funds from the oil overcharges for energy programs as appropriated by the Texas Legislature have totalled $233,748,392 as of October 1994. The LoanSTAR program accounts for the largest portion of this total, $98,462,000, at the present time. The Superconductivity and School Energy Management Grant programs also account for significant portions of the overcharge money at $18,225,000 and $17,000,000, respectively.[R#2]

CASE STUDY: THE PERRY CASTANEDA LIBRARY

The Perry Castaneda Library on the University of Texas' Austin campus is a six-story structure that was built in 1977 with a gross area of approximately 484,000 square feet. Its exterior walls consist of limestone panels and concrete blocks. Its windows consist of 1/4 inch, single-pane tinted glass and cover approximately 12% of the exterior wall area. Like many buildings of its vintage, not only was its energy consumption high but comfort levels in the building were suboptimal.

Thanks to the capital and expertise made possible through the LoanSTAR program, the library was retrofitted in November 1991 with variable air volume air handling units (AHUs) and variable speed pumping for its HVAC system. Under the new system the library is conditioned by four groups of air conditioning equipment consisting of eight variable volume single duct AHUs, twelve variable volume dual duct AHUs, four variable volume hot deck AHUs, twelve variable frequency drive return AHUs, and one variable volume chilled water pump. As of November 1994 the retrofit had resulted in savings of 119,000 MMBtu in steam, worth $738,500; 185,600 MMBtu in chilled water, worth $1,377,000; and 15,845 MWh, worth $720,100, for a total savings of $2,835,600 over a three-year period.

In addition to the direct energy savings that resulted from the hardware installed as part of the retrofit, by working with the library's facility managers operational efficiencies were also identified. Chilled water and steam were supplied by the main physical plant located on campus. Steam at 165 psi from the campus loop entered the building and was immediately reduced to 10 psi. Part of this low pressure steam was used to heat domestic water. The remainder was piped to reheat coils in the single duct units and to the dual-ducts units. Questions were raised about the high steam consumption at the site in June 1991. A visit was scheduled to check the metering hardware installation. The matter was discussed in detail with the building operator who suggested the closure of the reheat valves for the single duct air handling units. Detailed data regarding the building was sent to the building operator towards the end of June. Following another site visit and a careful analysis of the data, partial closure of the valves to the reheat coils was accomplished on July 3, 1991.

The result was a sharp decline in the usage of steam from 1.5 million Btu/hr to about 0.5 million Btu/hr. A second visit was made on July 10, 1991, accompanied by the facility and the design engineer. After a consensus was reached the remaining valves were also shut off. An additional drop in chilled water consumption for the eight single duct air handling units occurred and was confirmed through monitored data. Total savings to date have been $119,000.

Another operational improvement was identified in April of 1992. Until this time lights were left on during unoccupied hours while cleaning crews cleaned the building. A schedule change was made on the cleaning which allowed operators to turn off the unnecessary lights from midnight until seven o'clock in the morning. The new schedule was implemented, resulting in a sharp decline in evening electricity use, confirmed through monitoring data. The shut down resulted in savings of approximately $48,000 per year and thus total savings to date have been approximately $120,000.[R#18]

Buildings in the United States use more than 30 percent of the nation's energy resources and waste large amounts of energy due to poor design and inefficient operation. In response to this drain on resources, the State of Texas decided some years ago to use much of its oil overcharge funds to implement energy efficiency in school and State agency buildings throughout the State. Many of these buildings and public facilities were constructed in the 1960s and 1970s without energy efficiency in mind and thus represent ripe opportunities for efficiency retrofits.[R#6]

In 1988, SECO received approval from the U.S. Department of Energy to establish and administer a $98.5 million statewide retrofit demonstration revolving loan program called the LoanSTAR program. The LoanSTAR program provides a revolving loan mechanism whereby low-interest loans are granted for energy-efficiency retrofits to be made in State, public school, and other government buildings. As of November 1994, the program has provided the catalyst and financial support for the retrofit of 22,463,000 square feet of space in 225 buildings at 34 sites.[R#12]

MARKETING

LoanSTAR Program Manager Mike Wiley says that marketing a program of the magnitude of LoanSTAR has not been difficult. "Many State agencies and schools are eager to receive low-interest loans for energy retrofits that will end up saving them money. Therefore, no major marketing efforts have been required of SECO. The key has been simply raising awareness of the program to prospective end-users."

Initial marketing for the LoanSTAR program included open solicitation for audit requests by the State Energy Conservation Office. This was made via telephone inquiries, written notices, and direct mail brochures. SECO tracked prime candidates for energy retrofits across the State through a number of mechanisms. Big energy users were easily identified because large State government agencies are required to file annual energy management plans which list their total energy consumption. While there are sources of end-use information that were valuable in directing the program's early emphasis, currently marketing is carried out at SECO simply by "knocking on the doors" of facility managers and explaining the low-interest loans and benefits possible by retrofitting their facilities with high efficiency equipment. Now that the program has grown in stature and has a proven track record, it largely markets itself through word-of-mouth. Marketing the program is also supported through the use of information packets which can be provided to facility managers and other interested parties.[R#14]

Another primary means of promoting the program has been to work with engineering firms, energy service companies, and other trade allies. Their impetus is simple: promoting large-scale energy efficiency retrofits supports their prospective businesses. By coupling their efforts with SECO, which in turn enables low-interest funding through the LoanSTAR fund, they unfold a natural synergy that provides a three-way win-win situation between themselves, the State, and those large energy users in Texas most in need of tapping the rich potentials for energy efficiency.[R#14]

DELIVERY

Retrofit projects are identified by energy audits conducted by engineering teams under contract with SECO. Preliminary audits are available for free upon request and have no strings attached. Facilities audited are at no obligation to proceed with recommended retrofits. If the facility managers do elect to proceed and seek state financing, each retrofit competes for funds based on several variables designed to provide the best deal for Texas and its residents. Projects compete for funds based on the estimated payback period, the facility's ability to repay the loan through energy savings, engineering assessments of the viability of the retrofit technology, the ability of program staff to effectively monitor and meter the proposed project, and the ability of the applicant to implement and maintain the retrofit and thus create durable savings benefitting Texas taxpayers for the maximum duration.[R#5,15]

The LoanSTAR program is currently implemented in two phases. Phase 1 targets State agencies and institutions that received energy audits from 1984 to 1986. Capital intensive energy-efficiency improvements with a total retrofit potential of $40 million are candidates for funding in this phase. Public schools and local governments are targeted for Phase 2 of the LoanSTAR program. Previous engineering audits of these facilities conducted under the Institutional Conservation Program (ICP) revealed potential energy savings similar to those in State buildings.[R#5]

If a proposed project is indeed selected to receive funding, it engages in the basic LoanSTAR terms of engagement contract, termed from SECO's point of view as a "commitment" of loaned money. Once a loan is "committed," SECO waits to be billed by a facility as the retrofit process occurs. If a facility decides not to retrofit, the "committed" money is de-obligated and eventually loaned to another qualifying facility.

The maximum loan for State agencies and universities is $4.8 million. The maximum loan amount to a local government or

independent school district is $1.2 million. Repayments, which begin 90 days after the project has been implemented, are made semi-annually or quarterly at an annual interest rate of 4.04%. The length of the loan is determined by the combined estimated simple payback of the project(s). Loan proceeds are used to pay for the retrofit, engineering and design, and installation expenses.[R#5]

As part of the program, a statewide energy Monitoring and Analysis Program (MAP), covered extensively in the next section of this profile, was initially established and is now implemented by Texas A&M University's Energy Systems Laboratory (ESL). Several major objectives of the LoanSTAR MAP are assured by ESL including each project's ability to 1) verify energy and dollar savings of the retrofits, 2) reduce energy costs by identifying operational and maintenance improvements, 3) improve retrofit selection in future initiatives of the LoanSTAR program, and 4) initiate a database of energy use in institutional and commercial buildings located in Texas. The cost of the on-site metering and energy analysis performed under MAP is paid by SECO from the interest-income derived from the program. As such, total metering costs cannot exceed three percent of all retrofit costs.[R#5]

Initially, all metering installations were installed under the supervision of ESL. In 1994, the State of Texas was divided into four geographic regions. Four universities (Texas A&M University, Texas A&M University-Kingsville, the University of Texas at El Paso, and Texas Tech University at Lubbock) are responsible for all monitoring and metering of the LoanSTAR sites within their areas. These four universities work on the installation, testing, and maintenance of the metering and monitoring equipment, and also identify operations and maintenance opportunities at the sites throughout the State. Polling and archiving of metered data, analysis of savings, and reporting are principally done by Texas A&M through the central data center. There are also three more universities, Prairie View A&M, Texas Southern, and Sam Houston State University working with LoanSTAR. One university assists in developing mathematical analysis models, another is working on the development of calibrated models, and a third is developing software.[R#9]

DELIVERY: THE STEP BY STEP PROCESS

The Walk-Through Audit: First, SECO contracts with an independent consulting firm who determines a building or facility's potential for savings by performing an initial on-site review and walk-through audit. This involves reviewing past utility bills, inspecting lighting, HVAC, and control systems as well as determining operational features of these systems such as what times of day and what fraction of the time they are running.

The on-site review is completed in one day. Then a formal report is issued which determines the potential for a cost-effective retrofit. This report is issued to the facility manager and the Energy Systems Laboratory for review usually within one week as is a notice if a more detailed audit or engineering analysis is necessary.

The Detailed Audit: If it is determined that a detailed audit is needed, SECO assigns an experienced independent audit firm usually within one month to perform the task. ESL reviews all audit reports to make sure they are correct. The detailed audit identifies what type of retrofit is to be performed as well as the projected specific costs and savings resulting from the retrofit. There is an independent review of the audit firm's reports for verification of savings and appropriateness of the recommended energy efficiency improvements.

Agency Approval: Next, a SECO staff engineer meets with the facility manager to review the audit and determine whether to proceed with the implementation of the retrofit. At this time the SECO representative explains the specifics of the LoanSTAR program to the prospective candidate.

Establishing the Loan: If the agency decides to proceed with the retrofit, it signs a loan promissory note (also termed "commitment") for the specified amount. The loan then requires approval from SECO. It is amortized with an interest rate of 4.04%. Typical paybacks range from 2-4 years for lighting retrofits and 4-8 years for other measures. The average payback for all loans issued to date has been 3.5 years.[R#14]

Metering: After the loan is approved, ESL receives a copy of the loan agreement and measures to be installed and then develops a preliminary metering plan. This plan needs to be approved by the agency or facility that is being retrofitted. Metering of the program plays an integral part in tracking savings from a retrofit. Depending upon the size of the loan for the project, different metering procedures are followed. (In general, the larger the loan, the more rigorous the metering and verification aspect of the project.) For small and relatively straightforward retrofits, utility bill analysis is sufficient. For larger projects, meters are installed to establish pre-retrofit

baseline consumption and sub-meters are used to disaggregate hourly data for the largest retrofits.

Implementation: Finally, the actual design and implementation of energy-efficient measures is performed by independent contractors. Then, 90 days after completion of the retrofit the borrower must begin to repay the loan. After the retrofit is complete direct contact is made each month with the building operators and/or energy managers when problems are discovered or O&M opportunities are identified. Periodically site visits are made to recalibrate meters and instrumentation, discuss O&M opportunities, and investigate when changes in building energy use occurs.[R#12,14]

MEASURES INSTALLED

Measures recommended through an approved audit with an estimated payback of approximately four years or less are eligible for loans, although exceptions are made. The projects funded by LoanSTAR primarily include retrofits to lighting, HVAC systems, building shell, distribution systems, electric motors and drives, energy management and control systems, boilers, and thermal energy recovery systems. Other viable candidates for loans include improvements to central plants, cogeneration facilities, water and waste water projects, and other forms of demand-side management measures. Retrofits using alternative or renewable energy systems and load management also are considered.[R#5]

More specific measures that are typically installed in buildings include variable frequency drives, motion sensors, pump shutdown controls, eddy current variable speed drives (VSDs), pump and motor modifications, photocells, night setbacks, energy management control systems (EMCS), properly sized chillers, and steam shutdowns.[R#5]

STAFFING REQUIREMENTS

Three major groups are involved in the staffing of the program: the State Energy Conservation Office of Texas, Texas A&M University's Energy Systems Laboratory, and the consulting firms, engineers, and contractors that perform the audits, engineering analyses, and installations. At the State Energy Conservation Office headquarters, Mike Wiley is LoanSTAR Program Manager and devotes roughly 70% of his time to the program. (0.7 full-time equivalent or FTE) He is assisted by Theresa Sifuentes who devotes her full-time attention to the to the program. (1 FTE) Administrative support at SECO makes up 0.5 FTE along with engineering support adding another 0.3 FTE specifically for the LoanSTAR program.[R#14]

At Texas A&M's Energy Systems Laboratory, four faculty members each devote part of their time to the LoanSTAR program. Dan Turner, Associate Dean and Director of the Energy Systems Laboratory; Jeff Haberl, Research Associate Professor; David Claridge, Associate Professor; and Dennis O'Neal, Professor, have teamed up to lead the development of the extensive monitoring and metering side of the LoanSTAR program. Combined, these professors devote roughly 1 FTE of work to the program. Twelve graduate students each devote half of their time (totaling 6 FTEs) performing energy savings analyses. Ten staff engineers devote all of their time (10 FTEs) performing field audits, assisting in polling and archiving, and researching and measuring O&M savings. Thus approximately 17 FTEs manage the monitoring and verification aspect of the program at ESL. There are also approximately seven FTE's supporting the program at the six supporting universities. The mix consists of faculty, graduate students, and full-time staff engineers.[R#9]

Numerous contractors are constantly being involved in various phases of implementation. It usually requires one to two engineers to perform an on-site review and an engineering report. Audits vary in staffing, since the size of buildings varies also. Therefore no set number of contractors can be accounted for on an annual basis, although dozens of contractors are involved each year.[R#5,14]

THE MONITORING AND ANALYSIS PROGRAM

Perhaps the most exemplary feature of LoanSTAR is its emphasis on the Monitoring and Analysis Program (MAP). Not only was MAP one of the first comprehensive metering and monitoring programs ever established in the United States but it also provides an exceptionally solid underpinning for program savings and a high degree of confidence that taxpayers' dollars are indeed creating the benefits envisioned through the program. To accomplish this task, SECO contracted with Texas A&M's Energy Systems Laboratory, one of the nation's leading research and teaching programs in the field of energy conservation and management, to measure, assess, and report energy savings. Through this relationship, SECO and the State's taxpayers can be assured that their use of the oil overcharge funds is judicious and applied for maximum social benefit.

The Energy Systems Laboratory, part of the Texas A&M University system, has not only developed its own highly sophisticated monitoring and verification procedures, but has been instrumental nationally, maintaining solid relationships with other prestigious organizations involved in similar pursuits. A Monitoring and Analysis Review Committee (MARC) has been established to provide ongoing contact with other energy monitoring and analysis efforts to ensure incorporation of applicable techniques and results from those efforts. Organizations with participants on the MARC include the U.S. Department of Energy, the Electric Power Research Institute, Lawrence Berkeley Laboratory, Oak Ridge National Laboratory, Pacific Northwest Laboratory, the Massachusetts Institute of Technology, and the University of Texas.[R#5]

OBJECTIVES OF THE MONITORING AND ANALYSIS PROGRAM

The LoanSTAR Monitoring and Analysis Program (MAP) was designed to serve the differing needs of the many participants in the LoanSTAR revolving loan program. The MAP's first objective has always been to determine whether retrofits actually save as much as estimated in audits. When necessary, a monitoring plan is developed for each retrofitted facility to verify savings. This includes measurement of consumption data before and after the retrofit, and analysis of the data to account for weather and changes in operation of the building. This is a quality assurance procedure to affirm that agencies purchasing retrofits receive real savings from the LoanSTAR retrofits. Naturally feedback from this post-installation verification is fed back to the auditors on a regular basis.[R#5]

The second objective of the MAP is to use metering and monitoring to further reduce buildings' ongoing operations and maintenance energy costs by carefully evaluating their energy-using characteristics. Previous experience at several universities and at large Federal office buildings (for example the James Forrestal Building, Profile #100), has shown that continuous energy monitoring and analysis can lead to changes in operation and maintenance that can substantially reduce energy use in a building in addition to the hardware retrofits made possible through the capital loan aspect of the LoanSTAR program. Since the measurement equipment is in place to verify savings, and ESL staff have a wealth of knowledge related to building operations and are carefully tracking building energy consumption, savings and the program effect can be amplified through operational changes made possible through the measurement aspect of the program.

The third objective of MAP is to increase the cost-effectiveness of future rounds of the LoanSTAR program's loans by screening out ineffective retrofits.

The final major objective of the MAP is the establishment of an end-use database for institutional and commercial buildings in Texas. By establishing a database of this kind, proxy values for potential savings in similar building types can be established, providing important policy insights for Texas and the rest of the nation.[R#5]

THE FIVE TASKS OF THE PROGRAM

The primary work of the MAP has been divided into five tasks.

Task 1, Audit review and assignment: SECO has contracted with eight engineering consulting firms to conduct audits for the LoanSTAR program. An audit firm is assigned to each building based on expertise, geographic location, and workload.

Task 2, Selection and installation of monitoring systems: This task ensures that adequate, reliable, and affordable data are collected to monitor energy use of the buildings participating in the LoanSTAR program. Data collected from the buildings is the basis for determining the cost-effectiveness of different retrofits as well as providing indices of how well an individual building is performing. The major functions of this task include: Determination of metering requirements; selection and qualification of data acquisition system subcontractors; and installation and maintenance of metering systems.

Depending upon the size and cost of the project, retrofits fall into one of four levels of monitoring activity to be installed. Naturally the larger the installation the retrofit, the more important the metering and monitoring of results and the greater the opportunity for further operational improvements:

Retrofits with a cost of $20,000 to $50,000 fall into the Level 0 Facility/Whole-Building Utility Data. This means that monitoring of the building is based upon monthly consumption data taken from utility bills. Such data is useful for separating consumption into heating, cooling, and non-weather related end-uses such as water heating. A substantial portion of retrofits in schools and local government buildings fall within this category. This type of monitoring is the least cost, requiring no metering equipment at all.[R#5]

Retrofits which cost between $50,000 and $100,000 receive Level 1 Whole-Building and Limited Sub-metered Hourly Data. This metering utilizes one to four channel Data Acquisition Systems (DAS) and captures hourly whole-building gas and electric measurements. Each channel records a parameter, thus the more channels, the more data recorded. The cost for this type of metering equipment is roughly $3,000.

Retrofits which cost between $100,000 and $300,000 receive Level 2 Moderate Sub-metered Hourly Data. This level has all the capabilities of the first two levels and also enables more detailed analysis by identifying the savings from specific retrofits and pinpointing building operational problems. Also, moderate sub-metered DASs with four to twenty channel systems are employed. This type of metering costs approximately $8,000-$10,000.

Level 3 is Detailed Sub-metered Hourly Data for retrofits that range from $300,000 upwards to several million dollars. This type of metering includes systems with at least 20 channels of data. With such high costs, these are only cost-effective in large buildings and groups of small buildings. Costs for this type of metering average $30,000, or $1,000 to $1,500 per channel.[R#5]

Task 3, Calibration laboratory, "monitoring the monitors": Program experts insist that the key to successful energy monitoring lies in the accuracy of the sensors installed in the various heating, cooling, and other systems inside the buildings. Data obtained for this project must be accurate to maintain confidence and reliability. To ensure accuracy, the Energy System Laboratory has created a calibration laboratory to "monitor the monitors." The Laboratory is National Institute of Standards and Technology (NIST) traceable, meaning it achieves an accuracy traceable to the national standard. The calibration lab tests new energy monitoring systems for prequalification, studies faulty systems that have been in use, and furnishes their findings to other engineers through scientific papers and conferences.[R#6]

Task 4, Systems communications: The purpose of this task is to conduct benchmark communications testing of all field Data Acquisition Systems for the LoanSTAR MAP, develop software for automated polling and data archival, and provide support to the computer systems. Essentially this task takes advantage of the extensive network of monitoring equipment in the field as a result of LoanSTAR and allows ESL to check the accuracy and operation of this equipment for further uses in other locations.

Task 5, Monitoring plans, analyses, and reports: This task analyzes collected data in order to determine the energy and dollar savings of the retrofits and to reduce energy costs by identifying potential operational and maintenance improvements. The primary objective which will influence the analysis methods used is the need to determine the overall cost savings due to the retrofits and the savings and effectiveness of individual retrofits.[R#5]

Monitoring and Analysis Program personnel develop a reporting plan for each retrofitted facility to verify and analyze the savings and furnish operators with a six-page monthly energy consumption report including plots of energy consumption. The report summarizes energy consumption and provides comments on the past month's performance, revealing hourly, daily and weekly use patterns. This feedback helps pinpoint changes in energy consumption and ensures that savings accrue long before loan repayments are due. Continuous monitoring provides data that prompts changes in operation and maintenance to further reduce energy use in the buildings. Finally, the increased knowledge gained on retrofits will improve future projects and demonstrate to designers that investments in certain energy features are cost-effective.[R#6]

Most of the retrofits use "before-after" measurements to evaluate their effectiveness. Before-after consumption, normalized for environmental, operational, and system parameters is compared to audit estimates to determine if the retrofit is operating as intended. If there is a discrepancy between measured and audit estimates, corrective action is taken immediately to assure that the retrofit functions properly and as such will not affect the projected payback.[R#5]

IDENTIFYING AND IMPLEMENTING IMPROVED OPERATION AND MAINTENANCE MEASURES

Researchers at Texas A&M's Energy Systems Laboratory have identified opportunities for realizing savings from improved operation and maintenance practices. Traditionally these are identified as part of the energy audit process, however a methodology has been developed and implemented to identify O&M savings opportunities in buildings that have already been retrofitted.[R#12]

First, sites are chosen which have the largest potential O&M savings or which have facility personnel who are eager to improve their operation.

After a site or a building has been selected, candidate O&M measures are identified by using the LoanSTAR measured hourly energy consumption data for individual channels. The audit report, as well as the monthly energy consumption report and annual energy consumption report, provide heating, cooling, and electricity consumption information.

The measured hourly energy consumption data make it possible to identify O&M opportunities quickly and determine measures which would have been difficult or impossible to identify by a walk-through audit. Time series consumption plots are used to identify excessive operating hours, equipment malfunctions, over-sizing of systems, and building operation patterns. Non-efficient operation and malfunction problems can be identified by plotting the chilled water and steam consumption versus the ambient temperature.[R#12]

After the candidate O&M measures are identified, a site visit is scheduled during which the feasibility of these candidates is examined, new O&M opportunities are identified, and necessary information for the detailed O&M analysis is collected.

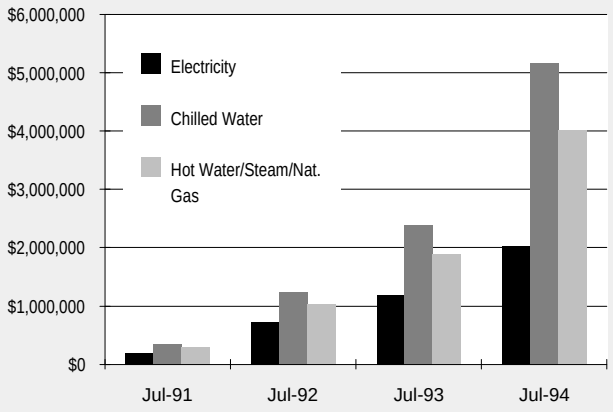
Identified measures include the correction of continued poor practices such as excessive operation of HVAC systems, excessive lighting, and failure to turn lights and office equipment off. Optimization of HVAC system operation, which includes hot deck shut-off, partial cold deck shut-off, and simultaneous reset, has proven to be another very important O&M measure. The hourly monitored data provides the opportunity for immediate feedback on the success of such measures and it also shows when a return to poor operating practices has occurred. Finally, the measures are implemented and then ESL conducts follow-up meetings with building facility engineers and operations personnel for fine-tuning the O&M measures. [R#12]

SUMMARY OF ENERGY CONSUMPTION AND SAVINGS (OCT. 1990 TO NOV. 1994)	ELECTRICITY	CHILLED WATER	HOT WATER/ STEAM/ NAT. GAS	TOTAL
Baseline Use	$32,639,000	$16,032,000	$7,142,000	$55,813,000
Post-Retrofit Use	$27,580,000	$9,988,000	$4,521,000	$42,089,000
Measured Savings	$5,059,000	$6,044,000	$2,621,000	$13,724,000
% of Baseline Use	15.5	37.7	36.7	24.6
% of Total Measured Savings	36.9	44.0	19.1	100.0
Audit Estimated Savings	$4,939,000	$3,788,000	$2,526,000	$11,253,000

Data alert: Most of the data in this section and the next is current through November of 1994. More recent data is presented where possible.

From the start of the program in October 1990 to November 1994, LoanSTAR has produced total measured cost savings of $13.7 million as a result of total LoanSTAR program expenditures of $17 million. In addition to expenditures on projects that have come to fruition, LoanSTAR has committed five times as much capital for projects in the pipeline. As of March 1995 the program has resulted in audit estimated cost savings of $21.5 million from $98.5 million in loaned capital. These savings represent 28.8% of baseline energy costs.

ENERGY COST SAVINGS BY END-USE

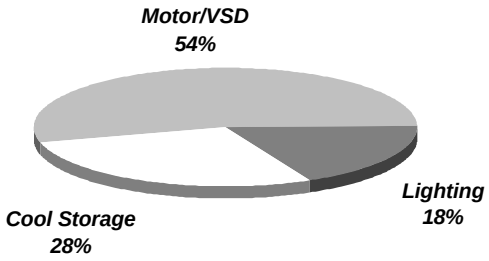


While the primary measure of savings for the program is dollars, LoanSTAR has saved a variety of energy sources including electrical capacity, natural gas, hot water, steam, and chilled water. For instance, through November 1994, the LoanSTAR program has saved 116,000 MWh of electricity, 631,200 MMBtu in chilled water, and 550,500 MMBtu in hot water/ steam. Measured cost savings of $13.7 million have resulted from savings of electricity, chilled water, hot water, steam, and natural gas. Of this total measured cost savings, $5.1 million (37%) was from decreased usage of electricity, $6.0 million (44%) was from chilled water, and $2.6 million (19%) was from decreased usage of hot water, steam, and natural gas. Chilled water savings produced the greatest amount of savings as a percent of baseline usage at 37.7%. Hot water, steam, and natural gas usage was reduced 36.7% of its baseline usage and electricity usage decreased 15.5% of its baseline usage. Combined, energy usage decreased 24.6% for measured buildings.[R#4,9]

SAVINGS OVERVIEW (OCT. 1990 TO NOV. 1994)	ELECTRICITY	CHILLED WATER	HOT WATER/ STEAM/ NAT. GAS
Cumulative Energy Savings	116,000 MWh	631,200 MMBTUs	550,500 MMBTUs

In terms of measured electricity savings the program saved 4.9 MW of capacity as of August of 1994. For tracking purposes, capacity savings are grouped into three categories: lighting, motors, and cool storage. Capacity savings from lighting measures, which includes all lighting related equipment, such as cut-backs, efficient ballasts, and controls, are 0.9 MW. The motors category resulted in the greatest capacity savings of 2.7 MW. This includes pumps and HVAC equipment as well as variable speed drives.[R#13]

TOTAL CAPACITY SAVINGS (MW)



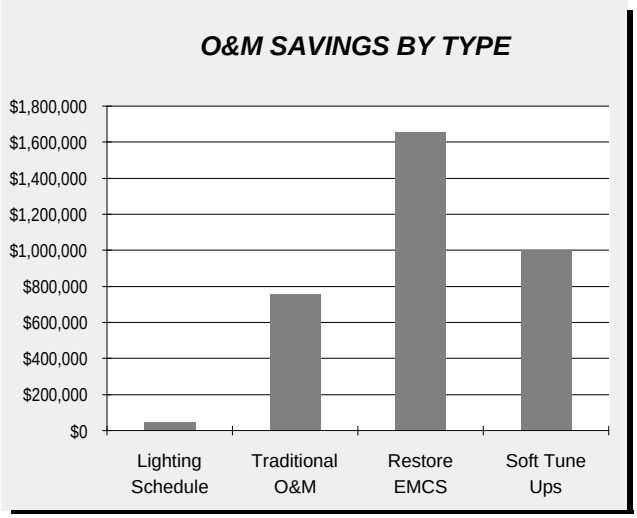
As of March 1995, motors and variable speed drive conversions resulted in the highest cost savings by measure, $6.5 million, or 30.1% of total cost savings. Lighting retrofits comprise the next greatest cost savings at $4.6 million, representing 21.2% of total cost savings. Combined, all the measures have an average simple payback of 4.4 years.

O&M SAVINGS

Measured cost savings from improved O&M practices were determined by researchers at Texas A&M's Energy Systems Laboratory. A methodology was developed and implemented to identify O&M savings opportunities in buildings that have already been retrofitted. Four categories of O&M savings were determined: delamping, traditional O&M, restored energy management control systems (EMCS), and "soft" tune-ups.[R#12]

O&M SAVINGS BY TYPE	*NUMBER OF BLGS.*	*SAVINGS ($/YR)*	*COST SAVINGS*
Lighting Schedule	1	$48,000	5%
Traditional O&M	19	$756,300	11%
Restore EMCS	104	$1,658,000	27%
Soft Tune Ups	9	$1,000,000	34%
Total	133	$3,462,300	23%

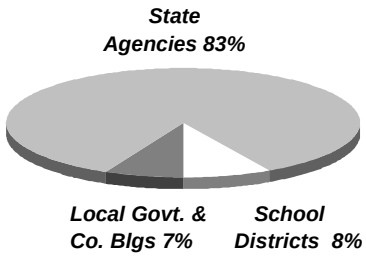
The largest source of O&M cost savings, $1.7 million, was derived from 104 schools covering 4.5 million square feet where energy management control systems were restored. This savings represents 27% of the total annual building energy costs. Soft tune-ups in another nine buildings resulted in $1,000,000 in cost savings, representing 34% of these building's total annual energy costs. Lighting schedule changes, although saving only $48,000 for one building, were an extremely simple operational means of saving energy. Total O&M savings of $3.46 million were identified and implemented, representing 23% of 133 building's total annual energy costs.[R#12]



PARTICIPATION RATES

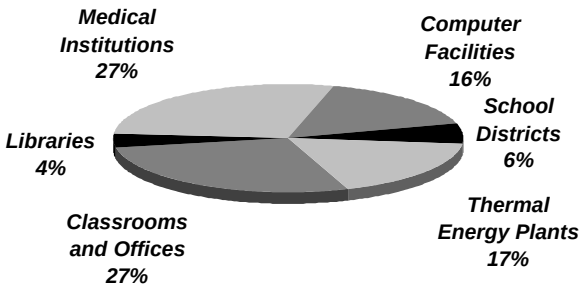
As of November 1994, 34 sites consisting of 225 buildings constituting over 22 million square feet have participated in LoanSTAR. As of January 1995, more than 70 state agencies, independent school districts, and local governments were enrolled in the Texas LoanSTAR program. Participation for the program is defined by the total retrofitted area. The most prevalent building type has been medical institutions, which have comprised 27% of the square footage of all buildings receiving loans. All types of classrooms combined have made up 26% of the total retrofitted area. General offices and computer facilities make up 16%. Other common building types that have participated in the program include libraries, school districts, and thermal energy plants on university campuses.[R#9]

PARTICIPATION BY SECTOR



LOANS EXECUTED BY SECTOR (AS OF JAN. 1995)

Total: $98,462,468



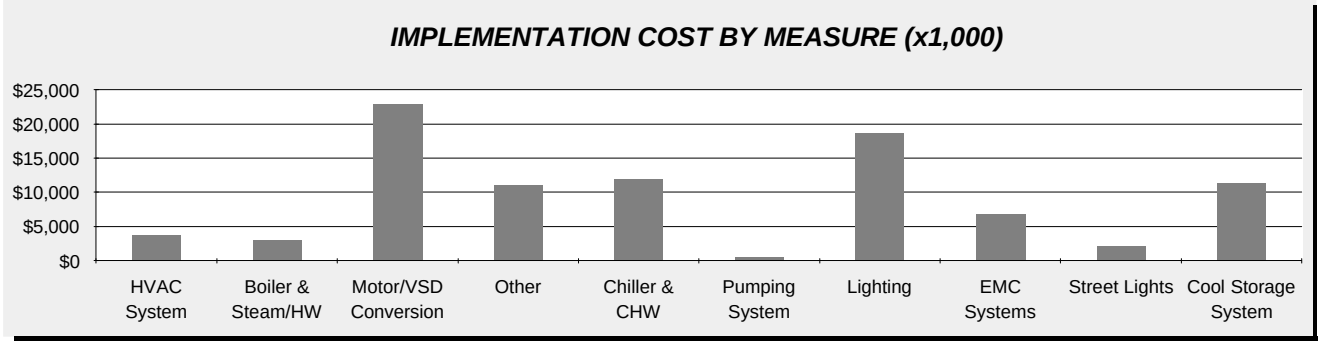
RETROFITTED BUILDINGS (through Jan. 1995)	PERCENT OF TOTAL AREA
Classrooms/Offices	10%
Classrooms/Offices/Labs	14%
Classrooms/Offices/Theaters	20%
Libraries	40%
Medical Institutions	27%
Offices	1%
Offices/Computer Facilities	16%
Schools Districts	6%
Thermal Energy Plants	17%
Total	100%

PROJECTED SAVINGS

The $98.5 million committed to date through the LoanSTAR program is projected to save Texas taxpayers more than $35 million by 1996 and a total of $250 million over the next 20 years. "The vision and foresight to invest in LoanSTAR could save Texas citizens more than $850 million over the next 20 years if the full $98.5 million is loaned over two loan cycles as currently approved by the U.S. DOE," said ESL Director Dan Turner. These projections point to the value of revolving loan funds as means to leverage greater and greater savings as loans are repaid and funds can be reapplied for subsequent retrofits.[R#6]

Cost of the Program

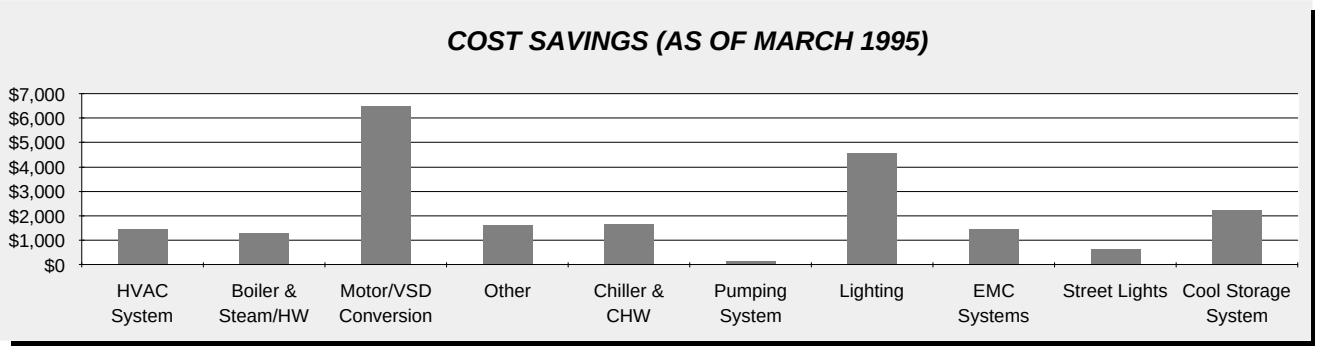
COSTS AND SAVINGS OVERVIEW BY MEASURE (AS OF MARCH 1995)	IMPLEMENTATION COST (x1,000)	% OF TOTAL IMPL. COST	COST SAVINGS (x1,000)	% OF TOTAL COST SAVINGS	SIMPLE PAYBACK (YRS)	CAPACITY SAVINGS (MW)
HVAC System	$3,741	4.1	$1,459	6.8	2.6	
Boiler & Steam/HW	$3,003	3.3	$1,308	6.1	2.3	
Motor/VSD Conversion	$22,840	24.8	$6,478	30.1	3.5	2.700
Other	$11,039	12.0	$1,604	7.5	6.9	
Chiller & CHW	$11,951	13.0	$1,658	7.7	7.2	
Pumping System	$541	0.6	$125	0.6	4.3	
Lighting	$18,701	20.3	$4,557	21.2	4.1	0.900
EMC Systems	$6,825	7.4	$1,479	6.9	4.6	
Street Lights	$2,098	2.3	$622	2.9	3.4	
Cool Storage System	$11,378	12.4	$2,226	10.3	5.1	1.300
Subtotal	$92,117	100	$21,516	100	4.4	4.900



From October 1990 to January 1995, the LoanSTAR program has committed (meaning under contract) a total of $98.5 million to a variety of retrofit projects. Of this, $92.1 million has been committed to loans and $6.3 million has gone to contingency and audit allowances. (Contingency allowances consist of escalation costs, price changes, employee costs, and construction management.) Of the $92.1 million, $17 million of the loans has gone towards monitored sites that have been finalized and are now providing measured and reported savings and thus loan repayments. Additionally, numerous sites are in the process of being monitored but have not reported savings due to projects being in the construction phase. Other sites are not being monitored but are in the process of having utility bill savings analyses performed. The remaining balance is allocated to committed loans that have yet to begin installation of equipment or are in the process.

From October 1994 through April 1995 over $50 million in committed projects were expeditiously brought into the program. These loan commitments came after close to two years of no loan activity. This underscores the fact that a great deal of activity is currently in progress but not yet resulting in measured savings.

When considering all measures, for both projects in progress and finalized, motor and variable speed drive conversions represent the greatest expenditure at $22.8 million, comprising 24.8% of total implementation costs. Lighting retrofits are also popular, representing $18.7 million and comprising 20.3% of total implementation costs. Pumping system retrofits comprise the smallest implementation cost at $541,000, 0.6% of total implementation costs.



COST COMPONENTS

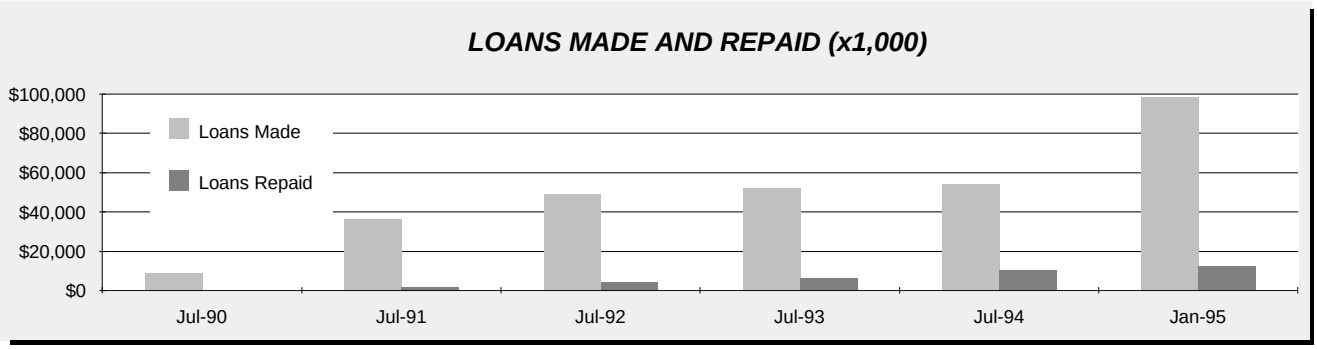
Of the $98.5 million loaned out, state agencies have received the greatest share, $82 million (83%) as of January 1995. Independent school districts (ISDs) account for $9.5 million (10%) in money loaned out, and city and county agencies account for $6.8 (7%) million. Most of the money loaned out, $92.1 million, or 93.6%, was spent on measures. Only 1.35%, or $1,330,000 was spent on audits and 5.1%, or $5.01 million, was spent on contingencies.

COSTS OVERVIEW BY RECIPIENT (AS OF JAN 1995)	TOTAL
State Agency Loans	$82,186,336
City and County Loans	$6,762,086
ISD Loans	$9,514,046
Total	$98,462,468

COSTS FOR MONITORING EFFORTS

The original contract with Texas A&M's Energy Systems Laboratory to perform all metering and monitoring activities was for $1 million per year. This contract, now involving six other universities, has been revised and totals $2 million for 15 months. Roughly $1.5 million of this money goes towards monitoring administration, field engineering, operations and maintenance changes in buildings, monthly and annual reporting, energy savings analysis, polling, and archiving. The remaining $500,000 is divided among the six additional universities and is used for mathematical modeling, calibration modeling, software development, and field and O&M work. The Monitoring and Analysis Program, as well as the metering and program administration are all fully funded by the 4.04% program interest.

LOANS EXECUTED	CUMULATIVE LOANS MADE (x1,000)	LOANS REPAID (x1,000)
Jul-90	$8,900	$0
Jul-91	$36,000	$1,946
Jul-92	$49,000	$4,082
Jul-93	$52,000	$6,502
Jul-94	$54,000	$10,328
Jan-95	$98,462	$12,434



Environmental Benefit Statement

AVOIDED EMISSIONS: Based on 116,000,000 kWh saved 1990 - 1994

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
Coal	***Uncontrolled Emissions***					
A	9,400	2.50%	250,096,000	5,933,000	1,199,000	120,000
B	10,000	1.20%	266,684,000	2,297,000	775,000	574,000
	Controlled Emissions					
A	9,400	2.50%	250,096,000	593,000	1,199,000	10,000
B	10,000	1.20%	266,684,000	230,000	775,000	38,000
C	10,000		266,684,000	1,531,000	766,000	38,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	266,684,000	702,000	383,000	191,000
B	9,400	2.50%	250,096,000	593,000	480,000	36,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	266,684,000	472,000	77,000	191,000
B	9,010		239,888,000	171,000	58,000	11,000
Gas	***Steam***					
A	10,400		145,464,000	0	332,000	0
B	9,224		126,324,000	0	791,000	37,000
	Combined Cycle					
1. Existing	9,000		126,324,000	0	485,000	0
2. NSPS*	9,000		126,324,000	0	230,000	0
3. BACT*	9,000		126,324,000	0	32,000	0
Oil	***Steam--#6 Oil***					
A	9,840	2.00%	210,540,000	3,190,000	376,000	357,000
B	10,400	2.20%	223,300,000	3,164,000	473,000	230,000
C	10,400	1.00%	223,300,000	452,000	380,000	120,000
D	10,400	0.50%	223,300,000	1,327,000	473,000	73,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	279,444,000	556,000	864,000	47,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	331,760,000	855,000	1,125,000	250,000

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

HOW TO USE THE TABLE

1. The purpose of the accomanying page is to allow any user of this profile to apply the Texeas State Energy Conservation Office's level of avoided emissions saved through its LoanSTAR Revolving Fund to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in both tables include a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

*** Acronyms used in the table**

TSP = Total Suspended Particulates
NSPS = New Source Performance Standards
BACT = Best Available Control Technology

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

LoanSTAR has been successful in fulfilling its primary mission: Certainly LoanSTAR has been highly successful in fulfilling its primary objective of returning oil overcharge dollars to the people of Texas. Not only have nearly $100 million been distributed to public institutions in the State, but these investments will leverage far greater savings over time, especially as the fund truly revolves, exploiting the basic advantages of such a financial mechanism.

Working with Texas A&M University's Energy Systems Laboratory has provided an invaluable technical foundation for the program: Clearly one of the great strengths of the program has been the collaboration between the State Energy Conservation Office and the Energy Systems Laboratory. While the State has administered the financial end of the program, ESL has been primarily responsible for all technical aspects of the program. This division of labor has allowed each agency to do what it does best. The State has also benefitted from similar collaborations with other universities that have joined the program more recently.

The monitoring and verification aspect of the program has given the program tremendous credibility: Unlike many government-run initiatives with energy efficiency, LoanSTAR has placed a major emphasis on monitoring and verifying savings. This aspect of the program has given the program credibility and provided policymakers in the State with the assurance that dollars expended on the revolving loan fund are indeed generating quantifiable savings. Not only is ESL verifying savings, but through its metering of specific installations and careful measurement of building energy systems, additional operational savings have been identified, amplifying the program's effect and leveraging yet greater dollar savings.

Timing issues and requirements for loan repayments have lessened the program's effect to date: While LoanSTAR's primary mechanism is sound, a key lesson learned from the program is that without more explicit repayment requirements and de-obligation protocols, capital repayments are delayed. As such, opportunities are lost for quicker reinvestment of the program's funds, disallowing the maximum use of the capital resources made possible in this case through the oil overcharge funds. LoanSTAR seems to have suffered by de-obligating loans without strict time schedules and by only requiring loan repayments once projects are complete.

Since SECO commits money to eligible projects, and many projects have been in the works for some years, dollars that could have been reinvested haven't been, minimizing the program's effect. For example, four million dollars was committed to the University of Texas-Galveston to build a cogeneration facility. The project was cancelled, and the four million dollars was in a state of dormancy for several years, tieing up money that could have been loaned to other projects.

These issues could be quite easily addressed by applying more strict time provisions – rather than the "honor system" – to when loans can be taken and when repayments have to be made. A problem experienced by LoanSTAR is that agencies have gladly accepted funds dedicated to projects that have lagged in implementation, significantly draining the revolving fund of its capital balance.

From the administrative side, the LoanSTAR program could be managed better: Administering the LoanSTAR program from a government agency, like Texas' SECO, has created problems with efficient delivery of the program. The program's staff, including program managers, changes every two years. This politically unstable environment only increases the "time lag" and decreases the effectiveness associated with implementing the program. This is due to the fact that it takes nearly a year for new program managers and supporting staff to get up to speed with administering the program.

Another problem stemming from administering the program from a government agency is excessive politicizing. Program staff are anxious to "commit" funds – meaning that allocated funds are placed under contract with a facility – so that the money will be "protected," allowing managers to request more funding, and allowing politicians to claim

that the program is loaning more money out for energy efficiency retrofits than has actually been used to complete retrofits due to the long time delays of up to two years.[R#11]

One solution to these problems would be to run the program from a separate office in a non-political environment that utilizes an external advisory group and can implement the program without political influences and bureaucratic inefficiencies. This would cut down on administrative time delays, permit stricter enforcement and adherence to time schedules for facilities to complete retrofits, and allow program managers and staff to focus more directly on the program [R#11]

Metering a large program of LoanSTAR's magnitude is possible, but must be done carefully to assure uniformity of quality and results: The metering aspect of the LoanSTAR program has demonstrated that it is logistically feasible to monitor large commercial buildings at reasonable cost. However, at the onset of the program the monitoring procedures used by different contractors resulted in nonuniformity in application of instrumentation. This was solved by the formulation and use of installation guidelines written for each piece of instrumentation.[R#16]

ESL professionals have found that contractors should be assigned a "test" site to judge their capabilities: According to ESL staff, even though many of the contractors selected through the request for proposal (RFP) process looked good on paper, it was decided to assign each contractor a single site so that an evaluation could be made of the quality of an actual installation. Through this process it became evident which of the contractors were fully capable.[R#16]

With the majority of the savings from the LoanSTAR program coming from data taken in the field by various types of metering equipment, it is essential to have metering equipment that is accurate and reliable in order to have a meaningful analysis of energy use data on buildings: ESL has also found that, unfortunately, instrumentation can provide a stream of numbers that may not reflect what is actually being measured. Equipment problems encountered in the first two years of this project have included instrumentation used in thermal metering, electrical measurement, and psychrometric measurements. Initial calibration and periodic recalibration of the equipment is the best way to ensure field accuracy.[R#17]

Typical field problems encountered with metering include: shunt meters sized and rated improperly, polarity of current transformers mismarked, thermal energy meters set inaccurately at the factory, thermal meters picking up 60 Hz noise from electrically noisy surroundings, different brands of thermal energy meters not agreeing with each other, temperature dependence in relative humidity meters, and failure of these meters. All these possibilities must be checked and considered during the metering process.

Maintenance of equipment may be more difficult to handle than the original installation: LoanSTAR has also reinforced the fact that once instrumentation is in place it must be maintained. If an instrument fails, it requires a trip to the site to diagnose the problem and at least one more subsequent trip to the site to fix the problem. The cost of maintenance will probably exceed the initial expectations of personnel on the project. The types of failures seen in the field will depend on the type of instrumentation used. The rule of thumb is to expect all instrumentation to fail at some point in the program. Often equipment gets dirty, damaged, disconnected, or simply fails.[R#16]

TRANSFERABILITY

Dan Turner, Director of the Energy Systems Laboratory, says that transferring LoanSTAR to other jurisdictions is one of the great opportunities that has become evident from his experience with the program. LoanSTAR, despite its administrative drawbacks, is a model that fundamentally makes sense and which can be used across the country – and potentially in other countries as well – to stimulate verified savings.

Essentially there are two key aspects of the program that can be transferred. First is the revolving loan mechanism itself. Already The Results Center has documented revolving loan funds in Oslo, Norway; the City of Philadelphia School Sys-

tem; the City of Phoenix; and in the State of Connecticut for acute-care hospitals. Presently, the Nebraska State Energy Office is running a revolving fund program financed from oil overcharge money. This program boasts being the nation's premier financing mechanism for leveraging money for energy efficiency improvements in all sectors including residential, commercial, industrial, governmental, and schools. As of January 1, 1995 the program has leveraged $46 million in loans from lenders statewide.

The second highly desirable and transferable aspect of the program relates to the extensive monitoring and verification aspects of the program conducted by ESL. Currently ESL and others are working to promote the dissemination of the LoanSTAR program to other states and energy ministries. Recently, ESL was selected as the metering and monitoring subcontractor for a DSM/Energy Conservation program for the State of Minnesota which is starting its program with the retrofit of two facilities over the next three years. Northern States Power, an investor-owned utility located in Minneapolis, is providing $15 million of interest-free capital for this revolving fund energy conservation program. ESL is now under contract negotiations with Northern States Power and work was expected to start during the summer of 1995. ESL is also working with the Florida Energy Office on a similar LoanSTAR type program. The Energy Office is calling the program "FlaSTAR." ESL is also working with the United States Federal Buildings program to encourage adoption of LoanSTAR as a model for all Federal facility energy efficiency initiatives.[R#9]

Another initiative involves one of ESL's metering subcontractors, NCAT-DC. NCAT-DC has a metering contract with the State of Pennsylvania to meter some of their state government buildings. ESL will also act as a subcontractor to NCAT-DC on this project. Eventually, Pennsylvania will facilitate the evolution of this program to include large scale metering and monitoring similar to LoanSTAR.[R#9]

ESL is also working with several electric utilities in the U.S. to help them set up LoanSTAR-like programs serving their customers. This type of program will allow the utilities to establish long-term relationships with their commercial and industrial customers. Preliminary contracts have also been made with South Korea, Canada, and the European Community. There is a possibility that international pilot projects will be initiated in 1995 using LoanSTAR protocols and procedures.

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