

High Performance Buildings for the State of Tennessee

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ABSTRACT

The Tennessee State Building Energy Management Program (SBEM) provides leadership for a statewide strategic plan to improve the operation, maintenance, energy efficiency and working environment in all state owned facilities while reducing energy costs. The SBEM vision is that all Tennessee State buildings provide a safe, comfortable and productive work environment while operating at optimum energy efficiency. The SBEM mission is to introduce, initiate and implement programs that will improve safety, comfort and energy efficiency at all State of Tennessee buildings. This paper summarizes the vision, priorities, goals and organization that, when successfully implemented, will establish an effective, self-funded program to reduce the growth of energy costs and deferred maintenance in Tennessee state buildings.

State Building Energy Management Program

In 1988, the State of Tennessee spent approximately \$72 million for energy to operate state-owned buildings. By 1998, that annual bill grew to between \$80 and \$90 million. Projected out the next ten years at a 2 percent growth rate, the bill approaches \$120 million.

In response to these projections, Tennessee has designed the State Building Energy Management Program (SBEM) to improve the operation, maintenance, energy efficiency and working environment in all state owned new and existing facilities. The program will be self-funded by using the savings generated from facility modifications to provide the investment capital necessary to fund the program activities. Under this concept, verified program savings are provided to the annual agency budgets to pay for debt service, program costs and performance period costs. Any additional savings are used to fund energy related projects. Long-term, net savings will accrue to the General Fund (see Figure 1).

The SBEM is modeled loosely after the U. S. Department of Energy's (DOE) Rebuild America Program. State agencies will voluntarily become partners in this program through a letter of commitment. Partner agencies will receive technical support, implementation standards, coordination of program resources including DOE and the U.S. Environmental Protection Agency (EPA) programs, and follow-up monitoring and verification of savings from SBEM. The program plan was approved by the State Building Commission of Tennessee in August of 1999. A pilot agency has been selected to test the implementation process and gauge the resource requirements for a more aggressive implementation of the plan statewide.

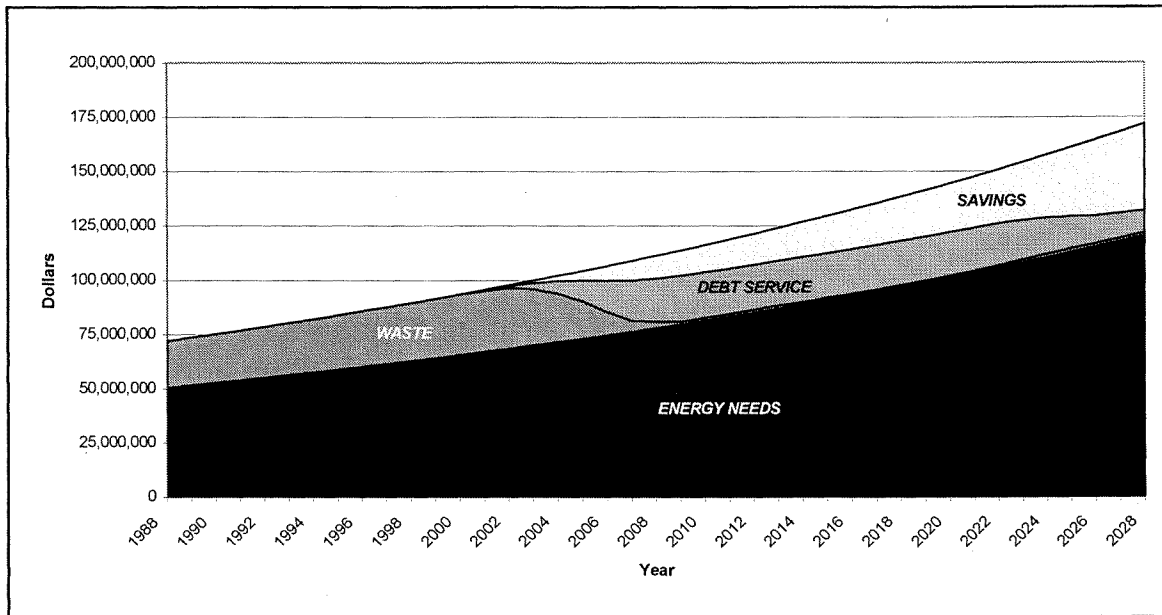


Figure 1. Projected State Building Energy Costs/Savings 1998-2025

SBEM Five-year Goals

- Achieve an average 30% operational cost saving (\$8,000,000) per year in selected State facilities each year for the next five years (20% net improvement from energy efficiency improvements and 10% savings from related operation and maintenance (O&M) improvements. These estimates are based upon average energy costs of \$ 1.22 per square foot per year for Department of General Services office buildings)
- Achieve environmental pollution reductions equivalent to 4,000 fewer cars
- Implement all appropriate efficiency measures in buildings brought into the plan over the next five years as follows:

Table 1 illustrates the three scenarios that are projected at various levels of effort. Scenario A represents a reasonable effort given existing resources and existing levels of interest from other state agencies. Scenario B is a more aggressive approach that will require additional resources to be provided to the program. Most of these additional resources can be provided through energy savings performance contracts (ESPC's). Scenario C represents the most aggressive approach. If these goals are met, substantial results are possible, based upon an estimated potential viable square footage of about 60 million square feet (80% of the total 72 million square feet).

Table 1. Three Energy Savings Goals Scenarios

	Goal for 5-yr period	Time to Complete All Viable SF	Attainable with Current Resources
Scenario A	<i>7 million square feet</i>	39 years	Yes
Scenario B	<i>20 million square feet</i>	15 years	No
Scenario C	<i>30 million square feet</i>	10 years	No

SBEM Objectives

- Create increasing net savings annually, beginning in year two
- Retrofit 50 million square feet of state-owned space in 15 years
- Provide savings guarantees to fund program activities
- Provide performance incentives to agencies and service providers
- Reduce or eliminate current deferred (unaccomplished) maintenance in State buildings
- Incorporate energy efficiency in the planning and design of new facilities

A program of this scope, magnitude and complexity requires careful planning and coordination if it is to be effective and well documented. It also is extremely important to deal with fundamental issues regarding budget and finance early in the planning process so that as quick payback measures are implemented the savings are “captured” for later use. An initial screening of current building stock and planned capital projects needs to be performed as each agency comes into the program in order to identify the best candidates for SBEM services.

Services for New Construction

Energy Efficient Design Assistance. The State offers to project teams technical design assistance that includes identification and analysis of energy efficient and sustainable design strategies that will improve the overall energy performance of the new building. Offered to the design team during schematic design, this technical assistance enhances the work of the architectural design team by analyzing and considering alternative technologies early in the process. If technologies are selected, the technical assistance continues through development of the construction documents.

Tennessee High Performance Building Design Guide. The Tennessee *High Performance Building Design Guide*, currently under development, provides a design team with the fundamental concepts for designing buildings that meet client expectations regarding indoor environmental quality, sustainability, energy efficiency, system functionality, control and maintainability. The guide incorporates major design principles, salient lists, guidelines,

appropriate rules-of-thumb, case studies, information sources and tools to assist a designer in realizing a first class design. Energy efficiency is a primary focus in the guide. Assistance in complying with the ASHRAE 90.1 energy standard is outlined. Commissioning guidelines and resources are provided along with a special section on designing for maintainability. Design fundamentals will be organized by design area; and procedures and issues designers need to consider are given by design phase.

Associated with the Design Guide is the *Energy Efficient Design Protocol*. This protocol provides the specific performance and documentation requirements, by design phase, that designers need to follow for compliance with the State's new building energy efficiency policy. The protocol is intended to ensure that designer's are meeting the State's energy requirements.

Tennessee New Construction Commissioning Program. The State of Tennessee is developing a commissioning program for new facilities. A key element of this program is to encourage State managers of capital projects to utilize the commissioning process to improve the design and delivery of new State buildings. The program seeks to educate, motivate and support owner agencies, project managers, architects, engineers, contractors and commissioning providers by providing them information and resources. The *High Performance Design Guide* provides the primary reference source for the commissioning process, including guide specifications, plans, scopes of work, sample tests, etc. Workshops will be conducted for these groups and ongoing commissioning consultation will be provided by State staff. An important feature of the program is the enlargement and enhancement of the commissioning provider infrastructure in Tennessee. Technical training will be provided for this purpose.

Integral to the commissioning program is the incorporation of commissioning requirements in the State's *Designer's Manual* (State Building Commission, 1998). This manual provides the contractual and process-related requirements for designing buildings for the state. This document requires that an appropriate commissioning program be incorporated into each project from early design through warranty.

Services for Existing Buildings

Recognizing the energy efficient opportunities available in the State's existing buildings, the SBEM offers to the State agencies several products and services that can be integrated into a comprehensive energy management action plan.

Strategic Energy Management Action Plan. The SBEM has formed a partnership with the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) to develop and implement a statewide action plan for existing buildings. The primary authority for this plan is the State Building Commission with plan leadership and administration provided by the SBEM. Other State agencies will become vital partners in the implementation process. Participating State agencies are expected to appoint a full-time energy manager with primary responsibility for coordinating all agency activities with the SBEM "management team". DOE under their Rebuild America Program, and EPA under their Energy Star Buildings Program will provide technical and other vital program resources including: software tools, implementation planning assistance, marketing resources, and

public recognition of partners. The Tennessee Valley Authority (TVA) is also a partner under this plan providing technical assistance and other resources. Other Rebuild America and Energy Star partners in the state (for example Middle Tennessee State University, and the Department of Corrections) provide additional program development support as pilot agency partners.

The following steps are all equally vital to the successful implementation of the plan:

1. Perform assessments of the agency's management and engineering capability and collect building inventory and energy data. Using assessment tools developed by DOE, EPA, and SBEM, estimates of savings potential and implementation costs are prepared for the gross square footage targeted by new partners. This step also serves to establish verifiable baselines for comparisons that will determine resulting savings. The assessments are intended to provide the following information:
 - Agency technical and management support needs
 - Annual energy use and demand for the selected buildings
 - Inventory of building systems and major equipment and current condition
 - Highest energy use equipment of groups of equipment
 - Building operational schedules
 - Major maintenance and operational problems
 - Potential energy efficiency retrofits and associated costs and savings
2. Establish standards for the procurement and delivery of energy savings performance contracts (ESPC's). Performance contracting is perhaps the most significant tool available to the State in implementing this plan. It can effectively guarantee successful accomplishment of the plan's goals and objectives.
3. Select and prioritize buildings for repairs, tune-up and retrofit. In this step, managers wisely select which buildings to include in the program and what priority each selected building should have in the competition for valuable program resources.
4. Perform operational repairs and tune-up energy consuming systems. It is during this step that retrocommissioning is performed to ensure that the building is performing as intended.
5. Perform detailed engineering studies, if warranted by the assessments and the commissioning activities. Such studies will clearly establish the potential costs and savings from major energy management retrofits. This may be done as part of an energy savings performance contract (ESPC); or, as part of the engineering / design phase of more traditional energy management retrofit projects (still performance oriented).
6. Complete all economically feasible energy management retrofits. This step also includes building operator training for maintenance and operational requirements of new systems and controls.
7. Monitor and verify results (savings) and report to management. If an ESPC is used, it will also include ongoing operations and maintenance support and follow-up for the duration of the contract period.
8. Perform annual checkup inspections to verify new performance efficiencies are being maintained.

Tennessee Integrated Energy Services Process (TIES). In this process, building retrocommissioning (RCx) is the foundation from which integrated, multi-disciplined energy programs and services are provided. Combined with performance contracting, TIES is the process that integrates the various program objectives, maintains a long-term perspective, reduce overall owning and operating costs, and ensures program success. As with other components of the plan, ongoing funding for TIES activities are provided from the savings generated. Figure 2 and the following detailed descriptions outline the activities occurring in the TIES process.

1. Agency assessment for new partner agencies including the following:
 - a) Evaluate agency resources, needs and mission (technical & budget)
 - b) Perform site survey and building energy evaluations
 - c) Identify major systems and equipment
 - d) Identify operational requirements and constraints
 - e) Conduct pre-functional test requirements
 - f) Identify potential O&M fixes / needs
 - g) Establish energy savings performance baselines
 - h) Identify potential energy management retrofit opportunities (order of magnitude costs & savings)
 - i) Prepare strategic energy plan for site
2. Implementation of Strategic Energy Plan
 - a) Conduct detailed engineering study
 - b) Establish performance contract as appropriate
 - c) Evaluate and select specific O&M and energy measures
 - d) Prepare commissioning plan
 - e) Commission existing building / systems (complete appropriate O&M fixes)
 - f) Select and perform energy retrofits & commission
 - g) Prepare implementation report (identify costs and savings)
 - h) Monitor and verify results
3. Partnerships Between DOE, TVA / Local Power Distributors, and Energy Services Companies (ESCO's) so that services can be provided and paid for from existing O & M budgets, including utilities.
 - a) Advanced metering services
 - b) Building commissioning services
 - c) Detailed energy studies
 - d) Energy services agreement
 - e) Project design and construction
 - f) Commissioning of new systems
 - g) Operation and maintenance services
 - h) Monitoring and verification

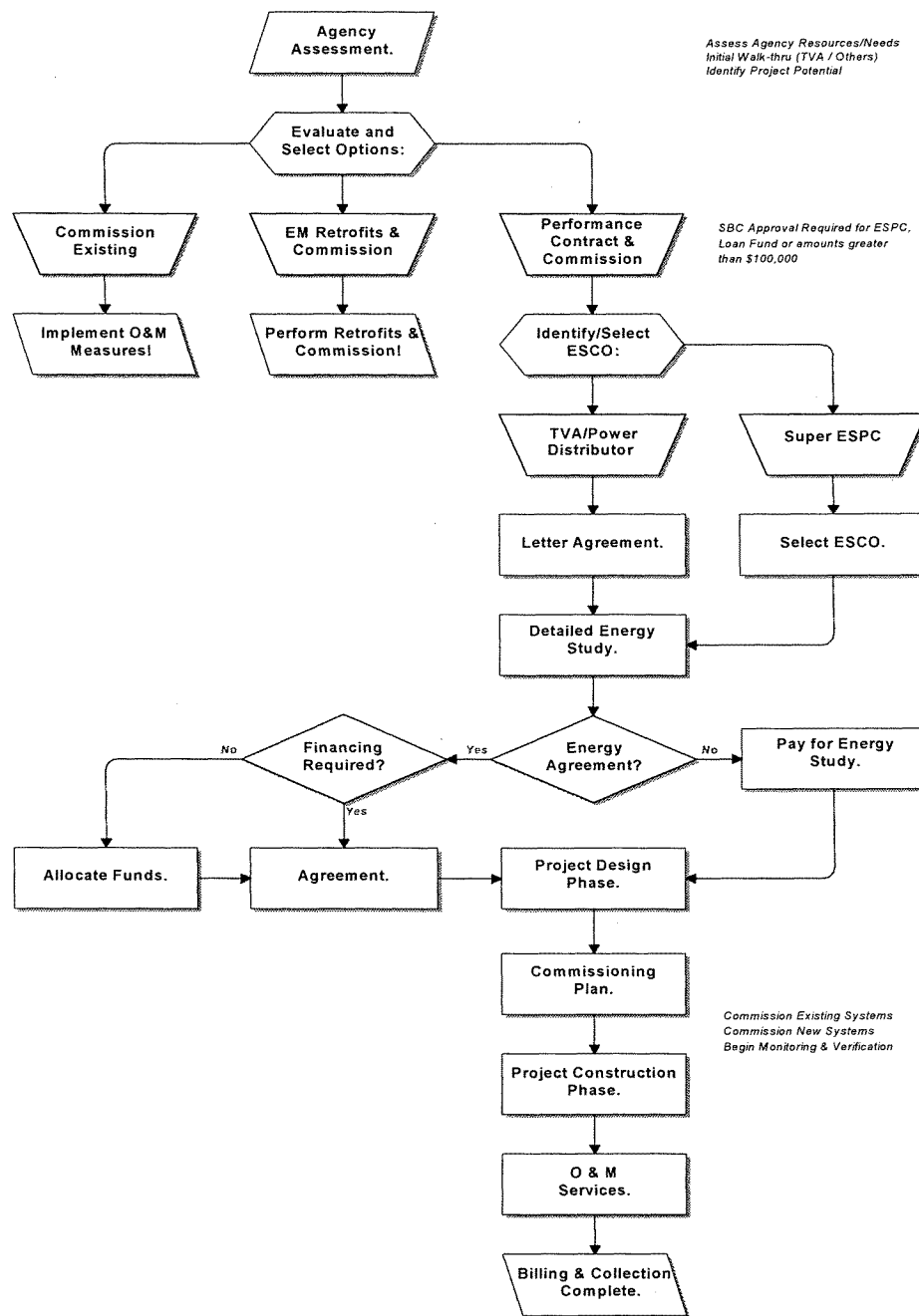


Figure 2. Tennessee Integrated Energy Services process (TIES)

Retrocommissioning. In the mid-1990s the State of Tennessee conducted two successful retrocommissioning pilot projects at Citizen's Plaza and the Chattanooga State Office Building (Edmunds 1997, Haas 1996). These pilots demonstrated for us how retrocommissioning can be used as an energy management strategy for state facilities. Since

Tennessee's existing state facilities have not been commissioning, the SBEM program integrates retrocommissioning to systematically investigate and identify opportunities to optimize individual systems and optimize how the systems operate together. Although the process may identify possible capital improvements for further investigation, it is the O&M tune-up activities along with the diagnostic testing that are primarily used to optimize the building systems. The goals and objectives for applying the process as well as the level of rigor may vary depending on the current needs of the occupants, budget, and condition of the equipment. The existing-building commissioning process most often focuses on the dynamic energy-using systems with the goal of reducing energy waste and obtaining energy savings.

Once a building has undergone building commissioning either as part of new construction or retrocommissioning, the periodic recommissioning ensures that the original results persist. Therefore, SBEM also integrates recommissioning as a *periodic event* that *reapplies* the original commissioning tests in order to keep the building operating according to design or current operating needs. In the best of worlds, recommissioning will automatically become part of a facility's ongoing O&M program. The frequency of recommissioning is based on the complexity of the building systems, building use, and occupant needs. Rigorous recommissioning every three years may be acceptable for some buildings where as annual recommissioning may be more appropriate for buildings where occupants request frequent operating changes and improvements (build-outs).

Energy Savings Performance Contracts (ESPC). Performance contracting is perhaps the single most important element of the SBEM plan for existing buildings. It provides the vehicle for implementing projects that "work" while not requiring large amounts of up-front capital.

Performance contracting is one of those things that sounds too good to be true. An owner (the state) can decrease energy usage, operating and maintenance expenses and simultaneously reserve available capital for other needs, or be able to complete such projects that could not otherwise be completed because of lack of funds. For State and local governments with growing deferred maintenance lists, the available capital is the most attractive component of performance contracting.

Performance contracting is now an approved procurement process in many state governments including Florida, Ohio, Maryland, California and others, because it can be a win-win situation (EPA, 1999). Everyone comes out ahead - business, government and the taxpayer. Under such agreements, a third party (energy services company "ESCO") provides a service package that typically includes the financing, engineering, installation and maintenance of energy-saving capital improvements. The customer uses the resulting energy savings to pay for the improvements.

The State Building Energy Management Program has reviewed in some detail how the Federal Energy Management Program (FEMP), and other states use performance contracting to accomplish major energy management retrofit projects. Also, Oak Ridge National Laboratory (ORNL) is using the Indefinite Delivery Indefinite Quantity (IDIQ) approach in creative ways that provide improved competition and eliminates much of the "mystery" associated with performance contracting. We believe Energy Savings Performance Contracts can provide the resources and expertise to accomplish a significant energy retrofit effort statewide in a relatively short period of time.

Based on our investigation, Tennessee has developed and proposed standards for the use of performance contracting with the following characteristics:

- The overall program is based upon the FEMP Energy Savings Performance Contract model
- Important features are the indefinite delivery, indefinite quantity (IDIQ) type of contract and best value procurement
- The general ordering agreement is for energy products and services only and no projects are awarded at time of selection of the ESCO
- Selection involves three evaluation criteria: a pricing model (using contractor margins), qualifications and past performance
- Each potential ESCO delivers an oral presentation and is interviewed by the evaluation team
- Following selection, bilateral task orders are issued for specific projects that clearly define owner and ESCO requirements, with the following elements:
 - Scope of energy saving measures
 - Operations and maintenance requirements
 - Health, safety and environmental issues
 - Energy baselines for each project
 - Measurement and verification requirements
 - Acceptable economic terms
 - Other project specific requirements

Once the Super ESPC contract is awarded, the technical and administrative team for both the State agency and the ESCO collaborate under the terms of the contract to develop a scope of work for each individual project and specific requirements that will be issued as Delivery Orders. Even when ESPC's are not utilized, specifications for procurement of energy projects and services are expected to be performance based to insure that the program achieves the desired results.

Table 2 gives examples of products and services that can be provided as part of the SBEM plan:

Table 2. SBEM Services

• <i>Energy efficient lighting</i>	• <i>indoor air quality analysis (IAQ)</i>
• <i>HVAC automation</i>	• <i>Modernize temperature controls</i>
• <i>Thermal storage systems</i>	• <i>high efficiency heat pumps</i>
• <i>lighting controls</i>	• <i>ground source heat pumps (GSHP)</i>
• <i>training services</i>	• <i>variable speed drives (VSD)</i>
• <i>boiler modernization</i>	• <i>chiller modernization</i>
• <i>commissioning services (Cx)</i>	• <i>advanced utility metering</i>
• <i>co-generation plants</i>	• <i>facility maintenance programs</i>

SBEM Project Financing and Guaranteed Savings. Specific new budgetary policy has been established for the accounting and utilization of savings generated by the plan (See figure 3). When developing and implementing energy efficiency projects in State buildings, including the use of Energy Savings Performance Contracting (ESPC), the energy related cost savings must be made available for use as the payment source for specific project and program related costs throughout the debt-service period of the projects.

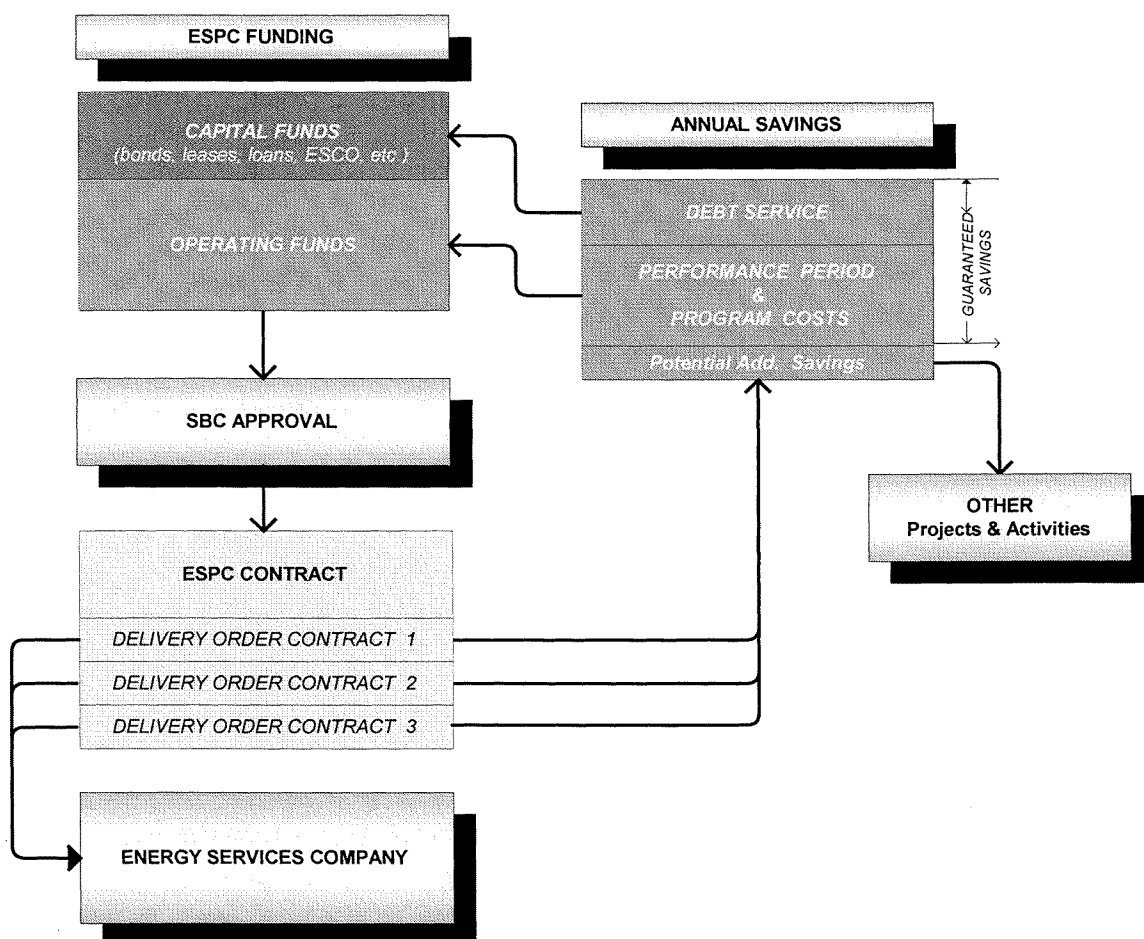


Figure 3. SBEM Project Financing and Guaranteed Savings

Any additional savings can be made available for use in implementing additional energy and related deferred maintenance projects at State buildings.

Performance contractors must guarantee the energy savings resulting from implementation of energy cost savings measures (ECSMs) and operations and maintenance (O&M) measures. This insures that the savings are real and available to the program. Savings are verified for each specific measure, utilizing the "International Monitoring and Verification Protocol, December 1997"(IPMVP), U.S. Department of Energy.

Expected Benefits of the Plan

With little or no internal capitol funds, the State will benefit from more efficient buildings, increased worker productivity, reductions in operation and maintenance costs, and improved equipment condition.

Direct benefits to State agencies include:

- Reducing energy consumption will slow rising energy costs and environmental pollution.
- Leveraging current program resources through improved coordination of activities will produce “more bang for the buck”.
- Unaccomplished maintenance needs can be reduced or eliminated
- Improving the monitoring and follow-up of efficiency upgrade projects will ensure program success.
- Improving the operation and maintenance of state buildings will reduce the number of emergency repairs and reduce costs.
- Increasing the environmental awareness of facility managers, tenants and clients will result in a cleaner environment.
- Improving the physical plant will result in fewer “trouble” calls from unhappy tenants.

Broader benefits to the State include:

- Tennessee can assume a leadership role in accomplishing energy efficiency at government facilities
- Spur economic development in urban areas
- Fuel economic growth by converting energy savings into local jobs and other community investments
- Reduce pollution and demand on existing power plants
- Will be better prepared for de-regulation of electric utilities
- DOE recognizes successes by sharing what has been done with others nationally (Tennessee is the first state with an action plan for its buildings)

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