The City of Phoenix
Energy Management Program
Profile #118

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Executive Summary

The City of Phoenix's Energy Management program for its municipal facilities is one of the best kept efficiency secrets in the United States. Years ago, Phoenix officials became aware of the fact that if the City's energy bills were treated as a single expense, energy would be the City's largest budget item after payroll. This provided the initial impetus for efficiency in Phoenix. Now its success story – 16 years in the making – has proceeded with little fanfare or accolades, but has provided $18 million in net repayments to the City's General Fund.

Phoenix has some 300 buildings including an airport, water and waste water treatment plants, downtown office facilities, libraries, fire and police stations, and public works maintenance service centers. To date, nearly 1,000 projects have taken place from small lighting retrofits to the construction of a 600,000 square foot, $84 million New City Hall which embodies state-of-the-art design and which is a showcase of energy-efficient equipment. The Energy Management program has been part of the Public Works Department and thus integrally tied to the City's Facilities Management department. This, its staff assert, has been a key ingredient to its success as Phoenix has taken a pragmatic orientation to efficiency, tying facilities managers' functions with energy management and thus providing durable savings through increased awareness of efficiency's interface with both day-to-day operations and longer-term equipment replacements and capital improvements.

The savings reinvestment mechanism established in Phoenix has also been an important factor in Phoenix's success. Each year a portion of documented energy savings are reinvested in further energy efficiency improvements, providing a means for leveraging greater and greater energy savings. To date $4.4 million (20% of the total savings) has been reinvested, resulting in direct and accountable savings of $22.8 million. Furthermore, the entire program was bootstrapped with virtually no capital outlays. Early program retrofits employed no- and low-cost measures and provided demonstrable results that laid a solid foundation for ever-more sophisticated efforts.

The core of Phoenix's success with energy management has been the existence and influence of its Energy Management Team. The team of professionals that has been devoted to the rational use of energy has created an effect in Phoenix well worthy of replication around the world. Through its concentration on energy efficiency – from routine, relatively simple measures to highly sophisticated measures such as district cooling and direct digital control of buildings – the focus on energy management has resulted in both direct and indirect savings that bolster Phoenix's overall resource efficiency and exemplary city management.

THE CITY OF PHOENIX
Energy Management Program

Sector:	*Municipal buildings and facilities*
Measures:	*Comprehensive energy managment of Phoenix's 300 buildings from extensive lighting and HVAC retrofits to highly sophisticated design and control of new City buildings*
Mechanism:	*Capital reinvestment plan provides fund for efficiency improvements through energy and dollar savings*
History:	*Municipal energy management began in 1978; capital reinvestment commenced in 1983; by 1994 City had trimmed 10% of its utility bills; greater reinvestment now planned*

1993-94 PROGRAM DATA

Energy savings:	*2,277 MWh*
Gas savings:	*2,037 MCF*
Lifecycle energy savings:	*34,155 MWh*
Cost Savings:	*$183,618*

CUMULATIVE DATA

Energy savings:	*290,692 MWh*
Lifecycle energy savings:	*551,521MWh*
Gas savings:	*260,093 MCF*
Cost savings:	*$22,841,156*

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.

City Overview

The City of Phoenix, Arizona is the eighth largest city in the United States, the capital of Arizona, and the center of the metropolitan area encompassed by Maricopa County. This metropolitan area – the twentieth largest in the United States – includes the cities of Mesa, Glendale, Tempe, Scottsdale, Chandler, Peoria, Gilbert, and Avondale as well as all unincorporated areas in the County. Phoenix is situated at 1,117 feet above sea level in the semi-arid Salt River Valley. The area is well known for its mild, sunny winters; hot summers where temperatures routinely reach 115 degrees F and occassionally soar to over 120 degrees F; and where the annual rainfall is limited to only seven inches. Given this scenario it's no wonder that air conditioning is of prime importance in Phoenix, while heating demands – typically only 4-6 hours a day on select winter days – are minimal.[R#9]

Phoenix was founded in 1870 as an agricultural community, was incorporated in 1881, and has grown steadily since then, with marked growth since 1950. The 1900 Census recorded Phoenix's population at 5,544. In 1950 the City occupied 17 square miles with a population of almost 107,000, ranking it 99th among American cities. By 1993 the City occupied 449.7 square miles and by 1995 had a projected population of 1,071,000 persons.[R#9]

In 1993 Phoenix received one of its highest honors – the Carl Bertelsmann Prize – in an international competition designed to recognize the best-run City government in the world. Christchurch, New Zealand tied with Phoenix for first place. Phoenix was awarded the prize based in large part on the City's highly efficient and customer-oriented systems. According to the Bertelsmann Foundation, the key to the City's success is the direct participation of residents who are socially active in their neighborhoods. In 1992, Phoenix citizens performed more than 600,000 hours of volunteer service.[R#9]

Given its hot, dry, and sunny climate, Phoenix has had to take stock and responsibility for its water supplies and use patterns. In 1994-95 the total amount of treated water for the metropolitan area was 64.1 billion gallons creating some 176 million gallons of waste water that has to be treated every day. The 2.7 million acre feet of water required annually by regional activities come from a diverse set of resources including surface water from the Salt and Verde Rivers supplied by the Salt River Project, and from the Colorado River transported by the Central Arizona Project. The area's supply is also augmented by water ranches purchased by a number of local cities and by the reuse of effluent for non-domestic purposes. The area also has hundreds of wells in place to supplement water supplies during periods of below-normal precipitation.

1993-94 CITY OF PHOENIX STATISTICS

Population	*1,052,00*	
Area	*449.7*	*sq. mi.*
City Employees	*11,705*	
City Buildings	*300*	
City Energy Costs	*$40*	*million*
Average Electric Rates		
Arizona Public Service	*9.0*	*¢/kWh*
Salt River Project	*7.5*	*¢/kWh*

Ironically, as the City grows in population demand for water in the year 2025 is projected to be lower than current levels. This is anticipated largely because of the shift from agricultural land in the area (characterized by water-intensive practices) to urban and industrial sites that require less water. In addition, savings will occur from conservation programs and the increased use of alternative sources of water such as effluent. Planners expect this will ease the need for groundwater withdrawals in the year 2025 from 22% of total water demand to 9%.[R#9,10]

With a population currently just exceeding one million people, Phoenix operates under a Council-Manager form of government and has an annual budget of just under $1.3 billion. The City Council is made up of a mayor and eight council members elected by the people on a non-partisan ballot for four-year terms. The Mayor is elected at large while council members are elected from the districts in which they reside. Within the City are a host of departments including the Public Works Department. It is this department and budget allocation that provides for the Energy/Facilities Management Division which in turn is home to the Energy Management Team whose success is the root of this Profile.[R#7,9,10,11]

The City of Phoenix pays about $40 million each year for electricity and natural gas. (Natural gas accounts for about 5% of the total cost.) The City buys electricity from two electric utilities whose service territories include Phoenix: Arizona Public Service (APS) and the Salt River Project (SRP). The City pays thousands of electric bills each month, with various accounts on different rate structures. The City's water and waste water departments, naturally, get special rate discounts. The City pays an average rate of 9.0 ¢/kWh to APS and about 7.5 ¢/kWh to SRP for an average blended rate used in this Profile of 8.5 ¢/kWh.

Agency Overview

The Public Works Department has had responsibility for Phoenix's energy management activities since they began in 1978. The Public Works Program currently requires about 4.7% of the total Phoenix City budget and includes Public Works Administration, Contracts Administration, Energy/Facilities Management, Equipment Management, and Solid Waste Management.

Within the Energy/Facilities Management division of Public Works are a host of responsibilities related to managing and maintaining the City's 4.9 million square feet of space. In FY 1994-95 staff expect that fully 10,000 service requests will be handled. The program provides mechanical and electrical maintenance and energy conservation services for City facilities. For FY 1994-95 the Energy/Facilities Management operating budget allowance was $12,328,000, about 20% higher than its FY 1993-1994 budget of approximately $10 million. Funding for the energy conservation activities are primarily provided from the City's General Fund, but also are supported by operating revenues from Civic Plaza, the airport, and water and waste water funds.

The Energy Management section of the Energy/Facilities division budget provides for 7 full time positions and appropriate vehicles. In fact, the Energy Management section routinely borrows staff, such as electricians and HVAC technicians from other sections of the Energy/Facilities division, and, in turn, lends engineering support to those sections. The Energy/Facilities staff totals 171 full-time positions. (Separate from Energy Management, the division provides for two positions and a vehicle to support the New Central Library and two electrician positions for the 23rd Avenue Waste Water Treatment plant. For accounting purposes these positions, while functions within Energy/Facilities Management, are charged to downtown enterprise funds and to the Water Services Department.)

Energy/Facilities Management provides facility management services for approximately 300 City-owned buildings. These include major energy users such as the water and waste water treatment and pumping plants, the Sky Harbor Airport, and the Downtown Facilities centered around the New City Hall. In addition, Energy/Facilities Management is responsible for fire stations, police precincts, maintenance yards, warehouses, libraries, human resource centers, and all forms of civic structures. Schools and hospitals are not part of the Division's responsibilities.

Energy conservation has deep roots in Phoenix, dating back to the 1970s. Spurred on by the oil shocks in the mid- and late-1970s and a growing awareness that the cumulative effect of the City's utility bills are the second largest expense after payroll, and promoted by the vision of Public Works Director Ron Jensen, in 1978 the City of Phoenix began to get its own house in order. Ron Jensen had the inspiration to tackle energy consumption in Phoenix, beginning with municipal facilities such as the airport, water and waste water treatment plants, police and fire stations, and an array of City-owned buildings. Later he envisioned spreading the City's leadership to the private sector.

The City's early energy efficiency initiatives also greatly benefited from an engineer by the name of Darshan Teji. His advocacy of energy efficiency and knowledge of its potentials and the technologies to advance efficiency were paramount to launching what has now become one of the nation's leading examples of municipal energy efficiency. Starting in 1981 the City received Arizona's Energy Conscious Community Award of Excellence for 14 consecutive years, clearly a tribute to the work of the Energy Management Team in which Teji was an essential player.

Currently the Energy Management Team is headed up by Dimitrios Laloudakis under the overall direction of Bill Murphy, the Administrator of the Energy/Facilities Management division. Under Laloudakis' leadership, Energy Management is taking a new tact – building upon its early success and solid track record – using the awareness of energy efficiency's potentials that has been developed in Phoenix, and carefully integrating efficiency into normal facilities management activities, recognizing that operations is as essential to energy savings as the multitude of hardware retrofits that have been put in place. While continuing to build upon Phoenix's success, Laloudakis has guided the program with an intense focus on its "customers," fellow workers for the City whose overall productivity is Energy Management's number one priority. With this orientation, and the critical support of Deputy Public Works Director Lera Riley, the program has been a huge success.

At the direction of Ron Jensen, Phoenix's Public Works Director, in 1978 Phoenix began its process of becoming a leading city in terms of energy efficiency. To fulfill his vision Jensen created a separate section within Public Works to handle energy management, realizing that a skilled staff was required for such a major task. The City hired its first full-time energy conservation engineer in 1978 to formulate an energy conservation policy and savings program for the City. Shortly thereafter four other energy specialists joined the staff to provide expertise in air conditioning, heating, energy management, and lighting systems. A Facilities Engineer was responsible for designing and coordinating energy projects. An Energy Management Program Specialist was in charge of installing, programing, and maintaining energy management systems. A Project Coordinator supervised the field installation crew. An Account Clerk was responsible for checking all utility bills for the correct amounts and rates.

The new energy policy that emerged from the Energy Management section was based on five basic tenets: First, the City was committed to eliminating wasteful and inefficient energy usage. Second, staff would develop cost effective alternatives. Third, the program was intended to develop employee awareness. Fourth, the City sought means to promote the use of renewable energy resources. Finally, Phoenix realized that its municipal initiatives could serve as a leadership example for the community.

EARLY EFFICIENCY INITIATIVES

In the first years of the Energy Management program focused on relatively easy to document efficiency retrofits such as lighting measures. This was a calculated and effective bootstrapping approach. Staff focused on no- and low-cost opportunities that could be spotted by simple walk-through audits of City-owned facilities. One of the first orders of business was to eliminate incandescent lights, replacing them with high and low pressure sodium lamps in exterior locations and compact fluorescent lamps indoors. In hallways that were overlit, lamps and ballasts were removed, paying special attention to the provision of adequate lighting levels for workers. Inefficient incandescent lighting was replaced where possible by efficient fluorescent tubes. Wall switches were installed in individual offices – replacing master switches – so that office occupants could control their own lighting. Later these switches were upgraded to motion sensors so that lights would automatically be turned off when offices were unoccupied. (Some of the early equipment was technologically inadequate and the Energy Management team has praised the patience and understanding of their fellow City workers!) By 1987 the City was saving an estimated $1 million annually thanks to no- and low-cost measures. After ten years of "attacking" wasteful lighting, Energy Management was able to document cumulative dollar savings of $4 million from lighting alone.

GRANTS AND DEMONSTRATION PROJECTS

In parallel with these early initiatives was an experimental track that was the passion of Darshan Teji. Teji was a strong advocate of efficiency who became quite well known nationally in part because of his involvement with the Energy Task Force of The Urban Consortium, a national coalition of 46 large cities and counties that make up 20% of the total U.S. population, with task forces that share their experiences with all sorts of projects and initiatives. (The Urban Consortium's members have an annual purchasing power of some $25 billion, an asset it has used to negotiate for special phone rates for its members and which it has considered using for energy efficiency technology and service procurements.) Teji was instrumental in the Energy Task Force and was able to attract grants from The Urban Consortium to support innovative energy management initiatives in Phoenix. This outside funding stimulated highly advanced projects that would otherwise not have been possible, nor politically feasible, using municipal funds. Phoenix also won the National Energy Technology Award for nine consecutive years from The Urban Consortium for 12 demonstration projects.

Another source of outside support came from the U.S. Department of Energy. Two federal grants were awarded to Phoenix for auditing 80 City facilities. The audits of municipal facilities in Phoenix served to identify next steps for the energy management program once the no- and low-cost measures had been complete. The audits showed that the City could save as much as 40% of the energy use cost effectively at some facilities. (Some buildings were photographed using infrared technology.) This coincided nicely with the City Council's formal funding of energy management as a separate budget item, effectively providing a degree of insulation from facilities funds that would otherwise be allocated to pressing demands.

BILL MONITORING

Bill monitoring, a function carried out by a single staff person known as the "Utilities Monitor," has been one of the most cost effective roles that the Energy Management Team has fulfilled. Bill monitoring fulfils at least two objectives: First, Phoenix pays literally hundreds of utility bills each month. Some are incorrect. By carefully assessing bills, errors can be detected. In one instance, a vacated building was being charged as if fully occupied. The utility company was simply estimating bills for the building because it no longer had ac-

cess to the closed building to read the meter. After Energy Management identified the problem, the utility assessed the situation and reimbursed the City $10,000. In another case, the Utilities Monitor found an account that had mysteriously generated a $25,000 credit, a situation that was quickly rectified by having the utility send a $25,000 check to the City Treasurer. In yet another instance, the utility was charging the wrong rate structure for a facility, overcharging that would otherwise have gone undetected and which resulted in thousands of dollars of annual bill savings for the City. Phoenix's experience is that usually errors have been to the City's disadvantage, propelling the importance of this function.

The second function that the Utilities Monitor and the bill monitoring function can provide is early warning, or detection, of unusual energy use patterns. For instance, when a local library showed no decrease of gas usage after an unusually heavy period, the Utilities Monitor alerted coworkers who found that the boiler had not been shut down properly when it was no longer needed. By comparing bills and assessing trends the Utilities Monitor has been able to save the City hundreds of thousands, if not millions, of dollars! Other less obvious situations have required the special attention of the Utilities Monitor. The City pays its bills with many different rates. For instance the City pays a special exterior lighting rate of 3.5-3.8 ¢/kWh on one hand, versus the general service rate of 8.5¢/kWh on another. By moving one outlet in a park concession stand (the only interior outlet on a billed circuit) the City was able to save $7,500 each year as the rate for the now lighting-only circuit was shifted from the interior to exterior lighting rate.

THE SAVINGS REINVESTMENT PLAN

In 1983 the Phoenix City Council took a bold and progressive step, electing to establish a reinvestment mechanism such that 50% of documented energy savings up to $500,000 annually would be reinvested in energy efficiency improvements. The mechanism created the Savings Reinvestment Program, a program that has enabled millions of dollars to be invested in Phoenix's energy efficiency and which has resulted in direct dollar savings of over $25 million since the program's inception.

The reinvestment mechanism was capped at $500,000 primarily so that the "fund" would not become a political target. By keeping it small, Jensen and his staff hoped that it would be somewhat sheltered. Furthermore, all the additional dollar savings from energy efficiency improvements would flow back to the City, allaying concerns of not supporting the overall City budget. In retrospect far more money has been returned to the City coffers than reinvested in efficiency, indicating that much more than $500,000 is saved each year. In fact, within a matter of three years, by 1986, the maximum $500,000 reinvestment mark was attained, a level that has been maintained ever since.

Despite its design intention of limiting its size, and while the reinvestment plan has clearly been the key to dedicated capital for further energy efficiency initiatives, it has not really been assured. In reality, the $500,000 is a "reappropriation" of funds that needs to be approved by the City Treasurer each year. And while the sum has leveraged greater and greater savings – in fact creating greater and greater "revenues" for the City – the reappropriation has been challenged. For a number of years in the late 1980s the City experienced severe budget restrictions. Each Department was ordered to cut its budget "across the board" by 10%. Naturally, at these times the reappropriation was in jeopardy. Nevertheless it survived, sometimes at the expense of other important City functions.[R#4]

Perhaps a central element of success regarding the reinvestment model is that in comparison to the current City budget – now in excess of one billion dollars – the appropriation seems relatively small. This has been a function of its survival in turbulent fiscal times. Energy managers, however, claim that their program would greatly benefit from increased funding, especially now that the City has committed to being a Green Lights partner. This has been a driving impetus for a City Council initiative that recently passed that will raise the appropriation by $50,000 annually for the next five years until the reinvestment reaches a level of $750,000, where it will again be capped.

ADVANCED ENERGY MANAGEMENT MEASURES

As the reinvestment program matured and after most of the obvious low-cost measures were executed throughout the City's properties, Energy Management staff began to work on more sophisticated energy management initiatives including design assistance for large City construction projects. Measures installed included the installation of variable frequency drives, daylighting, microprocessor load controls, thermal storage, photovoltaic lighting, and energy-efficient electric motors. These activities were made possible in part by early demonstrations of many of these technologies supported by The Urban Consortium. For example, in 1980 the Energy Task Force provided grant money for converting the conventional air distribution system in the Calvin C. Goode Municipal Building to an energy-saving variable air volume (VAV) system. Variable speed drives have subsequently been installed in a number of applications to control the speed of pumps and fans that suffer from the cube law, a law that dictates that the energy re-

quirement increases as the cube of the speed of a pump or fan. An early analysis of the Municipal Building showed that the amount of air that was being distributed with the old system was double the amount required. Thus not only were half the air handlers completely taken out of service, but the others were fitted with VAV systems. This project alone saved the City $121,940 a year in energy costs.

Energy Management also has supported a number of innovative projects over the years. For instance, in cooperation with Arizona State University Energy Management was involved in promoting the region's number one energy resource: solar energy. A demonstration project at ASU involved a solar cooling demonstration made up of 70 solar collectors and an absorption chiller to cool a Police Department building. In 1989 a small scale cogeneration project was completed to demonstrate the potential for cogeneration systems in Phoenix. Free cooling, through the use of plate and frame heat exchangers in the months of November through March, has also been a focus of Energy Management's work (see Profile #110). During these months when temperatures are mild and humidity is low, cooling tower water can be used to cool a facility rather than running chillers. As such Phoenix has installed heat exchangers in all its major buildings including the New City Hall, a project in which Energy Management was involved from an efficiency design standpoint.

Perhaps the most sophisticated measures of all are those that tie all the individual technologies together. Energy management systems which exploit microprocessor-based controls have been installed in the Phoenix CIvic Plaza Convention Center and Symphony Hall; at the Sky Harbor Airport and in its expansion (there security, lighting, and air conditioning are all under the same system); and at branch libraries and fire stations. The most advanced of these systems was recently installed at the New City Hall.

GREEN LIGHTS

In March of 1994 the City of Phoenix officially joined the U.S. Environmental Protection Agency's Green Lights program (see Profile #35) by signing an memorandum of understanding with the EPA. Green Lights is a voluntary program designed to reduce air pollution through energy-efficient lighting. Phoenix intends to spend approximately $300,000 per year on lighting upgrades during the life of the program using the capital reinvestment mechanism for energy conservation. The City's Green Lights commitment is clearly in line with Phoenix's commitment "to think globally and act locally," signifying also a major new emphasis for the Energy Management section in the coming years. For Phoenix, becoming part of Green Lights is not only good for its public image, but the City genuinely wants to be on the "right side" of pollution prevention, playing a leadership role in Arizona and the United States.

STAFFING REQUIREMENTS

Currently there are seven positions within the Phoenix Energy Management Section. Dimitrios Laloudakis serves as the Superintendent. He is supported by two engineers, two specialists, a project manager, and account clerk. In addition, secretarial support is provided by Energy/Facilities division. As previously stated, Energy Management also pulls staff liberally from the Public Works Department talent pool, using electricians and other trades for retrofits as necessary. During these time these staff are paid by Energy Management.

The Energy Management section is part of the Energy/Facilities Management division of the Public Works Department. (The fusion of Energy and Facilities management took place in 1993 to foster closer cooperation between the two sections.) Key to Energy Management's current success is the Administrator of Energy/Facilities Management, Bill Murphy, who brings a strong energy management orientation and a good deal of useful expertise to the division. Prior to his position within Public Works, Bill Murphy worked for Arizona Public Service and managed his own energy engineering and consulting firm. This background has rooted Energy Management's recent initiatives in solid engineering. Energy Management has also benefitted from the strong support of the Director of Public Works, Ron Jensen, who initiated the program in 1978 and from the current Deputy Public Works Director Lera Riley who is also a strong advocate of energy efficiency and champions the program as need be within the City government.

While Energy Management has the lead role in Phoenix's energy management initiatives, there are other departments that also pay critical attention to this pursuit. The Sky Harbor Airport, for instance, has its own energy management initiative and budget but does draw upon Energy Management's expertise from time to time. This is also true for the Downtown Facilities Management Team which provides a parallel function to Energy Management's for central downtown facilities. The Downtown Team also draws upon Energy Management and credits Energy Management for paving the way for its New City Hall project. In addition the Water and Waste Water Departments also draw upon Energy Management's expertise.

CASE STUDY: NEW CITY HALL

Clearly the pinnacle of the City of Phoenix's Energy Management program is the New City Hall, an $84 million, 20-story facility that opened in late 1993 and took five months to reach full occupancy in 1994. New City Hall, which was built for the low cost of $89 per square foot, embodies a host of progressive design features and is not only a symbol of Phoenix's awareness of energy efficiency, but also its technical sophistication of resource efficiency. Under a single roof, Phoenix has consolidated most City government functions, facilitating the City's reputation as one of the best-run large cities in the United States. The facility also nicely incorporates the adjacent and historic Orpheum Theater, sharing common walls and other landscaping features. And from an energy standpoint, the facility uses less than half the energy on a square foot basis than comparable facilities. Rather than a more typical $2.50 per square foot in annual utility costs, New City Hall costs under $1.25 and will cost even less when its rates are modified in collaboration with Arizona Public Service, its electricity supplier.[R#1,2,5]

Given the hot, arid climate that characterizes Phoenix, space conditioning is of paramount importance and fundamental to progressive design. The shell of the facility clearly relates to its desert climate with 300 days of sunshine and is distinguished by perforated stainless steel screens on its east and west elevations. In addition to these screens and also to minimize cooling costs, the building's "solar" design features recessed windows which provides for shading on the east, south, and western exposures. Windows located on the east and west walls are recessed four feet, providing four more hours of shading each day than if the curtain wall were flush with the building's exterior frame. Windows on the south wall are recessed three feet to provide passive solar gain in winter and shade in the summer. These design features represent a significant tradeoff as valuable interior space was lost in favor of reduced cooling bills. This was the focus of extensive analysis prior to construction when thermal analyses were performed to ascertain the savings relative to the costs of lost interior space. The windows themselves are also important design features, made of glass with high shading coefficient for maximum reflectivity of external heat gain. The use of light-colored offices and walls with glass side lights not only provides an air of calm and cleanliness, but also maximizes use of natural daylighting. The installation of T8, 32-watt lamps and electronic ballasts throughout the facility keeps internal heat gain to a minimum while complementing the aesthetic quality of the interior space.[R#5]

While the building's passive solar design features are fundamental to its operation (and also aesthetic design) it is the building's chilling plant that perhaps epitomizes the City's commitment to resource efficiency. Three electric chillers with a rated capacity of 2,080 kW – and which use the CFC-free R-123 coolant – provide coolth for not only the 600,000 square foot New City Hall but also for the district cooling system that provides for several adjacent buildings with an additional combined square footage of 400,000. The chillers provide 41 degree F cold water to a 1.5 million cool storage tank located in the parking garage during off-peak periods to take advantage of favorable electric rates. By doing so the chilling plant will save $172,000 annually. Furthermore, the City received a $156,000 utility rebate for the system due to its load management effect. Ultimately the system will provide cooling for four other adjacent facilities including the parking garage (which incorporates a retail shopping area), "historic" City hall, the ten-story Calvin C. Goode Municipal Center, and the City Personnel building. The Orpheum Theater is also cooled by the central chilling plant. In New City Hall, cold water is delivered to each floor via a major water loop located in the central core of the building. On each floor a heat exchanger pulls the coolth from the water and then distributes cold air throughout the floor through ducts using fans with variable air volume drives, another efficiency feature.[R#1,2,5,6]

Facility managers in New City Hall will be responsible for the energy management of the adjacent facilities as well. Like New City Hall, the other buildings are all controlled by the direct digital control (DDC) energy management system installed in New City Hall. This not only spreads the cost of the DDC system but maximizes the effectiveness of the Downtown Facilities staff. At a central office in the basement of New City Hall, or using laptop computers from anywhere within or outside the facility, operators can monitor temperatures, air changes, and the like for all five buildings, making adjustments as necessary to increase worker comfort and to improve City worker productivity. Currently the energy management system is manned 24 hours a day, seven days a week.[R#5,6]

One of the interesting aspects of the design process is that the successful bidder for the energy management system was awarded the right to, and signed a formal agreement to comply with the same pricing structure on future contracts with the City. This is part of the City's effort to standardize energy management and temperature control systems in its facilities so that their operation can be kept as simple and straightforward as possible for operators. Thus the City has bought an option for an energy management system for its new central library and other future facilities.[R#1,2]

MONITORING

While the Phoenix energy management program has not had to perform detailed monitoring and evaluation activities required of many utility DSM programs, it like any other efficiency initiatives must prove itself to an acceptable level of confidence. Each year Energy Management has had to report its activities to justify reappropriations of City funds.

Early monitoring initiatives: The program began with very little monitoring and verification as no- and low-cost measures were hardly worth the effort. Simply seeing basic hardware change-outs was adequate verification. From 1978-1983, a variety of lighting retrofits were done and in general the more that was spent on the retrofit, the greater the attention spent verifying the installation. Staff report that savings of lighting retrofits were generally calculated using engineering estimates which were periodically checked against utility bills. Some retrofits were metered.[R#1,2]

Tracking City utility bills: One of the great challenges that the City has faced with energy management is that there is no master metering at all in the City. Therefore, the City has literally thousands of meters. There are bills for everything from individual traffic signals to parks, irrigation systems, and major buildings. The various departments' bills are received and paid by Accounts Payable office. Several months later the departments receive a charge to their budget. They never see the actual bill. This has caused a classic case of what efficiency analysts call the “split incentive” in which those who use the energy have no incentive to conserve it.[R#1,2]

Historically the City’s Accounts Payable office received and paid the bills, and then filed them. At the prompt from Energy Management, however, this pattern changed. Energy Management wanted access to all bills to check for proper billing and any inconsistencies that might represent opportunities for efficiency gains. Initially, Energy Management’s request for this information was a burden. In some cases Energy Management waited for 2-3 months to get the information,... and when it arrived it was largely unusable! Now, thanks to computers and a smoother interaction between departments, the request is easily handled, bills are tracked on a large and sophisticated database, and a monthly bill tracking report is promptly sent to Energy Management from the City Treasurer’s office every month. This allows Energy Management to sort the bills and search for any clues of error or energy-saving opportunities. Energy Management is now working with APS and SRP to have on-line access to their billing database.[R#1,2]

Carefully monitoring large municipal facilities: Energy Management regularly tracks the energy use in 20 of its largest facilities. Many of these have energy management systems that allow for easy reporting and interface. Others do not and require special attention. These accounts’ energy use is compared with historical bills; monthly energy and demand charges are evaluated and tracked to gauge trends and possible areas for energy efficiency tune-ups.[R#1,2]

For major buildings where retrofits have recently occurred, projects are monitored in terms of pre- and post-retrofit energy use. These savings are compared with engineering estimates. Staff report that there is unfortunately not enough staff time to go back too many years. (Furthermore, the need for accuracy becomes somewhat less as reinvestment is capped at $500,000,... whether bill savings are $1,000,000 or $1,100,000 matters less.) For purposes of reporting savings there is no weather normalization of the data. Staff report that for larger buildings weather has a nominal effect; internal heat gain is the factor of greatest concern.[R#1,2]

Checks and balances within the City government: City Auditors review the reports generated by Energy Management. The City Auditors office has recommended to Energy Management that it monitor as accurately as possible to verify that projects are indeed operational. From 1979-1991, Energy Management maintained a chronological list of all completed retrofits on a Lotus spreadsheet. This spreadsheet was discontinued in 1991 and replaced with an annual project and savings summary.[R#1,2,13,14]

In 1989 the program was audited. This led Energy Management to review its impact and the durability of the savings for which it had earlier taken credit. While staff emphasize that the program has had limited funding to verify its effect, Paul Hudson, a former Energy Management Specialist with the Energy Management Team who recently retired, verified hundreds of projects. He personally checked retrofits dating seven years back to determine whether there was any basis for reductions in savings estimates. What he found was that 80% of the projects were still fully functional. Paul called this a “true-up,” a methodological check which began in 1989 and continued through 1992. As he found attrition, he updated the reported savings numbers accordingly. His true-ups are reflected in the energy savings and costs presented in the following sections.[R#1,2]

Program Savings

SAVINGS OVERVIEW	ANNUAL ELECTRICITY SAVINGS (MWh)	CUMULATIVE ELECTRICITY SAVINGS (MWh)	LIFECYCLE ELECTRICITY SAVINGS (MWh)	ANNUAL GAS SAVINGS (MCF)	CUMULATIVE GAS SAVINGS (MCF)	LIFECYCLE GAS SAVINGS (MCF)
1982-83	1,794	1,794	26,905	1,605	1,605	24,073
1983-84	3,539	3,374	53,079	3,166	3,018	47,492
1984-85	2,715	7,062	40,718	2,429	6,319	36,432
1985-86	4,030	10,914	60,447	3,606	9,765	54,084
1986-87	2,287	14,782	34,311	2,047	13,226	30,699
1987-88	4,258	19,740	63,863	3,809	17,662	57,141
1988-89	4,452	24,185	66,782	3,984	21,639	59,753
1989-90	4,993	31,427	74,895	4,467	28,118	67,011
1990-91	2,172	36,788	32,579	1,943	32,915	29,149
1991-92	2,981	41,694	44,722	2,668	37,305	40,014
1992-93	1,271	46,958	19,065	1,137	42,015	17,058
1993-94*	2,277	51,976	34,155	2,037	46,505	30,560
Total	36,768	290,692	551,521	32,898	260,093	493,466

* The figure given for 1993-94 Annual Savings is actually an incremental savings. The datum needed for annualizing this figure is not available.

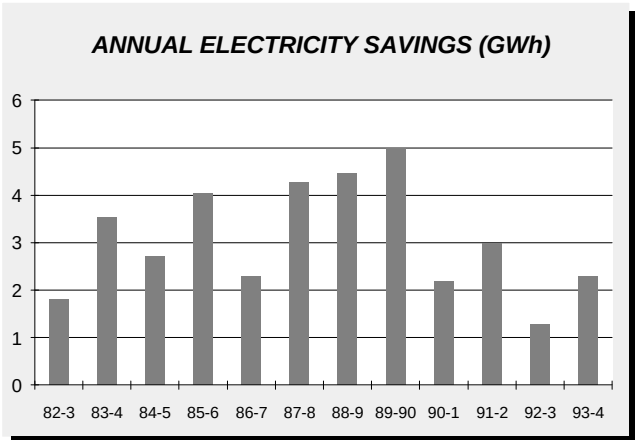
DATA ALERT: The following savings are based on several assumptions. First, that 95% of the dollars saved are electric, with the remaining 5% attributable to natural gas. Second, that the average electric rate is 8.5 ¢/kWh; $5.00 for an MCF of natural gas. Per staff accounting, utility rates are assumed to have increased by 6% annually since the start of the program. Note that the cumulative savings reflect incremental savings for first year savings.

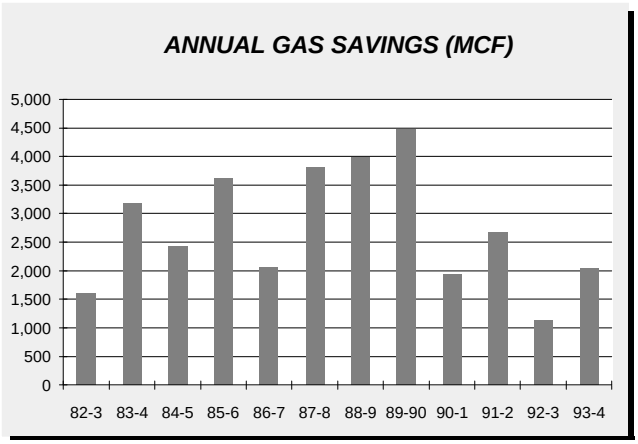
Over the past 12 years the City of Phoenix has saved 36,768 MWh in annual electricity savings; fully 290,692 MWh in cumulative electricity savings. When considering an average measure lifetime of 15 years, the retrofits financed through the reinvestment mechanism will save 551,521 MWh. Total annual gas savings for the program have been 32,898 MCF, with cumulative gas savings of 260,093 MCF.[R#15]

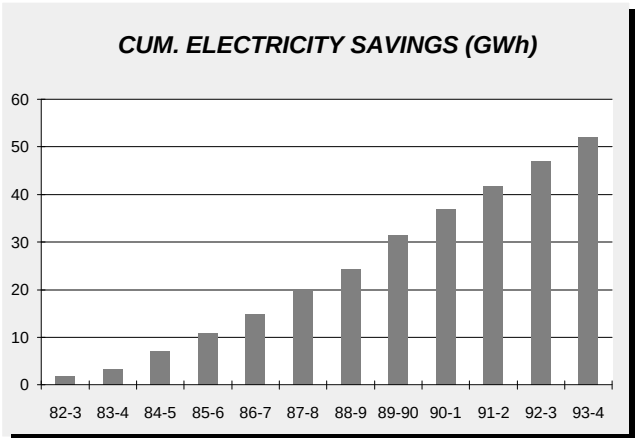
The height of program activity in terms of saved energy and dollars occurred in 1989-90. By this time staff was fully up to speed and well honed at relatively straightforward lighting and HVAC retrofits. Municipal buildings provided rich opportunities for relatively low-cost and high impact projects. In 1989-90 the program resulted in record annual savings, nearly 5 GWh of electricity savings and 4,467 MCF of gas savings.[R#1,2,15]

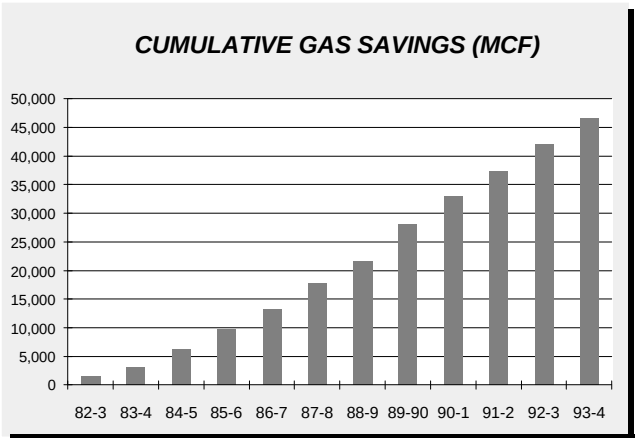
In 1992-93 the program's savings dropped off precipitously, a function of a significant program evolution and several factors. Perhaps the most important factor was that the program was going through an important transition. Darshan Teji, who had been the program's strongest advocate and the inspiration behind many projects, retired. His final months with the City were spent wrapping up projects rather than initiating new ones. The transition also reflected the fact that the program had to begin to address more sophisticated energy efficiency retrofits. The "big bang for the buck" retrofits were largely over and Energy Management had to dig in and tackle more complex projects. Outside funding such as grants from The Urban Consortium, which had fostered a host of demonstration projects, had also dried up by this time. Furthermore, staff became absorbed in the New City Hall project, using their abilities to help in the design of the facility and their financial resources to pay for additional improvements to the plans. Precious time and dollars were expended on new construction projects whose savings would be realized in subsequent years.[R#2]

By 1993-94 the program was solidly back on track, thanks in particular to the leadership of current Energy/Facilities Management Administrator Bill Murphy. The 1993-94 savings presented in the table above reflect only partial year savings. Staff









expect annualized savings for 1993-94 to reflect the fact that the program is back on track, reaping significant savings of well over 3 GWh annually while capturing these savings through more complex retrofits and using more sophisticated – and correspondingly more expensive – technologies. Much of the savings in the coming years will result from Green Lights projects. Under Bill Murphy's leadership, and Dimitrios Laloudakis' implementation, the program staff has not only risen to the challenge it faces, but has also put greater and greater emphasis on metering installations, further validating the program and its effect.[R#2]

PARTICIPATION RATES

In terms of participation, the energy savings reinvestment mechanism has reached on the order of 1,000 projects. Staff report that these vary dramatically in size and scope, ranging from the New City Hall project to simple relampings, making any sort of savings (or cost) per participant invalid. Suffice it so say that no type of facility has been omitted from Energy Management's "scourge" for energy and dollar savings in City facilities, while maintaining the utmost priority for the comfort and productivity of fellow City workers.[R#1,2]

PROJECTED SAVINGS

Looking to the future, Energy Management expects to build upon the more than 550 GWh of lifecycle energy savings that its investments in efficiency have already created. Although staff face a situation where they have captured many of the lowest cost and easiest efficiency gains (what some call the "low hanging fruit"), additional funding to the tune of $50,000 per year until the program reaches a new cap of $750,000, will allow the Energy Management team to reap more technologically difficult efficiency opportunities. Staff also expect that there will always be more savings to "squeeze out" of the City's impressive infrastructure!

Cost of the Program

While the reinvestment may seem small in comparison to the City's annual budget of one billion dollars (equivalent to one half of a single percent), by reinvesting approximately the equivalent of 1.25% of the City's annual utility bill in energy management ($500,000), the City has been able to trim its utility bill by about 10% in the past 12 years. Currently Phoenix spends about $40 million a year for electricity and gas for its municipal buildings; the savings reinvestment plan has created annual dollar savings of $4 million, 10% of the total.

Yet the story is even more colorful: The energy savings reinvestment mechanism began with no money at all, just clever accounting coupled with a healthy dose of municipal leadership! Levelized to 1990 US dollars, the program began with annual dollar savings of just over $200,000, then grew to $470,879, and has fluctuated each year based on the completions of projects treated through the Energy Management program. Cumulative dollar savings – based on savings from measures installed in prior years – have continued to grow, reaching almost $23 million in 1993-1994. By the end of FY 1994-1995, the program will have surpassed the $25 million mark.

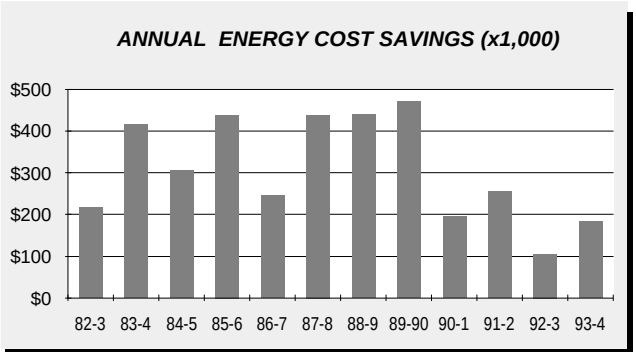
By 1985-86, half of the program's total annual dollar savings exceeded the $500,000 cap imposed on the reinvestment mechanism. From that point forward, only the maximum of $500,000 has been reinvested in efficiency measures. (The adjacent table reflects dollars levelized to 1990 and thus presents varying amounts for 1985-86 to 1989-90 while the nominal value was $500,000.) The vast majority of the dollar savings has been contributed to the City coffers. In fact, of the total dollar savings of $22,841,156, $4,422,010 or just under 20% has been reinvested in efficiency, while $18,419,146 – more than 80% – has been redirected for other civic purposes.

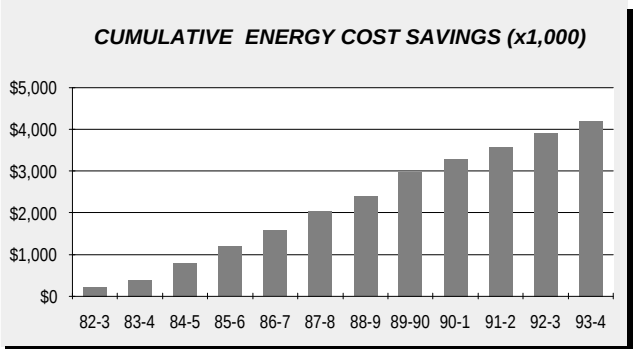
Grants have also contributed to Phoenix's program, providing key funding for select pilots and demonstrations that have since been expanded for advantage. Staff estimate that the grant money over the years in total has been less than a half a million dollars with funds from The Urban Consortium and the U.S. Department of Energy. In one case the DOE also gave in-kind funding by providing for two Arizona State Energy Office staff to perform building audits for the City.

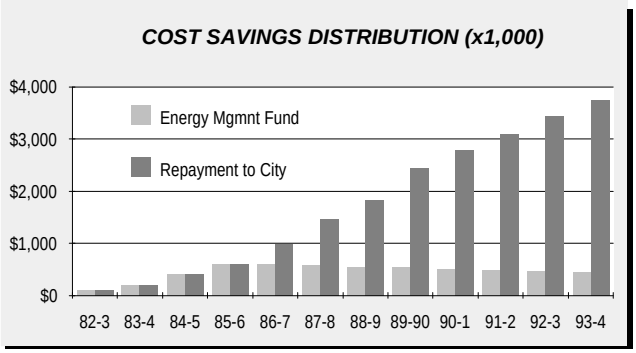
COST EFFECTIVENESS

In its early years, Energy Management sought to invest in projects with a payback of two years or less. This criteria was later relaxed to encompass a 3-4 year payback period. Now staff prioritize projects using far more criteria than simple payback and are accustomed to accepting projects with 6-8 year paybacks. The new library project's energy efficiency features, for example, have an eight-year payback.[R#1,2]

The Results Center has calculated the cost of saved energy for Phoenix's Energy Management program and has found a range of values from well under a cent per kilowatt-hour saved (in fact as low as 0.54 ¢/kWh at a 5% real discount rate), to as high as 5.09 ¢/kWh. Given Phoenix's average cost per kilowatt-hour of 8.5 ¢/kWh, the program's effects have certainly been cost effective. Finally, cities must compare the costs of maintaining an Energy Management Team with the savings that result. In Phoenix's case, the Team costs on the order of $500,000 a year in staff salaries, benefits, and office administrative costs, while providing more than $4 million a year to the City in dollar savings.







COSTS OVERVIEW	ANNUAL ENERGY COSTS SAVINGS	CUMULATIVE ENERGY COSTS SAVINGS	ANNUAL ENERGY MANAGEMENT REINVESTMENT	ANNUAL REPAYMENT TO THE CITY
1982-83	$217,361	$217,362	$108,681	$108,681
1983-84	$415,473	$396,101	$198,051	$198,051
1984-85	$305,525	$794,830	$397,415	$397,415
1985-86	$437,968	$1,186,167	$593,083	$593,083
1986-87	$244,065	$1,577,184	$596,259	$980,925
1987-88	$438,282	$2,032,105	$575,264	$1,456,841
1988-98	$440,105	$2,390,733	$552,409	$1,838,324
1989-90	$470,879	$2,963,778	$527,016	$2,436,762
1990-91	$194,329	$3,291,524	$500,000	$2,791,524
1991-92	$255,537	$3,573,512	$478,959	$3,094,552
1992-93	$105,656	$3,903,538	$464,541	$3,438,997
1993-94*	$183,618	$4,191,351	$450,635	$3,740,716
Total	$208,406	$22,841,156	$4,422,010	$18,419,146

* 1993-94 Annual Cost Savings is an incremental savings. The datum needed for annualizing this figure is not available.

COST OF SAVED ENERGY AT VARIOUS DISCOUNT RATES (¢/kWh)	3%	4%	5%	6%	7%	8%	9%
1982-83	0.51	0.54	0.58	0.62	0.67	0.71	0.75
1983-84	0.47	0.50	0.54	0.58	0.61	0.65	0.69
1984-85	1.23	1.32	1.41	1.51	1.61	1.71	1.82
1985-86	1.23	1.32	1.42	1.52	1.62	1.72	1.83
1986-87	2.18	2.34	2.51	2.68	2.86	3.05	3.23
1987-88	1.13	1.22	1.30	1.39	1.48	1.58	1.68
1988-89	1.04	1.12	1.20	1.28	1.36	1.45	1.54
1989-90	0.88	0.95	1.02	1.09	1.16	1.23	1.31
1990-91	1.93	2.07	2.22	2.37	2.53	2.69	2.86
1991-92	1.35	1.44	1.55	1.65	1.76	1.88	1.99
1992-93	4.43	4.76	5.09	5.44	5.80	6.18	6.56
1993-94	4.19	4.50	4.82	5.15	5.49	5.84	6.20

Environmental Benefit Statement

AVOIDED EMISSIONS: Based on 290,692,000 kWh saved 1982-1994						
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%	626,732,000	14,869,000	3,006,000	301,000
B	10,000	1.20%	668,301,000	5,756,000	1,941,000	1,439,000
	Controlled Emissions					
A	9,400	2.50%	626,732,000	1,487,000	3,006,000	24,000
B	10,000	1.20%	668,301,000	576,000	1,941,000	96,000
C	10,000		668,301,000	3,837,000	1,919,000	96,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	668,301,000	1,759,000	959,000	480,000
B	9,400	2.50%	626,732,000	1,487,000	1,202,000	90,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	668,301,000	1,183,000	192,000	480,000
B	9,010		601,151,000	428,000	144,000	29,000
Gas	***Steam***					
A	10,400		364,528,000	0	831,000	0
B	9,224		316,564,000	0	1,983,000	94,000
	Combined Cycle					
1. Existing	9,000		316,564,000	0	1,215,000	0
2. NSPS*	9,000		316,564,000	0	576,000	0
3. BACT*	9,000		316,564,000	0	80,000	0
Oil	***Steam--#6 Oil***					
A	9,840	2.00%	527,606,000	7,994,000	943,000	895,000
B	10,400	2.20%	559,582,000	7,930,000	1,186,000	576,000
C	10,400	1.00%	559,582,000	1,132,000	953,000	301,000
D	10,400	0.50%	559,582,000	3,326,000	1,186,000	183,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	700,277,000	1,394,000	2,165,000	118,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	831,379,000	2,142,000	2,820,000	627,000

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 City of Phoenix's level of avoided emissions saved through its Energy Management program 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.

LESSONS LEARNED

Phoenix's reinvestment mechanism has been a marked success and highly cost effective: The reinvestment fund created in Phoenix has been a marked success with $22.8 million in energy savings from a program bootstrapped with virtually no capital at all. Furthermore, more and more sophisticated measures were enabled by increased awareness and experience with energy efficiency, effectively coupled with the reinvestment mechanism that has allowed about 20% of the total savings to date to be reapplied to energy efficiency, leaving fully 80% of the total to replenish the City's General Fund. The program has resulted in an overall and simple benefit/cost ratio of four.

In addition to the savings achieved through the revolving fund mechanism, there have been a host of perhaps even more valuable intangible benefits: It has been the City's awareness and concentration on sophisticated energy management that led to the highly efficient new construction of the New City Hall. While its costs were paid from the Phoenix budget, with only minimal marginal costs paid through the reinvestment mechanism, its energy-efficient features and the long-term savings that they generate can be largely attributed to the Energy Management group that raised awareness in Phoenix regarding energy efficiency and which ever since has been ready and willing to provide design assistance and plan reviews as necessary for all sorts of projects in the City.[R#5]

In addition to this, City workers have been exposed to energy efficiency at all levels. Naturally, many workers will take their new-found impressions of energy efficiency home and perform retrofits of their own residences, installing compact fluorescent lamps for example. At another other end of the spectrum, building operators in Phoenix have been exposed and have become comfortable with both new hardware and practices, allowing for greater and greater technical sophistication in their buildings in the future. Essentially, Energy Management has "primed the pump" in Phoenix, paving the way for subsequent initiatives using technology coupled with enhanced operations in conjunction with basic behavioral and value changes that have taken place. This transformation of attitudes is perhaps the program's greatest success.

Energy Management staff view tenants as their "customers,"... despite the fact that the City workers in these facilities are really fellow employees: By considering buildings' tenants as their customers, Energy Management has developed a special appreciation for their needs and desires. This in turn has resulted in a good working relationship between Energy Management and other City departments. Staff also respect the relative value of energy bills and staff costs. While staff costs amount to on the order of $200 per square foot – staff are certainly an expensive commodity – energy management activities can only cut costs by a fraction of a single dollar a year. Thus energy efficiency gains at the expense of worker comfort simple don't make sense. Inversely, improving tenant comfort through better air handling for instance, or improved lighting, can boost productivity – affecting the value gained from the $\$200/ft^2$ – potentially far outstripping any and all efficiency gains possible. Taking this form of holistic economic outlook puts energy management in a healthy perspective.[R#1]

Sorting out basic information — like how many buildings and square feet of property the City owns — can be a difficult and futile activity: Energy Management staff have had to exercise a great deal of patience. For instance, early off staff sought what would seem to be really basic information, like the number of buildings or number of square feet of occupied space that the City owns or leases. Getting straightforward information was not always possible. Worse yet, in many cases staff remember getting two to three sets of contradictory numbers! This problem is not at all unique to Phoenix and must be considered when developing similar initiatives. Staff in Phoenix suggest "patience, patience, patience," and "letting go" when the answer may not be as necessary as first represented.[R#2]

Staff encourage nascent energy managers to "keep it simple:" Paul Hudson, who had been the program's Energy Specialist since the program began and who recently retired, reflects upon his years with Energy Management and suggests that other cities seeking to replicate Phoenix's success, "keep it simple." In the 1980s when DOE and Urban Consortium funds were available, Hudson recounts that Energy Management took on some sophisticated energy management projects such as cogeneration systems, few of which are in operation today. The problem, claims Hudson, was not the engineering but the maintenance. Energy Management had enough staff to install the projects but not to maintain them adequately. Furthermore, regular building operations personnel had neither the technical background nor the inclination to learn how to run and maintain unfamiliar electronic and electromechanical devices. The end result was the slow deterioration and breakdown of these technically complex systems.[R#2]

Hudson recommends that cities begin with clear winners, relatively simple retrofits such as what he calls, "the ideal conservation package," 32-watt, T8 fluorescent lamps and high efficiency electronic ballasts. This package, Hudson claims, can be easily installed, generally improves lighting levels, and reaps significant savings with virtually no maintenance. As such, it provides an excellent starting point for energy managers keen on establishing their credibility, developing staff expertise, while concurrently developing a savings stream which can be used later for more complex retrofits.[R#2]

Combining Energy Management and Facilities Management in the same Division has facilitated their interaction and new directions for the Team: In 1993 the Energy Management section was formally merged with the Facilities Management team to foster closer cooperation between the two. This was also part of a shift in direction and one that is a function of the maturity of the Phoenix energy management function. As the program has matured, it has become possible to progress from a project-oriented focus to an orientation based on comprehensive facilities management – including energy management – of public facilities.

In the future, Public Works hopes to shift into a proactive mode, enabling it to further enhance its efficiency initiatives: Staff envision a future scenario whereby energy management is integral to all Facilities Management plans. By fine-tuning facilities management, energy efficiency can be taken to a higher level of sophistication. Ultimately staff hope to get to a point where energy efficiency measures in planned capital improvements supersede the reactive actions and opportunities that they have effectively grasped thus far. While there will always be a roof to repair, energy efficiency can be most cost effectively deployed proactively and in conjunction with an overall maintenance regime.[R#3]

It has been essential to separate facilities and energy management funds: The organizational design that ties Facilities with Energy Management has already been successful for many reasons, but it is not without challenges. A situation inherent to Facilities, is that it is a City function that inevitably requires a great deal of "firefighting," reacting to burning issues such as leaky roofs, inoperable elevators, and pressing needs for replacement boilers. These issues not only divert attention away from proactive strategies for energy efficiency but cost a great deal of money. A key ingredient in Phoenix's success given the inherent conflicts between short-term pressing financial demands and longer-term investments characterized by energy efficiency, has been the clear separation of these funds.

Rotating staff within Public Works has bolstered the skill sets in the Department and fostered closer communication between program emphases: One of the strategies to redirect the program in line with the proactive approach to energy efficiency has been to rotate staff within Public Works and through Energy Management. This has provided for much-needed staff training and has been part of the transformation whereby energy efficiency is truly integrated into Facilities Management.[R#1,3]

Program staff now aim to further target the City's biggest energy uses and apply even more sophisticated hardware and software to energy management in these sectors: The City has clearly identified its water and waste water plants as its biggest users and will place additional emphasis on these facilities. Inversely, Energy Management staff plan to scale back their emphasis on tough and relatively small segments, such as fire houses, which provide marginal gains while "burning up" considerable staff time.

Fire stations, and to a lesser extent police stations, are tough customers for energy efficiency services! Of all municipal facility "customers," firemen in Phoenix have been the least receptive to energy efficiency. "They are unique," report staff with a chuckle. For one, many of them have side jobs as plumbers, electricians, air conditioning contractors, and the like,... thus there are many experts on board! "They bypass everything we have done," report staff. Why? Firemen tend to be very demanding (and understandably so) after fires. They want showers,... and lots of hot water. They also want to be cool, and warm in winter. Thus Energy Management has shied away from any measures that restrict their services and instead has been promoting other means of garnering efficiency in fire stations. For instance, they have received energy-efficient lighting and have had no complaints about electric to gas water heater conversions, a means to save the City source BTUs.

Police stations are sort of the same, except "police have guns," further restricting energy efficiency in the precincts! While they are reportedly not as hard on "messing with the equipment," they tend to be very fussy in the name of being ready for emergencies, staff comment. For both fire houses and police precincts, Energy Management's ability to perform retrofits has been serious restricted, so it has shifted its attention to

working with new construction, reviewing new designs and suggesting how to build in efficiency to new facilities.

The reinvestment mechanism is subject to political pressures and tight fiscal realities: While the revolving fund mechanism appears logical, pragmatic considerations must be considered by other cities seeking to emulated Phoenix's success: In reality, the reinvestment is an annual reappropriation of City funds. Despite the fact that the funds represent unspent dollars, since they are not escrowed they must be considered reappropriations, tough to get in tight fiscal budget years and hardly as assured as Energy Management would like.

Lera Riley notes that a few years ago when all City department budgets were cut by 10% across the board, naturally the fund was at risk. Thus management have had to protect the reinvestment, at times sacrificing other expenditures to keep the reinvestment amount whole and thus continuing to leverage savings for the City.[R#4]

Reinvestment funds need the support of upper management: The Energy Management team's success has benefited, perhaps been made possible, by the vision and support of upper management. Without this continued focus, City officials report that the program could have died a political death many times over. Ron Jensen not only had the initial vision for the program, but for many years was its champion. In fact, many consider that Jensen was the program's "protector" in early years before its credibility had been established and could stand on its own two feet.

The City's work with energy efficiency has unfortunately not resulted in substantial private-sector initiatives as originally envisioned: When Ron Jensen envisioned the Energy Management program in Phoenix, a program that has now enjoyed tremendous success, he imagined that by starting with public facilities, private sector initiatives would follow suit,... or that in the absence of such a free market response, that the City would initiate and promote energy efficiency. Just as efficiency has cost effectively saved the City millions of dollars which has been used to boost economic development in other ways, Jensen expected that the City's example would leverage far greater savings. For a number of reasons, including minimal utility DSM programs and rather small incentives, this has not taken place and thus remains one of the program's few disappointments.

TRANSFERABILITY

Revolving funds, or reinvestment programs, are an exciting option for promoting energy efficiency at the municipal level, as well as in other venues such as multi-building institutions, counties, states, and federal programs. The basic reinvestment mechanism can be used with a range of permutations and in a number of applications. The City of Philadelphia School District (Profile #114), for example, has saved $83 million through its reinvestment program, a clever means of aligning reinvestments in areas that will continue to leverage greater and greater dollar savings.

A range of options exist in terms of the program sponsor, in this case the City, its target (municipal or commercial or industrial, etc.), and its design. The Results Center has documented programs run by states, cities, school districts, and utilities. While this Profile addresses municipal facilities, other programs have promoted efficiency to homes in Nebraska and hospitals in Connecticut and all types of facilities to save all types of fuels. Just as ripe as these parameters are the litany of program designs possible, adjusting program design for revenue collection, determinations of baseline energy use, and the maximum amount allowed in the "fund" at any given time.

In Oslo, Norway and at the instigation of former premier Gro Harlan Brundtland, the Ekon Fund has been used to promote the wise use of energy. Fully $100 million has been collected through rate surcharges, interest on the balance, as well as interest on loans outstanding and repaid. There, this huge sum has become of considerable political envy, further validating the Phoenix program design that limits the reinvestment to half a million annually.

Despite the plethora of options for revolving funds and reinvestment programs such as the program that the City of Phoenix has so aptly demonstrated, reinvestment programs fundamentally make sense, leveraging greater and greater dollar savings. For more information and program design options see The Results Center Profiles #101 State of Texas: LoanSTAR; #116 State of Nebraska: Dollars and Energy Sense; #114 School District of Philadelphia; Save Energy Campaign; #79 Oslo, Norway: Comprehensive Municipal Energy Management; and Snapshots in Energy Efficiency News & Views, Issues #1 & 3.

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