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# Montgomery County, Maryland Resource Conservation Program

## Profile #125

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Montgomery County's Resource Conservation Program is one of North America's leading energy services programs and stands as a powerful model for the future and as such was selected for inclusion in the Series 4 Profiles by The Results Center Board of Advisors. The Results Center salutes Montgomery County for its success with the Resource Conservation Program; commends the County Council for supporting the program; and most especially congratulates the DFS staff for their dedication and their unquestionable success. In particular, we wish to recognize Ron Balon and Paul Tseng for their guidance throughout the development of this Profile.

This Profile is part of a collection of Profiles researched and published by The Results Center over the past four years. It is intended to provide a thorough understanding of the program and its unique elements. This Profile can also be used to compare this program with other programs documented by The Results Center. For a complete listing of the Profile Library see the back page. For additional information please contact The Results Center.

# Executive Summary

In Montgomery County, Maryland a strong engineering focus and awareness within the facilities management arena has led to impressive levels of savings in both new construction and existing County-owned buildings. Key to the County's success has been the insight and wisdom of its energy and engineering staff who understand that buildings must be treated as dynamic systems. First, they must be properly designed and commissioned to take advantage of the synergies between energy-efficient design and technologies. Second, the County has leveraged major dollar savings by plugging the leaks in its 187 existing buildings that constitute fully 3.25 million square feet of space. The facilities include a judicial center, libraries, police and fire stations, community health centers, day care centers, halfway houses, and recreation centers.

Montgomery County's foremost success has been the delivery of deep savings. For new construction, it has met the aggressive goal of saving 40% of the energy used in a typical new facility. Similarly, it is achieving 30-40% savings in retrofits. Remarkably, these major savings have been achieved with limited dollars. The County has also recognized that its facilities' operations must be continually refined. It has been a national leader in the field of commissioning buildings, stemming the erosion of measure savings while assuring dollar savings that can be used for social purposes such as adding staff to the police force and books to local libraries.

The County has also placed considerable emphasis on retrofitting existing facilities, drawing incentives from local utilities where possible. It is a Green Lights Partner and as such has the goal of retrofitting 100% of its facilities by the year 2000. (It has already addressed 56% of its square footage.) And having established an impressive track record, the engineering staff has earned credibility within the County government so that it can get projects approved expeditiously.

The bottom line is that the County's total electricity use has fallen by 5% since 1992. Even as it added 343,000 square feet of new space, its energy bill has remained stable. Cumulative cost savings of \$2.3 million from 1992 to 1995 have resulted from the installation of energy management control systems, roof insulation, lighting upgrades, and design guidelines. Thanks to its investments in efficiency, Montgomery County expects over \$5 million in cumulative energy cost savings by the turn of the century. Furthermore, it has leveraged non-energy related benefits such as improved work environments, promoting environmental responsibility, while setting a powerful example for private sector firms. And in the process, the County has been able to allocate saved energy dollars to more important public programs. These are the result of a facilities staff doing an exceptional job, developing a template for similar County and local government initiatives.

## **MONTGOMERY COUNTY, MARYLAND Resource Conservation Program**

**Sector:** *County-owned facilities*

**History:** *Energy efficiency initiatives prompted by oil crises of 1970s; basic low and no-cost measures installed in early 1980s; aggressive program developed and implemented in the late 1980s*

**Mechanism:** *Division of Facility Services implements programs to address facility design and commissioning, plus lighting and HVAC retrofits; coordinates other departmental activities related to energy such as roof and equipment replacements*

**Measures:** *Comprehensive lighting retrofits, implementation of energy design guidelines, HVAC upgrades, installation of energy management control systems in largest facilities*

### **1992-1995 CUMULATIVE PROGRAM DATA**

**Energy savings:** 35,578 MWh

**Lifecycle energy savings:** 420,860 MWh

**Cost savings:** \$2.3 million

**Nominal Cost:** \$2.1 million

### **CONVENTIONS**

All Series 4 Profiles will report nominal dollar values except where expressly stated as levelized. Levelized figures, used for comparative purposes, are based on 1990 U.S. dollars. 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. **ANNUALSAVINGS** 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. **LIFECYCLESAVINGS** 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.

# Program Managers' Perspective

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**BY RON BALON AND PAUL TSENG**

**“The problem of energy conservation has been solved — technically. All that remains is 50 years of implementation.” — Amory Lovins**

The story of energy conservation in Montgomery County facilities is a story of implementation. We have not made the technological breakthroughs that “solve” the energy problem. What we have done is made the organizational breakthroughs required to implement the technical solutions quickly and consistently. We have successfully made high-efficiency part of the “production line” of our building designs. This goal has been achieved through an interlocking set of programs in new design, renovation, retrofit, systems replacement, maintenance training and research projects. Funding has come from many sources, but the best ideas have had little or no net cost to the County to implement. This organizational work has been painstaking, requiring many organizational changes alongside the development of technical standards and design procedures. However, the benefits have proven to be worth many times the effort. We believe others can follow a similar path with less effort by drawing from our experience and products. Here are some “lesson learned” from our experience.

In terms of retrofits for energy efficiency, first be sure your left hand knows what your right hand is doing. Retrofit technologies should be consistent with new building technologies in lighting, energy management, and HVAC systems. Consistency improves maintenance, reduces parts stocks and reduces prices for replacement parts. Second, be sure you know about all your hands! In our organization there are many retrofit programs that affect energy, besides the official “energy retrofit program.” For example, the roof replacement program upgrades building mechanical systems, a “space and interiors” unit performs interior remodeling projects, an electric shop installs and maintains lighting, another unit performs preventive maintenance, and so on. All these people need to work from the same sheet of music on energy conservation. Achieving this harmony in an organization is difficult and ongoing work. We have recently reorganized again in the hopes of further improving energy control of our many facility functions.

In terms of new building design and major renovation, be prepared to tackle the total process from end to end, from before design starts, through construction and commissioning of the building, and on into long-term maintenance and operation. High-efficiency can be derailed anywhere along this line! Watch out especially for the following trouble points:

1) Begin at the real beginning. Sources on energy-efficiency building design often advise introducing energy-efficiency at the schematic design stage. In actual experience we found schematic design is far too late in the process. Waiting until schematic design we already had two strikes against us: i) the designer was not selected with knowledge of energy efficiency as a criteria and ii) energy was not in the “program of requirements” for the building and thus not considered in the design or construction budgets. These were fatal problems for energy efficiency. Problems were solved by starting at the real beginning of building design. Before schematic design, we now require an outline of energy-efficiency requirements in the program for a new building. We made knowledge of energy efficiency and building simulation a criteria for selecting designers, and contracts were prepared with efficiency requirements built-in. Starting the process right was the first critical step.

2) Check and check again. Once into design, standards and feedback have to be implemented step by step. It's not enough to set energy goals and let the designers go. The designers need clear, intermediate guidelines at each design phase. We require specific feedback at each phase to check their understanding and progress. A simple error not caught at schematic design can become an irreparable problem in construction. To control the design process we established advanced Energy Design Guidelines. The Guidelines address every important aspect of energy-efficient building design in an integrated way, making best choices of current technology, design techniques and cost trade-offs. A major unexpected benefit of closely integrated design was cost control. Highly efficient buildings cost no more to build than average buildings! Control of the design process was the second critical step to success.

3) Get what you pay for. The third step in new building design is quality assurance in construction. Many energy-efficient building designs are defeated by substitutions of inefficient products and materials or inferior workmanship. A contractor quality control and systems commissioning program was established to be sure we got what was designed. The quality of our construction improved dramatically. Commissioning also included extensive orientation and training of maintenance personnel to correctly operate the building over time.

In summary, changing our organization to produce efficient buildings was difficult and ongoing work. It is crucial to have careful orchestration by program management which addresses each piece of the energy equation for long-term success. The rewards have included not only low utility bills, but improved quality and cost control as well. Any of these outcomes would have fully justified the effort.

# Program Context

Montgomery County is located in Maryland's southern region just north of the District of Columbia and covers nearly 500 square miles. The land was originally inhabited by the Piscataway Native Americans and was rich in dense forest and wild game, along with an abundance of fish and seafood. The area was then first settled by Europeans more than 300 years ago. The first deed was recorded in 1688 as settlers cleared virgin forests for farming tobacco and other crops. The County was officially established in 1776 by colonists and was named after Richard Montgomery, a general in the colonial army. [R#27]

Today, the County is Maryland's most populated jurisdiction. In 1995, Montgomery County's population totaled 810,000 citizens and has been growing by an average of nearly 12,000 residents annually. Montgomery County operates on a "fiscal year" (FY) basis from July to June. (For example, FY 1996 starts July, 1 1995 and ends June 30, 1996.) The County Government employs approximately 8,000 workers for its 14 executive branch agencies including the departments of Public Works and Transportation, Environmental Protection, Public Libraries, County Police, Recreation, Fire and Rescue. The County has a total operating budget of over \$1.9 billion which includes all executive branch agencies, the public school system, and Montgomery College expenditures. The public school system represents 46.1% of this total budget while County Government agencies represent 28.1%. [R#17,18,31]

Montgomery County's principal economic activity is in high-technology industries such as telecommunications and biotechnology with private companies including IBM, Martin Marietta, Vitro Labs, and Hughes Network Systems. Because of its close proximity to the national capital, the County also houses major federal research and development centers including the National Institutes of Health, National Institute of Standards and Technology, the U.S. Food and Drug Administration, and the National Oceanic and Atmospheric Administration. Montgomery County's highly affluent population

## 1995 MONTGOMERY COUNTY STATISTICS

|                                      |               |
|--------------------------------------|---------------|
| <i>Population</i>                    | ~810,000      |
| <i>Geographic Area</i>               | ~500 sq. mi   |
| <i>Number of Employees</i>           | 8,000         |
| <i>Number of Buildings</i>           | 187           |
| <i>Annual Utility Costs</i>          | \$4.5 million |
| <b><i>Average Electric Rates</i></b> |               |
| 1995                                 | 6.084 ¢/kWh   |
| Average 1992-95                      | 6.054 ¢/kWh   |

earns on average nearly \$60,000 per household annually. Over 21% of households earn more than \$100,000 annually. It is estimated that over 25% of the workforce of Montgomery County are in professional and technical positions with graduate or professional degrees. [R#18]

The County's utility expenditure for electricity, fuel oil, natural gas, water, and sewer in FY 1995 totaled \$43,640,573, fulfilling the needs of its 14 agencies, public schools and Montgomery College. The majority of the County's electricity is supplied by the Potomac Electric Power Company (PEPCo), an investor-owned electric utility serving nearly two million customers not only in Montgomery County but also in the District of Columbia and major portions of Prince George County. PEPCo has implemented a number of DSM programs including high efficiency air conditioner and heat pump rebates and lighting rebates, in which Montgomery County has taken full advantage. Baltimore Gas & Electric Company and the Potomac Edison Company also supply electricity to portions of the County. (PEPCo and Baltimore Gas & Electric are now planning to merge and are seeking the regulatory approval of the Maryland Commission for the merger by March of 1997.) Natural gas is supplied by Washington Gas Light and Balti-

more Gas & Electric. Water and sewer treatment is provided by the Washington Suburban Sanitary Commission. [R#17,16,15]

Montgomery County has demonstrated a progressive stance in many areas including energy efficiency, air quality, and transportation. Its Department of Environmental Protection, a part of the executive branch of the Montgomery County Government, has set strict policies and guidelines for both energy efficiency, the subject of this Profile, and indoor and outdoor air quality. In addition, Montgomery County's Transportation Department is working to provide effective intermodal transport systems such as high-speed rail which interfaces with Washington DC's "Metro," local and regional bus service, carpool and vanpool incentives, and HOV lanes on several of its highways. Fully 80-90% of the County's residents take advantage of these transportation services. [R#13]

### FACILITIES AND SERVICES DIVISION

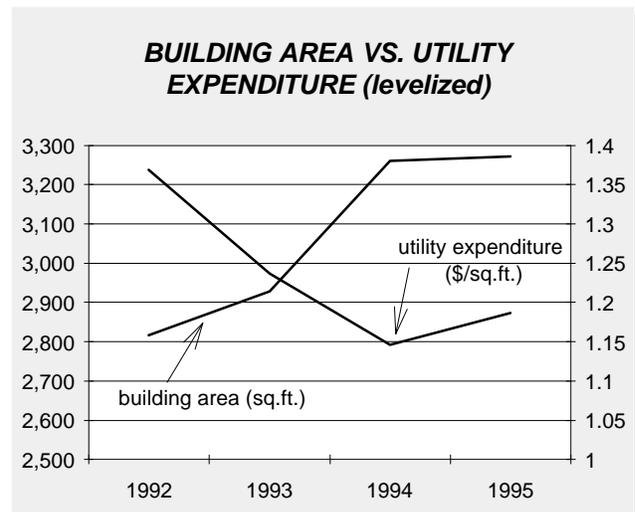
The Facilities and Services Division (DFS) operates and supports the 187 County-owned buildings which together constitute a total of 3,272,000 square footage of building area. These facilities include a variety of government and public service facilities including a judicial center, libraries, police and fire stations, community health centers, day care centers, halfway houses, and recreation centers. Building age varies from one to over 60 years old. Facilities and Services Division organize, strategically plan, and design conservation efforts for these government facilities. [R#1,5,12]

The predominant end-uses within the buildings are lighting, heating, air-conditioning, energy used for computing and other plug loads, and domestic hot water. Electricity is the primary fuel used in the buildings, accounting for 71% of the total, natural gas represents 25% of the fuel use, and the remaining 4% is provided with fuel oils. The County utilizes solar energy for supplemental water heating in three of its facilities. The total cost

of the utilities for these buildings operated by DFS including energy, water and sewer in FY 1995 was over \$4.5 million. [R#1]

The Engineering and Energy Division within the Division of Facilities and Services heads all energy conservation for the County. This division is made up of a staff of nine in-house, full-time energy engineers and technicians that are dedicated to the development and implementation of energy conservation programs headed by Paul Tseng, Chief of Engineering Services and Ronald Balon, Senior Energy Engineer.

The results of these efforts, as this Profile fully describes, are impressive. Because of its aggressive energy efficiency program, despite the construction of 343,000 square feet of new facilities, between 1992 and 1995 the County's total electricity use fell by over 5%, natural gas use was reduced by over 10%, and fuel oil consumption plummeted by 50%. In fact, as the graph below depicts, utility expenditures dropped by 25% from \$1.40 to \$1.05 per square foot. The DFS continues to reach for new heights in energy efficiency with the goal of reducing the overall energy consumption of County-owned buildings by 40%. [R#17]



# Program Design and Delivery

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## PROGRAM HISTORY AND DEVELOPMENT

Montgomery County's Facility and Services Division (DFS) has been developing and implementing energy efficiency within County-owned facilities since 1978. The energy conservation programs were started after the passage of a County Council resolution which was spurred on by the energy crises. At that time the County began formulating methodologies and guidelines to promote and employ wise energy practices.

It wasn't until the early eighties that specific funding was allocated for energy efficiency. However, given a lack of dedicated staff to carry out efficiency retrofits, only minor retrofits were undertaken then such as basic HVAC repairs, minor control upgrades, modest lighting retrofits, and building weatherization. In the mid-eighties, the legislative branch of the County government became more actively involved in setting policy and mandating efficient design in buildings. In 1985 Montgomery County officially founded the Engineering and Energy Division within the Division of Facilities and Services to develop and implement all energy conservation initiatives for County owned-buildings.[R#11]

In 1978, the County established an Energy Conservation Advisory Committee to guide its energy efficiency initiatives. It is comprised of 15 volunteers who are County citizens appointed by the County Executive Office. Citizens are appointed based on their technical knowledge and interest in energy-related issues. The Committee's intent has been to help develop a comprehensive energy and air quality policy, setting environmentally sound practices that interrelate aspects of transportation, land use development, and building energy use. The Committee members specifically help in developing policies on the promotion and implementation of short- and long-term energy awareness programs in the community, including voluntary energy conservation efforts, and energy efficiency education in the private and public sectors. This Committee, whose name was changed to the Energy Conservation and Air Quality Advisory Committee in 1995, also addresses issues relating to air quality standards for the County and generally meets monthly.[R#13,22]

## PROGRAM DESIGN

The DFS has designed and implemented a variety of energy conservation projects which fall into four main categories: Energy Design Guidelines, the Lighting Retrofit Program, Energy Management Control Systems, and Building Commissioning. Energy Design Guidelines are a mandatory set of building design standards for new construction and renovation which

aim at implementing energy-efficient equipment and design in new and renovated buildings. Montgomery County also puts much effort in lighting upgrades and implementation of energy management control systems for County-owned buildings. In addition, Building Commissioning focuses on strict standards and guidelines that ensures that equipment is properly designed and operated and accessibly located.

## ENERGY DESIGN GUIDELINES

The Energy Design Guidelines are a comprehensive set of technical and procedural guidelines for construction and renovation of County-owned buildings with the goal to spawn innovative and energy-efficient designs that exceed traditional, existing codes. In the early 1980s staff discovered that its retrofitted buildings were often more energy-efficient than new buildings. Keen on rectifying this incongruity, the Energy Advisory Committee pushed for an update in the existing building codes through County legislation. It wasn't until 1986 that DFS actually developed the Energy Design Guidelines which were successfully implemented starting in 1989.[R#6,12]

The goal of the Energy Design Guidelines is to reduce new County-owned buildings' energy consumption by 40% without increasing the initial construction cost. The Guidelines provide specific information on standard equipment, design methods, and design criteria for new construction and renovation projects. In addition, solutions for energy-related problems in local government buildings are addressed along with recommendations on high energy performance and standards for lighting, indoor air quality, and architectural creativity.[R#6]

The Energy Design Guidelines incorporate standards for the mechanical, architectural, and electrical aspects of design. The Guidelines direct general requirements for all buildings in the following categories: HVAC design, lighting design, energy management systems, building envelope, and ventilation standards. A detailed energy analysis is also required for County-owned buildings larger than 10,000 square feet which must demonstrate compliance with the energy budget and life-cycle cost specifications. All buildings must include high efficiency HVAC equipment, basic daylighting design, double pane low-emissivity glazing with non-metal window frames, and T8-lamp/electronic ballast installation.[R#17,26]

The Guidelines cover more detailed standards depending on the size of the facility, ranging from 2,000 square feet to over 90,000 square feet in area. For smaller buildings, the Guidelines promote efficient technologies such as exterior lighting

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## **MONTGOMERY COUNTY'S ENERGY POLICY**

The County's Energy Policy, as stated in the energy section of the County Code, "establishes both short- and long-term energy efficiency objectives, promotes immediate and long-range energy consciousness, identifies potential strategies for leadership at the County level to help secure the energy future, and stresses the link between energy and the environment." The County Executive reviews the Energy Policy's energy programs annually to ensure the activities are being accomplished in their proposed timelines. In addition, annual public hearings on the Energy Policy are convened by the County Council to give interested parties ample opportunity to comment. The County Council then makes appropriate revisions to the Policy when agreed upon by the Executive Office.[R#22]

The most recent Energy Policy was approved in November of 1995 and has ten initiatives:

- 1) Prepare for a future consistent with energy resource constraints. Fuels availability and the need to improve air quality may limit energy use of fossil fuels.
- 2) Integrate energy consumption considerations into land use, development and transportation planning as means of evaluating the impact of growth and development on energy consumption and the environment in the County.
- 3) Increase energy efficiency in County facilities and vehicles; work with the private sector to encourage enhanced energy efficiency for commercial and residential building codes and effect adequate energy code enforcement.
- 4) Integrate requirements for greater energy efficiency into commercial and residential building codes and effect adequate energy code enforcement.
- 5) Promote the efficient use of energy through example, education, and legislation.
- 6) Support government funding for projects that promote public and multi-person modes of transportation as one means of conserving energy, alleviating traffic congestion and reducing harmful emissions. Use legislative, regulatory and fiscal policies to discourage use of single-occupancy vehicles and encourage use of mass transit.
- 7) Educate the citizens of Montgomery County to the importance of more efficient energy consumption and the direct linkages between energy usage and a healthy environment.
- 8) Seek intergovernmental cooperation in developing effective, cost-efficient methods to meet the requirement of federal energy environmental legislation.
- 9) Encourage the reduction of per capita energy consumption of Montgomery County from 1990 base levels of 20% by the year 2005; support further per capita reduction in energy consumption thereafter as deemed practicable and appropriate.
- 10) Recognize and reward individual initiative and collective efforts that contribute to the County's energy/environmental policy goals.

management and explore terminal air conditioner, heat pump, and split system options for HVAC equipment. Guidelines for larger buildings include automated daylight controls, plant distribution control systems, and efficient HVAC system options such as ice storage, centrifugal chillers, or hydronic heat

pumps.[R#17]

The basic approach that the engineering staff took in developing the Energy Design Guidelines was "holistic." Instead of focusing on individual pieces of equipment and materials, the

## Program Design and Delivery (continued)

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Guidelines were intended to focus on whole buildings as complete systems. The Guidelines respect the fact that each part of a design affects an entire building's performance. By approaching building design in this manner, staff have been pleased to find that often a well-planned, efficient design does not bear an increased construction cost compared to a conventional building. For example, an efficient lighting design many times reduces the number of fixtures and size of the electrical distribution system needed, which in turn reduces cooling load. Similarly, a well-insulated building shell coupled with energy-efficient glazing helps to reduce both the cooling and heating loads because of decreased heat transfer across the envelope. Both of these effects can help downsize cooling and heating equipment which ultimately reduces construction cost. [R#6]

DFS maintains an enforcement program for the Energy Design Standards to ensure that all new County-owned buildings comply with the Guidelines. DFS tracked a total of 28 building designs between 1994 and 1995 both in the design and construction phase. DFS developed a Design Contract Package to help ensure that the Energy Design Guidelines are met in new construction and renovations. The Design Contract Package outlines all required steps in the design of buildings and renovations. Also included in the package are forms

that are required to be filled out which verify all aspects of the design meet energy efficiency standards set by the Guidelines. [R#26]

### LIGHTING RETROFIT PROGRAM

Montgomery County has an extensive lighting retrofit program. As part of this program, DFS has developed a "toolbox" of lighting technologies highlighting several prescribed avenues for energy savings, including delamping and ballasting, use of occupancy sensors, LED exit sign retrofits, installation of electronic ballasts, T8 lamp replacements, conversions of mercury vapor lamps to metal halide, and incandescent fixture replacements. All of these retrofits are characterized by a payback period of less than two years. In addition to these common measures, Montgomery County has also employed daylighting controls in many of its buildings. The daylighting controls which monitor light levels are installed near windows and serve to dim light fixtures when adequate daylight is available. DFS bids the lighting retrofits out to contractors through advertised and sealed bid proposals. [R#5,17]

The lighting retrofit program has been especially successful because of its unique project structure. To utilize funding most effectively, the energy management team of DFS devises one

### CASE STUDY: ENERGY STAR SHOWCASE

As part of the Environmental Protection Agency's (EPA) Energy Star Buildings program, Montgomery County implemented an "Energy Star Showcase" in the Hungerford Office Building, an 84,000 square foot social service facility built in the mid-1980s. EPA's program was kicked off in summer of 1994 and has assembled 25 Partners who have volunteered to complete comprehensive, single building efficiency upgrades. As one of the initial 25 volunteers, Montgomery County's engineering staff and energy management technicians upgraded the Hungerford Office Building with HVAC and air distribution improvements and lighting retrofits complete with a building tune-up which optimized the building's operation and maintenance.

The Showcase program has brought Montgomery County a host of financial rewards. As a result of the retrofit activity, the facility's asset value increased by \$8.82 per square foot at a total cost of only \$1.82 per square foot for the installed retrofit measures. In turn, Hungerford saved \$90,000 annually in energy bills, reducing the energy per square foot by \$1.07. [R#10,21]

Because its Energy Star Showcase has been so successful, Montgomery County plans to increase its participation in EPA's Energy Star Buildings program for its other buildings. Similar to the Green Lights programs, through the Energy Star Buildings program EPA provides technical support and public recognition for members who voluntarily make energy-efficiency improvements. Energy Star objectives include implementing Green Lights, optimizing operations and maintenance through building tune-ups, optimizing fan systems, and reducing HVAC load by improving building shell to decrease heating and cooling requirements.

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retrofit project for large groups of buildings instead of employing a building by building approach. In doing so, equipment is purchased in bulk and design is effective for numerous buildings, greatly reducing retrofit costs. For example, Montgomery County's replaced all incandescent and fluorescent exit signs with light emitting diode (LED) exit signs in all of its facilities in 1994 and 1995. Because it purchased these exit signs in quantity and thus at a low unit cost, the entire project's cost was nearly paid by incentives received from PEPco. Now the County is enjoying large energy savings from LED exit sign retrofits, as they only consume about five watts per sign, where fluorescents and incandescents use 24-40 watts respectively. [R#17]

Montgomery County became a Partner of the Environmental Protection Agency's Green Lights program in 1994, a voluntary, non-regulatory program aimed at preventing pollution by promoting energy-efficient lighting. (See Profile #35) Green Lights invites public and private organizations to become Partners who voluntarily commit to upgrading economically feasible lighting systems to within a five-year payback period, documenting annual progress, and working with EPA to publicize the benefits of energy efficiency. Because Montgomery County has already developed an extensive lighting program, there is little need for Green Lights technical support. However, Montgomery County is committed to meeting the Green Lights goal of retrofitting 90% of its facilities by 1998. And by 1999, the County expects to have had retrofit nearly 100% of its facilities. [R#17,25]

### **ENERGY MANAGEMENT CONTROL SYSTEMS**

Montgomery County's second largest energy use after lighting is heating, ventilation, and air-conditioning. HVAC systems can save significant amounts of energy by optimizing schedules through energy management control systems (EMCS). Beginning in 1985, Montgomery County began an aggressive program to implement such systems with direct digital controls (DDC) in its larger buildings. Currently, DFS has installed EMCS in 45 County facilities which encompass 1,980,000 square feet of building area. These systems have saved the County over \$300,000 annually in utility bills. [R#1,17]

Functionally, the larger EMCS systems are microprocessor-based controls that allow DFS staff to remotely monitor facilities' equipment, operating schedules, temperature and humidity via a telephone modem on a daily basis. The control systems assure that facilities' HVAC systems are optimized based on occupancy and energy use data for each building. The con-

trols also take advantage of "free cooling" by bringing cool outside air into the warm building. Furthermore, the systems not only control HVAC operations but also monitor and control lighting. These controls allow DFS staff to quickly respond to problems, creating workspaces that are more comfortable for their occupants. [R#5,17]

### **BUILDING COMMISSIONING**

The Building Commissioning program has been a significant effort that has cost over \$1 million annually for both new and renovated buildings. Ron Balon, Montgomery County's Senior Energy Engineer, developed the commissioning specifications along with an outside consultant. These specifications stress proper maintenance and operation practices and provide operations training guidelines for staff members. [R#12]

Commissioning focuses on four major aspects of equipment installation: HVAC equipment, energy management control systems, lighting systems, and electrical systems. From the design phase to equipment implementation and ultimately operation, a DFS team made up of energy engineers and technicians play an integral role in building construction by meeting regularly to oversee the design and construction. In addition, the construction contractor is required to hire a commissioning agent who oversees all aspects of equipment design and installation. The DFS engineering staff has authority on final approval of all commissioning efforts. [R#12]

The commissioning effort emphasizes equipment maintenance and assures that maintenance staff can both properly operate new equipment and easily access it. Many times DFS staff has found that equipment is inaccessible, making it virtually impossible to effectively maintain and operate. To help eliminate this problem, equipment installation is closely monitored by the commissioning team. Also, the construction contractor is required to train maintenance personnel in a comprehensive equipment maintenance program. In this process, the design engineer provides a complete building overview to fully familiarize staff with the essential aspects of the building and its equipment design. [R#12]

As a part of commissioning the County requires strict design and construction documentation and verification of equipment installation. Specifications of all HVAC equipment, lighting design, and electrical systems are confirmed. DFS utilizes the energy management control systems for this initial monitoring and has found that they have been quite instrumental in detecting problems. This allows DFS to record possible flaws by the contractor and assign financial responsibility

## Program Design and Delivery (continued)

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when appropriate. For example, during the commissioning process of the new library, the County revealed that the lighting designers miscalculated the lighting levels. In turn, the designers paid \$10,000 to correct the problem.[R#7,20]

### **PROGRAM FINANCING AND DELIVERY**

To date, Montgomery County has self-financed its energy efficiency activities through normal capital and operating budgets. The energy conservation program financing falls within the County's Capital Improvement Budget. As a subset of this, the Resource Conservation Capital Projects have an annual budget of approximately \$500,000 to fund lighting retrofits and energy management control system installations along with Energy Design Guideline enforcement. In addition, energy efficiency has been a subset of expenditures paid through other budgets such as Building Renovations, Planned Life-Cycle Asset Replacement (PLAR), Roofing Improvement, and HVAC Electrical Replacement Program which are each part of the County's Capital Improvement Budget.

The implementation of the Energy Design Guidelines fall under Building Renovations which has a total annual budget of \$10 million. PLAR has designated funding of \$1 million per year for equipment replacement which has reached its known life. The DFS energy staff assists in equipment selection to ensure that energy-efficient models are specified. Under Montgomery County's roof repair program with an annual budget of \$750,000, all roof insulation is upgraded during building re-roofing. The HVAC Electrical Replacement Program, with an annual budget just over \$0.5 million, replaces existing HVAC equipment with new, highly efficient equipment.[R#12,22]

The focus of the energy conservation programs is detailed in the Resource Conservation Plan (RCP). This annual report, mandated by the County Council, outlines proposed projects and goals related to energy efficiency. Internal funding for energy conservation is appropriated on an annual basis by the County Council based on the projects which are detailed in the RCP. County Council meets with energy engineering staff to discuss specific project details in the approval process. DFS energy conservation programs have been so successful in the past that little effort is needed for program approval. Because the overall utility expenditure in the last few years have remained very stable despite an increase in the number of County-owned buildings and rate increases, it is clear to the County Council that its investments in energy efficiency are cost effective.[R#12,22]

Montgomery County has also been very successful in acquiring outside funding for its efficiency programs, recognizing the fact that many federal and state agencies are forming alliances with local communities by offering grant dollars to support local projects. Since 1987, the County has been awarded a number of federal, state, and utility grants for specific projects such as developing the Energy Design Guidelines, new facilities, energy efficiency design center, and specific energy-related studies.

One of the strongest supporters of Montgomery County's resource conservation programs is The Urban Consortium Energy Task Force discussed further in the Transferability section. This organization has awarded Montgomery County several grants totaling \$464,000 which have helped to support the Energy Design Guidelines, new construction, CFC management, and lighting and energy management control system retrofits. Montgomery County has also received grants from the State of Maryland Energy Administration, Oil Overcharge Funds, and Potomac Edison. Through 1995, the County has received a cumulative total of \$619,000 in outside funding. For 1996, Montgomery County expects the total to reach nearly \$700,000, accounting for 9% of Montgomery County's gross efficiency expenditure.[R#1,17]

### **UTILITY REBATES**

Montgomery County has taken full advantage of PEPCo's and Washington Gas Light's rebate programs. Rebates have helped to shorten the payback period for many high efficiency products installed. Montgomery County is currently enrolled in two PEPCo programs, the Custom Rebate Program and the New Building Design Program, and Washington Gas Light's Efficient Equipment Program. PEPCo's Custom Rebate Program provides rebates for high-efficiency lamps and ballasts, automatic controls, energy-efficient motors, variable frequency drives and HVAC controls, and chiller replacement. PEPCo's New Building Design Program gives cash incentives for installing high-efficiency equipment such as lighting, HVAC, windows, and motors in new construction. Washington Gas Light's Efficient Equipment Program has provided Montgomery County with rebates for high-efficiency boilers and gas equipment.[R#17]

DFS began actively enrolling in available rebate programs in 1992. From 1992 to 1995, Montgomery County received over \$1 million in rebate money from PEPCo and Washington Gas Light. Over 86% of the rebate dollars have come from PEPCo's rebate programs, totaling over \$900,000. Washington Gas Light

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has awarded Montgomery County with roughly \$125,000 in rebates. Montgomery County expects to experience a 50% drop in rebates in 1996, however, due to PEPCO's restructuring and shift away from traditional DSM models.[R#12,17]

Ron Balon has noticed that the prices of many of the high-efficiency products' installed by Montgomery County have experienced significant reductions over the last several years because these products are beginning to penetrate the market. Thus he suggests that there is a silver lining to the drop in utility incentives. Even though utility rebates help to shorten the payback period, many of the products already meet Montgomery County's critical payback. For instance, the average lighting retrofit has a payback of two to three years without a rebate, well within Montgomery County's maximum payback criteria of five years.[R#12]

### **PROGRAM RECOGNITION: AWARDS AND HONORS**

Montgomery County's DFS has been recognized nationally for its innovation and effectiveness. In 1989 and 1990, DFS received three national awards for its Energy Design Guidelines: The Technology Achievement Award from Public Technology Institute, The Energy Achievement Award from the National Association of Counties, and the National Energy Technology Award from The Urban Consortium. In 1992, DFS received an additional national award, the National Energy Achievement Award from the National Conference on Energy-Efficient Cooling Technologies.[R#17]

Other awards include the 1991 Association of Professional Energy Managers Energy Management Excellence Honorable Mention for Paul Tseng, DFS Chief of Engineering. Tseng was honored for his technical merit and solution-oriented approach. In 1993, Montgomery County received the FAME Award of Merit from the American Institute of Plant Engineers. The FAME award recognized the County's economic success in saving millions of dollars through energy efficiency. Most recently, DFS was awarded the Special Recognition Award from the Energy Conservation and Air Quality Advisory Committee in 1996 for energy reduction in the County's Energy Star Showcase.[R#17]

### **MEASURES INSTALLED**

To date, the installation of energy management control systems have leveraged the greatest savings for the County. DFS has implemented direct digital controls in 45 facilities which together account for over half of the County's total space, fully

1,980,000 square feet of building area.

Lighting retrofits have mainly focused on relamping and reballasting all fluorescent fixtures with high-efficiency T8 lamps and electronic ballasts. DFS has also installed occupancy sensors, converted mercury vapor to metal halide lamps, and replaced incandescent fixtures with compact fluorescent lamps and fixtures. Montgomery County has retrofitted over 18,000 fixtures with T8 lamps/electronic ballasts and installed nearly 3,700 compact fluorescent fixtures. Between 1994 and 1995, a total of 751,681 square feet of building area was retrofitted. DFS has completed a comprehensive lighting retrofit schedule for 1996 for 15 facilities totaling 576,400 square feet. This program averaged a 75% reduction in annual lighting energy use.

The Energy Design Guidelines have been implemented in a total 21 buildings since 1989. In addition, DFS enforces the Guidelines for all newly constructed and renovated buildings. In 1994 and 1995, DFS tracked 28 buildings in the program and construction phases to ensure the Guidelines were being met.[R#1,17]

DFS continues to reach for new heights in energy conservation and has set goals which foster programs that not only produce permanent efficiency improvements but which also provide economical solutions with short paybacks. For example, DFS is aiming for a 40% reduction in total energy consumption of new buildings through the Energy Design Guidelines, cost-effective lighting upgrades in 90% of the County's facilities by 1998, and installation of energy management control systems in all large buildings. In addition to conservation efforts of its own facilities, DFS is sharing its success with other local and state agencies. Through an outreach program, funded by the Maryland Energy Administration, DFS is assisting other jurisdictions in the State with the implementation of its design guidelines and lighting retrofit programs.[R#17]

### **MONITORING AND EVALUATION**

As mentioned above, Montgomery County monitors building operations through its network of digital energy management systems in 45 of its largest buildings. Through remote control, daily records are taken on building temperature and humidity and crucial equipment parameters to help maintenance personnel identify malfunctions and problems in building operations. (For a similar monitoring program see Profile #76: City of Leicester, England, Comprehensive Municipal Energy Efficiency)

## Program Design and Delivery (continued)

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Montgomery County uses the FASER (Fast Accounting System for Energy Records) software system developed by Omnicomp for tracking energy consumption. DFS has been tracking energy use and savings since 1986 with actual data available since 1992. The software system assists DFS staff in examining changes in energy use over time. The FASER software program imports utility billing data and converts it to a readable format. The program tracks energy use and cost over time, showing general trends in facilities' energy consumption. The FASER program is equipped with a variety of reports and graphs which can assist in identifying unusual energy use or cost characteristics, signifying either meter problems or incorrect billing by the utility. [R#19]

The DFS engineering staff has found FASER to be an effective tool for evaluating its conservation programs. The staff has been able to identify billing errors and unusual use in energy and water use. For example, a major water leak was identified in one of the County's buildings when results from FASER showed a huge jump in water consumption for a particular month. [R#12]

To determine actual energy savings, DFS staff performs pre- and post-retrofit building simulations, examining the difference between the energy use before and after energy-efficient retrofits projects are implemented. In addition, energy calculations on lighting and HVAC energy based on change in energy efficiency of new equipment are performed to estimate savings on specific technologies. [R#12]

### **STAFFING REQUIREMENTS**

A total of nine full-time DFS staff members work in the Engineering and Energy Division of DFS which is responsible for coordinating all energy efficiency activities. Paul Tseng, DFS's Chief of Engineering Services, heads the conservation programs and develops the overall direction and goals, soliciting funding for the program, and coordinating many of the programs. Ronald Balon, Senior Energy Engineer, is the lead energy engineer for all the resource conservation programs, directing and developing the design and implementation processes. Homeira Razavi, Senior Engineer, manages the Green Lights initiative and reviews all lighting retrofit projects. There are also a variety of other engineers and technicians working with Tseng and Balon in managing Montgomery County's conservation program, including mechanical, electrical, and roofing engineers, and energy management and preventative maintenance technicians. The County's Department of Environmental Protection, headed by Mary Whitehead, also plays a role in developing energy policy and interacting with both utilities and the community on energy-related issues. [R#17]

# Program Savings

| <b>SAVINGS OVERVIEW</b> | <b>ANNUAL ENERGY SAVINGS (MWh)</b> | <b>CUMULATIVE ENERGY SAVINGS (MWh)</b> | <b>LIFECYCLE ENERGY SAVINGS (MWh)</b> |
|-------------------------|------------------------------------|--|---------------------------------------|
| <b>1992</b>             | 6,673                              | 6,673                                  | 133,460                               |
| <b>1993</b>             | 4,949                              | 7,366                                  | 98,980                                |
| <b>1994</b>             | 4,834                              | 9,876                                  | 96,680                                |
| <b>1995</b>             | 4,587                              | 11,663                                 | 91,740                                |
| <b>Total</b>            | 21,043                             | 35,578                                 | 420,860                               |

**Data Alert:** All savings correspond to the County's fiscal years. Note that County staff has not analyzed capacity savings and that overall savings are expressed in kilowatt-hour equivalents and cost avoidance. Thus, gas savings, for example, are represented in both electricity and dollar values.

In 1995 Montgomery County Government's Resource Conservation Programs resulted in energy savings of 4,587 MWh. From 1992 to 1995, total annual energy saving of 21,043 MWh were achieved with cumulative savings of 35,578 MWh. The programs will result in lifecycle energy savings of 420,860 MWh. [R#1]

In terms of cumulative end-use savings between 1992 and 1995, energy management control system retrofits have provided 57% of the savings, totaling over 20,355 MWh. Lighting retrofits have made the next largest contribution and have saved 9,172 MWh, or 26% of the total. So far DFS has successfully upgraded 56% of the lighting systems in all existing buildings. Design Guidelines have saved 1,510 MWh and other conservation measures such as roof insulation upgrades and variable speed drive installations were responsible for 4,542 MWh in energy savings.

## MEASURE LIFETIME

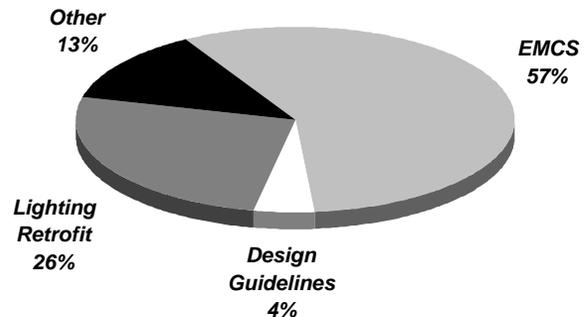
DFS staff estimate that the weighted average lifetime for energy-efficient measures installed by Montgomery County is 20 years. This 20-year life was used to calculate lifecycle energy savings and the cost of saved energy presented in the Cost section of this Profile.

## PROJECTED SAVINGS

Montgomery County projects a cumulative cost savings of over \$5 million from 1992-1999, not including grants and rebates received. This dollar savings equates to approximately 74,200 MWh in energy savings based on the County's 1996 average energy cost of \$0.0688/kWh. DFS also plans on upgrading 90% of all facilities' lighting systems by 1998 to fulfill its Green Lights commitment and is performing lighting retrofits on 11% of its space annually to meet this goal.

Montgomery County is meeting its energy savings goal of 40% for new construction through the Energy Design Guidelines. Based on an analysis of 30 new and renovated buildings, DFS estimates that its new buildings use 40-50% less energy and renovated buildings use 30-40% less than conventional buildings' energy consumption. [R#6,17]

### CUMULATIVE END-USE ENERGY SAVINGS



# Additional Program Benefits

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In addition to the direct benefits of energy savings and utility bill reductions, Montgomery County's energy efficiency initiatives have leveraged a number of additional benefits. Because the County approaches energy conservation from a systematic perspective and for the benefit of the entire County population, synergistic benefits are created that not only are economically appealing to the County's fiscal balance sheet but also add great value to building occupants and support community economic development.

**Avoided emissions:** As the accompanying Environmental Benefit Statement shows, electricity saving equivalents from Montgomery County's energy efficiency initiatives have resulted in significant avoided emissions. For example, a similar initiative implemented over a four-year period with similar success as Montgomery County's conservation programs would create avoided carbon dioxide emissions of a standard coal-fired power plant by over 38,000 tons.

**Other fuel savings:** While program results have been expressed in kilowatt-hour equivalents, in reality the program has saved electricity (both energy and demand), natural gas, and fuel oil. Between 1992 and 1995, the County reduced its overall natural gas consumption by over 10% while fuel oil consumption dropped by fully 50%. [R#1]

**Reduced maintenance:** For lighting upgrades, County engineering staff have found that the reduction in maintenance costs actually pays for the entire retrofit in four years. Energy management control systems also help to reduce maintenance time and costs because the controls assist in early detection and diagnosis of any problems. [R#11,12,17]

**Longer equipment life:** Paul Tseng explains that when upgrading equipment to higher quality, energy-efficient models, in addition to direct energy savings the County gets equipment that will last longer. This is equivalent to an "automatic life extension." He estimates that HVAC upgrades can add as much as 15-25 years to equipment life. Thus not only does premium quality equipment greatly reduce operation and maintenance costs, but replacement costs are reduced as well.

**Community benefit:** Because Montgomery County's efficiency programs have been so successful in reducing utility expenditures, freed up dollars can literally be redirected back to the community. Tseng and his staff report that the avoided costs created through energy savings have helped fund more community policing, children sports programs, and new libraries. Thus while the County is leveraging economic and environmental benefit, saved energy is turned into features that

enhance the quality of life in Montgomery County. [R#11]

**Improved worker productivity:** The lighting retrofits in Montgomery County have undoubtedly made a positive contribution to the work environment for County employees. This, in turn, leads to greater worker productivity, optimizing tax dollars for public benefit. The lighting retrofits conducted have greatly improved the quality of light. Retrofits exhibit better color quality, less glare, the elimination of annoying flicker experienced with older lamps and ballasts. Even the external lighting of County buildings – while more energy efficient – is more attractive.

In addition, energy management control systems afford greater control of facility environments providing means for facilities personnel to be highly responsive to changes in building environment. Extreme temperature and humidity for example can be easily adjusted, providing comfortable environments for building occupants. [R#17]

## **THE ENVIRONMENTAL BENEFIT STATEMENT**

The Environmental Benefit Statement is intended to provide approximations of avoided air emissions for the electricity savings from a particular program when applied to another region or service territory. To transfer Montgomery County's program success to your own situation, first determine the representative marginal power plant for your situation by perusing the left hand column of the table. What type of generation will be avoided if you enjoy the County's level of success with a similar program in your region or service territory? Once you have determined the proxy power plant based on fuel type, heat rate (the efficiency of the power plant), and sulfur content in the fuel, move to the right across the row selected to find approximations of avoided emissions should you achieve Montgomery County's results. Note that the coefficients in each cell of the table contain a 10% credit for transmission and distribution losses avoided through energy efficiency.

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

**ENVIRONMENTAL BENEFIT STATEMENT**

➔ **Avoided emissions based on 35,578,000 kWh saved**

| <i>Marginal Power Plant</i>                   | <i>Heat Rate BTU/kWh</i> | <i>% Sulfur in Fuel</i> | <i>CO2 (lbs)</i> | <i>SO2 (lbs)</i> | <i>NOx (lbs)</i> | <i>TSP* (lbs)</i> |
|---|--------------------------|-------------------------|------------------|------------------|------------------|-------------------|
| <b>Coal</b>                                   |                          |                         |                  |                  |                  |                   |
| <b>Uncontrolled Emissions</b>                 |                          |                         |                  |                  |                  |                   |
| A   | 9,400                    | 2.50%                   | 76,706,000       | 1,820,000        | 368,000          | 37,000            |
| B   | 10,000                   | 1.20%                   | 81,794,000       | 704,000          | 238,000          | 176,000           |
| <b>Controlled Emissions</b>                   |                          |                         |                  |                  |                  |                   |
| A   | 9,400                    | 2.50%                   | 76,706,000       | 182,000          | 368,000          | 3,000             |
| B   | 10,000                   | 1.20%                   | 81,794,000       | 70,000           | 238,000          | 12,000            |
| C   | 10,000                   |                         | 81,794,000       | 470,000          | 235,000          | 12,000            |
| <b>Atmospheric Fluidized Bed Combustion</b>   |                          |                         |                  |                  |                  |                   |
| A   | 10,000                   | 1.10%                   | 81,794,000       | 215,000          | 117,000          | 59,000            |
| B   | 9,400                    | 2.50%                   | 76,706,000       | 182,000          | 147,000          | 11,000            |
| <b>Integrated Gasification Combined Cycle</b> |                          |                         |                  |                  |                  |                   |
| A   | 10,000                   | 0.45%                   | 81,794,000       | 145,000          | 23,000           | 59,000            |
| B   | 9,010                    |                         | 73,575,000       | 52,000           | 18,000           | 4,000             |
| <b>Gas</b>                                    |                          |                         |                  |                  |                  |                   |
| <b>Steam</b>                                  |                          |                         |                  |                  |                  |                   |
| A   | 10,400                   |                         | 44,615,000       | 0                | 102,000          | 0                 |
| B   | 9,224                    |                         | 38,744,000       | 0                | 243,000          | 11,000            |
| <b>Combined Cycle</b>                         |                          |                         |                  |                  |                  |                   |
| 1. Existing                                   | 9,000                    |                         | 38,744,000       | 0                | 149,000          | 0                 |
| 2. NSPS*                                      | 9,000                    |                         | 38,744,000       | 0                | 70,000           | 0                 |
| 3. BACT*                                      | 9,000                    |                         | 38,744,000       | 0                | 10,000           | 0                 |
| <b>Oil</b>                                    |                          |                         |                  |                  |                  |                   |
| <b>Steam--#6 Oil</b>                          |                          |                         |                  |                  |                  |                   |
| A   | 9,840                    | 2.00%                   | 64,574,000       | 978,000          | 115,000          | 110,000           |
| B   | 10,400                   | 2.20%                   | 68,488,000       | 971,000          | 145,000          | 70,000            |
| C   | 10,400                   | 1.00%                   | 68,488,000       | 139,000          | 117,000          | 37,000            |
| D   | 10,400                   | 0.50%                   | 68,488,000       | 407,000          | 145,000          | 22,000            |
| <b>Combustion Turbine</b>                     |                          |                         |                  |                  |                  |                   |
| #2 Diesel                                     | 13,600                   | 0.30%                   | 85,707,000       | 171,000          | 265,000          | 14,000            |
| <b>Refuse Derived Fuel</b>                    |                          |                         |                  |                  |                  |                   |
| Conventional                                  | 15,000                   | 0.20%                   | 101,753,000      | 262,000          | 345,000          | 77,000            |

# Cost of the Program

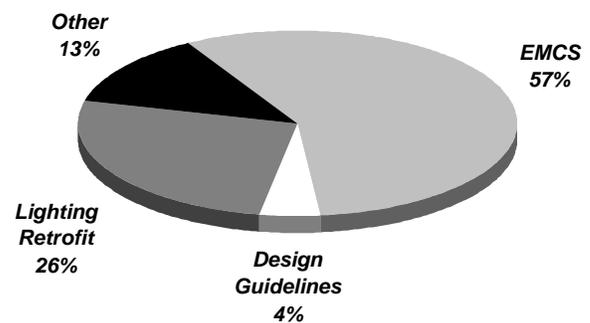
| <b>COSTS OVERVIEW</b> | <b>PLANNING DESIGN &amp; SUPERVISION<br/>(x1,000)</b> | <b>PROGRAM IMPLEMENTATION<br/>(x1,000)</b> | <b>Total Cost of Program (x1,000)<br/>Nominal</b> | <b>Total Cost of Program (x1,000)<br/>Levelized</b> |
|-----------------------|---|--|---|---|
| <b>1992</b>           | \$150.0   | \$535.0                                    | \$685.0   | \$636.4   |
| <b>1993</b>           | \$150.0   | \$398.0                                    | \$548.0   | \$493.9   |
| <b>1994</b>           | \$150.0   | \$351.0                                    | \$501.0   | \$440.0   |
| <b>1995</b>           | \$150.0   | \$198.0                                    | \$348.0   | \$296.9   |
| <b>Total</b>          | \$600.0   | \$1,482.0                                  | \$2,082.0   | \$1,867.2   |

In 1995 Montgomery County spent \$348,000 to promote energy efficiency within its facilities. Between 1992 and 1995 the County invested \$2.082 million in its Resource Conservation Programs. This has funded lighting retrofits, energy management control system installations, along with Energy Design Guidelines enforcement. The County has also been successful at leveraging more than \$600,000 in outside funding from grants and awards and \$1.3 million in utility rebates through 1995 which have also been used to pay for specific energy conservation projects.

In addition to these expenditures which are specifically related to energy conservation programs, other expenditures for energy conservation measures are paid through other divisions of the County government. For instance equipment replacement, building renovation, new construction, the Planned Life-Cycle Asset Replacement program, and HVAC replacement expenditures total over \$11 million each year and are paid through other department budgets. Although some activities within these initiatives are energy-efficiency related, they are considered normal County operating expenditures.

The Resource Conservation Programs resulted in a dollar savings of \$313,750 in 1995. From 1992 to 1995, cumulative cost savings of \$2.337 million were achieved. The County expects to save \$692,644 in 1996 and anticipates a total cumulative savings of over \$5 million by 1999 not including grants and rebate dollars collected by the County. In terms of cumulative end-use cost savings from 1992 to 1995, energy management control system retrofits account for \$1.3 million in cost savings, lighting retrofits savings total \$607,000, and Design Guidelines savings total \$102,000.[R#1]

**CUMULATIVE END-USE COST SAVINGS**



| <b>COST SAVINGS OVERVIEW</b> | <b>ANNUAL COST SAVINGS<br/>(x1,000)</b> | <b>CUMULATIVE COST SAVINGS<br/>(x1,000)</b> |
|------------------------------|---|---|
| <b>1992</b>                  | \$431.8                                 | \$431.8                                     |
| <b>1993</b>                  | \$313.8                                 | \$467.0                                     |
| <b>1994</b>                  | \$313.8                                 | \$641.0                                     |
| <b>1995</b>                  | \$313.8                                 | \$797.7                                     |
| <b>Total</b>                 | \$1,373.2                               | \$2,337.5                                   |

| <b>COST OF SAVED ENERGY<br/>(¢/kWh) Levelized</b> | <b>3%</b> | <b>4%</b> | <b>5%</b> | <b>6%</b> | <b>7%</b> | <b>8%</b> | <b>9%</b> |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>1992</b>                                       | 0.32      | 0.35      | 0.38      | 0.41      | 0.45      | 0.48      | 0.52      |
| <b>1993</b>                                       | 0.50      | 0.55      | 0.60      | 0.65      | 0.71      | 0.76      | 0.82      |
| <b>1994</b>                                       | 0.56      | 0.61      | 0.67      | 0.73      | 0.79      | 0.85      | 0.91      |
| <b>1995</b>                                       | 0.80      | 0.88      | 0.96      | 1.04      | 1.12      | 1.21      | 1.30      |

### **COST EFFECTIVENESS**

Montgomery County's Resource Conservation Programs clearly are cost effective -- the County invested \$2.082 million from 1992 to 1995 in energy conservation, yet saved \$2.337 million during this same time period. The Results Center has calculated the cost of saved energy for these programs. Using a 20-year measure life the Resource Conservation Programs has resulted in a cost of saved energy of 1.04¢/kWh at a 5% discount rate in 1995. This cost of saved energy represents the marginal costs of the DFS focus on efficiency; other related expenditures have been made through other departmental budgets as discussed above.

### **END-USE COSTS**

In 1995, Montgomery County invested \$198,000 in lighting retrofits; lighting investments totaled \$1.1 million between 1992 and 1995. In the upcoming years, Montgomery County estimates that \$290,000 in annual funding for lighting upgrades will be required to meet its Green Lights program goals. The County has invested a total of \$1.2 million in energy management control systems since 1985. Other programs such as Building Commissioning, Energy Design Guidelines implementation and enforcement, and other energy-efficient equipment replacement programs are not tracked.[R#1,17]

### **COST COMPONENTS**

DFS is required to report annually on the expenditure breakdown for its Resource Conservation Programs in Planning, Design, and Supervision and Program Implementation costs. Planning, Design and Supervision accounts for all DFS engineering staff and administrative costs which averaged \$150,000 annually. Program Implementation costs are associated with actual implementation of energy conservation projects such as lighting retrofits and EMCS installations. In 1995, DFS spent a total of \$150,000 in Planning Design and Supervision and \$198,000 in Program Implementation.[R#1]

From 1992 to 1995, DFS spent a total of \$2.08 million on its energy conservation programs. From 1988 to 1995, Montgomery County's Budget Office reports that DFS has spent a total of nearly \$3.9 million for energy conservation. Annual Planning, Design and Supervision costs peaked to \$391,000 in 1989 marking the great effort put forth by DFS in developing a strong foundation for the energy conservation programs. DFS retrofit implementation cost peaked in 1992 revealing the height of construction costs at \$535,000.[R#1,23]

# Lessons Learned

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**Deep levels of savings are possible to reap cost effectively:** First and foremost, Montgomery County's Facilities and Services Division has vividly demonstrated that deep levels of savings are not only possible, but can be achieved at low cost. For new construction, the County has realized savings of 40-50% of a typical facility's energy use. For retrofits, the County has achieved 30-40% savings. Lighting retrofits have typically saved 75%. Furthermore, these impressive levels of savings have been tapped cost effectively as the County has achieved its aggressive goals while staying well within its own payback guidelines.

**Deep savings represent dollars that can be better directed to improve the quality of life in the County:** While energy savings are attractive to engineers and those paying the utility bills, the millions of dollars of savings in Montgomery County have been redirected into social purposes such as increased police services, more libraries, child care, etc. These are the true societal benefits of the County's diligent work to responsibly cut energy use and environmental pollution.

**The County's track record with efficiency has streamlined the process for further retrofits activities, while providing credibility to lure outside sources of funding:** By now, the DFS staff has proven its worth many times over. This has led to a greatly streamlined process for further work, unencumbered by institutional barriers often characteristic of cutting-edge programs in bureaucratic environments. Efficiency is no longer considered innovative in Montgomery County, it has become institutionalized and thus staff do not have to wrestle with disabling policies or tedious reporting requirements. In addition, the County's demonstrated success has leveraged outside sources of capital such as grants from The Urban Consortium's Energy Task Force.

**To reap the benefits of truly energy-efficient buildings it is crucial to develop programs that are systematic in effect:** DFS engineering staff have been extremely successful at developing programs that work together in achieving a common goal – highly efficient, low maintenance buildings. Each program is just a piece of the overall puzzle. The first piece is to design highly efficient buildings – an outcome of the Energy Design Guidelines. Good designs must be linked with

proper operation and maintenance through comprehensive building commissioning and proper use of energy management control systems. Building commissioning allows maintenance personnel, engineers, and building designers to interact from the beginning of design to the installation of the equipment, ensuring that equipment is properly located and staff is well trained to operate and maintain equipment. Energy management control systems offer an important final connection, allowing for early detection and diagnosis of problems. As Paul Tseng explains, "No matter how good the design is, if it cannot be maintained, all the effort is for naught." [R#3,12]

**"Energy efficiency in new buildings requires more thinking but not more money!"** Through careful selection of efficient products and systems, the County engineers have proven that highly efficient facilities can be built for initial costs that are comparable with those of conventional buildings. DFS engineers have shown that there are often synergistic effects in energy-efficient technologies that can be capitalized upon to reduce if not eliminate any marginal cost. For example, high-efficiency lighting lowers light levels which can greatly reduce cooling load requirements, which in turn allows for downsizing of chillers, ducts, and piping, ultimately dropping initial total equipment costs. Montgomery County has successfully leveraged these synergies in design, taking credits from efficient design and equipment installations to get deeper savings at low or zero marginal cost. [R#3,12]

**DFS engineering staff has found that single building energy audits are expensive and not effective:** When Montgomery County began expanding its energy conservation program in the mid-1980's, energy audits were performed in thirty-six of the its largest buildings to help identify cost-effective retrofit measures. The County found, however, that single building audits were very expensive and cost as much as \$30,000 each. The County also found that audits' recommendations on a building-by-building basis could not be implemented quickly or cost-effective. Thus it switched from single building projects to systematic programs that reached multiple facilities. [R#12]

**Montgomery County creatively finances projects which are highly successful at leveraging funds:** By switching to a multiple facility approach, Montgomery County

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## CASE STUDY: THE DAMASCUS CENTER

The Damascus Center is a community center that houses a library, senior center, and day care center and which exemplifies Montgomery County's pledge of excellence to energy-efficient design. The building is passive solar and uses sophisticated controls to operate highly efficient equipment. As a tribute to its design, the building received a Merit Award from the American Institute of Architects shortly after its completion.[R#6]

The Damascus Center was built under Montgomery County's strict Energy Design Guidelines. Passive solar daylighting is employed throughout both the core and perimeter of the building. The facility's fluorescent lighting has three illumination levels which are automatically controlled in accord with variations in the daylight intensity. The HVAC equipment is highly efficient and includes an electronically controlled central chiller which maximizes part-load savings, a variable air volume distribution system, and pulse boilers for space heating. This equipment is connected to the County's energy management system for optimum control and monitoring. Insulation levels meet the proposed national ASHRAE standards and all windows are clad with heat mirror glazing.

Even with its high-tech design, the 30,000 square foot facility was built for the reasonable cost of \$3.5 million, very much in line with common commercial construction costs of approximately \$120 per square foot. Staff report with pride that the facility exemplifies its belief that if efficiency is properly incorporated in new construction, an efficient facility can cost the same as an inefficient one. By capturing the synergies between design and technologies, staff suggest that often deep levels of efficiency can be garnered for zero or little marginal cost.[R#6,12]

The building's performance has been exceptional. When staff compared its performance with an average community center they discovered that it uses only 66% of the energy of an average center. This savings is translated into an annual savings of \$10,400.[R#6]

is able to design large retrofit projects that implement a single measure in a large number of buildings. This enables the County to buy very large quantities of equipment at "bulk prices." For example, instead of retrofitting each building's exit signs separately, the County contracted for the retrofit of all county-owned buildings' exit signs under one bid. And better yet, the utility rebate it received for LED-exit signs practically paid for the entire installation thanks to the low unit purchase price that the County was able to realize by aggregating its requirements![R#12]

**Montgomery County believes that with better communication, its retrofit activities can be smoother for building occupants:** While Paul Tseng and his staff are clearly technically proficient, they are the first to admit that the implementation of energy-efficient equipment in County fa-

cilities could have been facilitated by better communication with building occupants. There's no question that retrofitting an office, for example, causes a disruption of the space if not the total uprooting of its occupant. While inevitable, staff suggest that there is room for improvement in regard to occupant outreach and education. Tseng believes that "closing the loop" by educating occupants about the energy improvements before, during, and after retrofits are completed can be a powerful proactive and effective step. In this way, occupants tend to be more flexible about the disruptions, will better appreciate the changes, and will feel more comfortable in their new surroundings. [R#11]

# Transferability

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Local government entities can address energy use within their jurisdictions in a number of ways. Montgomery County has excelled in addressing the energy use within its own 187 facilities and as this Profile has shown, its program has been primarily internally focused. The City of Phoenix has had similar success in capturing the potential for efficiency in its municipal facilities and boasts a program that has saved nearly \$25 million thus far through a clever reinvestment mechanism. (See Profile #118) Local governments can choose from a host of proven financial mechanisms (such as reinvestment mechanisms, revolving funds, performance contracting, tax exempt leases, etc.) which can be used to finance retrofits of their own facilities to free up capital for other more pressing civic purposes. (See for example Profiles #73,79,100,101,112,114))

Local governments can also seek to effect change within the private sector, concurrently working internally and externally to promote efficiency, productivity, and broad-based economic development. This can be done by establishing codes, incentive programs, regulations, and other instruments that are applicable to the general public. Counties – as well as cities, states, and other governmental jurisdictions – can also emphasize awareness building through outreach and educational activities, encouraging effective design and energy efficiency through demonstrations and various types of technical assistance. Of course these need not be limited to energy efficiency as initiatives can concurrently promote wise resource use through land-use and transportation planning, recycling, and water conservation.

## **THE ENERGY EFFICIENCY DESIGN CENTER**

While Montgomery County's foremost success and the subject of this Profile has been its internal focus on its own facilities, the County has also used its expertise and reputation to promote similar efficiency actions to a broader audience both within the County and for governments throughout the State of Maryland. In 1993 and as an example of its external leadership role, Montgomery County opened the doors to its Energy Efficiency Design Center to promote efficiency in new commercial construction. Thanks to the Maryland Energy Administration which provided a \$50,000 grant to help initiate the program, the Center was developed to assist the State of Maryland government as well as local governments in the implementation of Montgomery County's Energy Design Guidelines.

All agencies of the State government, University of Maryland system, local and county governments are eligible for services from The Design Center. In particular, the Center was established to provide useful engineering and management tools to assist in design of high quality buildings done in a quick and effective manner. DFS staff provide significant outreach services through The Design Center; its engineering staff spends up to 30 hours per week with colleagues in other government entities who need help developing comprehensive energy conservation guidelines for their own jurisdictions. [R#11,28]

In addition, The Design Center staff conduct comprehensive technical seminars related to new construction and the design guidelines. Detailed briefings are given by DFS staff to assist clients in variety of issues surrounding project design including architect and engineer selection, energy parameters, and development, preparation, and technical review of design contract. The Design Center also provides services that help clients design and implement lighting retrofits. Lighting surveys and economic analysis information are also available through the Center.[R#28]

The foundation for the Energy Design Center is the County's Energy Design Guidelines, a set of recommendations and requirements that have gained deserved attention. In an even broader outreach activity, DFS has placed considerable emphasis on disseminating information on the guidelines to other government agencies and private companies to support their adoption nationwide. The County has sold over 60 copies of the Energy Design Guidelines to public and private agencies including the U.S. Environmental Protection Agency, Public Works of Canada, the City Government of Houston, Texas, and major U.S. HVAC manufacturers. DFS has developed supplemental materials that give additional transfer guidance including publications such as the "Design Contract Package" and "Energy Efficient Building Design - A Transfer Guide for Local Governments."

## **THE MONTGOMERY COUNTY BUILDING CODE**

Another example of the County's focus on implementing efficiency in the private sector is the County building code. Although the County's progressive Energy Design Guidelines have not been incorporated into its County-wide building code, the awareness gained in its own facilities has led to an

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understanding of the benefits of adopting progressive standards for its citizens. For example, the County has implemented the ASHRAE 90.1 national standard for commercial buildings. The Model Energy Code has been adopted for single family residential homes within the past year. In fact, Montgomery County is the first county in Maryland to integrate the Model Energy Code into the existing building codes, a national code that governs building design, including building shell, thermal resistance, and air leakage; plus mechanical, electrical, service water-heating, and illumination systems design and selection.[R#32]

### **COMMUNITY OUTREACH ACTIVITIES**

At the community level, the work of the facilities staff has been nicely complemented by the outreach work conducted by Montgomery County's Department of Environmental Protection. It runs outreach programs that promote energy efficiency as well as other sustainable practices for the community at large through a number of interpretive tools and techniques. The Environmental Protection Department has developed a brochure titled "Spare the Air: Use Energy Wisely," which details helpful hints that inform citizens of simple actions that can take to save energy and reduce pollution such as home weatherization, HVAC equipment upgrades with new efficient units, car tune-ups which help to reduce emissions, and information on lawn and garden equipment alternatives. Environmental Protection also has other educational materials available which highlight effective actions for sound environmental practices.

Environmental Protection has also been active in presenting displays and lectures at County events to foster a public appreciation of energy and resource efficiency. This broad-based initiative includes an annual award ceremony which honors citizens, private companies, and organizations that have implemented outstanding projects related to energy efficiency and air quality. The County also exhibits an educational booth at the annual County fair to increase the public's awareness of issues related to energy and water conservation and air quality, focusing on the interrelation between them and a healthy environment. Through this range of public information efforts, Montgomery County has reinforced its internal focus, literally taking the success that it has had within its own facilities to the street and to the people the County is charged to serve to the best of its abilities.[R#13]

### **KEY RESOURCES FOR LOCAL GOVERNMENTS**

In addition to the number of relevant case studies of municipal actions documented by The Results Center which shed light on the range of strategies that local governments can employ to promote and finance municipal energy efficiency, there are two important organizations that provide valuable services and information for local governments: The International Council for Local Environmental Initiatives and The Urban Consortium Energy Task Force.

The International Council for Local Environmental Initiatives (ICLEI) is an international association of local governments dedicated to the prevention and solution of local, regional, and global environmental problems through local action. ICLEI is a member-based organization of local government entities from around the world whose headquarters are located in Toronto. Its role is to support its members through technical workshops and other dissemination tools. The organization has published a number of technical reports for its members including a survey of municipal measures to reduce energy use in buildings and a report on financing strategies for municipal energy efficiency. ICLEI has placed special emphasis on the link between cost-effective urban carbon dioxide reduction strategies as a means of cutting municipal operating costs while fulfilling international environmental accords. For more information, contact The International Council for Local Environmental Initiatives, World Secretariat, City Hall, East Tower, 8th floor, Toronto, Ontario M5H 2N2 CANADA, (416) 392-1462.

The Urban Consortium is a member-based organization comprised of over forty of the largest cities and urban counties in the United States. For over a decade its Energy Task Force has addressed local energy issues and assisted communities in developing strategic programs and applying innovative technology to improve energy efficiency while strengthening their economies. In addition to convening technical seminars and publishing technical reports, The Energy Task Force awards grants annually to major urban jurisdictions to help fund demonstration projects, creating a cooperative arena wherein energy managers have peer-to-peer exchanges, sharing vital experiences and perspectives on program strategies and technologies. For more information on The Urban Consortium and The Energy Task Force, contact Public Technology Institute, 1301 Pennsylvania Avenue, NW, Washington, DC 20004 (202) 626-2400.

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